

**CALL FOR TENDER ACTED/LebRelief Lebanon**
Instructions to Bidders

Date: 18/08/2023

Tender N°: T / 11 / EKA / D65 LTR / TRIPOLI / 18-8-2023

Through this tender ACTED/LebRelief is requesting a company to provide detailed written offers for the supply of the following products:

PRODUCT SPECIFICATIONS:

- | | |
|---------------------------------|--|
| 1. Description: | Construction of water tank and pump station in Tleil |
| 2. Product class / category: | Works |
| 3. Made in (origin of product): | Various |
| 4. Product stage: | Works / Products: final |
| 5. Quantity/unit: | Referred to offer form |
| 6. Packaging requested: | Works |

A detailed list of requested products is provided in the attached Offer Form.

RESPONSIBILITIES OF THE SUPPLIER:

- | | |
|--|--|
| 1. Place of delivery: | Tleil, Lebanon |
| 2. INCOTERM (delivery conditions): | DDP, Tleil, Lebanon |
| 3. Maximum date of delivery: | 6 months after contract signature or 31-04-2024, what comes first. |
| 4. Minimum offer validity period required: | 9 months minimum |

The responses to this call for tender shall include the following elements:

| | |
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| 1 | The present Instructions to Bidders (PRO-05) signed & stamped by the Bidder |
| 2 | An original Offer Form (PRO-06) dated, filled, signed & stamped by the Bidder (<i>detailed as per the requested currency USD</i>) |
| 3 | The Supplier Questionnaire Form (PRO-06.1) dated, filled, signed & stamped by the Bidder |
| 4 | ACTED Ethical Declaration (PRO-06.2) dated, filled, signed & stamped by the Bidder |
| 5 | The Bidder's official registration documents |
| 6 | A copy of the Bidder's legal representative ID or passport |
| 7 | ACTED's General Conditions for Purchase signed & stamped by the Bidder |
| 8 | Datasheets requested in the Offer Form (PRO-06) in a separate sealed envelope (if relevant) |
| 9 | The Bidder's Checklist (PRO-06.3) dated, filled, signed & stamped by the Bidder |
| 10 | Temporary Insurance Value: 60,000 USD (Sixty Thousand USD only) either as Bank guarantee or as a Bankers check. |
| 11 | List and C.V of the Key personnel working on the project |





| | |
|----|--|
| 12 | Proofs of past performances in a similar field of activity (eg past deliveries of similar items) recommendation letters must be added) |
| 13 | To submit signed copies for the General and particular specs, BoQ and drawings for Tleil reservoirs |
| 14 | Detailed work plan |
| 15 | List of Owned equipment |
| 16 | Safety Procedures plan |
| 17 | Attestation of third party liability for the whole duration of works and liability period dating less than 3 months. |
| 18 | A copy of valid quality assurances with relevant certificates dating less than 3 months. |
| 19 | Signed Attendance sheet to site visit |

It is important to note that all documents must be filled, dated, signed & stamped by the Bidders in order to be considered as eligible. LebRelief only accepts bids that have been filled in in either English or French.

GENERAL CONDITIONS:

1. The **closing date** of this tender is **08 / 09 / 2023 at 5:00 PM** in LebRelief office at the following address: Lebanon, Tripoli, Bahsas, Ghanem Building- Beirut Arab Open University building, GF floor.
2. The submission of an offer by a bidder to this call for tender may not result in the award of a contract.
3. The offer must be submitted to LebRelief Logistics department in a sealed envelope marked "Not to be opened before **14/09/2023** and the Tender reference number above.
4. A pre-tender information session will be held online on the **23rd of August,2023 at 10:30 am** (Lebanon local time) for all interested bidders, through the following link:
<https://us06web.zoom.us/j/82056757723?pwd=bVBkUDVrdHovZXgxcThQbXVDUWJRdz09>
Meeting ID: 820 5675 7723
Passcode: 736032
5. Unsealed envelope and late offers will not be considered.
6. To ensure that funds are used exclusively for humanitarian purposes and in accordance with donors' compliance requirements, all offers are subject to the condition that contractors do not appear on anti-terrorism lists, in line with ACTED's anti-terrorism policy. To this end, ACTED reserves the right to carry out anti-terrorism checks on any contractor, its board members, staff, volunteers, consultants, financial service providers and sub-contractors.
7. Collusive practices are prohibited and will lead to offers rejection.
8. **ACTED adopts a zero tolerance approach towards corruption and is committed to respecting the highest standards in terms of efficiency, responsibility and transparency in its activities. In particular, ACTED has adopted a participatory approach to promote and ensure transparency within the organization and set up a Transparency unit (supervised by the Director of Audit & Transparency) that can be reached through a dedicated phone number and e-mail address. As such, if you witness or suspect any unlawful, improper or unethical act or business practice (such as soliciting, accepting or attempting to provide or accept any kickback) during the tendering process, please contact the following phone number +33 6 07 22 46 28 and/or send an e-mail to transparency@acted.org.**



**SPECIAL CONDITIONS:**

9. Location of water tank: Lebanon, Akkar, Tleil (34.5943075 ; 36.1407186)
10. Eligible or prohibited origin of goods and/or exclusions (if applicable): N/A
11. Mandatory site visit with LebRelief technical team and the design consultant will take place on the 24th of August at 10:00 am, that will include technical explanation about the project and a discussion for all technical questions. Interested Bidders should send an email to: tender@leb-relief.org CC: Lebanon.tender@acted.org Tender@acted.org to register the company name with the attendees from each company.
12. Bidders selection criteria will be evaluated as described below:

| # | Criteria | Sub-criteria | Minimum Score | Maximum Score | 0 (0 if info not provided) | 1 | 2 |
|---|------------|-------------------------------------|---------------|---------------|--|--|---|
| 1 | Experience | Similar past contracts | 1 | 1 | The contractor has provided no past contract similar to the contract to award | The contractor has provided at least one past contract similar to the contract to award | N/A |
| | | Amount of past contracts | 1 | 1 | No similar past contract provided has an amount is equal or above the contract amount to be awarded | The amount of a similar past contract provided is equal or above the contract amount to be awarded | N/A |
| | | Positive past experience with ACTED | 0 | 1 | The contractor proved weaknesses in executing past contracts awarded by ACTED as per contractor database | The contractor has a positive record as per ACTED contractor database | N/A |
| | | Number of years in business | 0 | 1 | The contractor has been working in this business for less than 5 years | The contractor has been working in this business for 5 years or more than 5 years | N/A |
| | | Defect and liability | 1 | 2 | The contractor offers 0 year of warranty on provided items | The contractor offers 1 year of warranty on provided items | The contractor offers 2 years or more of warranty on provided items |

13. Bids award criteria will be assessed through a: **Scoring method**
14. Note: The scoring method consists in assessing all eligible offers based on a pre-defined scoring scale for each selection and/or award criteria. The best rated offer will be selected at the end of this process. Price may not account for less than 50% of the final score, unless authorized otherwise and stated in the present Instructions to Bidders.

| | Criteria | Sub-criteria | Minimum Score | Maximum Score | | | | | |
|-----|---------------|-------------------------|---------------|---------------|--|--|---|---|--|
| 2 | Price | N/A | NA | 50 | The price is scored proportionally from the lowest bid price | | | | |
| 3.1 | Quality 30 | Workforce qualification | 6 | 8 | 0 Points | 2 Points | 4 Points | 6 Points | 8 Points |
| | | | | | The contractor does not have qualified workforce | The contractor has between 0% to 25% of the required qualified workforce | The contractor has between 25% to 50% of the required qualified workforce | The contractor has between 50% to 75% of the required qualified workforce | The contractor has between 75% to 100% of the required qualified workforce |
| 3.2 | | Workplan | 3 | 6 | 0 Points | 1.5 Points | 3 Points | 4.5 Points | 6 Points |





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|--------|---------------------------------|--------------------------------------|-----|----|--|---|---|---|---|
| | | | | | The contractor does not propose a workplan | The contractor's workplan includes one of the following element: - overlap of work - completion rate - consistency in works sequence - quantities | The contractor's workplan includes two of the following element: - overlap of work - completion rate - consistency in works sequence - quantities | The contractor's workplan includes three of the following element: - overlap of work - completion rate - consistency in works sequence - quantities | The contractor's workplan includes all of the following element: - overlap of work - completion rate - consistency in works sequence - quantities |
| 3.3 | | Quality of materials | 4.5 | 6 | 0 Points | 1.5 Points | 3 Points | 4.5 Points | 6 Points |
| | | | | | The contractor does not propose materials of sufficient quality | The contractor proposes 0% to 25% materials with sufficient quality | The contractor proposes between 25% to 50% materials with sufficient quality | The contractor proposes between 50% to 75% materials with sufficient quality | The contractor proposes between 75% to 100% materials with sufficient quality |
| 3.4 | | List and pictures of relevant assets | 2 | 6 | 0 Points | 2 Points | 4 Points | 6 Points | N/A |
| | | | | | The contractor does not own any relevant asset | The contractor has one of the following relevant asset: - vehicles - heavy machinery - other equipment | The contractor has two of the following relevant asset: - vehicles - heavy machinery - other equipment | The contractor has three of the following relevant asset: - vehicles - heavy machinery - other equipment | |
| 3.5 | | Safety equipment | NA | 4 | 0 Points | 1 Points | 2 Points | 3 Points | 4 Points |
| | | | | | The contractor does not have safety equipment | The contractor has one of the following equipment: - safety boots - safety caps - visibility signs - first aid kits | The contractor has two of the following equipment: - safety boots - safety caps - visibility signs - first aid kits | The contractor has three of the following equipment: - safety boots - safety caps - visibility signs - first aid kits | The contractor has all of the following equipment: - safety boots - safety caps - visibility signs - first aid kits |
| 4 | Availability | Delivery time | 7 | 14 | 0 Points | 3 Points | 7 Points | 11 Points | 14 Points |
| | | | | | More than 4 weeks more than requested delivery schedule | More than 3 weeks more than requested delivery schedule | More than 2 weeks more than requested delivery schedule | More than 1 week more than requested delivery schedule | Equal or lower than requested delivery schedule |
| BO NUS | Social and environmental impact | | NA | 5 | To be argued upon carbon footprint or other environmental benefits | | | | |

15. ACTED's Special Conditions for Purchase for this tender are attached for the information of Bidders. When sending their offers to the present call for tender, Bidders acknowledge their agreement with these terms & conditions.

Company Name: _____

Authorized Representative Name: _____

Signature: _____

Stamp: _____



OFFER FORM ACTED/LebRelief *Lebanon*

Tender N° (filled in by LebRelief): T / 11 / EKA / D65 LTR / TRIPOLI / 18-08-2023

Order ID (filled in by LebRelief): OF / 11 / EKA / D65 LTR / Tripoli, Lebanon / 14-08-2023

Date (filled in by Bidders):

To be Filled by Bidder (COMPULSORY)

| | |
|--|--|
| Company's Name (as per registration documents) | |
| Company Authorized Representative's Name (as per registration documents or duly signed Power of Attorney) | |
| Company Registration Number | |
| Registration body | |
| Company's mailing address Shop/Office/Building No Street name City Governorate/province/district Country | |
| Commercial representative for the bid (if different from authorized representative) | |
| Phone contact number Landline Mobile No | |
| Email address | |

I undersigned (to be filled in by the Bidder) _____
 agree to provide ACTED, non-profit NGO, with items answering the following specifications, according to the general conditions and responsibilities that I engage myself to follow.



UNIT AND TOTAL PRICES MUST BE INCLUSIVE OF ALL COSTS (MATERIALS, EQUIPMENT, WORKERS, INSURANCES, ETC.).

LOT 1: Construction of water tank and pump station in Tleil

TECHNICAL SPECIFICATIONS

PLEASE ATTACH ANY TECHNICAL PROPOSAL, DRAWINGS AND DESIGNS AS PER THE VOLUME 3, 4, 5 AND 6 ANNEXED

| N° | To be filled in by LebRelief | | | | To be filled in by the Bidder | | | | |
|---|--|---|---------------------|----------|--|---|--|--|--|
| | Works Deliverables | Detail the related past performance sample required | Unit ^[1] | Quantity | Unit price of material supplies only excluding taxes (USD) | Unit price for labor only excluding taxes (USD) | Total price for material supplies excluding taxes (USD) (1) | Total price for labor excluding taxes (USD) (2) | Total Price excluding taxes (USD) (1) + (2) |
| Bill A - Civil works (Tleil reservoirs site) | | | | | | | | | |
| 1 | General | | | | | | | | |
| 1.001 | Checking, completing, and/or performing topographic survey and site delimitation | | L.S | 1 | | | | | |
| 1.002 | Site clearance | | L.S | 1 | | | | | |
| 1.003 | Site rearrangement after construction including removal of all construction debris | | L.S | 1 | | | | | |
| 1.004 | Shop drawings | | L.S | 1 | | | | | |



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|------------|--|------|------|--|--|--|--|--|
| 1.005 | As-built drawings after completion of works including site photos of executed control room | L.S | 1 | | | | | |
| 1.006 | Supply and installation of steel scaffolding for the construction of the Elevated water tank and other structures, including calculation note, installation and refitting. | L.S | 1 | | | | | |
| 2 | Earth Works | | | | | | | |
| 2.1 | Excavation in all types of soils and rocks and transport of unsuitable backfilling material to disposal sites | | | | | | | |
| 2.101 | Excavation for Water tanks | Cu.m | 515 | | | | | |
| 2.102 | Excavation for Pumps chamber | Cu.m | 21 | | | | | |
| 2.103 | Excavation for fences installation | Cu.m | 51 | | | | | |
| 2.2 | Backfilling | | | | | | | |
| 2.201 | Backfilling and compaction around footings and ground beams of the fence wall | Cu.m | 26.5 | | | | | |
| 2.202 | Backfilling and compaction around water tank | Cu.m | 53 | | | | | |
| 2.203 | Compaction of the bottom of the excavation to achieve 95% degree incase rock was not encountered. | Sq.m | 131 | | | | | |



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|--------------|--|------|--------|--|--|--|--|--|
| 2.204 | Backfilling and compaction around Pumps chamber | Cu.m | 2 | | | | | |
| 3 | Concrete works : Cast-in-place reinforced concrete including metallic scaffolding, formwork of any type and any shape, accessories, construction joints, inserts for openings, sleeves, etc., and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer. | | | | | | | |
| 3.1 | Blinding and mass concrete strenght class C20/25 | | | | | | | |
| 3.101 | Blinding concrete under water tank 10 cm thick | Cu.m | 13.9 | | | | | |
| 3.102 | Blinding concrete under ground beam of fence 10 cm thick | Cu.m | 3.24 | | | | | |
| 3.103 | Blinding concrete under Pumps chamber 10 cm thick | Cu.m | 1.66 | | | | | |
| 3.2 | Reinforced Concrete Strength Class C30/37 for structural concrete elements including all RC concrete materials and accessories | | | | | | | |
| 3.201 | Water tanks inculing raft: Reinforced Concrete, Class C30/37, 400 kg of cement /cu.m, for all structures containing water and in contact with soil, including formwork, fair faced concrete finishing and all needed materials for the execution of the works | | | | | | | |
| 3.2011 | Concrete raft 100cm/140cm thick | Cu.m | 138.87 | | | | | |
| 3.2013 | Concrete walls of elevated tank | Cu.m | 77.12 | | | | | |
| 3.2014 | Concrete walls of ground tank | Cu.m | 121.44 | | | | | |
| 3.2015 | Concrete upper slab of elevated tank | Cu.m | 39.68 | | | | | |
| 3.2016 | Concrete upper slab of ground tank | Cu.m | 23.64 | | | | | |



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|---------------|--|------|-------|--|--|--|--|
| 3.202 | <i>Shaft between water tanks : Reinforced Concrete Strength Class C30/37 dosing 350kg/m3 including formwork, fair faced concrete finishing and all needed materials for the execution of the works.</i> | | | | | | |
| 3.2021 | Shaft Concrete walls | Cu.m | 83.83 | | | | |
| 3.2022 | Concrete slab - Plateform at Level +363 | Cu.m | 1.48 | | | | |
| 3.203 | <i>Parapets at roof level of water tanks</i> | | | | | | |
| 3.2031 | Concrete parapets above elevated tanks: | | | | | | |
| | - 20x40 ht | L.m | 45.98 | | | | |
| | - 15x40 ht | L.m | 11.5 | | | | |
| 3.2032 | Concrete parapets above ground tank : | | | | | | |
| | - 25x40 ht | L.m | 39.71 | | | | |
| | - 15x40 ht | L.m | 3.76 | | | | |
| | - 15x40 ht | L.m | 10.45 | | | | |
| 3.204 | <i>Steel reinforcement for water tanks</i> | T | 87.4 | | | | |
| 3.205 | <i>Pumps chamber : Reinforced Concrete Strength Class C30/37 dosing 350kg/m3 including formwork, fair faced concrete finishing and all needed materials for the execution of the works</i> | | | | | | |
| 3.2051 | Concrete cyclopean | Cu.m | 1.05 | | | | |
| 3.2052 | Concrete footings 70x70x40ht | Cu.m | 0.82 | | | | |
| 3.2053 | Concrete ground beam 25x60ht | Cu.m | 2.61 | | | | |
| 3.2054 | Concrete bottom solid slab 20cm thick | Cu.m | 3.48 | | | | |
| 3.2055 | Concrete tie column | Cu.m | 1.94 | | | | |
| 3.2056 | Concrete lintel | Cu.m | 0.17 | | | | |



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|--------------|---|------|-------|--|--|--|--|--|
| 3.2057 | Concrete roof beam 20x35ht | Cu.m | 1.21 | | | | | |
| 3.2058 | Concrete upper solid slab 20 cm thick | Cu.m | 4.81 | | | | | |
| 3.2059 | Concrete parapets above roof 20x40ht | L.m | 20.38 | | | | | |
| 3.206 | Steel reinforcement for pumps chamber | T | 1.43 | | | | | |
| 4 | Metal works | | | | | | | |
| 4.1 | Galvanized steel louvers : Supply and installation of colored galvanized steel louvers and frames installed complete including frame, subframe transoms, sills, stainless steel fixing, accessories ironmongery sealants anchors, sand insect screens trap filter and protective coating | | | | | | | |
| 4.101 | Steel louvers for pumps chamber (100x60ht) | U | 3 | | | | | |
| 4.102 | Steel louvers for water tower (60x150ht) | U | 4 | | | | | |
| 4.2 | Galvanized Steel Doors Supply and installation of galvanized steel doors with protective coating and adequate support , including all necessary fixing devices, accessories, fasteners as specified and shown on drawings. | | | | | | | |
| 4.201 | Steel doors for pumps chamber (100x210ht) | U | 1 | | | | | |
| 4.202 | Steel doors for pumps chamber (100x120ht) | U | 1 | | | | | |
| 4.203 | Steel doors for water tower (60x210ht) | U | 1 | | | | | |
| 4.3 | Metal Ladders Supply and installation of epoxy coated metal ladder with epoxy coating steel adequate support, including all necessary fixing devices, accessories, fasteners . | | | | | | | |
| 4.301 | External galvanised Steel ladder for ground tank including guardrail protection. | U | 1 | | | | | |



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|--------------|---|------|------|--|--|--|--|
| 4.302 | Internal galvanised Steel ladder for ground tank | U | 2 | | | | |
| 4.303 | Galvanised Steel ladder in elevated tank | U | 2 | | | | |
| 4.304 | Steel Stair for the elevated water tank including handrails and all necessary fixing accessories (levels : from +341.20 to +363.00) | L.S | 1 | | | | |
| 4.4 | Steel fence : Supply and installation of galvanized steel columns with protective coating for external fence including galvanized steel wire mesh , with all necessary fixing accessories, all as specified and shown on drawings | | | | | | |
| 4.401 | External fence supply and installation | Sq.m | 56 | | | | |
| 4.402 | Main access steel gate with protective layer including all necessary fixing devices, accessories, fasteners with sliding rail. | Sq.m | 11 | | | | |
| 4.5 | Hand rail: Supply and installation of steel hand rail with epoxy coating protective layer , including all necessary fixing devices, accessories, fasteners complete, all as specified and shown on drawings | | | | | | |
| 4.501 | Hand rail in elevated tank | L.m | 43.7 | | | | |
| 4.502 | Hand rail in ground tank | L.m | 37.7 | | | | |
| 4.6 | Steel cover : Supply and installation galvanized steel cover with all supporting steel structures and with embedded steel angles installation, including welding, bolts, hinge, primer, 2 coats of oil-base paint, and all necessary material and accessories; as per the drawings | | | | | | |
| 4.601 | Steel cover for water tanks | | | | | | |
| 4.602 | Galvanized steel cover in elevated tank | | | | | | |
| | - Ø1000 | U | 1 | | | | |
| | - Ø1500 | U | 1 | | | | |



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|--------------|--|------|-------|--|--|--|--|
| 4.603 | Galvanized steel cover in ground tank | | | | | | |
| | - 1500x110 | U | 1 | | | | |
| | - 1100x1100 | U | 1 | | | | |
| | - Ø840 | U | 1 | | | | |
| 4.7 | I beams - runways for hoist cranes Supply and installation of IPE beams fixed in roof slab with epoxy coating protective layer , including all necessary fixing devices, accessories, fasteners complete, all as specified and shown on drawings. | | | | | | |
| 4.7.1 | - IPE300 | Kg | 217.4 | | | | |
| 4.7.2 | - Manual overhead crane (1 ton) | U | 1 | | | | |
| 5 | Waterproofing and thermal insulation | | | | | | |
| 5.1 | Water tanks | | | | | | |
| 5.101 | Bituminous coat on all underground structures in contact with soil Bituminous waterproofing paint to all exterior concrete surfaces of the control room in contact with soil including surface preparation as required per specifications | Sq.m | 125 | | | | |
| 5.102 | Waterproofing membrane: Application of 2 layers of SBS polymer modified bitumen membrane 4mm thick to be placed on top of concrete roof. After application of bituminous membrane, dressing up 150mm high against parapets along anodized aluminum flashing for waterproofing system, with mastic sealants and anchors including the flood test. | Sq.m | 254 | | | | |
| 5.103 | Thermal insulation Insulation extruded polystyrene pannels | Sq.m | 237 | | | | |



| | | | | | | | | |
|--------------|---|------|-----|--|--|--|--|--|
| 5.104 | Geotextile Geotextile - Supply and install nonwoven polyester sheet ,filter fabric, minimum density of 200 g/m ² between waterproofing and precast concrete protective tiles | Sq.m | 237 | | | | | |
| 5.105 | Waterproofing protection : Precast concrete tiles protection for water proofing system on roof slabs, dimension 40x40x4 cm3 | Sq.m | 237 | | | | | |
| 5.106 | Aluminium flashing : Anodized aluminum flashing installed, anchored and well sealed and turned into strips, sealants, anchors and protective coating, all including performed reglet as specified at roof slabs drawings. Aluminum flashing 200mm | L.m | 78 | | | | | |
| 5.107 | Roof drains : roof drains to evacuate rain water | U | 2 | | | | | |
| 5.108 | Ventilation pipes | U | 7 | | | | | |
| 5.109 | Water stop: Water stop inside tank walls (at each construction joint) | L.m | 62 | | | | | |
| 5.11 | Neoprene pads: Neoprene pads between walls and roof slab | L.m | 120 | | | | | |
| 5.111 | Cementitious waterproofing: Internal cementitious Waterproofing of floor, walls and upper slab of the watertanks | | | | | | | |
| | - Internal Waterproofing of Ground watertank including walls, raft, upper slab and both sides of shaft walls. | Sq.m | 680 | | | | | |



| | | | | | | | | |
|------------|---|------|-----|--|--|--|--|--|
| | - Internal Waterproofing of Elevated watertank including walls, upper slab, one side of shaft walls. | Sq.m | 340 | | | | | |
| 5.2 | Pumps Chamber | | | | | | | |
| 5.201 | Bituminous coat on all underground structures in contact with soil: Bituminous waterproofing paint to all exterior concrete surfaces of the control room in contact with soil including surface preparation as required per specifications | Sq.m | 23 | | | | | |
| 5.202 | Waterproofing membrane: Application of 2 layers of SBS polymer modified bitumen membrane 4mm thick to be placed on top of concrete roof. After application of bituminous membrane, dressing up 150mm high against parapets along anodized aluminum flashing for waterproofing system, with mastic sealants and anchors including the flood test | Sq.m | 27 | | | | | |
| 5.203 | Thermal insulation: Insulation extruded polystyrene pannels | Sq.m | 20 | | | | | |
| 5.204 | Geotextile: Geotextile - Supply and install nonwoven polyester sheet ,filter fabric, minimum density of 200 g/m ² between waterproofing and precast concrete protective tiles | Sq.m | 20 | | | | | |
| 5.205 | Waterproofing protection: Application of gravel layer for waterproofing protection | Cu.m | 1 | | | | | |



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|--------------|---|------|-----|--|--|--|--|--|
| 5.206 | Aluminum Flashing: Anodized aluminum flashing installed, anchored and well sealed and turned into strips, sealants, anchors and protective coating, all including performed reglet as specified at roof slabs drawings. Aluminum flashing 200mm | L.m | 18 | | | | | |
| 5.207 | Roof drain: Roof rain water drain | U | 2 | | | | | |
| 6 | Masonry works | | | | | | | |
| 6.1 | Masonry wal for the pumps chamber | Sq.m | 29 | | | | | |
| 6.2 | Masonry wall in the fence | Sq.m | 57 | | | | | |
| 7 | Finishing works | | | | | | | |
| 7.1 | PLASTERING: Sand cement plastering on internal walls and ceiling of control room and masonry wall above cover slab including hollow bloc repair and fill, corner beads, casing Beads and plastering repair where required with non shrink grout and painting including upper roof parapet | | | | | | | |
| 7.101 | Plastering on internal and external side of walls for pumps chamber | Sq.m | 95 | | | | | |
| 7.102 | Plastering on fence walls | Sq.m | 114 | | | | | |
| 7.2 | Painting | | | | | | | |
| 7.201 | Internal painting : Interior painting finish including preparation of surfaces, rubbing with sealer, sanding, cleaning, application of thin putty filler as required, under coat and two enamel final painting coats with semi-gloss finish, complete all as specified and shown on drawings and as recommended by manufacturer. | | | | | | | |
| 7.2011 | Enamel paint on internal pumps chamber walls | Sq.m | 45 | | | | | |



| | | | | | | | | |
|--------------|---|------|-----|--|--|--|--|--|
| 7.2012 | Ceiling painting of pumps chamber | Sq.m | 14 | | | | | |
| 7.202 | External Painting : External acrylic water repelient paint over smooth finish fairfaced concrete including preparation of surfaces, rubbing with sealer, sanding, cleaning, application of thin putty filler as required, undercoat and two final painting coats, all as specified and shown on drawings and as recommended by manufacturer. | | | | | | | |
| 7.2021 | Watertanks (Ground Tank, Elevated tank and Shaft) | Sq.m | 770 | | | | | |
| 7.2022 | Pumps chamber (External walls and parapet) | Sq.m | 50 | | | | | |
| 7.2023 | Fence (both sides) | Sq.m | 114 | | | | | |
| 7.3 | Indutrial resin – Epoxy floor coating | Sq.m | 14 | | | | | |
| 8 | Asphalt works | | | | | | | |
| | Asphalting for access road (compacted 5 cm thick) with required base and sub-base and execution of access road from D.P including all excavation/backfilling where required. | Sq.m | 130 | | | | | |
| 9 | Underground manhole (Valves' chamber) | | | | | | | |
| 9.1 | Construction of an underground manhole/valves' chamber (internal dimentionis 3m x 4m x 1.5m) including excavation, backfilling, concrete works, iron cover, waterproofing, drainage and all necessary works for the proper functioning of the system and to the satisfaction of the engineer. | U | 1 | | | | | |
| 9.2 | Conctruction of an electrical manhole (60x60x60ht) including, excavation, backfilling, concrete works, iron cover and waterproofing | U | 1 | | | | | |
| 10 | Piping works (Underground valve chamber) | | | | | | | |





| | | | | | | | | |
|------|---|-----|---|--|--|--|--|--|
| 10.1 | <p>Connecting the incoming lift line (Inlet Pipe) : Supply & Install pipes, valves, joints and all necessary works to connect the lift line to the proposed ground reservoir, along with all necessary works for the proper functioning of the system and to the satisfaction of the supervising engineer and as per submitted drawings.</p> | L.S | 1 | | | | | |
| 10.2 | <p>Connection to existing network (2 Outlet Pipes) :Supply & Install pipes, valves, joints and all necessary works to connect the ground reservoir and elevated water tank to the existing networks along with all necessary works for the proper functioning of the system and to the satisfaction of the supervising engineer and as per submitted drawings.</p> | L.S | 1 | | | | | |





| | | | | | | | | |
|--|--|-----|---|--|--|--|--|--|
| 10.3 | Drainage, Overflow pipes (2 overflow pipes) and Floor drain pipes Supply & Install pipes, valves, joints and all necessary works for the proper drainage and overflow pipes (of both tanks and underground manhole) to the nearest stream, along with all necessary works for the proper functioning of the system and to the satisfaction of the supervising engineer and as per submitted drawings. | L.S | 1 | | | | | |
| Bill B – Electro mechanical works (Teil reservoir site) | | | | | | | | |
| S2.1000 | Mechanical, electrical and control equipment and works | | | | | | | |
| S2.1100 | Pumping system | | | | | | | |
| S2.1102 | Surface booster motor pumpset Q=61 l/s, H=45m. | Nb | 2 | | | | | |
| S2.1200 | Piping and accessories | | | | | | | |
| S2.1201 | Suction Strainer DN 80 PN 10 | Nb | 1 | | | | | |
| S2.1202 | Foot valve DN 80 PN 10 | Nb | 1 | | | | | |
| S2.1203 | Y-Strainer DN 80 PN 16 | Nb | 1 | | | | | |
| S2.1204 | Rubber spherical joint DN 80 PN 16 | Nb | 4 | | | | | |
| S2.1205 | Double Air release valve DN50, PN16 with isolating valve | Nb | 2 | | | | | |
| S2.1206 | Sampling Valve DN13 PN16 | Nb | 2 | | | | | |
| S2.1207 | Dismantling Joints DN80 PN16 | Nb | 6 | | | | | |
| S2.1208 | Check Valve DN80 PN16 | Nb | 2 | | | | | |



| | | | | | | | |
|----------------|--|-------|----|--|--|--|--|
| S2.1209 | Butterfly Valve DN80 PN16 | Nb | 2 | | | | |
| S2.1210 | Gate Valve DN80 PN16 | Nb | 5 | | | | |
| S2.1211 | Supply and installation of ductile iron K9 pipes including all necessary fittings (bends, tees, reducers, flanges, dismantling joints, support, | | | | | | |
| S2.1211A | DI pipes, DN 80 (for suction, outlet and drain) | Lin.m | 70 | | | | |
| S2.1212 | Supply and installation of pump chamber floor drains | | | | | | |
| S2.1212A | Pump chamber floor drain, including pipe DN 100 and flap valve | Nb | 1 | | | | |
| S2.1213 | Supply and installation of water meters including Y strainers, filters, flow straighteners | | | | | | |
| S2.1213A | Water meter PN16, DN 80 | Nb | 2 | | | | |
| S2.1214 | Supply and installation of filters | | | | | | |
| S2.1214A | Filter PN16, DN 80 | Nb | 2 | | | | |
| S2.1215 | Supply and installation of flow straighteners | | | | | | |
| S2.1215A | Flow straighteners PN16, DN 80 | Nb | 2 | | | | |
| S2.1216 | Supply and installation of insert | | | | | | |
| S2.1216A | Insert DN 80 mm | Nb | 2 | | | | |
| S2.1300 | Electrical system | | | | | | |
| S2.1301 | Subscription to EDL 3 x 30 A | L.S | 1 | | | | |
| S2.1302 | Main ATS panel 32 A. The ATS shall be equipped with Power meter including Modbus Communication. | Nb | 1 | | | | |



| | | | | | | | | |
|----------------|---|-------|----|--|--|--|--|--|
| S2.1303 | STAR DELTA Starter control panel 7 kW. The Motor starter shall be equipped with Power meter including Modbus Communication. | Nb | 2 | | | | | |
| S2.1304 | Low voltage cable 1x(3x10+6) mm ² | Lin.m | 60 | | | | | |
| S2.1305 | Low voltage cable 1x(4x16+16) mm ² | Lin.m | 50 | | | | | |
| S2.1306 | Online UPS system, power autonomy at least 12 hrs with communication port compatible with PLC communication protocols for UPS and Battery Status as per attached IO List. The UPS DOD 70%. The Charger of UPS shall be able to charge the battery to 100% during maximum 4 hour | Nb | 2 | | | | | |
| S2.1307 | Grounding system - Lightning & Surge Protections Type II for ATS and Surge Protection for automation Panel in the pumping station and the reservoir. | Nb | 1 | | | | | |
| S2.1308 | Electric accessories (cables, Lugs, clamps, connectors, conduits, cable trays, insulation, junction boxes ...) | L.S | 1 | | | | | |
| S2.1400 | Instrumentation and control | | | | | | | |
| S2.1401 | Piezoresistive level measurement at reservoir | Nb | 2 | | | | | |
| S2.1402 | Piezoresistive pressure measurement | Nb | 2 | | | | | |



| | | | | | | | | |
|----------------|---|-------|----|--|--|--|--|--|
| S2.1403 | Electromagnetic Flow Measurement DN 80 PN 16 with 1 analogue output 4-20mA Pulse output | Nb | 1 | | | | | |
| S2.1404 | Temperture measrements sets (PTC) | Set | 2 | | | | | |
| S2.1405 | Telemetry Cable | Lin.m | 50 | | | | | |
| S2.1406 | PLC and HMI Panel along with all other instrumentation and control equipment necessary for the proper functioning of the system | L.S | 1 | | | | | |
| S2.1407 | Flow switch DN13 PN16 | Nb | 1 | | | | | |
| S2.1408 | Glycerine filled manometer Ø 100 with 3 way valve caliber 16 | Nb | 2 | | | | | |
| S2.1500 | Dosmetic electircal system | | | | | | | |
| S2.1501 | Complete internal and external electrical lighting, wiring, switches, etc... | LS | 1 | | | | | |
| S2.1600 | Potable fire extenguishers | | | | | | | |
| S2.1601 | Supply and installation of portable fire extinguishers (1x10 Kg Gaz Type, 1x10 Kg Powder Type) | LS | 1 | | | | | |
| S2.1700 | Shop Drawings, Technical Data sheets, Training, Testing and Commissioning, O&M and As-built drawings | | | | | | | |
| S2.1701 | Shop Drawings, Technical Data sheets, Training, Testing and Commissioning, O&M and As-built drawings of the complete system | LS | 1 | | | | | |



Bill C – General works

| 3 | | | | | | | | |
|--------------------------|--|----|---|--|--|--|--|--|
| General | | | | | | | | |
| 3.001 | Notice boards | Nb | 1 | | | | | |
| 3.002 | Insurance | LS | 1 | | | | | |
| 3.003 | Site Preparation and Mobilization-Demobilization: This item shall be paid as a lump sum value. 65% of the lump sum value will be paid upon mobilization completion, and the remaining 35% after the termination of site clearance upon completion of works | LS | 1 | | | | | |
| 3.004 | Health & Safety Measures | LS | 1 | | | | | |
| Total price (USD) | | | | | | | | |

WORKPLAN:

PLEASE ATTACH A DETAILED WORKPLAN DEMONSTRATING THE BIDDER'S ABILITY TO FULFIL LEBRELIEF'S BELOW EXPECTATIONS.



| | EXECUTION CONDITIONS REQUESTED BY ACTED | EXECUTION CONDITIONS OFFERED BY BIDDERS (if different) |
|---|---|--|
| INTERIM COMPLETION DATE #1 | <i>30 % completion by 31/12/2023 after completion 50% of the work</i> | Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO If no, detail expected workplan: |
| INTERIM COMPLETION DATE #2 | <i>60 % by 28/02/2024 after completion 80% of the work</i> | Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO If no, detail expected workplan: |
| FINAL COMPLETION DATE | <i>90 % by 31/05/2024 after completion 100% of the work,</i> | Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO If no, detail expected workplan: |
| ADVANCE PAYMENT GUARANTEE (Please use ACTED template) | NA | Advance payment requested by the Bidder (in % of its bid total price): <hr/> ACTED advance payment guarantee terms & conditions accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO |
| PERFORMANCE SECURITY (please use ACTED template) | 60,000 USD (Sixty Thousand USD only) either as Bank guarantee or as a Bankers check | Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO |
| RETENTION MONEY SECURITY & LIABILITY PERIOD (please use ACTED template) | <i>10% of the total contract value. Duration of the liability period 1 year</i> | Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO |

CAPACITY AND QUALITY OF WORKS:

PLEASE ATTACH:

- **AN ATTESTATION OF THIRD PARTY LIABILITY FOR THE WHOLE DURATION OF WORKS AND LIABILITY PERIOD DATING LESS THAN 3 MONTHS**
- **A COPY OF VALID QUALITY ASSURANCES WITH RELEVANT CERTIFICATES DATING LESS THAN 3 MONTHS**

Please fill in the below table for manpower and equipment that will be made available in awarded:



| | LEBRELIEF REQUIREMENTS | | BIDDER'S COMMITMENTS | |
|--|---|--|---|---|
| NUMBER OF ENGINEERS | Per site:1 | Total for all sites:1 | Per site: | Total for all sites: |
| NUMBER OF MANAGERS | Per site:1 | Total for all sites:1 | Per site: | Total for all sites: |
| NUMBER OF SUPERVISORS | Per site: | Total for all sites:1 | Per site: | Total for all sites: |
| NUMBER OF QUALIFIED WORKERS | Qualification Per site: Mason – 1 to 3 Waterproofing – 1 to 3 Carpenter – 1 to 3 Mechanical Plumber – 1 to 3 Steel Skilled labor- 1 to 3 Electrical-1 to 3 Painting -1 to 3 | Qualification Total for all sites: Mason – 1 to 3 Waterproofing – 1 to 3 Carpenter – 1 to 3 Mechanical Plumber – 1 to 3 Steel Skilled labor- 1 to 3 Electrical-1 to 3 Painting -1 to 3 | Qualification Per site: Qualification Per site: | Qualification Total for all sites: Qualification Per site: |
| NUMBER OF UNQUALIFIED WORKERS | Per site: 70-100 overall the project | Total for all sites: 70-100 overall the project | Per site: | Total for all sites: |
| PLEASE CONFIRM WHETHER WORKERS ARE HIRED IN THE WORK SITES LOCAL AREA | Qualified workers: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO Additional details: <u>NOT ALL THE WORKERS WILL BE SELECTED FROM THE LOCAL AREA.</u> | Unqualified workers: <input type="checkbox"/> YES <input type="checkbox"/> NO Additional details: <u>NOT ALL THE WORKERS WILL BE SELECTED FROM THE LOCAL AREA.</u> | Qualified workers: <input type="checkbox"/> YES <input type="checkbox"/> NO Additional details: | Unqualified workers: <input type="checkbox"/> YES <input type="checkbox"/> NO Additional details: |
| NUMBER OF TRUCKS FOR MATERIALS TRANSPORTATION | Minimum capacity: 2 | Minimum number at a given time for all sites: 2 | Minimum capacity: | Minimum number at a given time for all sites: |
| EQUIPMENT TYPE #1 Description Performances Number per site at a given time | | | | |



| | | |
|--|--|--|
| Number for all sites at a given time Current location Owned/rented/leased Name of the owner and contact details | | |
|--|--|--|

| | | |
|--|--|--|
| EQUIPMENT TYPE #2 Description Performances Number per site at a given time Number for all sites at a given time Current location Owned/rented/leased Name of the owner and contact details | | |
|--|--|--|

etc.



SOCIAL, HEALTH AND SECURITY ASSURANCES:
PLEASE ATTACH:

- THE ID COPY OF ALL SITE WORKERS TO BE EMPLOYED DURING WORKS SITES
- A HEALTH AND SAFETY PLAN ON WORKSITES

| | LEBRELIEF REQUIREMENTS | BIDDER'S COMMITMENTS |
|---|--|--|
| IMPLEMENTATION OF THE HEALTH AND SAFETY PLAN | <i>To provide Health & safety plan</i> | <i>The Bidder must here provide its health and safety plan as an attachment.</i> |
| ACCOMMODATION, DRINKING WATER, MEALS AND TRANSPORTATION OF STAFF | <i>NA</i> | <i>The Bidder must here provide its health and safety plan as an attachment.</i> |
| CODE OF CONDUCT | LebRelief expects from all its suppliers/service providers/contractors to ensure a full adherence to the principles of its Ethical Declaration which the Bidder hereby acknowledges as a duty throughout the execution of works if awarded a portion or the entire scope of works. | I, as the representative of the Bidder, hereby acknowledges that ACTED Ethical Declaration principles are implemented within my company and will be monitored throughout the contract execution if awarded a portion or the entire scope of works. In particular, all staff working on the works sites related to this contract will be trained. I also hereby acknowledge a zero tolerance approach, and my company's and its employees' duty to report to ACTED any abuse: <input type="checkbox"/> YES <input type="checkbox"/> NO |



ENVIRONMENTAL ASSURANCES:
PLEASE ATTACH:

- **AN ENVIRONMENTAL SAFEGUARDING PLAN ON WORKSITES**

| | LEBRELIEF REQUIREMENTS | BIDDER'S COMMITMENTS |
|--|---|---|
| PROTECTION OF ADJACENT AREAS, BIODIVERSITY, PREVENTION OF EROSION AND WASTEWATER MANAGEMENT | <i>You may refer to the general specification- Volume 3</i> | <p><i>The Bidder must here whether tick the box, and hereby accepting all environmental safeguarding requirements set by ACTED, or provide its own proposal as an attachment. He will refer it to here.</i></p> <p>Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> |
| TRAFFIC, NOISE AND ATMOSPHERIC EMISSIONS MANAGEMENT, LAND TAKE | <i>You may refer to the general specification- Volume 3</i> | <p><i>The Bidder must here whether tick the box, and hereby accepting all environmental safeguarding requirements set by ACTED, or provide its own proposal as an attachment. He will refer it to here.</i></p> <p>Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> |
| WASTE AND HAZARDOUS PRODUCTS MANAGEMENT | <i>You may refer to the general specification- Volume 3</i> | <p><i>The Bidder must here whether tick the box, and hereby accepting all environmental safeguarding requirements set by ACTED, or provide its own proposal as an attachment. He will refer it to here.</i></p> <p>Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> |
| VEGETATION CLEARING AND SITE REHABILITATION | <i>You may refer to the general specification- Volume 3</i> | <p><i>The Bidder must here whether tick the box, and hereby accepting all environmental safeguarding requirements set by ACTED, or provide its own proposal as an attachment. He will refer it to here.</i></p> <p>Accepted by the Bidder: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> |



BIDDER'S CONDITIONS:

| | GENERAL CONDITIONS RECOMMENDED BY ACTED | GENERAL CONDITIONS OFFERED BY BIDDERS (if different) |
|------------------------------|---|--|
| VALIDITY OF THE OFFER | <i>9 months minimum</i> | |
| TERMS OF PAYMENT | <i>30 % completion by 31/12/2023 after completion 50% of the work;</i> <i>60 % by 28/02/2024 after completion 80% of the work;</i> <i>90 % by 31/05/2024 after completion 100% of the work,</i> | |

Name of Bidder's Authorized Representative: _____

Authorized signature and stamp: _____

Date: _____



SUPPLIER'S QUESTIONNAIRE

PART I: INFORMATION

| A. Company Details and General Information | | | |
|---|---|--|---|
| Name of Company | | Trading As | |
| Address (headquarters) | | Telephone | |
| Zip Code (headquarters) | | Fax | |
| City (headquarters) | | E-mail address 1 | |
| PO Box | | E-mail address 2 | |
| Country (headquarters) | | Website address | |
| Parent Company or name of owner | | Subsidiaries/ Associates/ Overseas Representative | |
| Sales Person's Name | | Sales Person's Position | |
| Sales Person's phone | | Sales Persons' E-mail | |
| <i>Management of the company: CEO, Executive Director, Deputy Director, President or Vice-President</i> | | | |
| Name (as in passport or other government-issued photo ID) | | Date of birth (mm/dd/yyyy) | |
| Government-issued photo Identification Document (ID) number | | Type of ID | |
| ID country of issuance | | Rank or title in organization | |
| Other names used (nicknames or pseudonyms not listed as "Name") | | Gender (e.g. male, female) | |
| Current employer and job title | | Occupation | |
| Address of residence | | Citizenship(s) | |
| Province/Region | | E-mail addresses | |
| Is the individual a U.S. citizen or legal permanent resident? | <input type="checkbox"/> Yes <input type="checkbox"/> No | Professional Licenses – State Issued Certifications | |
| <i>Company's staff & insurance</i> | | | |
| No. Full Time Employees | | Employee average work wage per hour | |
| % of Men to Women | | Any employee(s) with relatives working with ACTED? | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Are children employed? | <input type="checkbox"/> Yes <input type="checkbox"/> No | Is a legal minimum wage applied? | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Paid vacations are offered? | <input type="checkbox"/> Yes <input type="checkbox"/> No | Are flexible working hours offered? | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Name of insurance company | | Staff covered by health insurance? | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <i>Description of the Company</i> | | | |
| Type of Business (multiple choices possible) | <input type="checkbox"/> Manufacturing <input type="checkbox"/> Consulting Company | <input type="checkbox"/> Authorised Agent <input type="checkbox"/> Other (Please Specify) | <input type="checkbox"/> Trader |
| Sector of Business (multiple choices possible) | <input type="checkbox"/> Goods/Supplies <input type="checkbox"/> Services | <input type="checkbox"/> Equipment <input type="checkbox"/> Other (Please Specify) | <input type="checkbox"/> Works |
| Year Established | | Country of registration | |
| Licence number | | Valid until | |
| Working languages | <input type="checkbox"/> English <input type="checkbox"/> Arabic | <input type="checkbox"/> French <input type="checkbox"/> Chinese | <input type="checkbox"/> Spanish <input type="checkbox"/> Other (Please Specify) <input type="checkbox"/> Russian |
| Technical documents available in | <input type="checkbox"/> English <input type="checkbox"/> Arabic | <input type="checkbox"/> French <input type="checkbox"/> Chinese | <input type="checkbox"/> Spanish <input type="checkbox"/> Other (Please Specify) <input type="checkbox"/> Russian |
| B. Financial Information | | | |
| VAT Number | | Tax Number | |
| Bank Name | | Bank Account Number | |
| Bank Address | | Account Name | |
| Swift/BIC number | | Standard Payment Terms | |
| Has the company been audited in the last 3 years? | <input type="checkbox"/> Yes <input type="checkbox"/> No | | |
| Please attach a copy of the company's most recent Annual or Audited Financial Report | <input type="checkbox"/> Attached | | |
| Annual Value of Total Sales for the last 3 Years: | Year: USD: Year: USD: Year: USD: | | |
| Annual Value of Export Sales for the last 3 years | Year: USD: Year: USD: Year: USD: | | |



C. Experience

Company's recent business with ACTED and/or other International Non Governmental organisation or United Nations Agencies:

| | Organisation | Contact person | Phone/E-mail | Goods/Works/Services | Value (USD) | Year | Destination |
|---|--------------|----------------|--------------|----------------------|-------------|------|-------------|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |

What is your company's main area of expertise?

What is your company's business coverage area?

National

Restricted to (specify locations):

To which countries has your company exported and/or managed projects in the last 3 years?

Provide any other information that demonstrates your company's qualifications and experience (eg. awards)

List any national or international Trade/Professional Organisations of which your company is a member

D. Technical Capability

Type of Quality Assurance Certificate

Attached

Type of Certification/Qualification Documents

Attached

International Offices/Representation

List below up to 10 of the core Goods and/or Services your company sells:

- | | |
|----|-----|
| 1) | 6) |
| 2) | 7) |
| 3) | 8) |
| 4) | 9) |
| 5) | 10) |

List the main assets of your company (trucks & heavy machines, heavy & valuable equipment, premises & warehouses, production sites etc.)

- | | |
|----|-----|
| 1) | 6) |
| 2) | 7) |
| 3) | 8) |
| 4) | 9) |
| 5) | 10) |

E. Miscellaneous

Does your company have an Environmental Policy?

Yes No

Does your company have an Ethical Trading Policy?

Yes No

Does your company have an Anti-terrorist Policy?

Yes No

Is your company compliant with the EU General Data Protection Regulation (or equivalent)?

Yes No

If you answered yes to the above two questions, please attach copies of your policy:

Attached

Has your company ever been bankrupt, or is in the process of being wound up, having its affairs administered by the courts, has entered into an arrangement with creditors, has suspended business activities, is the subject of proceedings concerning these matters, or is in any analogous situation arising from a similar procedure provided for in national law?

Yes

No

If you answered yes, please provide details:

Has your company ever been convicted of an offence concerning its professional conduct by a judgment which has force of res judicata?

Yes

No

If you answered yes, please provide details:

Has your company ever been guilty of grave professional misconduct proven by other means?

Yes

No

If you answered yes, please provide details:

Has your company ever not fulfilled its obligations relating to the payment of social security contributions, or the payment of taxes in accordance with the law of the country in which it is established, or with those of France, or those of the country where the contract is to be performed?

Yes

No

If you answered yes, please provide details:

Has your company ever been the subject of a judgement which has the force of res judicata for fraud, corruption, involvement in a criminal organisation or any other illegal activity?

Yes

No

If you answered yes, please provide details:

Has your company ever been declared to be in serious breach of contract for failure to comply with its contractual obligations, following another procurement procedure or grant award procedure financed by a donor country?

Yes

No



| | | | |
|---|--|--|---|
| If you answered yes, please provide details: | | | |
| Has your company ever been declared to be in serious breach of contract for failure to comply with its contractual obligations, following another procurement procedure or grant award procedure financed by a donor country? | | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| If you answered yes, please provide details: | | | |
| Has your company ever been in any dispute with any Government Agency, the United Nations, or International Aid Organisations (including ACTED)? | | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| If you answered yes, please provide details: | | | |
| Do you agree with terms of payment of 30 days? | <input type="checkbox"/> Yes <input type="checkbox"/> No | Do you accept visit of ACTED staff & external auditors to your office? | <input type="checkbox"/> Yes <input type="checkbox"/> No |

PART II: CERTIFICATION

I, the undersigned warrant that the information provided in this form is correct, and in the event of changes, details will be provided to ACTED as soon as possible in writing. I also understand that ACTED does not do business with companies, or any affiliates or subsidiaries, which engage in any practices that are in breach of ACTED policies for Child Protection, Conflict of Interest Prevention, Anti-fraud & Anti-Corruption, Anti-terrorism & Anti-Money Laundering, Data Protection, against Sexual Exploitation, and for Environmental Safeguarding.
 (available on <https://www.acted.org/en/about-us/values-and-policies/code-of-conduct-and-policies/> and on request at any ACTED office).

| | | | |
|---|--|----------------|--|
| Name: | | Date: | |
| Title/Position | | Place: | |
| E-mail address (for contact for verification purposes): | | Signature: | |
| Phone number (for contact for verification purposes): | | Company Stamp: | |

| Check list of supporting documents | | For ACTED use only |
|---|--|----------------------------------|
| 1) Trading license | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 2) VAT registration/tax clearance certificate | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 3) Company profile | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 4) Proof of trading/dealership/agent | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 5) Evidence of similar contracts | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 6) References | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 7) Particulars of CEO and key personnel | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 8) Articles of Association & Certificate of incorporation | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 9) Financial statements (latest) | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |
| 10) Other (specify): | <input type="checkbox"/> Attached <input type="checkbox"/> N/A | <input type="checkbox"/> Checked |

PART III: ASSESSMENT (ACTED use only)

| Assessors | | | |
|--|--|--|-------|
| Name & Title of Assessing ACTED Staff: | | | |
| 1) | | 3) | |
| 2) | | 4) | |
| Findings of Vendor's assessment: | | | |
| | | | |
| Vendor's office/ warehouse / works site visited? | | <input type="checkbox"/> Yes <input type="checkbox"/> No | Date: |
| Findings of Site Visit / Works Visit / Consultation with References: | | | |
| | | | |

| Decision | | | |
|---|-----------------------------------|---------|-------|
| <input type="checkbox"/> To be included in ACTED Database | <input type="checkbox"/> Rejected | Reason: | Date: |

By signing this supplier assessment, I hereby testify that:
 - I do not have any conflict of interest with any of the suppliers listed in the present document (as per ACTED Conflict of Interest Prevention policy)
 - I have not taken part into any fraudulent nor corruptive practice for the present procurement (as per ACTED Anti-Fraud & Corruption policy)

Area Logistics Manager's /
Country Logistics Manager's Name:

Signature:



SUPPLIER'S ETHICAL DECLARATION

Date:

Supplier's name:

Supplier's address:

Supplier's contact e-mail address: _____

ACTED is committed to carrying out its procurement in a free, fair and transparent manner, purchasing through competitive procedures, and suppliers adhering to the below ethical business principles & practices.

ACTED is governed by a set of global policies that are regularly revised and reinforced (refer to <https://www.acted.org/en/about-us/values-and-policies/code-of-conduct-and-policies/>):

- **Anti-Fraud, Bribery and Corruption Policy:** ACTED has a zero tolerance approach towards fraud and corruption and is committed to respecting the highest standards in terms of efficiency, responsibility and transparency in its activities.
- **Conflict of Interest Prevention Policy:** to ensure the most efficient, responsible and transparent delivery of aid, ACTED, its staff and partners commit to preventing their private interests conflicting with their duties and any other kind of conflict of interests.
- **Anti-Terrorism and Anti-Money Laundering Policy:** never knowingly support, tolerate, encourage or finance terrorism, the activities of those who embrace terrorism and anti-money laundering activities.
- **Child Protection Policy:** statement of intent demonstrating ACTED's commitment to safeguarding children from harm within internal procedure, throughout all activities.
- **Policy against Sexual Exploitation and Abuse:** ACTED adopts a zero tolerance approach towards sexual exploitation and abuse, and is thus committed to their prevention and sanction both within the organisation and within the framework of its programmes and beneficiary populations.
- **Environmental Safeguarding Policy:** ACTED is committed to the promotion of a 3Zero world: zero exclusion, zero carbon, zero poverty. In line with this, ACTED is committed to good environmental stewardship in its operations and in all of its humanitarian and development programming. ACTED commits to minimising the environmental impact of our operations.

The present document is considered an annex to all Purchase Orders and Procurement Contracts ACTED may conclude with your company. Therefore, any breach to the below statements and/or any failure to properly fill in the below statement may result in the termination of the Purchase Order or Procurement Contract without compensation.

1. By undersigning this Ethical Declaration, we, the authorized representative of the supplier stated above, certify that no legal relationship exists between our company, our joint ventures or our subcontractors, and any ACTED staff nor implementing partners. As a consequence, we hereby testify that we have no interest or connection with ACTED other than those disclosed below [please declare below whether you, the company, its owners, directors, staff or agents have any interest or connection with any ACTED employee, volunteer or agent, or any of ACTED implementing partners].

Situation 1¹

Name of the person or entity with possible interest or connection with ACTED staff or implementing partners:

Name of ACTED staff or implementing partners with possible interest or connection with you, the company, its owners, directors, staff or agents:

¹ Please use the same format for reporting any additional situation as an annex to the present document, signed & stamped.



Nature of interest or connection²:

2. We hereby certify that neither we nor any of our board members or legal representatives nor any other member of our Joint Venture including Subcontractors under the Contract are in any of the following situations:
- being bankrupt or being wound up, having their affairs administered by any courts, having entered into an arrangement with creditors, having suspended business activities, being the subject of proceedings concerning those matters, or being in any analogous situation arising from a similar procedure provided for in national legislation or regulations;
 - having been convicted of an offence concerning their professional conduct by a judgment which has the force of *res judicata*;
 - having been guilty of grave professional misconduct proven by any means which the concerned contracting authority can justify;
 - having not fulfilled obligations relating to the payment of social security contributions or the payment of taxes in accordance with the legal provisions of the country in which they are established or with those of the country of presence of ACTED or those of the country where the contract is to be performed;
 - having been the subject of a judgment for fraud, corruption, involvement in a criminal organization or any other illegal activity detrimental to the financial interests of ACTED or its donors;
 - being currently subject to an administrative penalty for being guilty of misrepresentation in supplying the information required by a contracting authority, for failing to supply this information or for having been declared to be in serious breach of their contractual obligations towards this contracting authority,
 - being subject to any national, regional or international sanction related to terrorism or money laundering.
3. We hereby acknowledge that:
- neither we nor any of the members of our Joint Venture or any of our Subcontractors shall violate the basic rights of ACTED's or its implementing partners' beneficiaries;
 - neither we nor any of the members of our Joint Venture or any of our Subcontractors shall be engaged in the manufacture of arms, in the sale of arms to governments which violate the human rights of their citizens; or where there is internal armed conflict or major tensions; or where the sale of arms may jeopardise regional peace and security.
 - neither we nor any of the members of our Joint Venture nor any of our Subcontractors shall participate, support or finance, directly or indirectly, in an act of terrorism or an act of money laundering;
 - neither we nor any of the members of our Joint Venture nor any of our Subcontractors have engaged or will engage in any Sanctionable Practice;
 - neither we nor any of the members of our Joint Venture or any of our Subcontractors under the Contract shall acquire or supply any equipment nor operate in any sectors under an embargo of the United Nations, or the European Union;
 - we comply with and ensure that our Subcontractors and major suppliers with international environmental and labour standards, consistent with laws and regulations applicable in the country and the fundamental conventions of the International Labour Organisation (ILO) and international environmental treaties.
 - neither we nor any of the members of our Joint Venture nor any of our Subcontractors directly or indirectly, voluntarily or involuntarily, participate, organise or benefit, by any means whatsoever, from any form of child ill-treatment or negligence;
 - neither we nor any of the members of our Joint Venture or any of our Subcontractors shall directly or indirectly participate in sexual exploitation and abuse, or take undue advantage of their professional position for their personal interest or to obtain a favour of a sexual nature.

² The existence of an interest or connection does not preclude being vetted as ACTED supplier; it enables to properly manage any potential conflict of interest for sound management of any contractual bindings between your company and ACTED in the future.



A summary of the ILO and international environmental standards are provided below as appendixes; however, we recognise hereby being knowledgeable of such standards in their entirety.

4. We undertake to bring to the attention of ACTED any change in situation with regard to points 1, 2 and 3 above.
5. We hereby commit to:
 - provide quotations & offers at the best value when requested;
 - accept payment by cash, cheque or bank transfer;
 - not offer or pay incentives to ACTED, its implementing partners or any of ACTED staff or of its implementing partners, either to be awarded to supply goods, equipment, services and/or works, nor as personal gifts or loans;
 - not to request favor nor payment from ACTED, its implementing partners or any of ACTED staff or of its implementing partners, to provide quotations or offers;
 - notify ACTED immediately at transparency@acted.org in case we have reasons to believe that practices listed above, or similar ones, have occurred.

Similarly, ACTED hereby:

- commits to assess quotations and offers fairly, based on non-discrimination, equal treatment, transparency, and confidentiality principles;
 - recalls that no payment, favor, gift, loan or any other kind of retribution is requested to submit any quotation or offer to ACTED.
6. We hereby accept as well as all members of our Joint Venture partners and subcontractors to:
 - upon request, provide information relating to our company's, our Joint Venture partners and subcontractors registration documents, past performances, and any other commercial or administrative documents relevant for assessing our experience and capacity;
 - and permit ACTED and its donors or an agent appointed by either of them to inspect the respective accounts, records and documents, to permit on-the-spot checks and to ensure access to sites and the respective project.
 7. In the case of being awarded a Purchase Order or a Procurement Contract, we, as well as all our Joint Venture partners and subcontractors under the Contract undertake to preserve above mentioned records and documents in accordance with applicable law, but in any case for at least ten years from the date of fulfillment or termination of the Contract. Our financial transactions and financial statements shall be subject to auditing procedures in accordance with applicable law. Furthermore, we accept that our data (including personal data) generated in connection with the preparation and implementation of the Tender Process and the performance of the Contract are stored and processed according to the applicable law by ACTED and its donors.
 8. In the case of being awarded a Contract, both parties hereby agree on:
 - require the immediate cessation of serious breaches to the present Ethical Declaration terms and, where these persist, terminate the business relationship.
 - seek to ensure all staff are aware of their rights and involved in the decisions which affect them.
 - recognise official regulation and inspection of workplace standards, and the interests of legitimate trades unions and other representative organisations.
 - seek arbitration in the case of unresolved disputes.

Name (company's legal representative, or representative otherwise authorized by the supplier's legal representative):

In the capacity of: _____

Duly empowered to sign in the name and on behalf of: Said Dib

Signature: _____



Appendix – Summary of Labour & Environmental Standards

A. Summary of Labour standards (indicative only, please refer to ACTED policies and ILO standards)

The labour standards in this code are based on the conventions of the International Labour Organisation (ILO).

- *Employment is freely chosen*

There is no forced, bonded or involuntary prison labour. Workers are not required to lodge 'deposits' or their identity papers with the employer and are free to leave their employer after reasonable notice.

- *Freedom of association and the right to collective bargaining are respected*

Workers, without distinction, have the right to join or form trade unions of their own choosing and to bargain collectively. The employer adopts an open attitude towards the legitimate activities of trade unions. Workers representatives are not discriminated against and have access to carry out their representative functions in the workplace. Where the right to freedom of association and collective bargaining is restricted under law, the employer facilitates, and does not hinder, the development of parallel means for independent and free association and bargaining.

- *Working conditions are safe and hygienic*

A safe and hygienic working environment shall be provided, bearing in mind the prevailing knowledge of the industry and of any specific hazards. Adequate steps shall be taken to prevent accidents and injury to health arising out of, associated with, or occurring in the course of work, by minimising, so far as is reasonably practicable, the causes of hazards inherent in the working environment. Workers shall receive regular and recorded health and safety training, and such training shall be repeated for new or reassigned workers. Access to clean toilet facilities and potable water and, if appropriate, sanitary facilities for food storage shall be provided. Accommodation, where provided, shall be clean, safe, and meet the basic needs of the workers. The company observing the standards shall assign responsibility for health and safety to a senior management representative.

- *Child Labour shall not be used*

There shall be no new recruitment of child labour. Companies shall develop or participate in and contribute to policies and programmes, which provide for the transition of any child found to be performing child labour to enable her/him to attend and remain in quality education until no longer a child. Children and young people under 18 years of age shall not be employed at night or in hazardous conditions. These policies and procedures shall conform to the provisions of the relevant International Labour Organisation (ILO) standards.

- *Living wages are paid*

Wages and benefits paid for a standard working week meet, at a minimum, national legal standards or industry benchmarks. In any event wages should always be high enough to meet basic needs and to provide some discretionary income. All workers shall be provided with written and understandable information about their employment conditions in respect to wages before they enter employment, and about the particulars of their wages for the pay period concerned each time that they are paid. Deductions from wages as a disciplinary measure shall not be permitted nor shall any deductions from wages not provided for by national law be permitted without the express and informed permission of the worker concerned. All disciplinary measures should be recorded.

- *Working hours are not excessive*

Working hours comply with national laws and benchmark industry standards, whichever affords greater protection. In any event, workers shall not on a regular basis be required to work in excess of the local legal working hours. Overtime shall be voluntary, shall not exceed local legal limits, shall not be demanded on a regular basis and shall always be compensated at a premium rate.



- *No discrimination is practised*

There is no discrimination in hiring, compensation, access to training, promotion, termination or retirement based on race, caste, national origin, religion, age, disability, gender, marital status, sexual orientation, union membership or political affiliation.

- *Regular employment is provided*

To every extent possible work performed must be on the basis of a recognised employment relationship established through national law and practice. Obligations to employees under labour or social security laws and regulations arising from the regular employment relationship shall not be avoided through the use of labour-only contracting, sub-contracting or home-working arrangements, or through apprenticeship schemes where there is no real intent to impart skills or provide regular employment, nor shall any such obligations be avoided through the excessive use of fixed-term contracts of employment.

- *No harsh or inhumane treatment is allowed*

Physical abuse or discipline, the threat of physical abuse, sexual or other harassment and verbal abuse or other forms of intimidation shall be prohibited.

- B. Summary of Environmental standards (indicative only, please refer to ACTED policies, Global Compact here <https://www.unglobalcompact.org/what-is-gc/mission/principles> & Green Procurement Policy here: https://ec.europa.eu/environment/gpp/index_en.htm)

ACTED suppliers will minimise, and wherever possible, eliminate the release of any pollutant that may cause environmental damage to the air, water, earth or its inhabitants, while as a minimum complying with all statutory and other legal requirements relating to the environmental impacts of their business. Detailed performance standards are a matter for suppliers, but should address at least the following:

- *Sustainable use of natural resources*

ACTED suppliers will sustain the use of renewable natural resources and will conserve non-renewable resources through efficient use and careful planning.

- *Conservation*

Processes and activities are monitored and modified as necessary to ensure that conservation of scarce resources, including water, flora and fauna and productive land in certain situations.

- *Waste Management*

Waste creation is minimised and wherever economically possible reused, repaired and recycled. Effective controls of waste in respect of ground, air, and water pollution are adopted. In the case of hazardous materials, emergency response plans are in place.

- *Energy Use*

All production and delivery processes, including the use of heating, ventilation, lighting, IT systems and transportation, are based on the need to maximise efficient energy use and to minimise harmful emissions.

- *Packaging and Paper*

Undue and unnecessary use of materials is avoided, and recycled materials used whenever appropriate.



**GENERAL CONDITIONS OF PURCHASE
(full version)****Article 1 - Scope and purpose**

The purpose of ACTED's General Conditions of Purchase (hereinafter the "General Conditions") is to define the terms and conditions for the purchase and/or rental of goods (hereinafter the "Goods") and/or the performance of services (hereinafter the "Services"). The term "Supply" refers to both the Goods and the Services provided by the seller or provider (hereinafter referred to as the "Contractor"). The description, specifications, specific conditions of performance, sale and delivery of the Supplies and any conditions derogating from the General Conditions shall be defined jointly by the Parties after negotiation and appear in the special conditions (hereinafter the "Special Conditions") and/or in the purchase order (hereinafter the "Purchase Order"). The General Conditions and their annexes form, together with the Special Conditions and/or the Purchase Order, the purchase contract agreed between ACTED or any company controlled by ACTED within the meaning of Article L.233-3 of the French Commercial Code (hereinafter the "Contracting Authority") and the Contractor (hereinafter the "Contract").

The response to an invitation to tender and/or the execution of ACTED's orders shall be deemed acceptance of these conditions and waiver by the Contractor of its general conditions of sale. These General Conditions shall prevail without exception over any other conditions specific to the Contractor unless express and written derogation granted by ACTED.

In case of contradiction or imprecision, these contractual documents are applied in the following hierarchical order, the document of higher rank taking precedence over the document of lower rank:

- The Special Conditions
- The Purchase Order(s)
- The General Conditions

Article 2 - Capacity of the Contractor

The Contractor declares to possess:

- sufficient technical skills and means to ensure the performance of the Contract in accordance with these Conditions and the rules of the trade,
- the financial capacity and personnel resources to ensure the performance of the Contract without any risk of interruption,
- the authorisations, rights and approvals necessary for the performance of the Contract.
- perfect knowledge of the conditions of access to the places mentioned in the purchase order and/or the special conditions of purchase.

The Contractor declares:

- to be in full compliance with social and tax legislation in force at the place of performance of the services.
- to vouch for the good behaviour of its staff and of the staff of its potential subcontractors.
- not to be subject to collective proceedings
- not to be subject to international sanctions (OFAC, EU, or others).

Article 3.1 - Delivery of goods**3.1.1. - Deadlines**

As an obligation of result, the Contractor, upon receipt of the Purchase Order from the Contracting Authority, undertakes to take charge of the supply, transport and delivery of the Goods ordered, the completion of export and import customs formalities and to pay the duties and taxes related to these operations interpreted on the basis of the latest INCOTERMS. The Goods shall be delivered to the Contracting Authority by a carrier chosen by the Contracting Authority/Contractor.

3.1.2. - Reception

Once delivery has been duly made by the Contractor, the Contracting Authority shall sign the delivery note (hereinafter the "Delivery Note") submitted by the carrier.

Under the terms of this Delivery Note, the Contracting Authority is only required to check the appearance of the parcels upon delivery and their number, and if necessary to address to the carrier, within two (2) working days, excluding public holidays, by registered letter with acknowledgement of receipt or any written means proving delivery, the reservations provided for in Article L.133-3 of the French Commercial Code.

The Contracting Authority or the Beneficiary, understood as the beneficiary of the purchase, rental or delivery of Goods or the performance of Services, has a maximum period of fifteen (15) working days following the date of delivery to unpack, test the functioning of the Goods delivered and formally accept them, by signing, where applicable, an acceptance report without reservation, or refuse them and request the return of the defective Goods so that they can be replaced or, where applicable, reimbursed.

The Goods are delivered and accompanied by their associated documentation (including a user manual) in French and English.

3.1.3. - Transfer of ownership and transfer of risk

The Goods shall become the property of the Contracting Authority or the Beneficiary upon signature of the Delivery Note or, where applicable, of the acceptance report without reservation by the Contracting Authority. The risks shall be transferred upon delivery of the Goods at the place of destination subject to any deterioration that may be caused to the Goods, by the Contractor or its subcontractors, after delivery.

3.1.4. - Warranty

The Contractor warrants that the Goods delivered are in conformity with their associated documentation, function in accordance with the characteristics described in the Special Conditions and their associated documentation and are suitable for their intended use.

Unless otherwise specified in the Special Terms and Conditions and/or the Purchase Order, the duration of the contractual warranty is twelve (12) months starting from the date of delivery or signature of the acceptance report without reservation of the corresponding Good. The contractual warranty consists, at the choice of the Contracting Authority, in a commitment to replace or repair free of charge the defective Goods delivered, regardless of the reason for the non-conformity (in particular a defect in quality or operation). The Contractor shall bear all corresponding costs, including transportation costs. The Contractor undertakes to carry out the replacement or repair within seven (7) calendar days of receipt, by the Contractor, of the Contracting Authority's notification of the defects found. If the Contractor fails to comply with its obligations in this respect,



the Contracting Authority reserves the right to perform or have performed by a third party at the Contractor's cost and risks, after having given it, formal notice to perform, without prejudice to the application of Article 13 of the General Conditions.

The aforementioned warranties apply to any Goods repaired or replaced for a further period of twelve (12) months.

The Contractor shall also repair any harmful consequences of such defects or damage and provide the Contracting Authority with such a guarantee.

In addition, the Contractor shall remain liable, in accordance with ordinary law, for any hidden defect of the Goods that may appear.

The Goods shall be delivered in compliance with European and national regulations and current health, safety and environmental standards and in particular with regard to dangerous substances and preparations, waste, electrical protection, radio-frequency, electromagnetic, ionising, optical and vibration radiations.

The Contractor undertakes to inform the Contracting Authority of any failure to comply with these regulations and shall compensate the Contracting Authority for any consequences resulting from the Contractor's failure to comply with the obligation described in this Article.

The Contractor shall provide the Contracting Authority with a bank warranty equivalent to five (5) percent (%) of the Contract Price as security for performance. This warranty shall be annexed to the Contract.

Article 3.2 - Conditions for performance of Services

3.2.1. - Quality of Services

Unless otherwise stipulated in the Special Conditions and/or the Purchase Order, as a strengthened obligation of means (the burden of proof being on the Contractor), the Contractor undertakes to perform the Services in a professional manner, in strict compliance with the rules of the trade, applicable to the type of services entrusted to the Contractor.

The Contractor undertakes to implement, at its own expense, adequate technical and human resources in order to ensure the perfect execution of the Services entrusted to it. In this respect, the Contractor shall define, under its responsibility, the resources, tools, methods and means of execution necessary for the performance of the Services.

The Contractor undertakes to comply with the technical information and the schedule established by the Contracting Authority.

3.2.2. - Continuity of Services and Contractor's team

In general, the Contractor warrants perfect continuity in the performance of the Services.

The Contractor shall be solely responsible for defining the type(s) of personnel profiles required and for designating the team members assigned to the performance of the Services and warranty their competence and experience for the performance of said Services.

The Contractor undertakes:

- to inform the Contracting Authority of the absence, leave or unavailability of one of its staff members, as soon as it is known.

- to replace, as soon as possible, the unavailable intervener with a person having equivalent technical skills and qualifications,
- to ensure that the change of participant does not interrupt the proper performance of the Services, by organising, at its own expense, a transition period in order to inform the replacement on the progress of the services,
- to ensure that the change of intervener does not affect the deadlines for performance of the Services,
- and to ensure full reversibility.

3.2.3. - Receiving Operations - Recipe

With respect to the Services which must be validated by the Contracting Authority, the Parties agree to carry out an acceptance test in accordance with the stipulations set out in the Special Conditions and/or the Purchase Order in order to check the conformity of the Services performed by the Contractor with its commitments defined in the Contract.

No receipt shall be deemed to be tacitly pronounced, only the signing of an acceptance report without reservation and duly signed by an authorised representative of the Contracting Authority may constitute a receipt. In particular, any use of the Services in whole or in part shall not be deemed to be revenue. Furthermore, acceptance shall only be declared if the documentation associated with the Services, where appropriate, has been submitted to the Contracting Authority.

In the absence of a specific acceptance procedure, the Contracting Authority shall, at its discretion, check the quality of the Services performed and, if they do not comply with the rules of the trade or the conditions stipulated in the Contract, the Contracting Authority shall ask the Contractor to bring the Services into conformity at its own costs and expenses, without prejudice to the provisions of Article 13 of the General Conditions.

The Contractor shall be responsible for the quality of the Services and shall set up a quality management system adapted to the methods and criteria defined by the technical documents, standards and specifications of which the Contractor has taken cognisance prior to the conclusion of the Contract.

Article 4 - Execution, time limits for execution, cancellation

The deadlines for performance of the Contract shall be set by mutual agreement with the Contractor and shall be systematically stipulated in the Special Conditions and/or the Purchase Order. The date set for delivery, which is indicated on the Special Conditions and/or the Purchase Order, is binding.

Any event which may influence the performance of the Contract shall be immediately brought to the attention of the Contracting Authority. The Contractor shall immediately notify the Contracting Authority in writing of any such event, as well as its probable duration and its consequences on delivery times.

However, in the event of any extension of the deadline for delivery of the Supplies accepted by the Contracting Authority, the Contractor undertakes to pay a compensation equal to 1% per fortnight of delay, calculated on the amount of the undelivered goods (purchase price excluding VAT), to the Contracting Authority. These sums shall be due without formal notice and shall be paid in the form of a credit note.



In the event of non-compliance with the delivery dates of the Goods and/or performance of the Services, the Parties agree, within the Special Conditions, on a mechanism for late payment penalties that the Contracting Authority may apply to the Contractor in accordance with Article L.441-6 of the French Commercial Code, except in the event of Force Majeure. Where applicable, the principle, amount and terms of application are specified in the Special Conditions. The amount entered is (i) an estimate made initially and determined after discussions with the Contractor so that it can check the materiality of the facts complained of and (ii) implies the existence of a damage sustained by the Contracting Authority. The application of penalties for delay excludes any other claim for damages based on the same ground and is independent of other rights to which the Contracting Authority may be entitled and other sanctions to which the failure of the Contractor may give rise.

Article 6 - Financial conditions

The remuneration agreed in consideration of the perfect performance of the obligations due under the Contract, is an amount in Euros/Dollars, exclusive of taxes, global, fixed, firm and non-revisable as provided for in the Special Conditions and/or in the Purchase Order and shall be understood, for Supplies delivered to the specified delivery place, free of carriage and packaging and of all duties and taxes. This amount remunerates the Contractor for all its costs, disbursements, charges, hardships and/or obligations of any kind.

Any additional costs of any nature whatsoever shall be subject to the prior agreement of the Contracting Authority in writing specifically indicated on the Purchase Order.

No payment will be made for work, meetings, research and studies required to enable the Contractor to respond to invitation to tender, unless expressly agreed in writing.

The orders shall not give rise to any payment of a deposit, the Contracting Authority also reserves the right to request the Contractor to provide security for tenders and/or performance.

The Contractor may issue its invoices after the Contracting Authority has issued an acceptance report..

Invoices shall be drawn up by the Contractor and must comply with the regulation and legislation in force on the date of issue, include the mandatory legal notices, mention the order number, the nature of the Services performed and/or the Goods delivered as well as the unit price and quantities and be accompanied by all the supporting documents necessary to verify the validity of their content. The Parties acknowledge that the invoices thus transmitted shall have the value of an original.

Unless otherwise expressly specified on the Order, the price is payable forty-five (45) days after the end of the month in which the Order is issued, in accordance with French Law.

Late payment by the Contracting Authority shall lead to the application as of right of default interest set at three times the legal interest rate in force and of the recovery indemnity set at forty (40) euros in accordance with Article D.441-5 of the Commercial Code.

By express agreement and in compliance with the provisions of article L.442-6 of the French Commercial Code, the Contracting Authority shall set-off the sums owed by the Contractor to the Contracting Authority against the sums owed to the Contractor or any assignee by the Contracting Authority, which shall be accepted by the Contractor in full knowledge of the facts. Such set-off shall be made in accordance with the due dates of the

debts and claims of each of the Parties and after prior information and authorisation from the Contractor.

Article 7 - Duty to advise

The Contractor has a duty to advise, warn and inform the Contracting Authority on an ongoing basis, and undertakes in this respect to:

- advise the Contracting Authority on the choice of technical solutions to be put in place to honour the Contract,
- request any information or data it deems necessary to honour the Contract,
- check the documents or technical information provided to it by the Contracting Authority to ensure that they are consistent and complete under the Contract,
- warn the Contracting Authority of any anomaly or omission,
- notify the Contracting Authority in writing as soon as it becomes aware of any factor, event or act likely to affect the proper performance of its obligations under the Contract,
- propose to the Contracting Authority any additions, improvements or adaptations which it considers desirable,
- warn the Contracting Authority where the choices it might make, of which the Contractor has been informed in writing by the Contracting Authority, might conflict with the objectives pursued or might result in a deterioration or a failure to comply with the expected quality, performance and functionality,
- keep the Contracting Authority informed of developments in the state of the art relating to the Contract,
- inform the Contracting Authority of any legal or regulatory obligations of a foreign country to which the Contractor may be subject and which would have an impact on the Contract.

Although the Contracting Authority has technical knowledge, it cannot be considered as a professional with the same speciality as the Contractor. The Contractor shall inform the Contracting Authority of any incident or analysis revealing risks associated with the use of the Supplies delivered. Each of the Parties undertakes to designate one of its employees to act as the other Party's privileged contact to ensure the monitoring of the Contract. The Contractor's privileged contact person shall have the skills and authority required to receive the Contracting Authority's observations on the performance of the Contract and to take appropriate action. The Contractor's employees shall only be subject to the Contractor's hierarchical authority; it being specified that the appointment of an employee of the Contracting Authority to monitor the Contract shall not constitute a limitation or derogation from the exercise of that authority.

Article 8 - Status of the Contractor's personnel

The Contractor's personnel shall in all circumstances remain under the administrative control and under the hierarchical and disciplinary authority of the Contractor, and no transfer of authority should occur throughout the performance of the Contract.

The Contractor shall ensure that its personnel strictly complies with all the terms and obligations of the Contract. In particular, if Services are performed on the premises of the Contracting



Authority, the Contractor's personnel must comply with the applicable code of conduct, internal rules and the health, safety and control rules in force within the Contracting Authority (hereinafter the "Internal Regulations"), and the Contractor expressly acknowledges being aware of said internal rules. The Contracting Authority reserves the right, at any time and without prior notice, to carry out or have carried out any control for the purpose of verifying the Contractor's compliance with the internal code of conduct and rules, which the Contractor expressly accepts. In the event that the Contracting Authority finds that the Contractor is not complying with one or more internal rules, the Contracting Authority may as of right and at its discretion, suspend all or part of the Services (if any) and all or part of the corresponding payments until the Contractor complies with the internal rules and/or terminates the Contract under the conditions defined in Article 14 of the General Conditions. For the purposes of this clause, the Contractor undertakes to cooperate fully and in good faith with the Contracting Authority or any third party indicated by the Contracting Authority. In this respect, the Contractor undertakes to facilitate access to any document, information, tool or any other element useful for the proper conduct of the inspection.

Article 9 - Dependence

The Contractor declares and acknowledges that it is not economically dependent on the Contracting Authority. The Contractor undertakes to inform the Contracting Authority in the event that its orders represent a share of the Contractor's turnover likely to place it in a situation of economic dependence within the meaning of positive law, as well as of any event that would change this situation. If so, the Parties shall meet to find a solution that protects their respective interests. The Contractor acknowledges, in any event, that throughout the term of the Contract, it shall retain and shall be solely liable in the event of insufficient diversification of its customer portfolio.

Article 10 - *Intuitu personae* and subcontracting

The Contract is concluded *intuitu personae*. Consequently, the Contractor shall not, without the prior consent of the Contracting Authority in writing, subcontract, assign, contribute or transfer, in any form whatsoever, all or part of the Contract, in particular and without limitation, by way of merger, demerger, partial contribution of assets, universal transfer of assets, management lease and, more generally, any operation the purpose or effect of which is to transfer the Contract.

As soon as it envisages the intervention of a sub-contractor, the Contractor shall, in order to obtain its prior approval in writing, communicate to the Contracting Authority, the social, banking, postal and technical references of the sub-contractor, the name of the subcontractor's legal representatives – and, more generally, any information needed to verify the subcontractor's eligibility, the terms of payment granted to the sub-contractors, a copy of the Contractor's commitment, and the tasks that it intends to sub-contract.

In addition, the Contractor shall provide the Contracting Authority with the Contractor questionnaire duly completed by the subcontractor. Notwithstanding, the Contracting Authority reserves the right to refuse to approve a subcontractor without reason, except in case of abuse.

The Contracting Authority may terminate as of right all Orders held by the Contractor in the event of failure to fulfil this obligation.

In the event of a transfer of shares or assets or a change of effective direct or indirect control of its company, the Contractor shall inform the Contracting Authority, which may terminate the contractual relationship as of right and without notice.

In the event of authorised subcontracting, the Contractor shall remain solely liable to the Contracting Authority and shall warranty compliance with these General Conditions by the subcontractors concerned.

Article 11 - Liability and insurance

The Contractor shall be liable to the Contracting Authority, without restriction or reservation, for the full performance of its obligations under the Contract, and for all consequences that may arise therefrom under the conditions of ordinary law. The assistance that the Contracting Authority may provide to the Contractor in the performance of the Order and the payment of invoices by the Contracting Authority shall in no way affect this liability. Consequently, the Contractor undertakes to compensate any damage caused to the Contracting Authority or the Beneficiaries.

Any clause limiting the Contractor's liability contained in the Contractor's general conditions or in any other similar document usually used by the Contractor shall be deemed to be unwritten for the performance of the Contract.

The Contractor must hold insurance policies, with a reputedly solvent company, covering its civil operating and professional liability for a sufficient amount against the pecuniary consequences of civil liability that may incur in the event of personal injury, intangible, material and immaterial damage, whether consequential or not, caused to the Contracting Authority or any third party, as a result of its studies and/or products ; the Contractor shall provide the Contracting Authority, as soon as the Purchase Order has been issued, with proof of insurance coverage of these risks and the amount thereof. The Contractor undertakes to maintain these insurance policies in force for as long as it has any obligation under the Contract.

In addition, the Contractor shall hold insurance policies covering its post-delivery liability (or product liability) with a reputedly solvent insurance company and shall provide the Contracting Authority, not later than the date of delivery of the Supplies, with proof of insurance coverage of this risk and the amount thereof.

The fact of having such insurances shall not in any way relieve the Contractor of its liability, in particular with respect for damage not covered by its insurance or for damage in excess of the sums guaranteed by its insurance.

At the request of the Contracting Authority, the Contractor shall provide it with proof of general and professional civil liability insurance, dated less than six months prior to the date of the request. In all cases, the Vendor shall, at the request of the Contracting Authority, provide adequate insurance covering the products until their arrival at the buyer's premises or any other destination approved by him.

Article 12 - Force majeure

Any occurrence of Force Majeure, i.e. any event beyond the control of the Parties, which could not reasonably have been foreseen at the time of the conclusion of the Contract and whose effects cannot be avoided by appropriate measures in



accordance with Article 1218 of the French Civil Code, in other words any unforeseeable and irresistible event, shall suspend the performance of the obligations of the Contracting Authority and the Contractor for the duration of the Force Majeure situation.

In the event of Force Majeure, it shall be the responsibility of the Party concerned to take action at the earliest opportunity after the occurrence of the event or it may no longer invoke it:

- to notify the other Party, by registered letter with acknowledgement of receipt or any written means proving the delivery, of the occurrence of the event, justifying its Force Majeure nature;
- to indicate its foreseeable duration;
- to inform the other Party of the measures taken or which it intends to take to mitigate the effects of the event.

In this way, the Party concerned shall do its utmost to alleviate the difficulties encountered and implement the necessary means to resume the continuation of the Contract under the best conditions.

The performance of the obligations concerned by the Force Majeure event is then suspended for the duration of the said Force Majeure event and then resumes, without prejudice to any request for termination provided for in Article 14 of the General Terms and Conditions.

Article 13 - Duration

The Contract is concluded for the duration specified in the Special Conditions and/or in the Purchase Order.

Any extension or renewal of the Contract shall imperatively give rise to the signature of an amendment and/or a new Purchase Order by the Parties.

Article 14 - Termination -Resolution

In the event of non-performance by one of the Parties of any of its obligations, the other Party may send it a formal notice by registered letter, with acknowledgement of receipt or any written means proving the delivery, requiring it to fulfil its obligation within a period of fifteen (15) days and stating that, failing this, it is entitled to terminate the Contract. If, at the end of this period, the non-performance by the defaulting Party persists, the other Party shall notify it of the as of right termination of the Contract by registered letter with acknowledgement of receipt, specifying the reasons thereof, without prejudice to any claim for damages to which it may be entitled.

If an event of Force Majeure continues for more than thirty (30) consecutive days, a Party shall notify the other Party, by registered letter with acknowledgement of receipt or any written means proving the delivery, of the as of right termination of the Contract with effect from the date on which the notification is sent.

A Party is entitled to terminate the Contract for non-performance, from prior to the date on which a Party performs it, if it is clear that there will be an essential non-performance on its part.

In the event of early termination of the Contract, the rights on the Supplies delivered to the Contracting Authority shall remain definitively vested in the Contracting Authority under the terms and conditions set out in the Contract. The sums due to the Contractor for the Supplies already delivered and/or completed shall nevertheless remain definitively vested in the Contractor.

Supplies not yet delivered shall be delivered to the Contracting Authority, upon request of the latter, in a usable form as specified by the Contracting Authority within ten (10) days of the termination of the Contract.

In the event of failure to deliver, the Contractor shall reimburse the Contracting Authority for the sums already received. In the event of timely delivery, and subject to acceptance of such delivery, the agreed price for delivery shall be paid by the Contracting Authority.

In any event, the Contracting Authority shall be at liberty to entrust to any third party the unfulfilled part of the Services, which the Contractor expressly acknowledges and accepts.

After termination of the Contract, a Party may recover sums paid for a Service which it has not received or has legitimately refused.

Article 15 - Non-waiver

The fact that one of the Parties does not enforce any of its rights or require the performance of any of the obligations or responsibilities of the other Party under the Contract shall not in itself be considered as a waiver of the Party's rights, obligations and responsibilities under the Contract.

Failure by the Contracting Authority to invoke any of the provisions of the GCP at any time shall not be deemed a waiver of the right to invoke the same provisions at a later date.

Article 16 - Independence of the Parties

Neither Party may make a commitment in the name and on behalf of the other Party. Thus, each of the Parties undertakes not to do anything that might mislead a third party in this respect, nor to make any commitment or offer any warranty in the name of the other Party.

Article 17 - Electronic signature

In accordance with Law N°. 2000-230 of March 13th 2000 in its consolidated version adapting the law of evidence to information technology and relating to electronic signatures, as well as the United Nations Convention on the Use of Electronic Communications in International Contracts of 2005, the Parties expressly agree that the Contract may be concluded in the form of an electronic writing. They agree that such a document shall have the force of an original and that it shall be drawn up and stored by the Contracting Authority in such a way as to permit its signatories to be duly identified and to guarantee its integrity. The Parties undertake not to contest its validity, admissibility, enforceability or probative value on the basis of its electronic nature.

The Parties agree to use an electronic signature process known as "on-the-fly", by means of a single-use electronic certificate that constitutes a reliable identification process guaranteeing its link with the act to which it is attached, in accordance with Article 1367 of the French Civil Code. The Contracting Authority proposes to use the process at its disposal within the framework of its partnership with a third party service provider as referred to in Regulation (EU) N° 910/2014 of the European Parliament and of the Council of July 23rd 2014 on electronic identification and trusted services for electronic transactions in the internal market (eIDAS).

Article 18 - Notices and means of communication



All notices and other means of communication necessary or permitted between the Parties shall be in writing and sent by mail and/or e-mail and/or fax to the address or number mentioned in the Contract. No communication shall be considered effective until it has been delivered and confirmed by acknowledgement of receipt for mailings and/or until receipt of a confirmation of uninterrupted transmission in relation to the transmission report for e-mailings. The Parties may change their addresses and/or numbers by giving at least a fifteen (15) day notice in writing to the other Party. Such notice shall be given in accordance with the above provisions.

Article 19 - Intellectual property

The software, documentation, any item protected by an intellectual property right and any technical or other information belonging to the Contracting Authority and made available to the Contractor are and remain the exclusive property of the Contracting Authority and may not be used by the Contractor for any purpose other than the strict performance of the Contract.

At the request of the Contracting Authority or upon termination of the Contract for any reason whatsoever, the Contractor undertakes to return automatically and immediately to the Contracting Authority all documents and items of any kind entrusted to it under the Contract. The Contractor undertakes not to keep any copies thereof.

The Contractor retains ownership of the intellectual property rights to its standard methodologies and tools acquired or developed by it prior to the entry into force of the Contract, which constitute its know-how. In this respect, the Contractor grants the Contracting Authority, without additional remuneration, a right to use the said tools and/or know-how incorporated in the results of the Services, for the needs and duration of use of the said results.

[Note: for clauses concerning the assignment of intellectual property, these shall be incorporated in the Special Conditions].

Article 20 - Confidentiality

It is understood by the Parties that the following will be treated as strictly confidential under the Contract:

- all of the provisions of the Contract;
- all information of any nature whatsoever, communicated or disclosed by the Contracting Authority to the Contractor either in written or oral form in connection with the negotiation or performance of the Contract;
- all information of any nature and in any form whatsoever to which the Contractor may have access under the Contract, whether or not indicated as confidential.

Consequently, the Contractor undertakes to keep such information strictly confidential and shall not communicate it to anyone other than those entitled to know it under the Contract. The Contractor further undertakes to solely use such information for the purpose of performing the Contract.

The Contractor vouches for the compliance of its employees and any subcontractors with this confidentiality agreement.

This confidentiality undertaking shall remain valid for the entire duration of the Contract and for a period of ten (10) years after the termination of the Contract for any reason whatsoever.

This confidentiality undertaking does not apply to information (i) that has entered the public domain prior to the date of its disclosure or communication; (ii) that falls into the public domain after its communication and/or disclosure without the cause being attributable to one of the Parties; (iii) that has been legitimately obtained from a third party to the Contract without breach of an obligation of confidentiality; (iv) that is developed by one of the Parties independently of the Contract without breach of an obligation of confidentiality.

This confidentiality undertaking also does not apply with respect to tax, administrative and judicial authorities, as well as accountants and auditors, the latter being bound by an obligation of confidentiality towards their clients.

Any communication to the public, press article, commercial reference, exhibition or advertisement of any kind whatsoever, displaying the name or logo of the Contracting Authority or referring to the Contract may not be made without the prior consent of the Contracting Authority by writing.

Article 21 - Protection of personal data

20.1 Processing of personal data in the context of training and performance of the Contract

The Contractor is hereby informed that the Contracting Authority shall process the personal data of the Contractor's servants, managers, subcontractors, agents and/or service providers in order to enable it to ensure the formation and performance of the Contract, revenue operations, Contract management and invoicing. This data is necessary for the proper management of the Contract.

Similarly, the Contracting Authority may implement a verification process for the Contractor's managers to ensure that there is no conflict of interest, financing of terrorism or anti-money laundering.

In this context, data subjects have a right of access and, where appropriate, of correction, deletion or portability of the data concerning them. They also have the right to define guidelines on the fate of their personal data after their death.

Furthermore, data subjects may oppose for legitimate reasons the processing of their personal data, withdraw or limit their consent.

These rights may be exercised at any time by writing to the Contracting Authority at the following address:

dpo@acted.org

Data subjects have the possibility to lodge a complaint with a supervisory authority.

The Contractor undertakes to inform its servants, managers, subcontractors, agents and/or service providers of these rights.

20.2 Processing of personal data carried out on behalf of the Contracting Authority

The Contracting Authority, within the framework of its activity, implements processing of personal data within the meaning of Law N°. 78-17 of January 6th 1978 on Data Processing, Data Files and Individual Liberties ("Law N°. 78-17") and of the General Data Protection Regulation ("GDPR").

By this Contract, the Contractor may be required to process personal data on behalf of the Contracting Authority in order to provide the Supplies subject to the Contract to the Contracting Authority.



In this case, the Contracting Authority is the controller of the processing and the Contractor acts as a subcontractor. The Parties then undertake to conclude a data processing agreement in accordance with Article 28 of the GDPR.

Article 22 - Non-solicitation of personnel

Unless expressly agreed otherwise, the Contractor and the Contracting Authority undertake not to hire or 'poach' any staff or collaborators of either Party involved in the performance of the Contract during the entire period of performance of the Contract and for two (2) calendar years following the termination of the contractual relationship.

In the event of non-compliance with this obligation, the offending Party shall pay the other Party, as a penalty clause, a compensation equal to twelve times the last salary, plus employer's charges, of the employee unduly 'poached'.

Article 23 - Ethics and compliance with regulations

The Contractor undertakes in the conduct of its business to respect ACTED's ethical values, in accordance with ACTED's Code of Conduct, organisational policies and reporting mechanism (available on <https://www.acted.org/en/about-us/values-and-policies/code-of-conduct-and-policies/>), to adopt a socially responsible approach and to comply with the laws and regulations of the countries in which they operate, as well as with the principles of the UN Global Compact aimed at respecting human rights, international labour standards, the environment and the fight against corruption.

In particular, the Contractor shall refrain from any form of abuse or child labour, from supporting or financing any act of terrorism, any form of money laundering, any form of fraud and corruption and any conflict of interest.

The Contractor acknowledges that it is aware of these values and commitments and undertakes to respect them, which constitute an essential condition of the Contract.

The Contractor is informed of the existence of the Transparency mechanism (transparency@acted.org) and acknowledges its duty to use it whenever there is a suspicion of behaviour contrary to the ethical values of ACTED.

The Supplies ordered must comply in all respects with the legal and regulatory requirements in force, in particular as regards:

- quality, composition, presentation and labelling of goods;
- labour law and employment: in any case, the Contractor shall refrain from offering for sale products that could have been manufactured by minors;
- provisions of international conventions on the rights of the child and, more particularly, those relating to child labour;
- environmental law;
- privacy, personal data, biometric data, data protection and confidentiality of communications.

In particular, the Contractor undertakes to comply with the legal and regulatory provisions in force applicable to him/her, and to provide the Contracting Authority on request with information relating to the consequences of the company's activity on the environment, given according to the nature of this activity and its effects:

- water resource consumption, raw materials and energy resources with, where appropriate, the measures taken to improve energy efficiency and the use of renewable energies, land use conditions,

- discharges into the air, water and soil seriously affecting the environment, the list of which will be determined by Environment and Industry Ministers' orders, noise or odour nuisance and waste;
- measures taken to limit biological balance, natural environment and protected animal and plant species damage;
- evaluation or certification procedures undertaken with regard to the environment; the measures taken, where applicable, to ensure the compliance of the Contractor's activity with the legal and regulatory provisions applicable in this regard;
- expenses incurred to prevent Contractor activity consequences on the environment; the existence within the company of internal environmental management services, employees training and information on this latter point, resources devoted to reducing environmental risks as well as the organization set up to deal with pollution accidents with consequences reaching beyond the company's establishments;
- the amount of provisions and guarantees for environmental risks, unless this information is likely to cause serious prejudice to the Contractor in an ongoing dispute;
- the amount of compensation paid during the financial year in execution of a judicial decision concerning environmental matters and the actions taken to repair the damage caused to it.

The Contractor shall be fully responsible for all consequences of its failure to comply with these provisions and shall bear all compensation costs to the Contracting Authority for all consequences resulting therefrom.

In accordance with the legal and regulatory provisions in force, the Contractor must provide the Contracting Authority with the following documents on the date of signature of the Contract, then systematically and regularly every six (6) months from the date of conclusion of the Contract until the end of its execution:

- an identification card proving registration in the trade register or an extract of the registration in the Trade and Companies Register of less than three (3) months (extract K or KBIS);
- a certificate of provision of social declarations and payment of social security contributions from the social protection institution in charge of collecting social security contributions and Contractor contributions, of less than six (6) months and containing the following information: the security code for checking its authenticity, its validity, the number of employees employed, the basis of remuneration declared on the last social security contributions summary sent to the collection agency;
- the sworn statement by virtue of which the Contractor certifies that it does not use undeclared work as defined in Articles L.8221-1 et seq. of the French Labour Code, of less than six (6) months;
- the certificate on honour pursuant to Articles L.8251-1, L.5221-8 and L.5221-9 of the Labour Code, indicating whether the Contractor intends to call upon employees of foreign nationality for the performance of the Contract and, if so, the list of names of the foreign employees subject to possession of a work permit, of less than six (6) months, indicating for each



- employee: his date of hiring, his nationality and the serial number of the title tantamount to work permit;
- all certificates of insurance as referred to in particular in Article 11 of the General Conditions, of less than six (6) months.

The Contracting Authority reserves the right to suspend payments due pursuant to the Contract in case of failure to communicate one or more elements as referred to after a formal notice which has remained unsuccessful for ten (10) days from its receipt by the Contractor.

If applicable, the Parties undertake to set up a prevention plan, in accordance with Articles R. 4511-1 et seq. of the Labour Code.

The Contractor warrants and undertakes to fully compensate the Contracting Authority for all financial consequences resulting from any claim or action of any nature whatsoever brought by a third party based on a breach by the Contractor of its obligations or warranties in accordance with this Article. The Contracting Authority shall inform the Contractor as soon as it is aware of any claim or action directly or indirectly involving the Contractor and/or the Supplies and/or Results and shall provide the Contractor with all information or documents in its possession relating to such claim or action.

The Contractor agrees that the Contracting Authority may conduct audits made by itself or by a service provider appointed for this purpose in order to verify compliance with the above-mentioned standards. Any infringement of the above provisions shall expose the Contractor to immediate termination of the business relationship without notice.

Article 24 – Fight against money laundering and terrorist financing (AML/CFT)

The Parties undertake to comply with all regulations concerning AML/CFT.

The Contractor undertakes to provide any document attesting to its good faith at the request of the Contracting Authority, proving its attachment to these regulations. Contractor's employees, subcontractors and other intermediaries are subject to these same regulations and requirements.

The Contractor warrants the Contracting Authority's liability throughout the duration of the Contract. Failure to comply with these regulations shall constitute a legitimate reason for the termination of the Contract in accordance with Article 14 of the General Conditions.

Article 25 - Audit

The Contracting Authority reserves the right to audit the Contractor and, where applicable, its subcontractors at least once (1) during the term of the Contract, by itself or through a third party not in direct competition with the Contractor, designated by it, in order to verify compliance by the Contractor and its subcontractors with all the conditions described in the Contract.

In this respect, the Contractor undertakes to allow the Contracting Authority, or the third party designated by the Contracting Authority, free access to the premises.

For its part, the Contracting Authority undertakes to ensure that the audit is limited to strict checks on the conditions of Contract performance of the Contract at the Contractor's premises and that it takes place over a reasonable period of time, in order to

avoid disrupting the Contractor and/or any potential subcontractors' activity.

At the end of the audit, the Contracting Authority shall draw up a detailed report of its findings and send it to the Contractor within eight (8) working day delay. The Contractor itself has a period of eight (8) working days following receipt of the report to contest the conclusions thereof, if any.

If the audit reveals any violation of the conditions described in the Contract, the Contracting Authority may choose (i) to suspend performance of the Contract and all or part of the corresponding payments until the Contractor regularises the situation found - the period for regularisation being assessed beforehand at the Contracting Authority's discretion in the light of the extent of the compliance operations to be carried out - being specified that suspension may only take place if the violation revealed by the audit is sufficiently serious and is notified to the Contractor by the Contracting Authority as soon as possible and/or (ii) to terminate the Contract under the conditions defined in Article 14 of the General Conditions. The financial burden of the audit shall be borne by the Contractor in the event that a breach of the conditions described in the Contract is found.

The Contractor shall vouch for its employees and any potential subcontractors comply with this Article.

Articles 26 - Good faith and co-operation of the Parties

The Parties are required to comply with the requirements of good faith in international trade throughout the duration of the Contract. They can neither exclude this obligation nor limit its scope.

The Parties have a duty to co-operate with each other when reasonably expected to do so in performing their obligations.

A Party may not act inconsistently with an expectation it has created in the other Party where the latter has reasonably believed in that expectation and has acted consequently to its disadvantage.

Article 27 - Embargo

This Contract shall apply in accordance with and take into account the regulations governing embargoes in force in the country(ies) where the Contract is executed. The Contractor declares she or he is aware of these regulations and their latest updates.

The Contractor shall ensure that its activity complies with these regulations, as well as that of its potential subcontractors, and any intermediary linked to the performance of the Contract.

The Contractor warrants the Contracting Authority's liability throughout the duration of the Contract. Failure to comply with these regulations constitutes a legitimate reason for terminating the Contract.

Article 28 - Partial invalidity

If one or more of the provisions of this Agreement are considered invalid, void, unwritten, unenforceable or purposeless, or declared as such by a final judgment of a competent Court or by a law or regulation enacted or to be enacted by a legislative or governmental authority, the remaining provisions of this Contract shall remain in full force and effect.

Thus, this clause is deemed to be unwritten and may not affect the validity or continuation of the Contract as a whole, unless it



is a clause that was of a decisive nature for one of the Parties on the date of signature of the Contract. In that case, the Parties shall negotiate in good faith in order to substitute a valid clause reflecting their original intention to the initial clause.

Article 29 - Modifications of the General Conditions clauses

The Contracting Authority reserves the right to modify its General Conditions, and therefore to modify the terms accepted by the Contractor. In this case, the Contracting Authority is obliged to inform the Contractor at least one (1) month before the date on which new General Conditions enter into force. This information specifies:

- the effective date of the new General Conditions;
- the possibility for the Contractor to terminate the Contract without termination penalty and without any right to compensation, up to four (4) months after the last amendment entry into force.

Only after this period upon their entry into force, and provided that the Contractor has not called into question the amendments or terminated the Contract, the General Conditions amendments shall be deemed to have been accepted by the Contractor.

The Contracting Authority undertakes to provide the Contractor with updated General Conditions upon request.

In the absence of any contrary provision in the Contract, no modification of the Contract shall be valid unless it is mentioned in a written document signed by the Parties.

Article 30 - Applicable law and jurisdiction

THIS AGREEMENT IS GOVERNED BY FRENCH LAW AND AMENDMENTS THERETO.

IN THE EVENT OF A DISPUTE RELATING TO VALIDITY, INTERPRETATION, PERFORMANCE OR TERMINATION ON ANY CAUSE WHATSOEVER OF THE CONTRACT THAT THE PARTIES CANNOT SETTLE AMMICABLY, THIS ONE IS SUBJECT TO THE EXPRESS AND EXCLUSIVE COMPETENCE OF THE FIRST INSTANCE COURT OF PARIS, NOTWITHSTANDING THE PLURALITY OF DEFENDANTS, INCIDENTAL REQUEST, EMERGENCY PROCEEDINGS OR CALL IN WARRANTY.

Name: _____
(company's legal representative or any other authorized person)

As: _____
(position in the company)

Duly authorized to signed on behalf of the Contractor:

Signature :



**BIDDER'S CHECK LIST ACTED Lebanon**

Date:

Tender N°: T / 11 / EKA / D65 LTR / TRIPOLI/ 18-08-2023

BEFORE SENDING YOUR BIDDING DOCUMENTS, PLEASE CHECK THAT EACH OF THE FOLLOWING ITEMS ARE COMPLETE AND RESPECTS THE INSTRUCTIONS TO BIDDERS CONDITIONS:

| # | Description | To be filled in by Bidder | | For ACTED use only (to be filled in by Purchase Committee) | | |
|----|--|---------------------------|----|--|----|----------|
| | | Included | | Present | | Comments |
| | | Yes | No | Yes | No | |
| 1 | The present Instructions to Bidders (PRO-05) signed & stamped by the Bidder | | | | | |
| 2 | An original Offer Form (PRO-06) dated, filled, signed & stamped by the Bidder (<i>detailed as per the requested currency USD</i>) | | | | | |
| 3 | The Supplier Questionnaire Form (PRO-06.1) dated, filled, signed & stamped by the Bidder | | | | | |
| 4 | ACTED Ethical Declaration (PRO-06.2) dated, filled, signed & stamped by the Bidder | | | | | |
| 5 | The Bidder's official registration documents | | | | | |
| 6 | A copy of the Bidder's legal representative ID or passport | | | | | |
| 7 | ACTED's General Conditions for Purchase signed & stamped by the Bidder | | | | | |
| 8 | Datasheets requested in the Offer Form (PRO-06) in a separate sealed envelope (if relevant) | | | | | |
| 9 | The Bidder's Checklist (PRO-06.3) dated, filled, signed & stamped by the Bidder | | | | | |
| 10 | Temporary Insurance Value: 60,000 USD (Sixty Thousand USD only) either as Bank guarantee or as a Bankers check. | | | | | |
| 11 | List and C.V of the Key personnel working on the project | | | | | |
| 12 | Proofs of past performances in a similar field of activity (eg past deliveries of similar items) recommendation letters must be added) | | | | | |
| 13 | To submit signed copies for the General and particular specs, BoQ and drawings for Tleil reservoirs | | | | | |
| 14 | Detailed work plan | | | | | |
| 15 | List of Owned equipment | | | | | |
| 16 | Safety Procedures plan | | | | | |





ACTED

LOGISTICS
PRO-06.3
Version 01/2022



| | | | | | | |
|----|--|--|--|--|--|--|
| 17 | Signed Attendance sheet to site visit | | | | | |
| 18 | Attestation of third party liability for the whole duration of works and liability period dating less than 3 months. | | | | | |
| 19 | A copy of valid quality assurances with relevant certificates dating less than 3 months | | | | | |

First & Last Name of Bidder's authorized representative: _____

Position of Bidder's authorized representative: _____

Authorized signature: _____





**REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOLIDARITÉS INTERNATIONALE**



**PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
WITH SAFE, RELIABLE, AND SUSTAINABLE WATER
SERVICES**

CONTRACT N°. CNT/SRV/LBN/WSH/001/21

**VOLUME 5
BILL OF QUANTITIES**

Part A Preamble to Bill of Quantities
Part B Bill of Quantities

MARCH 2023



Bureau Technique pour le Développement (BTD)

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PART A

PREAMBLE TO BILL OF QUANTITIES

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1.000 INTRODUCTION

1.010 GENERAL

The Bill of Quantities is not and does not purport to be either exhaustive or explanatory of all the obligations and duties of the Contractor who shall be deemed to have satisfied himself as to the correctness and sufficiency of the rates and prices entered by him in the Bill of Quantities all of which shall cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant or services or of contingencies) and all matters and things necessary for the proper execution and completion of the Works and the remedying of any defects therein and which may reasonably be inferred to be necessary for the Works as described in the Contract whether expressly mentioned therein or not.

1.011 ITEMS DESCRIPTION

A detailed description of the items and of the conditions under which and the manner in which the work is to be done and measured is not set out in each item of the Bill of Quantities. Reference should be made to this Preamble and all other documents forming the Contract.

1.012 DEFINITIONS OF BILL OF QUANTITY CATEGORIES

The Bill of Quantities is specific for Civil Works.

The Civil Works shall include, but not be limited to, a complete topographic survey, excavation works, backfilling, concrete works, block works, cladding, plastering, waterproofing, metal works, glazing, painting, fencing, and all necessary works not mentioned above and needed for a good finishing and exploitation of the different structures.

1.013 RATES AND PRICES

The Contractor shall be deemed to have inserted against each item in the Bills such rates and prices as he may deem necessary to cover the requirements of the Contract. Where neither price nor rate is entered against an item or if the term "included" or any such similar term is used it shall be deemed to have been included in the other priced items in the BOQ and measured accordingly. All rates and prices entered against any item in the BOQ shall be deemed to include all the detailed requirements of the General and Particular Specifications.

Rates and prices shall be inserted in the unit rate column of the Bill of Quantities. Each part of the Bill of Quantities shall be totaled and the totals carried to the Summary and Grand Summary.

1.014 MEASUREMENT

The Bill of Quantities includes items as lump sum and others as measured quantities.

1.014.1 Lump Sum

The lump sum items shall not be subject to re-measurement, and shall include the prices for all necessary equipment, construction, installation, testing and commissioning among others. The lump sum entered in the Bills shall include the price for a complete installation as described in the specifications.

The prices shall include all work necessary for completion of the Works and shall include the prices for all necessary building work such as forming box outs, supports plinths, cable trenches, and the like and all necessary safety and access works including guards, handrails, firefighting equipment and the like.

1.014.2 Measured Quantities

All measurements in the Bill of Quantities are taken strictly net. The principle of net measurements shall apply to all Works executed. All quantities measured for payment shall be measured by the Contractor and checked and approved by the Supervisor on the basis of actual net quantities of Work fixed in position. Item not used shall neither be measured nor included by the Contractor in his statements.

The quantities given in the Bill are the estimated quantities. In no sense shall such quantities be considered as limiting or extending the amount of the work to be done by the Contractor and of the materials to be supplied by him. The Contractor shall be responsible for checking quantities and for making any necessary surveys and investigations prior to placing any order for materials.

1.015 DEFINITIONS

The following definitions shall apply to items in the Bill of Quantities.

- **Extra - Over**
Any “Extra-Over” (EO) item shall be measured and paid for in addition to the measurement of the basic item to which it relates.
- **Included**
Where the term included is used in the Preamble or in the Bills any items stated to be included within another item shall not be subject to measurement and their costs shall be deemed to be included within the rates of the billed item.

1.016 DEALING WITH WATER

Items in the Bills of Quantities shall be deemed to include the prices for dealing with water flows and keeping the Works free of water.

1.017 WATER AND POWER

Unless otherwise explicitly stated in the Contract, water and power for the purpose of constructing, cleaning, and testing the Works shall be provided by the Contractor at his own expense, and shall not be measured separately.

1.018 RECORDS AND “AS-BUILT” DRAWINGS

After the work has been completed, the Contractor shall furnish “as-built” drawings prepared whilst surveying during construction, showing the Works as constructed together with all other information that may either be required or be useful for the operation and maintenance of the Works in the future, such as type of soil, dimensions and location of structures, size of existing pipelines and cables encountered during excavation.

The cost of preparing the shop drawings and Records shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately. The As-built Drawings shall be submitted, if required by the Supervisor, on CD/DVD and shall be paid for separately.

1.019 TRAFFIC REGULATION CONTROL AND SAFETY PROVISION

The provision of traffic control, safety equipment, signs, diversions, control systems including obtaining approvals and liaison with third parties for work in public roads and streets or in private sector will not be measured separately but shall be included in pipes rates, and shall include but not by way of limitation:

- Preparing all necessary plans, details and schedules and submission to the contracting authority/supervisor to obtain all necessary approvals.
- Liaison with third parties.
- Erecting, maintaining, moving and removal of safety barriers, signs and traffic control equipment.
- Establishment and management of road diversions.
- Watching and lighting.
- Maintaining, roads and streets clean and free from construction debris.

2.000 BILL A - CIVIL WORKS

2.010 TOPOGRAPHIC SURVEY AND SITE DELIMITATION

The price per site of the topographical surveys shall include checking, completing and/or performing land surveying based on approved benchmarks, the existing ground elevation, property lines, northing and easting coordinates, topographical maps, layouts, delimitation of plots (official delimitation from the concerned Authorities), implantation of foundations of reservoirs, the measurement of earthworks etc.... as well as all other additional tasks imposed by the site and/or the Supervisor. It also includes all necessary topographical works, official delimitation certificate and approved plan, labor expenses, transport costs as well as all expenses resulting from calculations and data transfer on drawings and/or on technical sheets that will accelerate the progress of works.

The site survey shall be supplied as digital data suitable for automated plotting.

2.011 SITE CLEARANCE

The lump sum price shall include cleaning the entire surface of the site and clearing it from any obstacle (material or equipment) located within the area of works, it shall also include the demolition of existing unused structures (reservoirs, valve chamber, reinforced concrete structures, etc....), labors, necessary equipment, transport of soil or wastes to environmentally approved public dumps (permit from the concerned authorities) and all tasks to deliver the site for excavation.

2.012 CONSTRUCTION SITE SIGN BOARD

The lump sum price of construction site sign board shall include support, supply, transport, fixing, and all tasks necessary for a perfect execution.

2.013 SITE REARRANGEMENT AFTER CONSTRUCTION

The lump sum price shall include the reinstatement of the site after completion of the works according to the drawings and to the Supervisor's instructions. It also includes backfilling all around the structures and foundations with selected materials and/or backfill in order to deliver the site in a good condition and prepared for the proposed improvements.

2.014 AS-BUILT DRAWINGS

As-built drawings shall be paid as lump sum and shall include formwork details, metal works, reinforcement drawings and bar bending schedule. Plans view shall be presented on scale 1/50 and details on scale 1/20.

Payment shall only be made for as-built drawings approved by the Supervisor and submitted on transparent paper and AutoCAD files which shall be submitted via email.

2.015 EXCAVATION AND TRANSPORT OF UNSUITABLE BACKFILLING MATERIALS

The price per cubic meter of excavation shall include but not be limited to:

Excavation in all kind of soils and rocks for structures and for access roads, use of all adequate equipment, transport of soil to environmentally approved disposal sites accepted by the Supervisor, labor, dewatering, temporary and/or final retaining structures for trenches or open digs. The volume of excavations shall be measured from the geometric dimensions of structures and levels determined according to the site layout and drawings. No excess excavations or earthworks shall be paid for unless otherwise stated by the Supervisor.

2.016 PREPARATION OF FORMATION UNDER ELEVATED WATER TOWER

The price shall be measured in cubic meter for preparation of formation under the construction's foundation or slabs on grade and shall include compacted gravels, sand, polyethylene sheet (250 μ), compaction equipment, labor and all material and equipment necessary to achieve the sub base and base to receive the concrete. The volume shall be measured according to geometric dimensions shown on the drawings.

2.017 BACKFILLING AND COMPACTION

The price of cubic meter of backfilling shall include backfilling layers (25 cm thickness each before compaction) placed and compacted inside the fences, around mechanical room if ordered by written instructions from the Supervisor or shown on the drawings. It shall also include geotextile sheets and drainage system if needed (minimum thickness 1.2mm, mass \geq 300 g/m²), bituminous coating, etc....

The volume of backfill materials shall be computed according to the dimensions shown on the drawings and the site layout and shall be composed of selected material for each case.

The price shall also include material, equipment, labor and all necessary tasks to achieve the work in perfect conditions.

2.018 BLINDING AND MASS CONCRETE C20

The price of cubic meter shall include all material, equipment, labor, transport, blinding and/or mass concrete and shall be composed of at least 250 kg of cement per cubic meter of concrete and shall be measured according to the geometric shapes shown on the layout drawings and/or Standard Drawings. Any quantity executed in excess of the indicated dimensions shall not be paid for. Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Supervisor.

2.019 REINFORCED CONCRETE GRADE C30 (RESERVOIR AND ELEVATED WATER TOWER)

The price per cubic meter shall include all material, equipment, labor, transport, admixtures (retarders, plasticizers, waterproofing materials, ...) batching, mixing, placing, vibrating, curing, testing, finishing, scaffolding, reservations for equipment, formwork, wrought formwork (fair face), surface leveling with mechanical float, etc. Dosage of cement shall be 400 kg/cu.m. for reservoirs and retaining aqueous liquid structures. All joints or sealing systems shall be included in the price. Measurement shall be determined according to the geometric shapes indicated on the layout drawings and/or buildings drawings; any quantity executed in excess of the indicated dimensions shall not be paid for. Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Engineer.

The price shall also include all materials, equipment, labor, transport, storage, placing, bending, scaffolding, etc. of reinforcing steel supplied, placed, bended, etc. with all needed materials, accessories and tasks to achieve the works in perfect conditions. Detailed bar bending schedules and sheets should be submitted for approval before placing and installation.

The price shall also include all needed works, labor, material, transport, formwork, etc... to execute a fair faced concrete for interior and exterior walls and ceilings.

2.020 REINFORCED CONCRETE GRADE C30 (FOR OTHER PARTS OF WATER TOWER AND PUMPS ROOM)

The price per cubic meter shall include all material, equipment, labor, transport, admixtures (retarders, plasticizers, waterproofing materials, ...) batching, mixing, placing, vibrating, curing, testing, finishing, scaffolding, reservations for equipment, formwork, surface leveling, etc. Dosage of cement shall be 350 kg/cu.m. for technical buildings, channels, retaining walls, foundations, wellhead manholes, etc... All joints or sealing systems shall be included in the price. Measurement shall be determined according to the geometric shapes indicated on the layout drawings and/or buildings drawings; any quantity executed in excess of the indicated dimensions shall not be paid for.

Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Engineer.

The price shall also include all materials, equipment, labor, transport, storage, placing, bending, scaffolding, etc. of reinforcing steel supplied, placed, bended, etc. with all needed materials, accessories and tasks to achieve the works in perfect conditions. Detailed bar bending schedules and sheets should be submitted for approval before placing and installation.

2.021 LEVELING WITH MECHANICAL FLOAT (GROUND WATER TANK)

The price per square meter includes material, equipment, transport, labor and consists in leveling horizontal surfaces of slab on grade at ground floor, cover slab of technical area, bottom of reservoir slab and cover slab of tank troweled to ensure smooth concrete finish and sloped to drain outlets.

2.022 CYCLOPEAN CONCRETE

The price per cubic meter of cyclopean concrete shall include material, equipment, transport, supply, placing, mixing, labor ... and shall be composed of 250 kg of cement per cubic meter of concrete and a maximum of 40% of hard rocks (ϕ 200mm). Formwork and scaffolding are included and cyclopean concrete shall be measured according to geometric shapes determined by written instructions of the engineer. All tasks necessary for the completion of the work are deemed to be included in the price.

2.023 SCREED

The price per square meter of screed above the roof slab of the water tower and the reservoir shall include material, equipment, transport, supply, placing, mixing, labor... Formwork and scaffolding are included and shall be measured according to geometric shapes determined by written instructions of the engineer. All tasks necessary for the completion of the work are deemed to be included in the price.

2.024 STEEL REINFORCEMENT

The price per ton shall include all materials, equipment, labor, transport, storage, placing, bending, scaffolding for reinforcing steel supplied, placed, bended with all needed materials, accessories and tasks to achieve the works in perfect conditions.

The price shall be paid per ton of reinforcement steel supplied, bended and placed, and shall be measured according to the dimensions shown on the drawings. Detailed bar bending schedules and sheets should be submitted for approval before placing and installation. These bar bending schedules and sheets will be used for calculation of reinforcing steel weight.

2.025 WATERSTOP

The price per linear meter of P.V.C. water-stop joints (expansion, contraction,) and/or hypalon strip of 15 cm width shall include the supply, transport and installation of the water stop strips (up to 25cm width) according to drawings (essentially between slab and walls of reservoirs). Any additional water stop strips to be used, according to particular methods of execution, shall not be taken into account for measurement. Written instructions from the engineer shall be obligatory. The price also includes the backing rod, sealant and fiber boards, if needed.

2.026 NEOPRENE PADS

The price per linear meter of neoprene pads placed between reservoir roofs, slabs and reservoir walls shall include preparation and application of neoprene pads which shall withstand all strains exerted by the roof cover. It shall also all needed equipment, materials, scaffolding, accessories and others that turn out to be necessary for a good execution.

2.027 EXTERIOR RENDERING WITH TYROLEAN COAT (FOR PUMPS ROOM)

The price of exterior rendering with colored Tyrolean coat per square meter shall include all material: cement, sand, water, equipment, labor, scaffolding, expenses, supply, transport, placing mortars and shall be measured according to geometric shapes of rendered areas, no

excess and no measurement shall be paid for re-entrant or salient angles of openings, chamfered angles or others. The rendering shall be executed according to specifications.

2.028 PRECAST CONCRETE TILES

Precast concrete tiles shall be measured in squared meters as the net tiled area in accordance with the Drawings, with no allowance for waste due to cut tiles at corners or finished edges. The unit rates for roof tiling shall include for all approved precast concrete materials tiles including expenses of supply, transport, application, labor.

2.029 INTERNAL WATERPROOFING

The price per square meter of internal surface waterproofing coating for reservoirs shall include preparation of the surface (sand blasting, water blasting), treatment of singular points (contraction or expansion joints, pipe penetration, ...) material, transport, scaffolding, application in several layers, labor, expenses in conformity with the technical sheet of approved material, quality tests, structures test, before and after application and warranty. Cementitious waterproofing products shall be applied on reservoirs walls, bottom and upper slabs.

All products used shall be non-toxic.

2.030 WATERPROOFING OF ROOF SLABS AND OTHER STRUCTURES WITH THERMAL INSULATION

The price per square meter of cover slab waterproofing shall include material, transport, equipment, labor, supply, installation, preparation of support, treatment of singular points (rain outlets, ventilations, openings). Roof slab waterproofing shall be composed of a thermal insulation with minimum thickness of 50 mm and a thermal conductivity $\alpha = 0.037$ Kcal/h.m²/°C, and a double layer waterproofing membrane (SBS) 2x4mm thick minimum. Vertical up stands shall be aluminum self-protected. The price shall also include the supply and installation of a nonwoven polyester sheet 200 g/m². Supply and installation work of necessary roof drains are deemed to be included in this item and shall not be paid for separately.

The membranes shall be measured only for horizontal surfaces and no measurements or excess shall be paid for vertical surfaces.

2.031 BITUMINOUS COATING

As for the protection of underground concrete elements, the price per square meter of bituminous waterproofing paint shall include material, transport, equipment, labor, supply, installation, preparation of support, treatment of singular point, scaffolding and shall be composed of two layers of bituminous paint including 1 coat of water based primer in order to assure a protective coating for underground structures.

2.032 GEOTEXTILE

The price per square meter of geotextile placed above the waterproof membrane on the roof of the electrical room shall include material, equipment, transport, supply, placing, mixing, labor... Formwork and scaffolding are included and shall be measured according to geometric shapes determined by written instructions of the engineer. All tasks necessary for the completion of the work are deemed to be included in the price.

2.033 GRAVEL

The price per square meter of gravel placed above the geotextile on the roof of the electrical room shall include material, equipment, transport, supply, placing, labor... and shall be measured according to geometric shapes determined by written instructions of the engineer. All tasks necessary for the completion of the work are deemed to be included in the price.

2.034 WATER TESTING AND DESINFECTION OF RESERVOIRS

The lump sum price of water testing of reservoirs per site shall include:

- Supply, transport and filling of reservoir with water, and checking for leaks. This operation shall be repeated to the Engineer's satisfaction.
- Water sampling for analysis and transport in an adequate packing to the laboratory
- Bacteriological analysis type B2 (2 per reservoir)
- Cleaning and disinfection including all material, scaffolding, labor, expenses and all tasks necessary to accomplish the work.

2.035 EXTERIOR STEEL DOORS INCLUDING PAINTING

The price per square meter of exterior steel doors shall include all material, equipment, transport, labor, expenses, water-resistant hardware, ventilation, mechanical protections, approved minimum two coat protective paint system after grit blasting and shop priming, louvers, openings, locking system, supply, installation, anchoring, reinstatement of support, finishing and all tasks and accessories, necessary to a perfect execution. Metal sheets shall be 3mm thick minimum.

2.036 METAL WORKS

The price per kilogram of metalwork (protection bars, louvers, ventilation, ladders type Saf-T-Climb or similar, grating, railings, trap doors, ...) shall include all material, equipment, transport, labor, expenses, hardware, painting with approved minimum two coat protective (anti-corrosion), supply, installation, anchoring, locking system, reinstatement of support, finishing and all tasks and accessories necessary to a perfect execution.

2.037 STEEL LADDER (RESERVOIRS)

The price per kilogram of internal ladder inside the reservoir shall include all material, equipment, transport, labor, expenses, hardware, painting with approved minimum two coat of resin, supply, installation, anchoring, locking system, reinstatement of support, finishing and all tasks and accessories necessary to a perfect execution.

2.038 STEEL STAIR

The price per kilogram of steel stair providing access to the elevated water tank shall include all material, equipment, transport, labor, expenses, hardware, guardrail, painting with approved minimum two coat of anticorrosion paint, supply, installation, anchoring, locking system, reinstatement of support, finishing and all tasks and accessories necessary to a perfect execution.

2.039 HEAVY DUTY IRON COVER

The price per square meter of covers and frames from ductile iron in accordance with BS EN 124:1994, non-rock, locking and solid tops. Grades of covers shall be Grade A, heavy duty test load 40 tons. The price includes include all material, equipment, transport, labor, expenses, and application.

2.040 HOLLOW CONCRETE BLOCK WALL (20CM THICK)

The price per square meter of built areas of hollow concrete blocks (20 cm thick) shall include concrete blocks, sand and cement for mortar, all materials, equipment, labor, expenses, scaffolding, placing, junctions, concrete lintels, openings, ... and shall be measured according to net areas built from one side.

2.041 MOISTURE PROTECTION

Works shall be measured net, according to an "Engineering measurement", as per the layout and units of the Bills of Quantities; no other method of measurement or applicable custom shall be allowed or considered.

Rates shall include all materials, accessories, workmanship, dam proofing, joint sealers, screeds, grooves and the like.

2.041.1 BITUMINOUS WATERPROOFING PAINT

The price per square meter of external waterproofing paint for the wellhead and the retaining wall shall include all materials, equipment, transport, labor, expenses, scaffolding, surface preparation, application, preparation of support, finishing cleaning, singular points, and shall be composed of primer and a minimum of two coats of external paint.

The surfaces shall be measured according to geometric shapes of painted area, no measurement and no excess shall be paid for re-entrant or salient angles of openings.

2.041.2 EPOXY RESIN COATING

The price per square meter of internal surface waterproofing coating for the wellhead shall include preparation of the surface, treatment of singular points (pipe penetration, ...) material, transport, scaffolding, application in several layers, labor, expenses, ... in conformity with the

technical sheet of approved material, quality tests, structures test, before and after application, warranty.

2.041.3 SBS-MODIFIED BITUMINOUS MEMBRANE WATERPROOFING

Cost of overlaps of membrane, geotextile, polyethylene sheets, cement fillets, membrane reinforcing angles, grooves, flashing, mastic, drain points accessories, inserts and the like, are deemed included in the unit rates.

No deduction shall be made for voids not exceeding 0.25 m².

Rates shall include all materials and accessories, workmanship, dam proofing, thermal insulation, membrane waterproofing, flashing and sheet metal, joint sealers, gravel beds, screeds, grooves.

Rates shall also include (by way of indication and not limitation) the following:

- Cleaning down and preparing surfaces,
- Underlying slope to drain non shrink mortar (minimum 2cm thick) for existing roof leveling,
- Lower points in existing roof to be filled with grout,
- Application of 2 layers of SBS polymer modified bitumen membrane 4mm thick to be placed on top of existing roof. After application of bituminous membrane, dressing up 150mm high against parapets along anodized aluminium flashing for waterproofing system, with mastic sealants and anchors
- Separation layers, geotextile, polyethylene sheets, drainage boards where required,
- Any width or area, fair and rounded edges, drips arises and angle fillets,
- Cutting to line, overlapping, turning into grooves and pointing,
- Laying vertical, to slopes, falls or cross falls, curved or circular work, fixing accessories if required,
- Accessories and detailing at inserts and penetration in substrates,
- Cutting, trimming, making holes and forming openings, fitted or fair ends, angles, intersections and the like, including working around pipes and openings and making good,
- Skirting shall be deemed to include for grooves where required, ends and angles, metal flashings shall include for angles, intersections, ends, extra material at seams, passing at ends, treatments at edges and dressing over profiled roof coverings and the like, mastic pointing and protection,
- Overlapping and wastes,
- All accessories and works necessary for a complete execution.

2.041.4 PRECAST CONCRETE TILES

Precast concrete tiles shall be measured in squared meters as the net tiled area in accordance with the Drawings, with no allowance for waste due to cut tiles at corners or finished edges.

The unit rates for roof tiling shall include for all approved precast concrete materials tiles including geotextile sheets (minimum thickness 1.2mm, mass $\geq 300 \text{ g/m}^2$) expenses of supply, transport, application, labor.

2.041.5 INTERNAL LINING FOR RESERVOIR

The price per square meter of internal surface waterproofing coating for reservoirs shall include preparation of the surface (sand blasting, water blasting), treatment of singular points (contraction or expansion joints, pipe penetration, ...) material, transport, scaffolding, application in several layers, labor, expenses in conformity with the technical sheet of approved material, quality tests, structures test, before and after application and warranty. Crystallization or mineralization products shall be applied on reservoirs walls and slabs on ground, and flexible protective and waterproofing slurry products on bottom faces of roof slabs or domes.

All products used shall be non-toxic.

2.041.6 WATER TESTING AND DESINFECTION OF RESERVOIRS

The lump sum price of water testing of reservoirs per site shall include:

- Supply, transport and filling of reservoir with water, and checking for leaks. This operation shall be repeated to the Engineer's satisfaction.
- Water sampling for analysis and transport in an adequate packing to the laboratory
- Bacteriological analysis type B2 (2 per reservoir)
- Cleaning and disinfection including all material, scaffolding, labor, expenses and all tasks necessary to accomplish the work.

2.041.7 POLYURETHANE LIQUID MEMBRANE

The price per square meter of polyurethane liquid membrane shall include material, transport, equipment, labour, supply, installation, preparation of support, treatment of singular point, and shall be composed of Primer PU, Double PU coats and a Topcoat highly resistant to UV in order to assure a protective waterproofing, with special treatment on angles with fiber mesh reinforcement and cracks.

2.041.8 FRENCH DRAIN

The price per unit of French drain shall include bedding and filter material (geotextile, 2 layers of gravel with different sizes, soil).

The price shall be computed according to the dimensions shown on drawings.

The price shall also include material, equipment, labor, etc... and all necessary tasks to achieve the work in perfect conditions.

2.042 FINISHES

2.042.1 Portland Cement Plaster

The price per square meter shall include all materials and accessories. Surfaces are measured net, as the effective executed quantity. All openings shall be entirely deducted.

The price per square meter shall include (by way of indication and not limitation) the following:

- Preparation of substrates,
- Placing embedded items, such as metal lath, reference spots, and the like,
- Any additives needed to improve workability and/or waterproofing and/or other property of plaster, subject to Consultant's approval, such as fiber reinforcement product, waterproofing admixture, and the like,
- Waterproofing admixtures (for external plaster and plaster in wet areas) and any other material needed,
- Control joints,
- Application to any surface indicated, as per required number of coats and tolerances,
- Making good around inserts, recesses and the like,
- Finishing surfaces, curing,
- Cutting and patching, protection in general,
- all materials, accessories and workmanship.

2.042.2 Painting

Works shall be measured net, according to an "Engineering measurement", as per the layout and units of the Bills of Quantities; no other method of measurement or applicable custom shall be allowed or considered.

The price per square meter shall include all materials and accessories, workmanship, surface preparation, and quantities will be measured as the effective executed quantity in contact with the substrate.

Rates for painting include (but are not limited to) the following:

- Preparation of paint or varnish including rubbing down of surfaces to be painted, cleaning and dusting-off, rubbing down between coats, priming and putty filling as necessary,
- Plastering repair where required with non-shrink grout and painting for maintenance of exterior elements.
- Epoxy painting on cementitious surfaces shall include acid etching and cleaning,

- Cutting in edges and cutting to line and work on additional surfaces exposed by such open edges, pipe clips, saddle and holder bats and the like and rubbing down between coats,
- Washable painting for internal walls, including one undercoat and two coats of enamel paint with semi-gloss finish, all as specified as recommended by manufacturer.
- Attendance, protection and making good after all works.

2.043 INDUSTRIAL FLOORING (PUMPS ROOM)

The price per square meter of industrial flooring shall include all material, equipment, transport, labor, expenses, application, preparation of support, scaffolding, curing, finishing, cleaning, singular points, screed if necessary. It shall be composed of heavy-duty chemical and abrasion resistant epoxy resin floor (5mm thick). For walls skirting, 2mm thick of epoxy resin will be sufficient (the number of layers should be in compliance with the manufacturer's recommendations and the Engineer's instructions).

The surfaces shall be measured according to geometric shapes of painted area (floor), no measurement and no excess shall be paid for re-entrant or salient angles of openings or wall skirting.

2.044 WASHABLE PAINT INTERNAL OR EXTERNAL USE COATING

The price per square meter of paint includes all materials, equipment, transport, labor, expenses, scaffolding, surface preparation, application, preparation of support, finishing cleaning, singular points, and shall be composed of external putty, primer and a minimum of two coats of external paint.

The surfaces shall be measured according to geometric shapes of painted area, no measurement and no excess shall be paid for re-entrant or salient angles of openings.

2.045 FENCE

The price per linear meter of fence shall include all excavation, reinforced concrete, metalwork, epoxy paint finishing, material, labor, equipment, supply, transport, anchor bolts, reinstatement of property line, and all tasks necessary for a perfect execution. The price shall also include fixing the fence to the concrete support.

2.046 ACCESS GATE

The lump sum price of access gate per site shall include all excavation, reinforced concrete, steel access gate, locking system, protective coating paint, water resistant hardware, anchors, finishing material, labor, equipment, formwork, scaffolding, supply, transport, reinstatement of property line and all tasks necessary for a perfect execution. For access gate width refer to site implantation.

2.047 ASPHALTING

The price per square meter of asphaltting for structures and access roads layout shall include earthwork, sub-base preparation (scraping, leveling, compaction), sub-base material layer (hard stones, gravel), base course material (hard crushed aggregate) bituminous tack coats, asphalt and all material, equipment, supply, transport labor, expenses, drainage system, testing, quality control, hauling, spreading and compaction, and all necessary tasks for laying, jointing and a perfect execution and shall include, but not be limited to:

- Base course supply, and transport of materials, earth work, scraping, levelling, compaction, labor, final thickness after compaction 20 cm, testing quality control and all necessary tasks for a perfect execution.
- Asphalt: supply and transport of materials, bituminous, tack coat, asphalt and all necessary materials, labor, expenses, testing, quality control, hauling, spreading and compaction and all necessary tasks for laying, jointing and a perfect execution.

2.048 RESERVOIRS HYDRAULIC ACCESSORIES

2.048.1 SUPPLY AND INSTALLATION OF PIPES

Pipes shall be classified for payment according to diameter and material and shall be measured in linear meters of pipeline in place measured along the crown of the pipeline.

The length measured for payment shall include the lengths of all fittings, valves and specials installed in the line.

The price shall cover all fittings, bends, joints, reducers, flanges, holderbats, supports, puddle flanges, inserts, bolts, nuts, brackets, bell mouths, as well as hauling, transport, unloading, staking and all necessary labour and accessories to provide a complete installation.

2.048.2 SUPPLY AND INSTALLATION OF GATE VALVES

Gate valves shall be classified for payment by nominal diameter and nominal pressure class and shall be measured by number.

Price shall include for all fittings necessary to joint the assembly to the pipeline (either new or existing), including thrust flanges, flexible joints, dismantling joints, supports and all items necessary to make a complete installation.

2.048.3 Floor drain

Floor drains shall be measured by number, and shall include for floor drain pipe DN 80mm, excavation, backfilling, reinstatement of the concrete surface level, flap valve, bends and all components necessary to provide a complete installation.

2.048.4 Supply and installation of float control valve

Float valves shall be classified for payment by nominal diameter and nominal pressure class and shall be measured by number. Price shall include all the requirements as stipulated in item 2.048.10 “Pressure regulating valves” below.

2.048.5 SUPPLY AND INSTALLATION OF suction STRAINERS

Suction strainers shall be measured by number according to nominal diameter. Material shall be stainless steel, coated cast iron or bronze.

Price shall include for all fittings necessary to install the suction strainer inside the reservoir on the outlet pipe including flanges, joints, bolts, nuts and all accessories to make a complete installation.

2.048.6 Supply and installation of level indicator

Level indicators shall be measured by number, and the price shall include for all necessary fittings to install the level indicator, civil works, concrete drilling, grouting with suitable material, level indicator, testing, bolts, nuts, etc...

2.048.7 SUPPLY AND INSTALLATION OF double AIR RELEASE VALVES

Air valves shall be measured by number for each air valve size and nominal pressure, and shall include for tees, ARV, gate valves, riser pipes, flanges, bolts, nuts, supports and all components necessary to provide a complete installation.

2.048.8 SUPPLY AND INSTALLATION OF WATER METERS

Water meters shall be measured by number for each nominal diameter and nominal pressure class, and shall include for **filters/Y strainers, flow straighteners** (both having same DN and PN as water meters. Moreover, flow straighteners should be of the type which eliminate the need for any straight length of pipe before and after the water meter), flanges, dismantling joints, supports, bolts, nuts and all components necessary to provide a complete installation.

2.048.9 SUPPLY AND INSTALLATION OF manometers

Manometers shall be measured by number regardless of the calibre of the pressure gauge and the diameter of the tapping collar. Price shall include for manometers (case 10 cm, glycerine filled), isolating valves (DN = 15 mm, PN as required), tapping collars, bolts, nuts and all components necessary to provide a complete installation.

2.048.10 SUPPLY AND INSTALLATION OF PRESSURE REGULATING and pressure sustaining VALVES (PRV and psv)

Pressure regulating and sustaining valves shall be measured by number for each diameter of pipeline and pressure class and shall include for thrust flanges, dismantling joints, filters/Y strainers, manometers, supports, and all components necessary to provide a complete installation.

2.048.11 SUPPLY AND INSTALLATION OF INSERTS

Inserts shall be classified for payment by nominal diameters, and shall be measured by number, price shall include for material, inserts, installation, grouting, bolts, nuts, flanges, etc...

3. BILL C - ELECTROMECHANICAL WORKS

3.010 ELECTRO-MECHANICAL EQUIPMENT & WORKS

3.010.1 MECHANICAL. ELECTRICAL AND CONTROL EQUIPMENT AND WORKS

The mechanical, electrical and control equipment and works category of the BOQ shall include all the prices to supply the specified equipment including factory cost, factory tests, reports, packaging, shipping, handling, customs fees, delivery on site and storage. This category will be used to evaluate the country of origin for the equipment provided under this contract.

In addition, this category will also include the prices for operation and maintenance manuals, installation, trenching, backfilling, interconnections, connection to power supply, testing and commissioning for a complete system in place according to specifications and design drawings.

3.010.1.1 Lump Sum

The lump sum items shall not be subject to re-measurement, and shall include the prices for all necessary equipment including construction, installation, testing and commissioning among others as described in the specifications.

The prices shall include all work necessary for completion of the works and shall include the prices for all necessary building work such as forming box outs, supports plinths, cable trenches, and the like and all necessary safety and access works including guards, handrails, firefighting equipment and the like.

3.010.2 MECHANICAL & ELECTRICAL EQUIPMENT

3.010.2.1 Piping and Accessories

The price of the piping and accessories items, shown on drawings, shall include, but not be limited to, supply of the complete piping system, all hydraulic equipment and accessories, packaging, shipping and handling, customs fees, delivery on site, spare parts, storage and any other items and accessories deemed necessary for the complete installation and trouble free operation of the mechanical system.

In addition, the price shall include, but shall not be limited to, installation on site of the complete piping system all hydraulic equipment and accessories, connection to electrical, control and monitoring systems, preparation of O & M manuals and any other items and accessories deemed necessary for the complete installation and trouble-free operation of the mechanical system. Electrical System

The price of the electrical system items shall include, but not limited to, supply of all electrical equipment, all electrical cables & wires, supply of all electrical control panels, all work associated with the existing generator and A.T.S, supply of Software, spare parts, packaging, shipping and handling customs fees, delivery on site, storage, and any other items and accessories deemed necessary for the complete installation and trouble-free operation of the electrical system.

In addition, the price shall include, but not be limited to, installation on site of all electrical equipment, all electrical cables & wires and all electrical control panels, preparation of O & M manuals, connection to the electric power system of (E.D.L.), connection to control and monitoring systems and any other items and accessories deemed necessary for the complete installation and trouble-free operation of the electrical system.

3.010.2.2 Instrumentation and Control System

The price of the instrumentation and control system items shall include, but not limited to, supply of the complete instrumentation, control and monitoring systems, supply of all wires and cables, cable containment (conduits, trays, etc.), supply of all furniture, packaging, shipping and handling customs fees, delivery on site, spare parts, storage, and any other items and access deemed necessary for the complete instrumentation and trouble free operation of the instrumentation, control and monitoring systems.

3.010.2.3 Uninterruptible Power Supply

The price of the uninterruptible power supply shall include, but not be limited to, supply, transportation, storage, installation and testing of an uninterruptible power supply (UPS) as shown and specified including:

- Lead Acid (VRLA) type batteries.
- Batteries rack.
- Cables and cable connection up to the ICA compartment of MCC.

This item shall be measured by number of uninterruptible power supply completely installed and tested and shall be classified for payment according to UPS rated power.

3.010.2.4 Domestic Lighting and Electrical System

The lump sum price for the domestic lighting and electrical installation shall include, but not limited to, supply of all electrical panel boards and their accessories, supply of all cables, conduits, junction boxes and their accessories, supply of all lighting fixtures, switches, sockets, plugs and their accessories, packaging, shipping and handling, customs fees, delivery on site, spare parts, storage, and any other items and accessories deemed necessary for the complete installation and trouble free operation of the domestic lighting and electrical system.

In addition, the price shall include, but not be limited to, installation on site of all electrical panel boards and their accessories, of all cables, conduits, junction boxes and their accessories, of all lighting fixtures, switches, sockets, plugs and their accessories, preparation of O&M manuals, necessary electric connections for the proper operation of the complete installation, connection to electric power system, testing and commissioning and any other items and accessories deemed necessary for the complete installation and trouble free operation of the domestic lighting and electrical system.

3.010.2.5 Training, Testing and Commissioning

The lump sum price for training, testing and commissioning shall include, but not limited to, on site tests for all, electrical, mechanical, control, and performance tests on equipment and systems, all measurements, equipment, apparatus, materials, power supply, and labour, tests reports, supply of necessary training sessions, training material and documentation, supply, transportation, accommodation and expenses of trainers and commissioners, and any other items and accessories deemed necessary for the comprehensive training of water authority and appointed personnel, and necessary for the on-site testing and commissioning of the plant.

3.010.3 Technical Schedules

The following Technical Schedules, where appropriate shall be completed by Tenderers. Additional Technical Schedules shall be submitted for any alternative plan proposed by Tenderers.

| PIPES | | |
|--------------|--|--|
| Manufacturer | | |
| Material | | |

| VALVES | | |
|---------------|--|--|
| Manufacturer | | |

| CABLES | | |
|---------------|--|--|
| Manufacturer | | |

| ELECTRICAL PANEL BOARD | | |
|-------------------------------|--|----|
| Enclosure IP rating | | |
| Starter Rating | | Kw |

| U.P.S. | | |
|---------------|--|--|
| Manufacturer | | |

| PLC | | |
|------------|--|--|
| Make | | |

| LEVEL SENSOR | | |
|---------------------|--|--|
| Make | | |
| Type | | |

| FLOW SENSOR | | |
|--------------------|--|--|
| Make | | |
| Type | | |

| PRESSURE SENSOR | | |
|------------------------|--|--|
| Make | | |
| Type | | |

| TEMPERATURE SENSOR | | |
|---------------------------|--|--|
| Make | | |
| Type | | |

| DIGITAL INDICATOR | | |
|--------------------------|--|--|
| Make | | |
| Type | | |

| MODEM | | |
|--------------|--|--|
| Make | | |

| TELEMANAGEMENT CENTER EQUIPMENT (CPU, Memory, I/O, Colour VDUs, Peripherals Printers) | | |
|--|--|--|
| Make | | |
| Type | | |

| SOFTWARE | | |
|---------------------------|--|--|
| Make and application name | | |

| SYSTEM OPERATION | | |
|-------------------------|--|--|
| Configuration | | |

4. BILL D – GENERAL WORKS

4.010 NOTICE BOARDS

Notice board shall be paid by unit and the price shall include manufacturing, transportation, installation (including concrete, excavation, equipment, labour, etc...) and removal prior and after completion of the works (refer to particular Specifications paragraph 101.15) and any other works to make a complete installation of the boards.

4.011 INSURANCES

This item shall be paid as a lump sum and the price shall cover, during the contract duration and the defects liability period, the insurance of Contractor's personnel and staff, employer and his representative(s) and all equipment in accordance to the Contract.

4.012 SITE PREPARATION AND MOBILIZATION-DEMobilIZATION

The rate shall include the full mobilization / demobilization of all resources and equipment necessary for the execution and completion of the works. The rate shall also include the design and construction of offices, stores, workshops, clinics and all other facilities required for the completion of the works under this Contract. The price shall be paid as a lump sum and the works shall include but not be limited to the following:

- Protection of public and private properties
- All necessary procedures for the supply and testing of material in conformity with the specifications and as directed by the Engineer,
- Temporary works and site protection, watching, fencing and lighting,
- Supply of the required equipment in order to execute all the required works including but not limited to:
 - Transport of material and equipment to the different parts of the project,
 - Ensuring storage areas and disposal sites,
 - Supply of water and power to complete the works,
 - Keeping the site free of water for excavation, backfilling and concrete works,
 - Supply of compressed water (not less than 2 bars),
 - Accomplish excavation including removal of excavated material and backfilling,
 - Installation of wrought steel
- Management, operation and maintenance of site equipment,
- Indemnification and remedying of all damages caused by the execution of the works to the private or public properties,
- Guiding and protecting traffic and pedestrians through areas of construction including the erection of signs, barriers and lighting,
- Removal of utilities, plants, machinery and all other facilities after completion of the works, including reinstatement to the Engineer's satisfaction,
- Ensuring that all parts of the project are operating as required after the completion of the works and after testing and remedying of all defects that may appear while testing,
- Completion of all procedures necessary for the taking over and commissioning,

- All items necessary to complete the mobilization / demobilization including all related costs.
- The rate shall also cover all costs related to providing facilities for the engineer's representative as stated in the particular specifications paragraph 101.12.

4.013 ACCESS TO SITE

This item shall be paid on a Lump Sum basis and shall include all necessary equipment or labor for the site access to deliver material needed for the good installation of the PV system. The price shall include for all safety measures and equipment for the safety of labour, equipment and materials.

This item shall also include the preparation of a temporary access road to the site(s). Access road shall be constructed prior to the beginning of the works and shall be kept in good condition for traffic for the whole duration of the project. Maintenance of access roads and all costs pertaining to this matter shall be deemed to be included by the Contractor in his unit rates for this item and shall not be paid for separately.

4.014 HEALTH AND SAFETY REQUIREMENTS

Health and Safety requirements shall be paid as a lump sum and shall include but not be limited to the following:

- PPE including safety boots, gloves, safety vests, helmets, masks ...
- Safety barriers.
- Safety lights, signs and cones.
- Firefighting equipment.
- COVID 19 health & safety measures (refer to particular specs paragraph 205.2)
- Etc...

Health and safety requirements shall also include an induction training for all personnel. Refer to Conditions of Contract.

PART B

BILL OF QUANTITIES



**REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOLIDARITÉS INTERNATIONALE**



**PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
WITH SAFE, RELIABLE, AND SUSTAINABLE WATER
SERVICES**

CONTRACT N°. CNT/SRV/LBN/WSH/001/21

**VOLUME 3
GENERAL SPECIFICATIONS**

**Part 1 - General Requirements
Part 2 - Civil Works**

MARCH 2023



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PART 1

GENERAL REQUIREMENTS

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101 GENERAL REQUIREMENTS

101.1 GENERAL REQUIREMENTS AND PARTICULAR SPECIFICATION

These General Requirements shall form an integral part of the General Specifications. In addition to these General Requirements, the Contract contains a Particular Specification, to supplement and/or modify the General Specification as may be necessary in each particular case.

The provisions of the Particular Specification for any specific section or number of sections shall prevail over those of the General Specification. Whenever the term "Specification" without further qualification is used in the Contract Documents, it shall mean this General Specification together with the Particular Specification.

101.2 REQUIREMENTS OF SPECIFICATION

The Contractor shall fulfil all requirements and obligations of all clauses of the Specification applicable to the construction work involved in the Contract. Neither the following clauses of this Specification nor the Bill of Quantities shall limit the obligations of the Contractor under the accompanying Conditions of Contract. Where items are not included in the Bill of Quantities for any such requirements or obligations the cost of such requirements or obligations shall be deemed to be spread over all the items of the Bill of Quantities unless otherwise stated.

101.3 ISO 9000 CERTIFICATION

Imported manufactured products and equipment shall comply with their relevant international standards. The quality assurance of all imported goods shall be granted the ISO 9000 certification.

Locally manufactured products and equipment shall comply with US or Western European Standards. ISO 9000 certification for locally manufactured goods is not essential, however these good shall be subject to the approval of the Engineer.

101.4 DRAWINGS, RECORDS AND DOCUMENTS

101.4.1 Drawings

All works shall be performed in accordance with the drawings furnished with the Contract documents and any such additional drawings as may be issued by the Engineer from time to time during the progress of the work or any drawing furnished by the Contractor and approved by the Engineer. Additional drawings (if any) will be furnished to the Contractor in due time so as to enable him to perform the work shown thereon in its proper sequence and for any advance planning that may be necessary for the efficient performance of such work. The Engineer will decide in each instance whether additional drawings are required for advance planning of the works and determine the time required for same.

In all cases, detailed shop drawings for all components of the Works shall be prepared by the contractor, after the approval of all related equipment items. The design and the shop

drawings shall be submitted to the Engineer who shall within 21 days approve, reject or ask the Contractor to revise or modify such documents and resubmit them for approval. All these documents shall be approved by the Engineer prior to commencement of the work. The structural design will be in accordance to the recommendations based on soil investigations.

101.4.2 Records and “As-built” Drawings

After the work has been completed, the Contractor shall furnish “as-built” drawings prepared whilst surveying during construction, showing the Works as constructed together with all other information that may either be required or be useful for the operation and maintenance of the Works in the future, such as alignment and depth of cover of pipelines, type of soil, type, dimensions and location of structures, size of pipelines and cables encountered during excavation.

Unless specific items are included in the bill of Quantities, the cost of preparing the shop drawings, “as-built” Drawings and Records shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately. The As-built Drawings shall be submitted, if required by the Engineer, on computer diskettes.

101.4.3 Ownership of Drawings and Documents

The Drawings and documents are issued to the Contractor for the purpose of the execution of the Works under the Contract and shall remain the property of the Employer to whom they are to be returned by the Contractor after completion of the work, as a precondition for the issue of the Certificate of Completion.

101.5 BOREHOLE INFORMATION

The Contractor shall satisfy himself as to the nature of the strata underlying the sites of the works. He may carry out at his own expense borings, tests and investigations as he may consider necessary and utilize the information thus gained for the preparation of his tender.

Any subsoil information and test results provided by the Employer shall be given to the Contractor for his preliminary information only. Such information shall not relieve the Contractor in any way of his obligation to inspect the sites and of his sole responsibility for carrying out the works as specified and required by the Engineer and at the rates set out in the Bill of Quantities. No claims for additional payment and/or extensions of time shall be entertained in respect of data furnished to the Contractor by the Employer or the Engineer.

101.6 METEOROLOGICAL AND HYDROLOGICAL CONDITIONS

The Contractor’s attention is directed to the meteorological and hydrological conditions prevailing in the project area and its vicinity. In his planning of the work and in his unit rates, the Contractor shall take these factors into account. No increase in prices and/or

extension of time shall be granted due to rains, floods and/or other adverse climatological conditions in the project area and along the roads to it.

For information, the climatic conditions in Lebanon can be summarized as follows:

| | Temperature (deg C°) | | | | | | Relative humidity | | | | | |
|--------|----------------------|-----|------------------|-----|--------------|-----|-------------------|-----|------------------|-----|--------------|-----|
| | Coastal zones | | Mountanian zones | | Bekaa Valley | | Coastal zones | | Mountanian zones | | Bekaa Valley | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Summer | 20 | 35 | 15 | 25 | 10 | 35 | 65 | 85 | 50 | 60 | 40 | 65 |
| Winter | 7 | 15 | -5 | 10 | -1 | 15 | 60 | 75 | 55 | 75 | 55 | 80 |

101.7 BILL OF QUANTITIES

101.7.1 Rates and Prices

The rates and prices inserted by the Contractor in the Bill of Quantities are to be the full and inclusive value of the work described. They are to cover all costs, expenses and general risks which may be involved, together with all liabilities and obligations set forth or implied in the Specification and other documents on which the Tender is based. They must include all plant, tools, materials, transport of men and materials, insurance and labour of every description. They must also take into account the conditions referred to in the general Conditions, and include time lost due to weather, payment of guaranteed minimum and holidays with pay. The cost of any travelling time subsistence and incentives such as overtime etc. must be included in the rates and prices. Where any special risks, liabilities and obligations, mentioned above or otherwise, cannot be dealt within the rates, then the price thereof is to be separately stated in items provided for the purpose or added by the Tenderer.

Any item left unpriced shall be held to have had its cost included in the unit rates for other items of work.

101.7.2 Provisional Items and Quantities

Care shall be taken to distinguish between “Provisional items” which represent work they may not be required, and “Provisional Quantities” which represent work that will be required but the quantity of which cannot be closely estimated in preparing the Bill of Quantities and details of which will be given on site.

101.7.3 Methods of Measurement and Payment

The methods of measurement and payment for each trade are normally specified in the General Specification, provided that where a different method of measurement is indicated in the Bill of Quantities or specified in the Particular Specification, the Bill of Quantities and the Particular Specification, in that order, take precedence over the General Specification.

Where no method of measurement is specified in any of the foregoing documents, the work will be measured in accordance with the latest edition of the Standard Method of Measurement of Civil Engineering Quantities, published by the Institution of Civil Engineers of London, U.K.

101.8 UNITS

In this Specification, on the Drawings and in the Bill of Quantities the S.I. (Systeme International d'Unites) metric system of dimensioning has been employed.

Where dimensions are given in metric units for materials which are only available in Imperial dimensions, the Contractor may, subject to his obtaining prior approval of the Engineer, substitute suitable sizes of materials as are available in the Imperial system. Such approval shall not unreasonably be withheld, provided that there is no difficulty in making interface connections with any other parts of the Works.

101.9 STANDARDS

For convenience and in order to establish the necessary standards of quality, reference has been made in the Contract Documents, to specifications issued by International Standards. Such specifications shall be defined and referred to hereinafter as "Standard Specifications" and shall be the latest editions of such Standard Specifications issued prior to the issue of Tender Documents together with such additions and amendments to such editions as may have been issued prior to the same date. Subject to the approval of the Engineer, any other internationally accepted Standard which specifies an equal quality of work may be used.

In reference to Standard Specifications, the following abbreviations have been employed:

| | |
|--------------|--|
| B.S. | British Standard |
| A.S.T.M. | American Society for Testing Materials |
| D.I.N. | Deutsche Industrie Normen |
| I.S.O. | International Organization for Standardisation |
| A.A.S.H.T.O. | American Association of State Highway and Transport Officials |
| A.W.W.A. | American Water Works Association |
| N.F. | Normes Française |
| AFNOR | Association Française de Normalisation |

101.10 SURVEY AND SETTING OUT

101.10.1 Engineer's Benchmarks and Survey Markers

Prior to the commencement of the work, the Contractor will receive from the Engineer a number of benchmarks and survey markers on the Site. Before starting any work, the Contractor shall check the alignment and levels of the benchmarks and markers in the presence of the Engineer's Representative and shall correct any error or mis-alignment which may be discovered during such checking with the consent of the Engineer's Representative. Thereafter, the Contractor shall establish from these corrected benchmarks and markers all levels and lines necessary for the performance of the work.

The Contractor shall be responsible for the preservation of the benchmarks and markers during the entire period of construction, and shall at his own cost repair or replace any of them that may be damaged, destroyed, or removed by any cause whatsoever.

101.10.2 Setting Out

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the work accurately and shall establish and locate all lines and levels and be responsible for the correct location of all works.

Whether or not directed by the Engineer's Representative, the Contractor shall take such levels and dimensions as may be required prior to disturbance of the ground for the purpose of measurement and these shall be agreed between the Contractor and the Engineer's Representative in writing before any of the surface is disturbed or covered up.

The Contractor shall establish parallel survey lines or other points of reference at a safe distance, permitting the re-establishment of lines and points, wherever the original lines and points must inevitably be destroyed or removed during the progress of work.

101.10.3 Surveying for Measurement of Earthwork

All intermediate and final surveying necessary for the establishment of quantities of excavation and earthfill will be done by the Contractor, who shall establish elevation points and prepare cross-sections sufficient to permit an accurate calculation of the quantities of earthwork. The Contractor shall notify the Engineer's Representative at least three days in advance of his intention to perform such measurements. The cross-sections prepared by the Contractor and approved by the Engineer's Representative shall be basis for the measurement and payment of earthworks.

101.10.4 Payment

Unless specific items are included in the Bill of Quantities, the cost of all surveying, modifications to drawings, setting out, and measuring to be done by the Contractor and all other expenses incurred by him in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.11 PROGRAMME OF WORKS AND PROGRESS REPORTS

The time allocated for the performance and completion of all works under this Contract shall be as stated in the Appendix to Form of Tender (Volume 2 of Contract Documents).

The Contractor shall submit to the Engineer, before commencing work on site, a fully detailed programme showing the order or procedure and method by which he proposes to carry out the construction and completion of the Works, and particularly of the organisation and staff proposed to direct and administer the performance of the Contract.

The information to be supplied to the Engineer shall also include drawings showing the general arrangement of his temporary offices, camps, storage sheds, building and access roads, and details of Construction Plant and Temporary Works proposed.

The Contractor when preparing his programme shall take due account of the time required for the delivery of materials.

The Engineer will check the proposed programme and will return same to the Contractor within 14 days of its receipt with his approval or comments and requirements for changes (if

any). The Contractor shall make all requested corrections and changes not later than 7 days after having received the Engineer's comments. The programme as finally agreed to and approved by the Engineer will serve as the only basis for the carrying out of the Works.

After the commencement of each and any part of the Contract, the Contractor shall forward to the Engineer in triplicate, for each calendar month, a progress report and a chart showing the approved programme, the work completed to date and the progress made during the month. Such monthly progress reports and charts shall be submitted by the Contractor to the Engineer or his Representative not later than the 6th day of the month following that to which the report and chart refer.

101.12 WORK SITES

101.12.1 Right of Way and Sites of Works

The Employer will provide all the necessary rights of way, lands and sites on which the Works are to be carried out and will designate the access roads to the sites which the Contractor will be permitted to use.

In no case shall the Contractor occupy lands, right-of-ways or way-leaves without the previous written permission of the Engineer.

101.12.2 Contractor's Work Area

The location of the Contractor's work area, i.e. the area or areas where the Contractor may set up his offices, stores, workshops, yards for mechanical plant, etc., and transport depots, shall be agreed beforehand with the Engineer and shall be such as to avoid obstruction and nuisance to the public. The Contractor shall provide, within his work area, a Site Office for the use of his agent where written instructions from the Engineer may be delivered.

The Contractor shall make his own arrangements for and pay all costs incurred in the use of such areas of land as he may require for work areas for the purpose of the Contract.

101.12.3 Access and Construction Roads

The Contractor shall at his own expense construct and maintain within the right of way any temporary access roads and construction roads on the work sites that he deems necessary for the proper performance of the works, but the routes of such temporary roads and the method of their construction shall be subject to the Engineer's approval.

The Contractor will be permitted the use of existing roads on the Site provided that such use is co-ordinated with other users.

The Contractor will be permitted to use public roads as access roads to the Works only after having obtained permission in writing from the relevant Authorities and from the Engineer. The Contractor shall strictly adhere to all requirements and conditions prescribed by the relevant Authorities and set out in Clauses 29 and 30 of the Conditions of Contract.

The cost of preparation and maintenance of all access and construction roads and all costs incurred in complying with the requirements of this subsection shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.12.4 Existing Services

The Contractor shall make himself acquainted with the position of all existing works and services inter alia roads, sewers, storm water drains, cables for electricity and the telephone lines, telephone and lighting poles, and water mains, before any excavation is commenced.

The Contractor will be held responsible for damage caused in the course of the execution of the Works to such existing works and services and shall indemnify the Employer, the Engineer and their agents against any claims arising from such damage (including consequential damages). Any damage caused must be made good at the Contractor's own expense.

Where the works required the crossing of existing roads, railways, fuel pipelines and services, the Contractor shall obtain the prior permission of and shall make all necessary arrangements with the relevant authorities and/or owners of said utilities and shall obtain their consent to the time and manner of execution of all work connected with such crossings.

When crossing a road in public use the Contractor shall either leave half the width of the road free for traffic or shall construct a bypass, as may be required by the road authority. The length, width and shape of any such bypass and the mode of its construction shall be as directed by the Engineer, but shall at all times permit for the passage of traffic using the main road. The Contractor shall put up warning and traffic signs, and shall employ flagmen to direct the traffic and shall mark the road crossings and put up lights from sunset to sunrise.

The Engineer's Representative may order the Contractor to repair bypasses, strengthen any temporary structures, put up additional signs or lights and generally improve the arrangements as he may deem necessary, and the Contractor shall forthwith comply with such orders. Regardless of whether or not the Engineer's Representative orders any such repairs or improvements, the Contractor shall remain solely responsible for the proper performance of all work in connection with the erection, maintenance and subsequent removal of all temporary structures required under this Clause, to the complete satisfaction of the Engineer.

Where the Works cross existing pipes, sewers, drains, channels, telephone or power lines and cables, the Contractor shall be responsible for the preservation of all such utilities in a good and serviceable condition during the execution of the Works and shall see to it that any damage done to any of the services be immediately repaired. Insofar as necessary, the Contractor shall construct temporary bypasses for such pipes, channels and cables and restore them to their original position after the work at the junction or crossing has been completed.

The Contractor shall construct all bypasses and do all repairs to roads, pipes, channels and cables in accordance with the requirements of the proper authorities and/or the owners thereof or shall bear the expenses of all such work done by them.

Existing access to lands, property and all other facilities shall be maintained by the Contractor during the continuance of the Works to the Engineer's satisfaction.

Where work is being carried out in the vicinity of overhead power lines the Contractor shall take special measures to ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines and that adequate safety precautions are being taken. The Contractor shall ensure that none of his employees commits any act which will cause damage from, or to, overhead power lines.

Unless specific items are included in the Bill of Quantities, the cost of all works required under this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.13 WATER AND POWER FOR USE IN THE WORKS

The Contractor shall be solely responsible for the location, procurement and maintenance of water supplies adequate in quality and quantity to meet his obligations under the Contract.

The Contractor shall be responsible for the supply of all electric power to meet his obligations under the Contract and for the distribution thereof.

All costs associated with the supply of water and power shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.14 BUILDING REGULATIONS

All buildings erected by the Contractor upon the Site and Work Area shall comply with all Laws and local By-laws insofar as they are applicable.

101.15 WORKS IN THE DRY

All parts of the Works are to be carried out in the dry, and shall be kept free at all times from surface or groundwater from whatever source it may come to the satisfaction of the Engineer. Keeping the Works dry shall include all pumping and diversion of water that may be necessary in carrying out the Works, also provision and filling-in of sump holes, installation and operation of drains, pumps, well points etc., in a manner and with equipment and materials satisfactory to the Engineer.

The Contractor shall, at his own expense, make such provision for the discharge of any water from the Works as shall be satisfactory to the Engineer and to any person having rights over the lands or watercourses over or down which such water is discharged. He shall hold the Employer indemnified against any claim that may be made through non-compliance with this section. In the event of any interference with existing land or road drains due to the construction of the Works or to the dumping of spoil, etc., within or without the limit of the Works, the Contractor shall take immediately steps to restore the drainage to the satisfaction of the Engineer and the Owners, occupiers, or Authority concerned.

Unless specific items are included in the Bill of Quantities, the cost of keeping the Works dry as specified in this section, shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.16 WATCHING, FENCING AND LIGHTING

The Contractor shall employ competent watchmen and guard the Works by day and night.

From the time that any portion of the Works shall be commenced, until the end of the works, the Contractor shall be responsible for protecting the public and his workmen from anything

dangerous to persons or property and for the safe and easy passage of pedestrian, animal and vehicular traffic.

Any excavation, material dumps, soil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night protected by red warning lights. The Contractor shall, at his own expense, and immediately upon completion of any part of the Works, fill up all holes and trenches, and level all mounds and heaps of earth which have been excavated or made in connection with the Works. The Contractor shall be responsible for the payment of all costs, charges, damages and expenses incurred or sustained on account or in consequence of any accident which may happen by reason of holes and trenches being dug and left or placed in improper locations.

Fencing shall consist of at least three 15 mm diameter hemp ropes or 4 mm diameter wires, or more, if required, stretched tightly between poles, standards, etc., securely planted in solid ground, well clear of the excavation and enclosing the spoil from the excavation. The poles, standards, etc., shall not be more than 15 m apart. If circumstances require it, they shall be placed closer and the ropes or wires shall be stretched tight, approximately 0.40 m, 0.80 m and 1.20m, respectively, above the ground.

Banks of spoil of suitable height and form may be accepted by the Engineer in lieu of fencing.

Fences and spoil banks shall be clearly marked at the ends, all corners and along the length at intervals of not more than 15 m, by means of white lime-washed boards, discs, stones or oil drums during the day and by red lamps kept burning at night. Markers shall be freshly lime-washed at regular intervals to ensure that they are white and clean.

The Contractor shall detail a man to trim and fill the lamps during the day and they shall be lit at least one half hour before sunset and not extinguished until at least one half hour after sunrise.

If a road is closed, or partly closed, to traffic, temporary traffic signs and barricades shall be erected by the Contractor, to the satisfaction of the Engineer and the Police, to give proper warning to traffic and to the public. Road signs shall be not less than 1.20 m x 0.80 m in size, surmounted by a red circle. Lettering shall be black, on a yellow ground and shall incorporate reflective material. The signs shall be adequately illuminated at night. The Contractor shall be solely responsible for the proper control of all traffic.

The cost of watching, fencing and lighting and all other costs incurred in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.17 PRESERVATION OF TREES

No trees shall be cut down without prior permission of the legal public authority and the Engineer who will limit the removal of trees to the minimum necessary to accommodate the Permanent Works.

If trees are cut down or damaged by the Contractor or his employees and without approval, then the Contractor shall replace such trees at his own expense with trees of not less than two

years of age obtained from a reputable nursery and of species to be approved by the Engineer. The Contractor shall plant, water and ensure that the replacement trees are properly established all at his own expense.

All costs incurred in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items on the Bill of Quantities and shall not be paid for separately.

101.18 WORKS EXECUTED BY THE EMPLOYER OR BY OTHER CONTRACTORS

The Employer reserves the right to execute on the Site works not included under this Contract and to employ for this purpose either his own employees or another Contractor whose contract may be either a sub-contract under this Contract, or an entirely separate Contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operations of the Employer or his Contractor employed on such Works and the same obligations shall be imposed on the Employer or other Contractor in respect of work being executed under this Contract.

101.19 MATERIALS

101.19.1 General

All materials shall be of the best quality throughout. Materials delivered to the Works shall be equal in all respects to the samples approved by the Engineer. The methods of stocking, mixing, transporting, fixing, placing and applying all materials shall be in compliance with the specifications and to the approval of the Engineer, who shall be kept advised of any change of plan. Materials failing to comply with the Specifications shall be immediately removed from the Works, at the Contractor's expense.

All goods and materials used in the execution of the Contract shall comply in all respects with ISO 9000 Standards or other equivalent standards approved by the Engineer.

101.19.2 Approval of Materials

Before entering into any sub-contract for the supply of any material or goods, the Contractor shall obtain the Engineer's approval in writing of the manufacturers and/or suppliers from whom he proposes to obtain such materials or goods. If requested, the Contractor shall submit to the Engineer samples of such materials and shall have them tested in approved laboratories. Such tests shall be carried out at least seven days prior to the inclusion of such materials in the Works. The cost of all samples and tests shall be borne by the Contractor.

Should the Engineer, at any time, be dissatisfied with such material or goods or with the methods of production or operation carried out at the manufacturer's or supplier's works or place of business, he shall be empowered to cancel his previously given approval of such supplier and to specify any other supplier whom he may choose for the supply of such material or goods. The Contractor shall then obtain such said material or goods from such other supplier and shall bear any additional costs thereof.

Materials which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials and shall be cut out and removed from the Works and replaced as directed by the Engineer, at the Contractor's own expense.

101.19.3 Alternative Materials

Where brand names or products of a specific manufacturer are specified in the Contract, the Contractor may, subject to the Engineer's approval (which shall not be unreasonably withheld) supply alternative materials, having similar characteristics and showing performance and quality at least equal to those specified.

Whenever the Contractor wishes to propose an alternative material he shall submit detailed information concerning the type of material and/or product, the Vendor's name, drawings if required, test certificate, etc. If the alternative material is not approved by the Engineer, the Contractor shall supply the material originally specified in the Contract.

If the price of the approved alternative material is in excess of the material specified in the Contract, the Contractor shall not be entitled to extra payment over the rates in the Bill of Quantities.

101.19.4 Supply by Contractor

Pursuant to Clause 36 of the Conditions of Contract, all materials required in the Works, except as otherwise provided for in the Contract, shall be supplied by the Contractor and the cost thereof shall be included by the Contractor in his rates in the Bill of Quantities.

The Contractor's Tender shall be construed as an undertaking that all the materials and equipment to be provided by the Contractor are in his possession, or readily available and will be delivered to the Site in accordance with the Time Schedule.

101.20 MAINTENANCE OF WORKS

During the period of maintenance the Contractor shall maintain the Works and make all repairs, as defined in clauses 49 and 50 of the Conditions of Contract.

After the commencement of the Period of Maintenance, the Contractor shall do nothing which might endanger the safety of the Public and he shall carry out all instructions of the Engineer or other duly authorised person or authority in this regard. Throughout the Period of Maintenance the Contractor shall notify the Engineer what work or operations it is intended to be carried out on the Site and he shall carry out any instruction which the Engineer may give as to times and manner of working so that any inconvenience to the Public is kept to a minimum.

The Engineer will give the Contractor due notice of his intention to carry out any inspections during the Period of Maintenance and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and take note of all matters and things to which his attention is directed by the Engineer.

101.21 WORKS LOG BOOK

The Engineer's Representative will keep a Works Log Book on the Site.

To assist the Engineer's Representative in keeping the Log Book, the Contractor shall supply daily to him full details in writing on the following:

1. The number of workmen of the various trades and grades employed in carrying out the Works.
2. Quantities of the various materials brought to or removed from the Site.
3. Quantities of the materials incorporated by the Contractor in the Works.
4. Constructional Plants and Contractor's equipment brought to and removed from the Site.
5. The use of Constructional Plant in the Performance of the Works.
6. Other details as requested by the Engineer's Representative.

The Engineer's Representative may, if he so desires, use the above data to conduct the Log Book. However, such data shall not bind the Employer or the Engineer in any manner whatsoever.

The Log Book will be signed by the Engineer's Representative, and a signed copy of the daily entries will be handed to the Contractor or his authorized representative, who within 48 hours from the receipt of said copy, may object to any of the entries therein by written notice to the Engineer's Representative. Such objections by the Contractor shall be recorded in the Log Book. If the Contractor or his authorized representative has not made any such objection within 48 hours as aforesaid, he shall be deemed to have confirmed the correctness of the data entered in the Log Book.

The Contractor may enter in the Log Book his remarks regarding the performance of the Works. However, such remarks shall not bind the Employer or the Engineer.

Entries in the Log Book, except those to which the Contractor has objected in writing as described above, shall serve as evidence between the parties as to facts included therein; however, they shall not in themselves form the basis for a demand for any payment under the Contract.

101.22 RESIDENT ENGINEER'S OFFICE

101.22.1 Construction

The Contractor shall, within 4 weeks of the issuance the order to commence of works, hand over to the Engineer a fully completed, furnished and equipped Engineer's office. The Contractor shall provide suitable temporary office space for the Engineer until the office is completed.

All facilities provided for the Engineer and/or Employer's staff shall be provided upon issuance the order to commence of works and shall remain available until the end of the defects liability period or until such earlier time as the Engineer may instruct.

The Contractor shall provide prefabricated portable or demountable offices or other as may be approved by the Engineer for the sole use of the Engineer and his staff, comprising:

- 2 offices size of each approximately 4 m x 4 m
- 1 pantry
- 1 toilets

Entrance area with space for desk

Offices are to be of proprietary manufacture, with hard-wearing, easy-clean surfaces and robust and secure fittings. Submit full details to the Engineer for approval before delivery to the Site and erection.

101.22.2 Furnishings

Each office shall contain:

- 2 desks with lockable drawers and swivel chairs
- 2 lockable steel filing cabinets
- 2 office chairs
- 1 drawing hanger for 10 sets
- 2 shelves
- 1 pin boards
- 2 waste paper baskets.
- 1 reference table

KITCHEN FURNITURE AND EQUIPMENT

- 1 refrigerator 14 cu. ft. capacity
 - 1 water filter and 20 liters water cooler/hot/cold
 - 1 electric boiling rings
 - 1 stainless steel sink and drainer
 - 1 heat resistant worktop
 - 1 set of storage cupboards
 - 1 set of crockery and cutlery for each member of the staff
 - 1 large waste basket with cover.
- and all necessary consumables for the making of beverages for the duration of the contract

LAVATORY FURNITURE AND EQUIPMENT

- 1 w.c. suite
 - 1 toilet roll holder
 - 1 wash hand basin
 - 1 mirror
 - 1 paper towel holder
 - 1 soap dispenser
 - 1 waste basket with cover.
- and all necessary consumables.

and, in addition, the following shall be provided:

- 1 secretary's desk and swivel chair
- 2 large lockable sheet filing cabinets
- 1 photocopying machine similar to FT500 I with duplex, sorter and document feeder + consumables + all photocopying papers pin boards, shelves and waste paper baskets.

SERVICES: The Contractor shall provide and maintain the following minimum services:

- heating and air-conditioning
- electric lighting and power
- water supply
- drainage system
- fire fighting appliances
- cleaning facilities and general attendance including all personal.
- All bills and charges related to the services shall be paid by the Contractor.

TELEPHONES: The Contractor shall provide a three separate telephone connection (one cellular) and one regular phone line and one dedicated Facsimile service for the representative's offices, with PABX, extensions and telephone set for each office, secretary and conference room and shall pay all charges.

At the end of the project all the above equipment shall remain the property of the Contractor.

101.22.3 Miscellaneous Facilities and Services

The Resident Engineer's office shall be cleaned daily and provided with clean towels (every other day), soap, glasses and at all times with a fresh and adequate supply of drinking water. The cost of these services shall be paid for by the Contractor.

The Contractor shall be responsible for the security of all plans, papers, books, instruments from theft or fire during the continuance of the Contract and his insurance policies shall cover the office of the Resident Engineer.

The Contractor shall provide a complete set of all ASTM, AASHTO, BS EN and other Standards, Materials Manuals and Codes of Practice referred to in this Contract, or relevant thereto, shall be provided to the Engineer by the end of the mobilization period.

The Contractor shall provide all ladders, access lighting facilities and assistance etc. required by the Engineer to inspect any part of the Works.

The Contractor shall provide for the use of the Engineer when required by the Engineer, one total station surveying equipment, all of approved type and make, complete with accessories and all instruments, tapes, staffs, poles, pegs, stagings, moulds, templates, profiles, and all other requisites for checking and setting out and measurement of the Work. The Contractor shall also provide, when required by the Engineer, the services of two experienced chainmen.

101.22.4 Maintenance and Removal

The Contractor shall fully maintain the Resident Engineer's office throughout the Contract Period and effect all repairs, painting etc. required during that period.

At the end of the Contract, the office with all its furnishings and facilities will revert to the Contractor who, upon receiving the Engineer's instructions to do so, shall dismantle the office and remove it, leaving the Site neat and tidy to the Engineer's satisfaction.

101.22.5 Payment

Unless specific items are provided in the Bill of Quantities, the cost of the use by the Engineer and his staff of the office, its furnishings and all facilities and the cost of their maintenance etc., all as specified in this Section, shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.23 DAYWORKS

When Dayworks are authorized by the Engineer all equipment, labour and materials shall be paid for at the rates listed in the Schedule of Dayworks in the Bill of Quantities.

All major materials for Dayworks authorized by the Engineer but not included in the Schedule of Dayworks shall be paid for on a Prime Cost basis. The Contractor shall be paid on the basis of paid invoices showing cost of materials less any discount, paid receipts for transportation and handling charges and paid receipts for insurance on materials and delivery of materials. Before authorizing the use of materials in Dayworks the Engineer may require the Contractor to supply estimates of the costs of the materials.

The Contractor shall be compensated for his expenses, overhead, labour and profit involved in procuring and delivering the materials by an amount equal to a percentage of the actual cost of the Prime Cost Sum.

101.24 WATER SAMPLES AND ANALYSES

101.24.1 Procedure

Water samples shall be out from the well. For the physico-chemical analyses, it is advisable to take a minimum of 2 liters of water. Whereas for the dosage of heavy metals and trace elements, it is necessary to take a minimum of 5 liters of water. Water will be sampled according to the indications of the laboratory and/or of the Engineer, in one or several small polyethylene flasks, with an eventual adjunction of certain substances.

The Contractor will install a regulating valve on the upper part of the pipe. The regulating valve will be fixed at a minimum height of 0.50 m above the ground. The flask in which water is sampled will be rinsed 3 times with pumped water before being filled. Each flask will be hermetically sealed and carefully labeled.

Water samples for bacteriological analyses will be taken in sterilized flasks of 250 to 500 ml. The regulating valve should be imperatively previously sterilized. Sampling flasks should not be exposed to direct sunlight and kept at a temperature of + 4 °C, before being transported to the laboratory within a maximum delay of 24 hours.

Physico-chemical and bacteriological analyses should be carried out by a laboratory approved by the Engineer.

101.24.2 Water analyses

Water analyses will be carried out and defined according to the French regulation method (decree N° 89.3 of January 3, 1989).

The required analyses are defined in accordance with:

- The origin of water: Ground or surface
- The treatment performed (if any)
- The sampling point.

At each well head, a sample of raw water will be taken to undergo a complete analysis. According to the sampling point:

- First analysis before starting works: Type P2P - C3 + B3
- Second analysis upon completion of works: Type P1 - C2 + B2.

101.24.3 Essential elements, measurements and criteria for each type of analysis (Tables 1, 2 and 3).

Table 1: Bacteriological analysis

| BACTERIOLOGICAL ANALYSES | | |
|--|---|--|
| Limited (B1) | Summary (B2) | Completed (B3) |
| Thermoturic coliforms. Fecal streptococci | Thermoturic coliforms. Fecal streptococci. Count of aerobic bacteria revivable at 22 °C et 37 °C. | Thermoturic coliforms. Fecal streptococci. Coliforms. Count of anaerobic bacteria revivable at 22 °C et 37 °C. Spores of sulfite-reducing anaerobic bacteria. |

Table 2: Standard analyses defined in accordance with the sampling point.

| Site | Source | | Production | | | Distribution | | |
|---------------------|---|---------------------------------------|--|----------------------------------|------------------------------------|-------------------------------------|-----------------------------------|------------------------------------|
| | (R.P.) | (R.S.) | (P1) | (P2) | | (D1) | (D2) | |
| | At point of withdrawal, treatment performed (R) | | After treatment and prior to discharge, or at the point of withdrawal if no treatment is performed (P) | | | In network (D) | | |
| Origin of the water | Ground water | Surface water | Ground water and surface water | Ground water (P2P) | Surface water (P2S) | Ground water and surface water | Ground water and surface water | |
| Standard Analyses | B1 - - - C3 - - | B1 - - - C3 C4a C4c | - - B3 - C2 - - | - - - - C3 - - | - - - - C3 C4a - | - - - - - C4a C4c | - B2 - C1 - - - | - - - C2 - - C4b |

Table 3: Types of physico-chemical analyses

| PHYSICO-CHEMICAL ANALYSES | | | | | | |
|---|---|--|--|--|-------------------------------|--|
| | Limited physico-chemical analyses (C1) | Summary physico-chemical analyses (C2) | Complete physico-chemical analyses (C3) | Specific physico-chemical analyses (C4) | | |
| | | | | C4a | C4b | C4c |
| Organoleptic parameters | - Appearance (qualitative): odour, taste, colour - Turbidity | - Appearance (qualitative): odour, taste, colour - Turbidity | - Appearance (quantitative): odour, taste, colour - Turbidity | | | |
| Physico-chemical parameters Natural structure of the water | - pH - Conductivity | - Temperature - pH - Conductivity - Nitrates - 3 of the following parameters: nitrates, ammonium, chlorides, sulfates, permanganate value,, metyl orange alkalinity or total hardness. | - Temperature - pH - Conductivity - Chlorides - Sulphates - Silica - Calcium - Magnesium - Sodium - Potassium - Aluminium - DS - Dissolved oxygen - Free carbon dioxide (marble test) or calculation of carbonate balance - Carbonates - Hydrogen-carbonates. | | | |
| Parameters concerning undesirable substances | - Residual chlorine or any other parameter relating to the disinfection treatment | - Residual chlorine or any other parameter relating to the disinfection treatment | - Nitrates -Nitrites - Ammonium - Permanganate value, hot, in acid medium - Hydrogen sulphide - Iron - Copper - Zinc - Manganese - Phosphorus - Fluorine - Residual chlorine or any other parameter relating to the disinfection treatment. | - Kjeldahl nitrogen. - Dissolved hydrocarbons - Surface agents - Phenol index | - Iron - Copper - Zinc. | |
| Parameters concerning toxic substances | | | | | -Cadmium - Lead - PAH | - Arsenic - Cyanides -Chromium - Mercury - Selenium. |
| Other parameters | | | | | | - Pesticides - Volatile halogenated organic compounds. |

101.24.4 Interpretation of analyses (Potability)

The results will be compared to the values set by:

- EEC directives/No/ 80/779/EEC-Official Journal of the European Communities, August 30, 1980. This directive groups together 62 admissible value parameters (guide level and maximum admissible concentration).
- WHO recommendations (Geneva 1986). Grouping parameters into five categories.
- French regulations (Decree No. 89.3-Official Journal of January 3, 1989). This decree groups analyses types and tables of admissible physico-chemical and bacteriological parameters relating to the definition of water potability.

These analyses will be given to the administration for the interpretation of data and the follow up.

101.24.5 Interpretation of analyses (corrosion)

During its transportation or use, water may cause various changes to the materials with which it is in contact. The most frequent deterioration is metal corrosion.

- Effects of aeration conditions (O_2H):
 - Corrosion in a non aerated place: corrosion caused by hydrogen
 - Corrosion in an aerated place: corrosion caused by oxygen.

The iron-water equilibrium potential in the absence of oxygen, and the oxygen and hydrogen electrodes equilibrium potentials will be controlled according to the pH value of the water.

- Effects of the mineralization influence (T.D.S.-T.A.C.)
 - The global mineralization of water increases its conductivity and decreases its resistance to corrosion. In particular, the concentration of chloride shall be verified (RYZNAR index).
- Effect of temperature variation

In conclusion, the approved laboratory should confirm, according to total mineralization and pH, the action of water and temperature on the different metals.

PART 2
CIVIL WORKS

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201 EARTHWORKS

201.1 GENERAL

201.1.1 Scope

Earthworks under this Specification include excavation and backfill for pipelines, excavation for ponds and open canals, excavation and backfill for structures, excavation from borrow areas, construction of embankments, compacted fill and surfaces and other earthworks and works related thereto, as required in the Works.

201.1.2 Classification of Excavation

Unless specific items for Rock Excavation are included in the Bill of Quantities, earthwork will not be classified in accordance with the hardness of the excavated material and all excavation will be deemed to consist of Common Excavation, as defined hereafter, regardless of the actual hardness of the excavated material.

Where excavation is classified according to hardness of excavated materials, the following definitions shall apply:

- Rock excavation shall include hard and solid rock that cannot be broken up by mechanical excavating equipment, including a heavy tractor equipped with a rooter, but which necessitates the use of pneumatic tools or blasting for its loosening and removal. Rock excavation shall also include detached boulders exceeding one half of a cubic metre in volume.
- Common excavation shall include all material other than rock as defined above and also detached boulders less than one half of a cubic metre in volume.

No material, except the aforesaid, will be defined as rock and classified as such for the purpose of payment, whether actually loosened by blasting, pneumatic tools or otherwise.

The decision as to the classification of any excavation into “rock” or “common” shall be at the sole discretion of the Engineer’s Representative, subject only to Clause 2 of the General Conditions of Contract.

Where specific items for Rock Excavation are included in the Bill of Quantities, the Contractor shall not be entitled to be paid for excavation in rock unless, at the time the excavation is open and visible, the Contractor shall give notice in writing to the Engineer’s Representative that he claims to be paid for excavation in rock. After giving such notice the Contractor shall not fill in the excavation or otherwise prevent it from being inspected by the Engineer’s Representative for the purpose of classification and determination of payline in respect of same.

201.1.3 Natural Ground Levels

The natural ground levels, as marked on the Drawings, shall form the basis of measurement for payment for excavation, fill and all other works where the site levels have bearing and no field

surveys will be made. Natural ground levels at intermediate points shall be checked on the field by the Contractor.

The Contractor shall check the natural ground levels before the commencement of earthworks, and such checking shall be made by the Contractor at his own expense, in the presence of the Engineer. The results, approvals in writing by the Engineer, shall thereafter prevail.

The cost of checking natural ground levels shall be borne by the Contractor alone, whether checking is carried out at the Engineer's request or at the Contractor's own request. No allowance will be made for normal bulking or shrinking of the soil and the Contractor shall make allowance for this in his rates.

201.1.4 Dewatering, Supporting and Fencing of Excavations

The Contractor shall, during the whole period of construction, keep the work area and all excavations dry and protected from the influx of water from any source whatsoever (rain and seepage water, water from surface and subsurface streams, groundwater, etc.) and shall provide and operate all pipes, pumps, well points and other apparatus and materials and all labour required for this purpose. The Contractor shall, throughout the period of construction, prevent structures and/or pipelines from flotation either by keeping the work area dry or by temporarily filling the structure and/or pipeline with water, all as approved by the Engineer.

The provisions that the Contractor shall make for the discharge of any water from the Site of the Works shall be satisfactory to the Engineer and to any persons or authorities having rights over the lands through which such water is discharged. The Contractor shall keep the Employer indemnified against any claim or damage that may be caused by non-compliance with the requirements.

The sides of excavations shall be supported whenever necessary or directed by the Engineer's Representative by means of timber, steel or other type of struts, walling, boards, sheeting or any other approved system. No support work shall be removed without the approval of the Engineer.

Every precaution shall be taken by the Contractor against slips, falls, or subsidence in the excavations, but if any slips, falls, or subsidence should occur the Contractor must at once make good the same including all surface restoration and reinstatement, all at his own cost. Should any such fall, slip or subsidence disturb or weaken any foundation or support to the Works or to any adjacent structure or facility, or create empty spaces and gaps near the new works, the Contractor shall carry out such additional works as the Engineer may require in consequence thereof, such as filling the gaps so caused with concrete or other suitable material as the Engineer may direct, all at the Contractor's own expense.

Steel sheet piling may be used by the Contractor in his supporting, bracing and dewatering operations, as specified above, of his own choice or at the direction of the Engineer, or where shown on the Drawings as a permanent part of a structure. The sizes and types of sheet piles used for temporary supporting and bracing shall be determined by the Contractor but will be subject to the Engineer's approval. Where sheet piles form a permanent part of a structure, their sizes and types shall be as shown on the Drawings or as directed by the Engineer.

The Contractor shall take all the necessary precautions during the excavation to protect his workmen and the publics. This may include, but shall not be limited to the supporting of the sides of the excavations, fencing the areas, providing warning lights and providing watchmen.

The Contractor shall be entirely responsible for the proper dewatering, supporting, fencing, lighting, watching, etc. of excavations, trenches and pits and shall not be relieved of his responsibilities under the Contract even though no objection has been raised by the Engineer to the conditions of the work.

Unless specific items are included in the Bill of Quantities, the cost of dewatering, supporting, bracing and timbering (including steel sheet piles), fencing, lighting, watching, etc. of excavations, trenches and pits and any extra earthworks and labour, materials and apparatus required for them shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.1.5 Use of Explosives

The Contractor shall use explosives only with the written express permission of the Engineer's Representative and related legal authority and all blasting shall be carried out by properly licensed and qualified workmen under experienced supervision. When using explosives, the Contractor shall abide by and conform to all the Laws pertaining to the purchase, transportation, storage and handling of explosives and shall obtain all required licences from and make all necessary arrangements with the relevant authorities prior to commencing blasting operations.

When blasting operations are in progress, all precautions shall be taken to protect all persons and livestock, the Works, and any other property from injury or damage.

The Engineer's Representative shall have the power to regulate, restrict or prohibit blasting if in his opinion it is necessary to do so for the safety of persons or property, or to safeguard the foundations or sides of the excavation, and the Contractor shall have no claim against the Employer in respect of such regulations or prohibitions. Explosives shall not be used within 20 metres or any other distance as the Engineer's Representative may direct, of concrete in permanent structures.

Notwithstanding anything said in this Sub-Section, the Contractor shall be held solely and entirely responsible for any injuries to persons and livestock and damage to public or private property.

201.1.6 Programme and Methods of Work

In addition to the information furnished by the Contractor with his Tender, the Contractor shall, after award of Contract but no later than two weeks prior to commencement of Works, submit for the Engineer's approval detailed proposed methods of excavating, transporting and placing earthfill material, watering and compacting and any subsequent modifications thereof, together with a detailed list of quantities and type of plant to be used for all these operations. Amendments shall be made by the Contractor in accordance with any instructions issued by the Engineer before commencement of works and from time to time.

201.1.7 Excavated Materials - Handling and Disposal

As far as practicable and as determined by the Engineer's Representative, all suitable materials from excavations shall be used in the permanent construction required under the Contract.

The Contractor's operations in excavations shall be such as to yield the maximum of suitable materials for construction purposes, and shall be subject to the approval of the Engineer's Representative. Where practicable, and as determined by the Engineer's Representative, suitable materials shall be excavated separately from those considered unsuitable, and the suitable materials shall be segregated by loads during the excavation operations and shall be placed in the designated final locations either directly from the excavation, or shall be placed in temporary stockpiles for later placing in the designated locations, all as directed by the Engineer's Representative.

Excavated materials that are considered unsuitable or are in excess of those required for permanent construction, shall be removed from the Site. The Contractor shall be entirely responsible for the removal of all surplus excavated material from the Site to such disposal areas as he shall have obtained at his own cost and responsibility and shall keep the Employer indemnified against any claims, charges or proceedings arising out of the transportation and disposal of such surplus excavated material.

Spoil heaps shall be located where they will not interfere with the progress of the Works, or with the flow of water in natural streams or drainage courses, and where they will neither detract from the appearance of the completed project and environment, nor interfere with access to the structures. Spoil heaps shall be levelled and trimmed to reasonable regular lines, as determined by the Engineer's Representative.

The cost of complying with all requirements of this Sub-Section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.1.8 Earthworks in Urban Areas (Not Applicable)**201.1.9 Restoration of Waterways and Pipelines**

The Contractor shall clean out and restore to their original condition all waterways or pipelines which may have been cut by the excavation or in any way damaged or silted up as a result of his operations.

Unless specific items are provided in the Bill of Quantities the cost of all additional work involved in crossing under or cutting through any waterways and pipelines and reinstating to their original condition shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.1.10 Restoration of Surfaces

The Contractor shall be responsible for the temporary and permanent restoration of all surfaces of roads, fields, paths, gardens, verges etc. whether public or private which are affected by his operations.

Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition satisfactory to the Engineer and responsible Authority until the permanent reinstatement is made.

The Contractor shall be responsible for the permanent reinstatement of all surfaces already described including asphalt surfaced public roads as specified in Section 201.3.11.

Should, at any time, any trench become dangerous, the Engineer will be at liberty to call upon the Contractor to restore it to a proper condition at three hours notice and, should the Contractor fail to carry out the work, have it done at the Contractor's expense.

The Contractor shall include in his rates for all materials and labour which he may have to employ in reinstating the trenches and surfaces to the satisfaction of the responsible Authority concerned.

Restoration shall be deemed to be included by the Contractor in his various unit rates for earthworks and shall not be paid for separately, except where specific items have been provided in the Bill of Quantities.

201.1.11 Equipment for Earthworks

Generally, equipment for earthworks, shall be of a modern type and of a design suited for each specific purpose. Only equipment and machinery approved by the Engineer shall be used in the Works.

Grading equipment shall be of any type of earthmoving equipment the Contractor may desire or has at his disposal, provided the equipment is in a satisfactory condition and of such capacity that the programme can be maintained. The Contractor shall furnish, operate and maintain such equipment as is necessary to control uniform layers, section and smoothness of grade for compaction and drainage.

Compacting equipment shall be of a design, weight and quantity so as to obtain the required density.

Pneumatic Roller shall consist of pneumatic tires arranged in a manner so as to provide a satisfactory compacting unit. The roller shall have an effective rolling width of at least 150 cm. and shall give a compression of at least 130 kg. per cm. of width of tread when fully loaded. The tires shall be uniformly inflated.

Smooth Roller shall be self-propelled or power roller and shall weigh at least 10 tons and may be of the tandem or three-wheel type. The wheels of the roller shall be equipped with adjustable scrapers.

Other equipment, such as vibrating machines, may be used for compacting and consolidating the embankments, subgrades, and other areas, upon approval of the Engineer. Such equipment shall be routed over the area being compacted and shall be operated until the required density is obtained.

Watering shall be carried out by means of tank wagons, tank trucks, or distributors equipped with a suitable sprinkling device. Satisfactory equipment shall be maintained on the site at all times when embankment construction is in progress.

201.2 CLEARING AND STRIPPING

201.2.1 Clearing

The areas upon which new construction is to take place, the rights-of-way along which pipelines are to be laid and all other such areas as may be designated by the Engineer and/or indicated on drawings as required for auxiliary purposes, (site offices and workshops, transport and machinery yards, borrow pits, stockpile sites, etc.), shall be cleared of all vegetation, shrubs and small and large trees, together with their roots, and from all other foreign and deleterious matter that may affect and interfere with the progress of the Works.

Trees and shrubs shall be cut or burnt down under strict control to ground level, the roots grubbed up to a depth of not less than 1.0m and removed from the area. All other scrub, vegetation, rubbish, etc., shall be cleared or burnt down to ground level and removed from the area to any distance.

All trees shall remain the property of the Employer and the Contractor shall collect these trees and store them until required by the Employer. All trees near to and about the Works except such as are to be removed, shall be carefully protected from damage by the Contractor during the period of maintenance and no trees shall be removed without the prior consent of the Engineer.

The Contractor shall take particular care at all times to prevent erosion on every site and elsewhere on land which may be affected by his operations and the Engineer may impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances seem to him to warrant.

Unless otherwise specified in the Contract, clearing shall be measured by square meters. The unit rate shall include for all operations required under this Sub-Section, including removal of trees (see also Sub-Section 201.2.2 hereafter).

No clearing shall be carried out without prior written approval of the Engineer's Representative and only such areas approved or ordered to be cleared shall be measured and paid for.

201.2.2 Removal of Trees

Clearing as defined in Sub-Section 201.2.1 shall include the removal of small and of large trees. Trees of a girth of 40 cms. or less when measured at a height of 1.0m above ground

shall be classified as small trees. Trees of a girth exceeding 40 cms when measured at a height of 1.0m above ground shall be classified as large trees and shall be removed only at the express order of the Engineer's Representative.

The removal of large trees, except where a specific item is provided in the Bill of Quantities, and the removal of small trees will be deemed to be included in Clearing and will not be paid for separately.

Where a specific item is included in the Bill of Quantities for the removal of large trees, they will be measured for payment by number.

201.2.3 Stripping

Areas on which compacted fill is to be placed and areas of excavations from which material for fill is to be extracted, including borrow areas, shall be stripped of top soil containing organic or otherwise deleterious and objectionable matter to a depth of at least 15 cm. or to such greater depth as may be determined by the Engineer. The stripped soil shall be stored in separate dumps for subsequent re-use in covering the slopes of embankments or the borrow areas after excavation therein has been finished, or shall be otherwise disposed of as directed. Under no circumstances shall such stripped material be used as compacted fill.

Stripping shall not be carried out unless the Contractor is able to proceed immediately with the further earthworks upon the stripped areas. Overstripping shall be backfilled and compacted, at the Contractor's own expense, to the satisfaction of the Engineer.

Stripping shall be measured in cubic metres, computed by multiplying the area stripped by the depth of stripping. The unit rate shall include for all excavation, stacking-re-spreading and running excess to spoil.

No stripping shall be carried out without prior written approval of the Engineer's Representative and only such areas approved or ordered to be stripped shall be measured and paid for.

Unless otherwise specified, stripping of borrow areas shall not be measured for payment and the cost of such stripping shall be deemed to be included by the Contractor in his unit rates for earthwork in the Bill of Quantities.

201.3 EXCAVATION AND BACKFILL FOR PIPELINES

201.3.1 Surface Excavation to Reduce Levels

Where shown on the Drawings or required or approved by the Engineer, the Contractor shall execute surface excavation in advance of trench excavation, to the lines and grades shown on the Drawings or ordered by the Engineer.

Any surface excavation not shown on the drawings and not ordered by the Engineer that the Contractor may wish to execute for the convenience of his work shall be subject to the Engineer's approval, but shall be done entirely at the Contractor's expense.

Surface excavation shall be measured in cubic metres according to the dimensions, lines and levels shown on the Drawings or directed by the Engineer. The unit rate shall include also for hauling the excavated material to fill areas, at any distance, and spreading them in layers of thickness not exceeding 20 cm. after compaction and disposal of the surplus material, all in accordance with the Drawings or as directed by the Engineer.

201.3.2 Trench Excavation for Pipelines

Pipe trenches shall be excavated to the typical cross-sections shown on the Drawings, and in no case shall the trench width up to the level specified exceed that shown on the Drawings. The Contractor shall ensure that at any point the width of the pipe trench is sufficient to permit the pipeline to be laid, jointed, bedded/surrounded and backfilling to be placed and compacted around the pipeline to the Engineer's satisfaction.

The trench invert shall, at any location, be at the proper level and trench width of the proper dimensions to allow for sand and/or concrete bedding or surrounds as shown on the Drawings and directed by the Engineer. Where pipes are laid directly on the bottom of the trench, the latter shall be straight and even so as to provide a good support for the pipe over its entire length and shall be free of roots, stones, lumps and other hard objects that may injure the pipe or its coating.

Where welding or jointing of pipes and/or accessories is required to be done in the trench, the same shall be widened and/or deepened to form bell-holes of sufficient size as directed by the Engineer's Representative so as to easily permit the proper execution of all welding, connecting and fixing works in all their stages, all necessary repairs to the pipe and coating, and for the thorough inspection of all these operations.

The length of trench to be kept open at one time shall be determined by the Engineer and shall in no case be exceeded. Should there be any danger that trenches may erode, then sections shall be left unexcavated for as long as possible and the laying and backfilling of pipelines shall follow excavation as soon as possible.

The excavated material shall be placed alongside the trench in such a manner as not to interfere with the work and to prevent its falling into same.

Should any part of a trench be excavated, in error, deeper than required, the extra depth shall be filled up with concrete, solely at the Contractor's expense.

Trench formations shall be in undisturbed ground. Where in the opinion of the Engineer, the formation is unsuitable for bearing, extra excavation shall be carried out under the direction of the Engineer and the level made up again with sound soil material carefully compacted or with concrete. This work shall be paid for by the Employer provided that the unsuitability of the formation is not due to the method of working of the Contractor, in which case the Contractor shall carry out the work at his own expense.

Trench walls excavated in rock shall be as nearly vertical as possible, and the Contractor shall consolidate the walls wherever they have been loosened by blasting or other reasons, and shall remove all loosened material. If rock occurs at a level higher than the required level of the trench bottom, the clearance between the pipe and the trench sides and bottom shall, where in

rock, be made to the dimensions shown on the Drawings or directed by the Engineer, to allow for sand or concrete bedding or surround.

In confined areas, where the passage of excavating equipment is impossible, or where the Engineer's Representative deems the use of such equipment impracticable or undesirable for any reason whatsoever, trench excavation shall be done by hand. All requirements specified above shall apply to trench excavation by hand. No extra payment shall be made for works in confined areas. All excavation, whether in confined or unconfined areas, shall be paid for at uniform rates as specified hereafter.

If, in the opinion of the Engineer, there is undue delay in testing the pipelines; removing surplus material; general tidying up of areas where pipes have been laid; partial restoration of maintenance of surfaces; or similar operations, then the Engineer may order that no further trenches shall be opened until the outstanding work has been carried out to his satisfaction and the Contractor shall have no ground for a claim against the Employer on this account.

No work will be started on the laying of pipes or bedding in any section of trench, until the trench formation of that particular section has been approved by the Engineer.

Once the pipeline section has been tested and the bedding and surround approved by the Engineer, the trenches shall be backfilled by layers as specified hereafter. Each layer shall be separately compacted and any subsidence resulting from insufficient compaction shall be the Contractor's liability and he shall forthwith add the necessary extra material which shall then be thoroughly compacted.

Unless otherwise specified, items for trench excavation shall apply to all kinds of soil, including rock, and the excavation will be measured for payment in linear metres measured along the centreline of the pipeline, classified by pipe diameter and for each section by average depth to invert of pipes. The average depth of a section shall be the average between adjacent manholes or as directed by the Engineer's Representative. The cost of trench excavation shall be deemed to include for excavation, drilling and blasting, to the required width and depth to underside of pipe barrel, finishing the trench bottom as specified, digging boreholes where required, removing excavated material and storing it alongside the trench for backfilling whenever permitted, removal of material that may result from land slides, removal of loosened earth or rock, removal and disposal of all excess spoil to any distance, timbering and dewatering as and where required if no specific items have been provided in the Bill of Quantities.

201.3.3 General Backfill

The excavated material or selected material which can be classified as suitable for backfilling shall be in accordance with the requirements of Section 201.5.

Where necessary, excavated material shall be sieved or sorted to remove large stones, rocks, or other particles which, in the opinion of the Engineer's Representative, may impede compaction.

201.3.4 Type A Fill

Type A fill shall be good hard well graded material screened and crushed as necessary to lie within the grading envelope given in Table 1.1. The material shall have a CBR greater than 25%.

The liquid limit should not be more than 25% and the plasticity index should not exceed 6%.

The minimum value of the sand equivalent should be 50%. The maximum value of abrasion test should be 40%.

Table 1.1: Grading Envelope for Type A Fill

| Sieve Size | % by Mass Passing |
|-------------|-------------------|
| 75 mm | 100 |
| 37.5 mm | 85 - 100 |
| 10 mm | 45 - 100 |
| 5 mm | 20 - 65 |
| 600 microns | 8 - 45 |
| 75 microns | 0 - 20 |

201.3.5 Type B Fill

Type B fill shall be clean hard fill free from deleterious material and free from stones greater than 150mm in size. The material shall have a CBR greater than 15%. The liquid limit should not be more than 40% and the plasticity index should not exceed 10%.

201.3.6 Hardcore

Hardcore shall consist of broken stone or other suitable hard material. It shall be free from clay, dust or other deleterious matter, shall not contain pieces exceeding 100mm and not more than 5% of the material shall pass through a 20mm sieve.

201.3.7 Beddings and Surrounds - Sand and Granular Material

(i) Sand Bedding and Surrounds for Concrete, A.C. and Metal Pipes -

Where shown on Drawings, pipes shall be laid in sand bedding or surround.

The bedding and surrounds material shall be fine, uniformly graded sand (sand comply with BS 882 grading zone c), clean and free of stones, rubbish, clay or organic matter. Free draining, incompressible, fine granular material may be used instead of sand, subject to written approval of the Engineer.

The beddings and surrounds up to 30 cm above the pipe shall be wetted and thoroughly compacted in layers not exceeding 15 cm in thickness after compaction. Special care shall be taken to obtain proper compaction under and around the pipe.

Sand beddings and surrounds at any depth shall be measured in linear metres of trench in which surround has been placed, classified by diameter of pipe. The unit rates inserted in

the Bill of Quantities for surrounds shall include the additional excavation in trench bottom, supplying the necessary materials, spreading, levelling and compacting the materials.

(ii) Granular Material Beddings and Surrounds for P.V.C. and G.R.P. Pipes

All P.V.C. and G.R.P. pipes shall be laid in suitable granular material bedding or surround. Suitable bedding and surround material shall be broken stone or gravel from 3/8" (9.5 mm) to 3/16" (4.8 mm) size, sand (as specified in Section 201.3.7(a)) or other material having a compaction factor not exceeding 0.1. The compaction factor shall be obtained by the following test:

Equipment

1. Open-ended cylinder 225 mm long and 150 mm internal diameter (a pitch fibre or P.V.C. pipe is suitable).
2. Metal rammer with striking face 40 mm diameter and weighing 0.9 to 1.1 kg.
3. Rule.

Method

Obtain a representative sample more than sufficient to fill the cylinder viz. about 11.5 kg. It is important that the moisture content of the sample should not differ materially from that of the main body of material at the time of its use in the trench.

Place the cylinder on a firm surface and gently pour the sample material into it, loosely and without tamping. Strike off the top surface level with the top of the cylinder and removal all surplus spilled material. Lift the cylinder up clear of its contents and place on a fresh area of flat surface. Place about one-quarter of the material back in the cylinder and tamp vigorously until no further compaction can be obtained. Repeat with the second quarter, tamping as before, and so on for the third and fourth quarters, tamping the final surface as level as possible.

Measure from the top of the cylinder to the surface of the compacted material. This distance divided by the height of the cylinder (255 mm) is referred to as the Compaction Factor.

Interpretation of Values

| <u>Compaction Factor</u> | <u>Suitability for Use</u> |
|--------------------------|----------------------------|
| 0.1 or less | Material suitable |
| Over 0.1 | Material unsuitable |

For each batch of material, three (3) Compaction Factor tests shall be made and the average value used. Material sufficient for the surround of two hundred linear metres of pipe shall be considered to comprise one batch.

The granular material bedding and surround shall be wetted and thoroughly hand-tamped in layers not exceeding 15 cm in thickness after compaction. Special care shall be taken to obtain proper compaction under and around the pipe.

Granular material beddings and surrounds for pipes, at any depth, shall be measured for payment in linear metres of pipe, classified by diameter. The rates shall include additional excavation in trench bottom, supplying the necessary material, spreading, levelling, compacting and carrying out Compaction Factor tests.

201.3.8 Beddings and Surrounds - Concrete

Where required, pipes shall be bedded on or surrounded by concrete, to the dimensions, lines and levels shown on the Drawings or determined by the Engineer. All concrete used for bedding and surround of pipelines shall comply, in all respects, with the provisions of Division 202 hereafter. Plain concrete and reinforced concrete shall be of Grade C20P.

Pipes shall be supported and jointed at the correct level, clear of the trench bottom upon two blocks of precast concrete of suitable height, each supporting one end of the pipe. Concrete shall then be poured and rammed beneath and around the pipes in one operation and finished off to the level and dimensions shown on the drawings.

The precast blocks shall first be properly set on the trench bottom and boned to the correct position and level. The pipes shall then be laid on the blocks and properly centred, socketed and finally brought to the correct gradient by the application of wooden wedges one on each side of the pipe and between the pipe and the concrete blocks. These wedges shall remain left-in whilst the pipes are jointed and tested, as herein specified and during the pouring of the concrete beneath and around the pipes. Where the concrete while being poured would otherwise cause the pipes to float, pipes shall be effectively anchored to prevent such flotation.

The Contractor may, according to his own choice, pour concrete either with or without forms. Whatever the Contractor chooses; the concrete for payments shall be measured as per Drawings and no extras shall be paid for dimensions in excess of those required according to the Drawings.

Concrete beddings and surrounds shall be measured for payment in linear metres, classified according to diameter of pipe and according to type of bedding and surround. The rates shall be valid for any depth and shall include all additional excavation in trench bottom, concrete, reinforcement, formwork, materials, labour, etc.

201.3.9 Backfilling of Pipe Trenches

Backfilling of pipe trenches (except at joints) shall be done as soon as practicable after the pipes have been satisfactorily laid in position and jointed and in no case shall more than five pipe lengths be left uncovered after laying. Where shown on Drawings, the first stage of the backfill, up to 30 cm above the crown of the pipe, shall consist of selected material. Selected material shall be granular, free from stones, rubbish, clay and organic matter. It shall be free-draining and readily compactable. This backfill shall be spread in layers not exceeding 15 cm in thickness after compaction, and compacted at least to 92% of modified A.A.S.H.T.O. density as defined in Part 2 Section 201.7.

The remainder of the pipe trench (from 30 cm above the crown of the pipe to the sub-base coarse of the road or to the top of the trench) shall be backfilled, after the completion of testing, by one of the following methods:

- (i) Where the pipeline crosses or runs underneath roads or pavements, backfilling shall be of type B, type A will be used when directed by the Engineer or shown on the Drawings, and shall be placed in layers not exceeding 15 cm after compaction, wetted as necessary and compacted at least 90% of modified A.A.S.H.T.O. and the last 60 cm below the road sub-base course shall be compacted at least 95% of modified A.A.S.H.T.O. density as defined in Section 201.7.
- (ii) In open areas, where the requirements of para. (a) do not apply, the second stage backfill may be done with excavated material dumped into the trench by means of a bulldozer or similar equipment, provided that the fill material does not contain any large stones, that the trench is completely filled without leaving any voids, and the fill is finished with a neat mound raised to about 30 cm above the trench edges to allow for future subsidence.

All joints and other accessories shall be left uncovered until after the pipeline shall have passed any pressure or leakage tests that may be prescribed by the Specification.

Where the backfill cover over the pipes is less than 70 cm, the travel of the tracks or wheels of heavy equipment thereon will be strictly prohibited, and the Contractor shall use suitable small compactor, and shall be responsible for any damage caused to the pipe by non-compliance with this requirement.

The Contractor shall be responsible for any subsidence of trench backfill and shall make good any damage to road or structures caused thereby during the Period of Maintenance.

Where lengths of trench are excavated partly in rock, stony ground, or in other material unsuitable for backfilling, there may not be sufficient suitable material available from the excavation for backfilling as specified above and in such cases the Contractor shall transport suitable material from other parts of the work or from borrow areas.

The Contractor shall make arrangements for sites for tipping the spoil and shall include in his rates for excavation the cost of haulage and tipping of spoil and all expenses in connection with the obtaining of suitable backfilling material.

Backfilling of pipe trenches will be measured for payment in linear metres along the centreline of the pipeline, classified by pipe diameter and for each section by average depth to the top of surrounds material which is placed to 30 cm above the top of the pipe. The average depth of a section shall be the average between adjacent manholes in case of gravity pipelines, and the average between adjacent stations in case of pressure pipelines. The cost of trench backfilling shall be deemed to include supplying of material and compaction in layers not exceeding 15 cm after compaction.

201.3.10 Cased Borings

Where shown on the Drawings or instructed by the Engineer, pipes shall be installed in casings inserted into horizontal borings across embankments at existing installations or in road crossings. The casing pipe shall be of sufficient strength to withstand the forces acting on it during insertion in the bore and the external pressure of the earth, and shall have a nominal diameter as shown on Drawings but at least 6" larger than that of the line pipe. Where the soil is sufficiently cohesive and stable, the casing may be pushed into a bore previously drilled through the embankment to a diameter slightly larger (by 2-3 cm) than the external diameter of the casing. Where the nature of the soil does not permit such a procedure, the casing shall be

jacked through the embankment or under the road with simultaneous drilling and removing the material from the interior of the casing pipe. In both cases, the casing pipe may be inserted in successive sections welded to each other as the work proceeds. The Contractor shall choose the most suitable and efficient method for drilling and casing and shall submit the procedure proposed by him for the Engineer's approval. Drilling and casing shall be done at the exact locations and to the lines and grades shown on the drawings or determined by the Engineer. After the casing has been installed in position and approved by the Engineer, the line pipe shall be installed therein. To protect the line pipe and especially its coating against abrasion and other injury or damage during installation and thereafter, the Contractor shall use specially designed spacers of timber or plastic or shall produce such spacers. The distances between spacers of either kind shall not exceed 3.00 m. After the line pipe has been installed in its final position, the annular space at each end of the casing shall be filled with a mixture of bitumen and sand to seal off the interior of the casing against the entry of water, mud, small animals, vermin and other foreign bodies.

Cased borings shall be measured, separately for each diameter of casing, in linear metres by the actual length of cased boring through embankment as approved by the Engineer.

The unit rates for cased borings shall include: open-cut excavation and preparation of work area at both ends of boring, drilling through embankment, supply of casing pipe, welding of casing pipe sections, inserting of casing pipe in bore, installation line pipe in casings, supply and placing of spacers and sealing of openings at the ends, supply, transport and removal from Site of boring equipment and backfill of open-cut excavation connected with boring.

201.3.11 Road Reinstatement

a) Cutting into Paved Areas

Where pipes have to be laid under existing paved areas such as roads or sidewalks, cutting into the pavement shall be done with appropriate tools, to ensure straight and neat cuts. The

trench shall be vertical and its width across the top edges shall not exceed the following values:

MAXIMUM WIDTH OF THE TRENCHES AT THE TOP IN PAVED AREAS (IN m)

| Depth of trench from paved surface to pipe invert (m) | Maximum width of trench at the top in paved areas (m) |
|---|---|
| ≤ 1.50 | O.D(*) + 0.55 |
| 1.51 - 2.50 | O.D(*) + 0.85 |
| 2.51 - 3.50 | O.D(*) + 1.15 |
| 3.51 - 4.50 | O.D(*) + 1.45 |
| 4.51 - 5.50 | O.D(*) + 1.85 |
| 5.51 - 6.50 | O.D(*) + 2.25 |
| 6.51 - 7.50 | O.D(*) + 3.00 |

(*)O.D = Outer diameter of pipe barrel.

The Contractor shall take all necessary measures, such as shoring, bracing, etc. to keep the width of the trenches within the limits given in the table.

Cutting into paved areas will be measured for payment in linear metres of cut pavement.

b) Reinstatement of Surfaces

All surfaces whether public or private which are affected by the Works shall be reinstated in two stages, the first stage shall be carried-out in the first instance, and when the ground has consolidated fully the Contractor shall proceed with the second stage at the order of the Engineer.

First stage and second stage reinstatement of all surfaces, affected by the operations of the Contractor shall be carried out and maintained to the satisfaction of the Engineer and the responsible authority or owner.

First stage reinstatement shall be carried out immediately the trenches are backfilled.

Second stage reinstatement shall not be carried out until the ground has consolidated completely. The Contractor shall inform the Engineer before carrying out this work. In the event of further settlement occurring after the completion of the second stage reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority.

For the purposes of first and second stage reinstatement in bitumen and surfaced roads the surface width of trenches shall be increased by recutting 15cm on each side of the trench for a depth of 8 cm to provide a solid abutment for the surfacing material.

Reinstatement of surfaced roads shall be carried out to the approval of the relevant authority.

The responsible authority shall have the right to carry out final reinstatement at the Contractors expense.

Trenches in open ground shall be reinstated to the condition in which the ground was before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In verges and other grass surfaces and after the backfilling has been thoroughly consolidated the topsoil shall be relaid rolled and planted with grass or other vegetation as-directed by the Engineer as may be necessary and watered until the grass has become well established. Should the planting fail it shall be replanted as required until a satisfactory growth is obtained.

If at any time any reinstatement deteriorates the Contractor, shall restore it to a proper condition immediately.

Should the Contractor not remedy the defect to the Engineer's satisfaction forthwith any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

All trees, shrubs and plants shall be carefully transplanted and shall be returned to their original location after the refilling of the excavations. Return of old or mature trees may be waived in cases where the age of the tree makes return impracticable.

Top soil shall be carefully set aside and replaced at the surface of the backfilling.

The trenches shall be refilled and rammed solid as specified in the Contract and shall not be topped up above the original surface level to allow for settlement.

If any trench becomes dangerous the Engineer may call upon the Contractor for its reinstatement at three hours' notice and failing this to have the work done by others at the Contractor's expense.

c) Safety of Excavation in Roads

Where the surface of the road (other than that which lies immediately above the trench) is damaged either by the concentration of traffic caused by an open trench, by subsidence or other causes arising from the operations of the Contractor, he shall permanently reinstate the whole of the surface so damaged to its original condition.

The Contractor shall ensure that trenches and reinstatement are maintained in a safe condition and shall take immediate action to remedy any deterioration which renders the works unsafe. If in the opinion of the Engineer any excavation or reinstatement is in a dangerous condition the Contractor shall immediately remedy the defect. Should the Contractor fail to carry at the reinstatement promptly the work may be carried out by others at the Contractor's expense.

d) First Stage Reinstatement

In all paved roads the trenches shall be refilled and compacted to the underside of the sub-base layer of the road at 48 cm below the road finished level.

A sub-base layer of 20 cm thick shall then be laid consisting of approved free draining granular material conforming to section 218.1.3 requirements.

A base layer of 20 cm thick shall then be laid consisting of approved crushed limestone material conforming to section 218.1.3 requirements.

Prior to application of the first stage reinstatement the surface of the road foundation shall be cleared of all dust, debris and other deleterious matter and shall then be primed with one application of prime coat MC-70 or similar approved. All joints with adjacent road surfacing shall be cut straight and vertical and primed.

The road surfacing of the first stage consists of 5 cm thick of finished asphalted concrete layer.

The surface shall be maintained with the end of the period of Maintenance or until instructions are given for the final reinstatement to be carried out.

f) Reinstatement of unmade roads

In all unmade roads the trenches shall be refilled and compacted as specified in the Contract to within 15 cm of the surface.

The trench shall be surfaced with 15 cm compacted thickness of base layer material as specified above.

The surface shall be maintained until the end of the Period of Maintenance and shall not be topped up above the level of the original surface to allow for settlement.

e) Second Stage Reinstatement

Second and final reinstatement consists of a wearing course of 4 cm compacted thickness of 14 mm nominal size dense wearing course macadam. The laying and finishing of the coated macadam shall be carried out so as to achieve a dense, smooth and even surface using a roller of not less than 12 tonnes mass.

201.4 EXCAVATION FOR PONDS AND CANALS

Excavation for ponds and canals shall be carried out and finished to the lines, grades and dimensions shown on the Drawings and to the tolerances specified hereafter.

Excavated material shall be used for earthfill in embankments and in other locations, as shown on Drawings, except for material rejected by the Engineer as unsuitable, which shall be run to spoil. Under this Section, suitable material shall be excavated, moved to fill areas, dumped and spread, as specified. The Engineer shall be entitled to designate the earthfill where individual loads of material shall be deposited.

The Contractor shall take all necessary precautions to prevent excavation beyond and below the lines and levels indicated on Drawings. Any damage to the work due to the Contractor's operations, including shattering of the material beyond the required depths and lines, shall be made good by the Contractor at his own expense. Any and all excess excavation for the convenience of the Contractor or any overexcavation performed by the Contractor for any purpose or reason, except as may be directed by the Engineer in writing, shall be at the expense of the Contractor. Where required to complete the work, all excess excavation and

overexcavation shall be refilled, consolidated and made good with materials provided by the Contractor at his own expense, as directed by the Engineer's Representative.

Unless otherwise specified, items for excavation for ponds and canals shall equally apply to all kinds of soil, including rock, and excavation shall be measured by cubic metres of excavated material, to the lines and levels shown on the Drawings or as directed by the Engineer. The unit rate shall include for excavation, drilling and blasting, stacking, hauling excavated material in fill areas, and disposal of spoil material, all as specified in this Section.

201.5 EXCAVATION AND BACKFILL FOR STRUCTURES

All excavation for structures shall be carried out to the dimensions, lines and grades shown on the Drawings or directed by the Engineer.

Excavations on or against which concrete or compacted fill is to be placed, shall be clean and free from stones, clods, debris and other loose material. Where the bottom of an excavation does not provide a solid basis for casting concrete, it shall be consolidated by tamping and/or watering as necessary until the required density is obtained.

Any over-excavation in the bottom of the structure shall be cleaned and backfilled with concrete or selected backfill compacted to the density of the adjacent natural soil. Over-

excavation in rock shall be backfilled with the concrete of the structure or with dry stone pack, as directed by the Engineer. Any and all excess excavation for the convenience of the Contractor for any purpose or reason, except as may be directed by the Engineer in writing, and all refilling of such over-excavation as specified, shall be at the expense of the Contractor.

Where possible, concrete foundations and blocks shall be cast against the undisturbed sides of the excavation. Where over-excavation beyond the lines of the structure is unavoidable due to the nature of the ground, because of the shape of the structure or for any other reason, the space between the structure and the faces of the excavation shall be backfilled to the original ground level (whether natural or reduced) as specified hereafter for backfilling.

Excavated material, to the extent that it is required and suitable, shall be put aside for use in backfill. Surplus excavated material shall be either used for backfill in other locations on the site, or shall be otherwise disposed. Wherever required, the Contractor shall obtain suitable material for compacted backfill from borrow areas.

Backfill shall be carried out to the lines and grades shown on the Drawings. The backfill material shall be placed in horizontal layers not exceeding 15 cm in thickness after compaction. The backfill material shall completely and firmly fill the spaces between the excavation lines and the structure without leaving any voids, and shall be compacted to the density of the adjacent natural earth. The sides and bottom of the excavation shall be moistened before backfilling and so shall the backfill material, in order to obtain the moisture content necessary for the required compaction. Every layer shall be compacted by pneumatic tampers approved by the Engineer.

Unless otherwise specified, items for excavation and backfill for structures shall equally apply to all kinds of soil, including rock.

Excavation shall be measured by cubic metres to the neat lines and dimensions of the structures, as shown on the Drawings or described in the Specification, with no allowance whatsoever so actual side-slopes, working space, etc. The unit rates for excavation shall include for excavation, drilling and blasting, stacking, hauling of excavated material to any distance, spreading and compacting and running surplus to spoil.

Backfill will be measured for payment by cubic metres, and the unit rates for backfill shall include for supplying of material, spreading and compaction of material in layers not exceeding 15 cm after compaction.

201.6 EXCAVATION FROM BORROW AREAS

Wherever required or directed by the Engineer, the Contractor shall obtain suitable material for compacted fill from borrow areas. Such suitable borrow material shall be excavated, moved to fill areas and spared as specified. The locations and boundaries of the borrow areas as well as the depths and slopes of excavation therein shall be as determined or approved by the Engineer's Representative. Before commencing to extract filling material from any borrow area, the Contractor shall strip its surface as specified in Sub-Section 201.2.3 above and shall also remove therefrom all material which is, in the Engineer's opinion, unsuitable for filling. The surface of the borrow shall be left in a reasonably smooth and even condition, as approved by the Engineer's Representative.

No excess borrow material shall be brought to fill areas. Unnecessary material shall be rejected and dumped and shall not be measured for payment.

Measurement for payment of excavation in borrow areas shall be made only for excavation of borrow material actually used as fill, to the lines and dimensions prescribed by the Engineer's Representative. Measurement shall be by cubic metres and the unit rate shall include for stripping (which shall not be measured and paid for) and for removing unsuitable material, hauling to fill areas at any distance. All materials from borrow pits placed in embankments and compacted backfill will again be included for payment under the applicable rates of the Bills of Quantities for compacting such earthwork. Provided always that the cost of borrowed material has not been specified to be included in those relevant pay items for which the same borrowed material is to be supplied.

201.7 EMBANKMENTS AND COMPACTED FILL

201.7.1 General

Wherever the term "embankment" is employed it shall also mean "compacted fill", unless the distinction between those two terms is clearly emphasized.

Embankments shall be constructed to the lines and grades shown on the Drawings. Where grassing is required, a compacted fill embankment shall be constructed up to the underside of the layer of top soil, as shown on the Drawings.

No brush, roots, sod, or other perishable or unsuitable materials shall be placed in the embankments. The suitability of each part of the foundation for placing embankment materials thereon and of all materials for use in embankment construction will be determined by the Engineer. The Contractor shall maintain the embankment in an approved manner until the final completion and handing over of all the Works.

The embankment operations shall be so conducted and the various soil strata shall be placed so as to produce a soil structure as shown on the typical cross sections, or as directed by the Engineer. The slopes of the division lines between zones and/or portions of the embankment are tentative and shall be subject to variation, at any time prior to or during construction, and the Contractor shall be entitled to no additional allowance above the unit rates in the Bill of Quantities, by reason of such variations. The embankment for each portion shall be maintained approximately level throughout the entire length of each layer from abutment to abutment. All openings through the embankment required for construction purposes shall be subject to approval, and such openings shall be constructed so that the slope of the bonding surface between embankment in place and embankment to be placed is not steeper than 1:4. The bonding surface of the embankment in place shall be prepared as provided for embankment foundations.

The Contractor shall be responsible for the stability of all embankments made under the contract and shall replace any portion which, in the opinion of the Engineer, has become displaced due to carelessness or negligence on the part of the Contractor.

Where excess spoil, or other material for which compaction is not specified, is dumped and spread, the Contractor shall route his equipment, both when loaded and when empty, to travel over the entire area of the above mentioned material. No payment will be made for this

operation, and its cost shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities.

When the state of the weather is such that it would adversely affect the placing of fill, all embanking shall be stopped. In particular, embanking work will not be permitted during rain nor for such time afterwards as the Engineer may judge to be necessary to allow the upper layers in the embankment to dry to their correct moisture content as directed by the Engineer.

At all times during dry weather, whether embanking is taking place or not, the surface of the embankment is to be watered everywhere as directed by the Engineer, or protected to his satisfaction to prevent undue cracking of the surface. Watering is to be done by means of tankers, sprinklers or other methods approved by the Engineer.

Any material not complying with the specified density or moisture content shall be replaced in the embankment at the Contractor's own expense notwithstanding the fact that it may be overlaid by more recently placed material.

201.7.2 Preparation of Foundation

No material shall be placed in any section of the embankment until the foundation for that section has been suitably prepared and approved by the Engineer's Representative.

All excavation made for test pits or other subsurface investigations, and all other existing cavities found within the area to be covered with earthfill which extend below the established lines of excavations for the embankment foundations shall be filled with compacted earthfill. The foundation for earthfill, where in clayey soil, shall be scarified, wetted and compacted as specified for the earthfill to be placed thereon. Where the foundation is granular material it shall be compacted by vibrating rollers to a depth of not less than 30 cm to the same density as specified by the overlaying earthfill. Surfaces upon or against which the earthfill portions of the embankment are to be placed shall be cleaned of all loose and objectionable materials in an approved manner by hand-work or other effective means immediately prior to placing the first layer of earthfill. The surfaces of each portion of the foundation, immediately prior to placing the earthfill, shall have all water removed from depressions and shall be properly moistened and sufficiently clean to obtain a suitable bond with the earthfill. Where compaction of fill is to be started, or continued after the previous layer has been in place for over 6 hours, the area shall be harrowed to a depth of 20 cms, wetted and compacted to the required degree of compaction.

201.7.3 Compaction Control

Compaction shall be controlled by field density and field moisture tests, or by such other tests as prescribed by the Engineer.

The densities of the compacted earth materials shall be defined as follows:

- (i) Modified A.A.S.H.T.O. Density shall mean the maximum dry density obtained from the compaction test in accordance with the A.A.S.H.T.O.-T-180-61 (method D) test or the (identical) A.S.T.M.-D-1557 (method D) test.

- (ii) Relative Density shall be defined by the following formula (in accordance with the U.S. Bureau of Reclamation Earth Manual Designation E-12):

$$D_d = \frac{Y_d \max (Y_d - Y_d \min)}{Y_d (Y_d \max - Y_d \min)} \times 100$$

where

- D_d = Relative density
 $Y_d \max$ = greatest dry density obtained by laboratory
 $Y_d \min$ = least dry density obtained by laboratory
 Y_d = the dry density at which the soil is to be placed or the in-place dry density

The field density of compacted material in place shall be determined by the A.A.S.H.T.O.-T-191-61 method or by the identical A.S.T.M.-D-1556-64 method. Field moisture content shall be determined by the A.S.T.M.-D-2216-63-T method.

Samples of all fill materials, both before and during placement, shall be taken for testing at frequent intervals. The following tests shall be performed:

- (i) Tests to determine the maximum dry density and the optimum moisture content. The number of samples for these tests shall be as determined by the Engineer but not less than one sample per 1,000 m³ of fill shall be taken.
- (ii) Field density tests. The number of samples for these tests shall be as determined by the Engineer, but not less than one sample per 1,000 m³ of compacted fill or one sample per day, whichever is larger.

For the performance of all the above-mentioned tests, the Contractor shall provide a fully-equipped field laboratory and the necessary trained personnel for sampling and testing, all subject to the Engineer's prior approval. All costs for providing the field laboratory and the necessary personnel and for sampling, testing, transportation, etc., shall be deemed to be included by the Contractor in his unit rates for the various items of earthworks in the Bill of Quantities and shall not be paid for separately.

201.7.4 Placing and Compacting - General

Embankment materials shall be deposited in horizontal layers over the entire width of the embankment and compacted to the required densities as shown on the Drawings or as specified.

Embankments shall be formed of satisfactory materials. The thickness of each layer shall not exceed the thickness shown on the Drawings or as specified. In the construction of embankments, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, layers shall be constructed approximately parallel to the finished grade line.

The material in the layers shall be brought to the optimum moisture content before rolling is started to obtain the prescribed compaction. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankments thus affected shall be delayed until the material has dried to the required moisture

content. Sprinkling shall be done with sprinkling wagons, pressure distributors, or other approved equipment that will sufficiently distribute the water. Sufficient equipment to apply the required water shall be available at all times.

The optimum moisture content shall be determined by the Engineer and the actual content shall not vary from the required one by more than plus 4 or minus 2 percent. This optimum moisture content, determined by the Engineer as required for compaction purposes, shall be uniform throughout each layer of the earth-fill prior to and during the compacting.

The distribution of materials shall be such that the compacted fill be homogeneous and free from lenses, pockets streaks or other imperfections.

The number of successive passes of the compacting equipment over each and every point in any layer shall be not less than six (6). The overlapping of two adjacent passes shall be not less than 30 cm. The Engineer's Representative shall have the right to test every layer. However, the Contractor shall not be permitted to start work on the successive layers without the Engineer's Representative's permission, irrespective of whether tests have been made or not.

Where due to small width of required fill or any other reason, compaction of material in horizontal layers by sheeps foot rollers or pneumatic rollers will in the Engineer's opinion be impracticable, the Engineer may permit the use of other equipment and procedures such as compaction by mechanical tampers or spreading the material in small quantities in layers parallel to the slope and compacting same by cylindrical rollers applied along the slopes, or otherwise. Compaction shall be carried out to the Engineer's satisfaction and to the specified density.

After compaction has been completed as specified, all surfaces and slopes shall be trimmed and smoothed to accuracy specified hereafter. The cost of such trimming and smoothing shall be deemed to be included in the various rates for construction of embankments.

201.7.5 Compaction of Clayey and Silty Materials

Clayey and silty materials shall be deposited in horizontal layers of thickness not exceeding 15 cm, after compaction. The excavating and placing operations shall be such that the materials when compacted will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability. Prior to and during compaction, the materials shall have the optimum moisture content as determined by the Engineer, and the moisture content shall be uniform throughout each layer.

Insofar as practicable, as determined by the Engineer's Representative, moistening of the material shall be performed at the site of excavation, but if necessary shall be supplemented by sprinkling at the Site. Should the actual moisture content not be within the limits prescribed in Subsection 201.7.4 above, compacting operations shall not proceed until the layer has been brought to optimum moisture content, whether by wetting or scarifying and drying. No additional payment shall be made on account of any operation by the Contractor in drying or wetting the materials or on account of delays occasioned thereby.

When the filling material has been conditioned as specified, it shall be compacted by tamping with sheeps foot rollers having staggered and uniformly spaced knobs and of sufficient weight for proper compaction, by tyre rollers, by hand or power tampers, or by other compacting

equipment approved by the Engineer. When tamping rollers are used, the tamping knobs and cleaner bars shall be properly maintained and the space between the tamping feet shall be kept clear of anything which may impair the effectiveness of the roller. Unless otherwise specified, the dry density of the soil fraction in the compacted material shall not be less than 92 percent of the Modified A.A.S.H.T.O. Density as defined in Subsection 201.7.3 above.

201.7.6 Compaction of Cohesionless Free-Draining Materials

Cohesionless free-draining materials, such as sand and gravel, shall be deposited in horizontal layers of not more than 15 cm if compacted by tampers or rollers, not more than 30 cm if by treads of crawler-type tractors, surface vibrators or similar equipment and not more than the penetrating depth of the vibrator if compacted by internal vibrators.

Unless otherwise specified, the relative density of the compacted materials, as defined in Subsection 201.7.3 above, shall be not less than 70 percent.

201.7.7 Compaction of Intermediate Soil Types

Unless otherwise specified, in borderline cases between clayey and silty soils and those that fall under the definition of cohesionless free-draining materials, the density shall be either 92 percent of the Modified A.A.S.H.T.O. Density or 70 percent relative density, whichever value is the higher.

201.7.8 Pipelines and Structures in Embankments and in Compacted Fill

Where pipelines are to be laid in embankments or in compacted fill, the embankment or fill will first be constructed to the lines and levels shown on the Drawings, to a height of 1.5 m above the crown of the pipe or to the top of the embankment or fill. After the embankment or fill have been constructed to the height specified above, the Contractor shall excavate in the compacted fill a trench to the Typical Trench Cross Sections; shall lay, joint, etc., the pipes in it; shall backfill the trench, as specified, to the top of the embankment and shall complete all other operations of constructing and covering the pipeline. After all the above operations have been completed, the Contractor shall resume, where necessary, the construction of the embankment or fill and its compaction.

Where steel pipes are to be laid in compacted embankments, the work shall be carried out as specified above, except that the embankment shall be completed to a level of 50 cm above the crown of the pipes.

Where structures, such as manholes, chambers, channels, etc., are to be constructed in compacted embankments or fill, the embankment or fill will first be completed to the lines and levels shown on the Drawings. The required excavation for the structures shall then be made and the structures constructed in it. After the completion and testing of such structures, the excavation shall be backfilled and compacted to the specified density.

201.7.9 Methods of Measurement and Payment

The supply of fill material, including its hauling and spreading and running of surplus to spoil, shall not be paid for separately and shall be deemed to be included in the relevant pay items for excavation, whether from borrow areas or from excavations for pipelines, structures, etc.

Compaction of Embankments shall be paid for separately and measured by cubic metres of the volume of compacted fill in place. No payment shall be made for additional material required to be added due to Settlement, and the Contractor shall make due allowance for this in his rates. The unit rate shall include wetting and compacting and the performance of all field and laboratory tests as specified. The unit rate shall also cover all additional costs of scarifying, harrowing, etc., where and when needed and trimming and smoothing of surfaces.

No additional payment shall be made in case of stockpiling of excavated materials and later rehandling of such material if directed by the Engineer in order to produce the specified embankment structure and the cost thereof shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.8 TOLERANCES OF FINISHED EARTHWORKS

All earthworks shall be finished to the dimensions and elevations shown on the Drawings. Unless otherwise specified, the following variations shall be acceptable:

- (i) Embankment width - not more than 20 cm over the specified widths and not more than 10 cm less than the specified widths. Embankment elevations - not more than 5 cm.
- (ii) Elevations of bottoms of ponds - no more than 5 cm.
- (iii) Channel invert elevations - not more than 3 cm, provided a continuous slope is maintained in the direction of flow so as to prevent the formation of puddles on bottom of channel.
- (iv) Irregularities in surfaces of all earthworks - not more than 1.5 cm when checked by a straight edge.

201.9 SOIL INVESTIGATIONS

The Contractor shall carry out soil investigations according to BS 1377 (Methods of test for soil for civil engineering purposes) at the stations, buildings, reservoirs and water towers construction site, whenever he is requested to do so by the Contract and as directed by the Engineer's Representative. These investigations shall comprise various boreholes (according to the nature of the soil) as well as reports determining the specifications of the layers, the bearing capacity of the soil, the nature of foundations and the retaining structures if needed.

201.9.1 Borings

According to the nature of the soil or rocks, one of the three following borings shall be carried out:

- a) Alluvial soils

(loose soils or slightly to fairly consistent)

Borings shall be:

- Either, penetrometric borings performed by a penetrometer ≥ 100 KN, static-dynamic with a measurement of the cone resistance and the lateral friction.
- or, core-borings $\varnothing \geq 76$ mm performed with core samplings and in-situ-SPT. The number of borings is conditional upon the area of the structures, and shall be carried out at the rate of one boring for every 200 m^2 , with a minimum of two borings. Depths shall be conditional upon the nature of the soil and the loads, and shall be fixed according to each site but shall not, in principle, exceed 15m.

In case underground water was found at a slight depth, a piezometer shall be installed. Moreover, in some cases, a trench shall be dug with a mechanical shovel down to 1 to 2 m beneath the aquifer and a permeability test performed by pumping shall be carried out (watertable drawdown and recovery).

b) Calcareous rocks

Destructive soil investigation shall be carried out with a measurement of the rate of drilling progress and the pressure exerted on the bit. These borings aim at locating the fractures and fissures in rocks, since these fissures and not the hardness of the rocky matrix limit the bearing capacity of the foundations. Borings shall reach 5 m beneath the level of the foundation.

The number of borings shall be conditional upon the surface of the structures and shall be carried out at the rate of one boring every 100m^2 , with a minimum of five borings. In case borings show cavities or considerable cracks, supplementary and closely distributed borings shall be carried out after the beginning of earthworks.

In case groundwater was found, a piezometer shall be installed.

c) Extremely consolidated soils or very soft rocks (Sandstone, marl, clay)

Continuous core samplings shall be performed with a double core-driller. The diameters of borings shall be 76mm as a minimum.

A representative sample of each layer and boring shall be taken from the core-samples and shall undergo unconfined compression tests. Some samples shall eventually undergo free swelling tests.

The number of borings shall be conditional upon the surface of the structures, and shall be carried out at the rate of one boring every 200 m^2 , with a minimum of two borings.

The depths shall be conditional upon the nature of the soil and the loads, and shall be fixed according to each site, but shall not in principle, exceed 15m.

In case underground water was found, a piezometer shall be installed.

201.9.2 Report

After carrying out borings and taking measurements, a report shall be drawn. It shall treat of the following issues:

- Opening and stability of excavations and the drainage methods.
- Treatment of the foundations soil, if need be.
- The permissible constraint exerted on the soil, in terms of the nature of foundations and differential settlements.
- Special recommendations concerning problems such as drainage, etc...

201.9.3 Methods of Measurement and Payment

The soil investigation shall be measured for payment by linear metre of borehole depth, the unit rate shall include mobilisation and demobilisation of equipment, labor, boreholes, tests, report, etc...

202- CONCRETE WORKS

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202 CONCRETE WORKS**202.1 STANDARDS, GRADES, COMPOSITION AND TYPES****202.1.1 General**

This division describes the quality of materials and workmanship of concrete and reinforced concrete works cast in situ in all parts of structures below or above ground in all site locations.

The Specification shall apply to concrete prepared on site as well as ready mixed concrete and small precast concrete elements. Generally, it is based on CP 110 Part I 1972 and on BS 4881, 5328 and 5337.

In case of discrepancy or contradiction, the requirements of this Specification shall rule over any standard.

202.1.2 Standards and Codes

The current ruling Standards and Codes of Practice, detailed below, are made by reference part of this Specification.

| | | |
|---------------|-----------|--|
| BS | 12 | Portland Cement (ordinary and rapid hardening) |
| BS | 146 | Portland - Blastfurnace Cement |
| BS | 410, 1796 | Test Sieves and Test Sieving |
| BS | 882, 1201 | Aggregates from Natural Sources |
| BS | 1305 | Batch Type Concrete Mixers |
| BS | 1370 | Low Heat Portland Cement |
| BS | 1881 | Methods of Testing Concrete |
| BS | 1926 | Ready-Mixed Concrete |
| BS | 3148 | Tests for Water for Making Concrete |
| | 4027 | Sulphate Resisting Portland Cement |
| BS | 4251 | Truck Type Concrete Mixers |
| BS | 4449 | Hot Rolled Steel Bars for the Reinforcement of Concrete |
| BS | 4461 | Cold Worked Steel Bars for the Reinforcement of Concrete |
| BS | 4466 | Bending Dimensions and Scheduling of Bars for the Reinforcement of Concrete (Plain round mild steel or high yield steel) |
| BS | 4482 | Hard Drawn Mild Steel Wire for the Reinforcement of Concrete |
| BS | 4483 | Steel Fabric for the Reinforcement of Concrete |
| BS | 5075 | Concrete Admixtures |
| BS | 5135 | Metal Arc Welding of Carbon and Carbon-Manganese Steels |
| BS | 5328 | Methods for Specifying Concrete Part 1 to Part 4 |
| PD | 6440 | Accuracy in Building |
| BS | 6588 | Portland Pulverised - Fuel Ash cement |
| BS | 8007 | Design of Concrete Structures for Retaining Aqueous Liquids |
| BS | 8102 | Protection of Structures against Water from the Ground |
| BS | 8110 | CP 110 Part 1 and Part 2 |
| | | Structural use of Concrete |
| ASTM Standard | C309 | Liquid Membrane Forming Compound for Curing Concrete |
| ASTM Standard | C260 | Air Entraining Admixtures for Concrete |

In case of discrepancy or contradiction, the requirements of this Specification shall overrule any standard.

202.1.3 Classification and Composition

Concrete of all grades shall consist of coarse and fine aggregate, cement, water and additives. Generally, the grades of concrete shall be detailed as described in the following table. However, other grades may be required in the Particular Specification.

Table 2.1 Concrete grades and Classifications

| Grade/Class of Concrete Per B.S. 5328 | Characteristic Compressive Strength (Kg/cm ²) | Minimum Cement Content (Kg per m ³) of Ready Concrete | Characteristic Use |
|---------------------------------------|---|---|--|
| C 7P | 70 | 150 | Lean Concrete |
| C10P | 100 | 200 | Non-Reinforced Concrete |
| C15P | 150 | 200 | |
| C20P | 200 | 280 | Reinforced Concrete |
| C25P | 250 | 280 | |
| C30P | 300 | 280 | |
| C40P | 400 | 300* | Prestressed Concrete and Concrete for Special Purposes |
| C50P | 500 | 300* | |
| C60P | 600 | 300* | |

* For prestressed concrete the following maximum cement contents shall not be exceeded:

Grade C40P - 375 kg per 1.0 m³
Grade C50P, C60P - 450 kg per 1.0 m³

The relationship between grade of the concrete and its characteristic strength shall be as given in BS 5328. The grade of concrete to be used in particular locations shall be as given in Table 2.2 unless noted otherwise on the Drawings.

Table 2.2 Concrete strength requirements

| Location | Maximum Coarse Aggregate Size (mm) | Grade of Concrete (BS 5328) |
|---|------------------------------------|-----------------------------|
| Blinding Concrete | | |
| - General Structures | 20 or 40 | C15P |
| - Liquid Structures | 20 | C20P |
| Blinding concrete | | |
| - Sulphate Condition | 20 | C25P |
| Substructures thickness less than 400 mm | 20 | C25D |
| Substructures, walls and slabs more than 400 mm | 20 | C25D |
| Superstructures normal concrete | 20 | C25D |
| Liquid retaining structures | 20 | C35D |
| Fine concrete | 10 | C25D |
| Precast concrete | 10 or 20 | C30D |

In the above table suffix P means a prescribed mix, D means a designed mix and A means a design mix complying with the requirements of BS 8007.

The specific grades of concrete to be employed in the different structures or parts of structures shall be as shown on the Drawings or indicated in the Specification Bill of Quantities. The quantity of cement in the ready concrete shall in no case be less than the minimum quantities detailed in the above table.

The Contractor shall have trial mixes for the various structures designed by an approved laboratory. The mixes shall be designed with the objective of producing concrete having suitable workability, density, impermeability and required strength.

Proportions shall be determined in accordance with the “Design of Normal Concrete Mixes” published by the United Kingdom Department of The Environment and obtainable from:

Building Research Establishment and Bookshop
Garston
Watford
WD2 7JR
ENGLAND

or other approved methods, for the requirements set out in this Specifications.

The amount of water used in the concrete shall be changed as required to secure concrete of the proper consistency and to adjust for any variation in the moisture content or grading of the aggregates as they enter the mixer. Addition of water to compensate for stiffening of the concrete before placing will not be permitted. The mix to be used in every part of the Work shall be subject to the Engineer’s approval and the Engineer shall have the right to demand the mix proportions and water-cement ratio to be changed during the progress of the work if in his opinion such changes shall be necessary to secure the required quality of the concrete as detailed above.

The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, having regard to the structural element

being constructed, the disposition of reinforcement, and taking full account of the environment to which it will be subjected.

The minimum cement contents and maximum water/cement ratios of designed mixes shall be as given in Table 2.3. In the event of sulphate exposure precautions requiring lower cement content than those required for normal conditions the latter requirements shall prevail.

**Table 2.3 Minimum cement contents
Normal Conditions**

| Type of Structural Element | Exposure Conditions (BS 8110) | Minimum Cement Content (kg/m ³) | | | Maximum Water/Cement Ratio |
|--|-------------------------------|---|-------|-------|----------------------------|
| | | Maximum Aggregate Size | | | |
| | | 40 mm | 20 mm | 10 mm | |
| Liquid Retaining Structures, Shafts and Tunnel Linings | Severe | 295 | 325 | 356 | 0.55 |
| All Foundations and Buried Structures | Moderate | 270 | 300 | 340 | 0.60 |
| Building Super-Structure | Moderate | 270 | 300 | 340 | 0.60 |

Additional requirements when exposed to sulphate conditions (all structural concrete)

| Concentration of Sulphates | | Type of Cement | Minimum Cement Content (kg/m ³) | | | Maximum Water/Cement Ratio |
|----------------------------------|-------------------------------------|----------------|---|------|------|----------------------------|
| In Soil (Total SO ₃) | In Ground Water (Parts per 100,000) | | Maximum Aggregate Size | | | |
| | | | 40mm | 20mm | 10mm | |
| < 0.2 | < 30 | OPC | NORMAL CONDITIONS | | | |
| 0.2 - 0.5 | 30 - 120 | OPC | 300 | 330 | 370 | 0.50 |
| | | SRPC | 250 | 280 | 320 | 0.55 |
| 0.5 - 1.0 | 120 - 250 | OPC | Not Permitted | 330 | 370 | 0.50 |
| | | SRPC | 300 | | | |
| 1.0 - 2.0 | 250 - 500 | OPC | Not Permitted | 370 | 410 | 0.45 |
| | | SRPC | 340 | | | |
| > 2.0 | > 500 | SRPC | Ditto but with protective coating | | | 0.45 |

202.1.4 Types of Concrete

a) Ready-Mixed Concrete

The use of ready-mixed concrete will be permitted provided the production, transportation, sampling and testing of the ready-mixed concrete shall conform to the requirements of B.S. 1926 and that the concrete meets the requirements of this Specification as to strength, cement content, impermeability and other properties. The methods and equipment used and the speed required for transporting concrete shall be such that concrete having the required composition and consistency will be delivered into the work, without objectionable segregation, loss of slump, and delay.

The Contractor shall notify the Engineer of the supplier from whom he intends to purchase the ready-mixed concrete and shall obtain the Engineer's approval in writing of such supplier. Prior to the commencement of concrete production, the Engineer shall be given notice to enable him to check the composition and cement content of the concrete about to be produced at the supplier's plant. However, the Engineer's approval of the supplier and his inspection of the concrete production shall not relieve the Contractor of his sole responsibility for the quality concrete, and the Contractor shall make good any damage and shall indemnify the Employer against losses caused by concrete not meeting the requirements of the Specification. The Engineer may at any time and at his own discretion prohibit the use of any ready-mixed concrete which in his opinion does not meet the requirements of the Specification, and in such an event the Contractor shall discontinue the use of such ready-mixed concrete and shall at no extra cost to the Employer supply concrete mixed on the site, or ready-mixed concrete from another source meeting the Engineer's approval.

b) Lean, Blinding and Cyclopean concrete

Concrete shall be proportioned to 200 kg of cement per 1 m³.

Stones for cyclopean concrete shall be wetted and cleaned from any deleterious matter prior to batching. Stones with a maximum size of 20 cm and covered with concrete shall be added to fresh concrete.

The proportion of concrete shall not be less than 60% of the total volume. Stones shall not be in contact with one another, nor with the formworks or trenches sides. The minimum distance between two stones or between one stone and the side of the formwork is 5 cm. Aggregates shall not form honeycombing in the surface of concrete. Should such defect be found after the removal of formworks, the concerned parts shall be demolished and cast anew at the expense of the Contractor. Cyclopean concrete surfaces shall be thoroughly finished. The location of these types of concrete shall be indicated on the drawings. In all cases the Engineer must give his written approval for concreting.

c) Porous Concrete

Porous concrete is made of single-core coarse aggregates and practically no-fines. It produces a low slump and has a low water/cement ratio; just enough cement is used to bind the aggregates into a mass resembling popcorn. The ratio of aggregate to cement shall be 8:1 by volume or 10:1 by mass.

It is characterized by 20% to 35% of voids, and a high permeability allowing a free water flow.

Porous concrete will be used in hydraulic structures where drainage is desired. It is also used to allow the recharge of groundwater by water penetration through concrete.

To maintain the required permeability properties, concrete surfaces should not be stopped nor sealed. No finishing work even with a trowel shall be required. The compressive strength of the various mix proportions vary from 3.5 to 27.5 Mpa. Drainage velocity ranges between 100 and 900 liters/mn/m².

The concrete shall be mixed by machine or by hand to a uniform color and consistency before placing. The quantity of water used shall not exceed that required to coat all of the aggregate particles without forming excess grout.

d) Shotcrete concrete

Shotcrete concrete shall be mortar or concrete conveyed through a hose and pneumatically applied using either the dry mix process or the wet mix process.

The dry mix process shall consist of thoroughly mixing a proportional combination of dry fine aggregate and portland cement; conveying the mixture through a delivery hose to a special nozzle where water is added and mixed with the other materials immediately prior to its discharge from the nozzle. The wet mix process shall consist of premixing by mechanical methods a proportional combination of portland cement, aggregate, and water required to produce mortar or concrete; conveying the mortar or concrete through the delivery hose to the special nozzle where additional compressed air is added at the nozzle prior to discharge.

Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in place hardened shotcrete meeting the required strength.

The surfaces on which shotcrete is to be placed shall be finely graded to the lines and grades shown on the drawings. The surfaces shall be thoroughly compacted and shall be uniformly moistened so that water will not be drawn from the freshly placed shotcrete.

e) Chuted concrete

Chuted concrete is a plain concrete to which is added at the end of mixing a superplasticizer giving it a flowing consistency (slump at Abram's cone test = 20 to 24 cm). This concrete is especially used for heavily reinforced reservoirs or those having complex shapes. However, the following precautions should be taken:

- Check beforehand the efficiency of the superplasticizer (plasticity modification, effect on strength, duration,...)
- Mix concrete as close as possible to its final position, since this type is more prone to segregation than plain concrete.
- Use resistant formworks because chuted concrete transmits pressures (height of concrete in formworks) better than plain concrete (reduced internal friction).

f) Fibre concrete**General**

Fibre concrete contain appropriate quantities of metallic fibres as to form a composite and homogeneous mixture and shall be designed according to British Standard.

The main characteristics of metallic fibre concrete are:

- Strong cohesion which gives a high strength to shocks.
- Important ductility with small cracks (< 8mm) which reduces construction cracks.
- Resistance to rupture.

Materials

Metallic fibres are machined directly from the steel slab. They are triangular, twisted, curved and have a smooth side and a rough side.

Fibres shall be stored in a dry place.

The percentage of fibres shall vary between 20 and 40 kg per cubic meter of concrete.

Cement shall be chosen according to BS 12.

Granular materials shall comply with BS 882.

Sand shall be graded 0 to 3mm or 0 to 5mm and contain 15% of fines ($\leq 0.315\text{mm}$). Grading shall be continuous as far as practicable with a maximum grain size of 25mm.

The water shall comply with BS 3148.

Addition of water on site shall not be permitted.

The admixtures permitted to be used with fibre concrete are:

Super Plasticizer

Super Plasticizer are used to increase the workability of fibre concrete, at the time of placing without addition of water.

Plasticizers-water reducers

They are used to increase the plasticity of concrete (especially pumped concrete) at a constant quantity.

Prior to adding fibres, concrete shall have an ultimate bending-tensile strength equal to 3.4 MPa, in order to allow the good anchoring and performance of fibre.

Concrete fluidity shall be measured by the Abram's cone (slump test).

Fibres decrease greatly the workability of concrete. Therefore, fluidizers shall be added directly on site in the truck mixer in order to facilitate placing while the water/cement ratio is kept constant.

Two types of concrete may be used:

1) Chuted concrete

This is the best solution.

Slump:

- | | | | |
|------|-------------------------------------|---|-------------|
| i) | Prior to adding fluidizers | : | 4 to 6 cm |
| ii) | After adding fluidizers | : | 15 to 18 cm |
| iii) | After adding fluidizers and fibres: | | 10 to 14 cm |

Chuted concrete allows to decrease the quantity of water ($0.4 \leq W/C \leq 0.5$), and, therefore, develops good mechanical resistances and ensures a considerable workability.

Fluidizers shall be added on site.

2) Plasticized concrete

Slump:

- i) Prior to adding fibres : 9 to 12 cm
 ii) After adding fibres : 6 to 8 cm

Plasticized concrete requires no addition of water on site. Given its low workability, it is difficult to place this type of concrete.

The performance of metallic fibre concrete is measured by the ultimate tensile bending strength test after 28 days. The average common performances are tabulated hereunder:

| Proportion | 20 kg/m ³ | 25 kg/m ³ | 30 kg/m ³ | 35 kg/m ³ | 40 kg/m ³ |
|----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Performance MPa (maximum stress) | 4 | 4.5 | 4.9 | 5.2 | 5.5 |

Placing

Fibres shall be mixed directly with concreted without forming “urchins”.

No “dosing-untangling” device shall be needed.

Placing shall be done:

- either, in the truck mixer on site, with an additional mixing of 6mm at 14 r.p.m.
- or, at concrete factory with aggregates or, at the end with an additional mixing of 4mm.
- or, in the concrete mixer on site, with an additional mixing of 6mm.

The concrete should be adequately consolidated. The vibration method is conditional upon the type of concrete.

- Chuted concrete requires almost no vibration. It is placed by means of vibrating rulers or even without any external vibration (evenness is controlled by a laser level).

Chuted concrete allows concreting large surfaces without any construction joints.

- Plasticized concrete or admixtures free concrete shall be consolidated by means of a vibrating ruler.

In the event of fair-faced concrete surfaces, fibres shall be properly integrated in concrete though adequate mechanical or manual troweling.

No particular precautions are required for other traditional finishings (sprinkling, incorporated or added finish). A curing product shall be applied to the finished surface of concrete slab to prevent rapid desiccation.

Should surfaces be painted, concrete may be cured by sprinkling with water.

Joints shall be formed in fibre concrete. However, given the plasticity and coherence of this type of concrete, it is preferable to place it continuously and, then, form contraction joints by sawing.

Joints are formed each 8m x 8m outdoors or in non covered surfaces (at the time of execution) or each 10m x 10m, and even 12m x 12m indoors. In the latter case, the proportion of fibres shall be 30 kg/m³).

1. Construction joints

They shall be either keyed or dowelled, with or without angle iron. However, chuted concrete allows the concreting of large surfaces without needing to form construction joints.

2. Contraction joints

Joints are sawn over $\frac{1}{4}$ of the thickness minimum.

3. Separation joints

Joints shall be formed around hard zones: stringers, footings, columns.

4. Expansion joints

Expansion joints shall be avoided, as far as practicable, in covered slabs where no major temperature variations are observed.

Design of concrete pavement

According to each case, the Engineer shall determine the sizing of works.

- Westergaard modulus of subgrade reaction
- Exact definition and location of applied loads.

The maximum strengths used for calculation of concrete are conditional upon the proportion of reinforcing fibres and tabulated hereunder:

| Proportion | 20 kg/m ³ | 25 kg/m ³ | 30 kg/m ³ | 35 kg/m ³ | 40 kg/m ³ |
|--------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Allowable σ (MPa) | 2.8 | 3.2 | 3.5 | 3.7 | 3.9 |

Controls

The user of metallic fibre concrete shall establish a self-control procedure concerning the following:

1) Taking over of support ground

The user shall take over the foundation ground in order to make sure that the slab is homogeneous and true to the adopted assumptions.

(Westergaard modules $> 30 \text{ MPa/m} = 3 \text{ bar/cm}$)

A membrane may be placed to prevent contamination with fine particles especially in silty soils or saturated with water.

It may be necessary to insert a polyethylene sheet (150 microns minimum thick) between the foundation ground and the slab to:

- i) separate the slab from the foundation ground and facilitate sliding
- ii) avoid infiltration of water or laitance into the foundation ground.

iii) avoid rising of underground water

2) Concrete quality

The user shall check the composition of concrete at the time of manufacture in the batching-mixing plant or when delivered on site, and make sure that grading curves are consistent with the present technical specifications document.

The user shall check the workability of the various types of concrete mentioned above through a slump test prior to and after placing of fibres.

According to the placement method, the user shall carry out a self control on the quantity of used fibres with regard to the volume of placed concrete, and verify that concrete is free of “urchins”.

3) Mechanical strengths

Verifications shall be performed according to “the Professional Rules for Pavement Works”. The user shall namely verify:

- Quality of plain concrete (tensile bending strength ≥ 3.4 MPa)
- Mechanical strength of concrete; the performances level defined above being checked out.
- Tests shall be carried out on prismatic samples 4cm x 14cm x 56cm
- Such verifications shall be carried out:
 - at the concrete factory during the self control. The proportion of added fibres shall be determined on the delivery notes.
 - and, on site, by the Contractor, prior to placing concrete as per the Technical Specifications.

Workmanship

The works shall be carried out by the Contractor. The Contractor shall comply with the technical specifications and the Special Specifications provided by the manufacturer.

The pavement slab shall not be used before:

48 hours after placing concrete for light pedestrian traffic

7 days after placing concrete for light traffic

28 days after placing concrete for normal traffic.

All workmanship details shall be in accordance with the requirements of all concrete sections mentioned in these specifications.

202.2 MATERIALS FOR CONCRETE -

202.2.1 Cement

Cement shall comply with one of the following sub-Clauses (i) to (iv) below:

- i) BS 12 (Ordinary and rapid-hardening Portland cement).
- ii) BS 146 (Portland-blastfurnace cement).
- iii) BS 4027 (Sulphate resisting Portland cement).
- iv) BS 6588 (Portland pulverised-fuel ash cement) provided that sub-Clause (vii) below is complied with.
- v) A mixture of BS 12 (Portland cement) and BS 3892: Part 1 (Pulverised-fuel ash for use in structural concrete) provided that the amount of pulverised-fuel ash is not less than 15% nor more than 35% by weight of the total cement and sub-Clause (vii) below is complied with.
- vi) A mixture of BS 12 (Portland cement) and BS 6699 (Ground granulated blastfurnace slag for use with Portland cement) provided that the amount of slag is not more than 65% by weight of the total cement.
- vii) The pulverised-fuel ash used shall have a maximum colour index of 6 (Colour Comparator disc reference No. 296570) when measured using the Lovibond Colour Comparator system as recommended in BS 3892: Part 1 Appendix H, Clause H8.

The Concrete Cement used for Concrete Structure in contact with wastewater shall be Sulphate resisting Portland Cement and in accordance with BS 4027.

Consignments of any cement shall be used in the order in which they are received. Any cement stored on the site over three months may be rejected by the Engineer. Should the quality of the cement be adversely affected by dampness or any other cause the cement shall be removed from the site.

Each shipment of cement shall be stored so that it may readily be distinguished from other shipments. The cement shall be free from lumps and shall be otherwise undamaged when used in concrete.

Sacked cement shall be delivered to the Site in the sound original bags of the manufacturer and shall be stored in a watertight and weatherproof shed on a floor raised at least 15 cm from the ground. Stacking cement bags to excessive heights they may cause damage to cement or is otherwise undesirable, as determined by the Engineer, will not be permitted.

Bulk cement shall be stored in weatherproof bins or silos to be approved by the Engineer. The bins shall be emptied and cleaned at reasonable intervals as directed by the Engineer.

The quality of each consignment of cement shall be verified by manufacturers' certificates showing the results of tests, as per B.S. 12, appropriate for cement to be used in tropical climates. Where the Engineer so orders, the Contractor shall perform at his own cost additional tests on samples selected by the Engineer, all in accordance with B.S.12.

202.2.2 Water

The water used for mixing concrete shall be of potable quality, free from harmful materials such as clay, loam, acids or trade effluent. River water may be used after its suitability is ascertained beyond doubt by tests according to B.S. 3148. Periodic tests shall be carried out to keep a continuous check on the suitability of such water. The source of the water shall be subject to the Engineer's approval.

202.2.3 Admixtures

Usually the water proof concrete specifications are written aiming to achieve a watertight concrete structures.

But practically the concrete can sometime be very difficult to place.

If agreed by the Engineer, the contractor will be permitted to use concrete with more plastic consistency helping to produce a smoother and denser floor and wall finishes requirements.

In heavy reinforced structures, a good and long workability is also important.

It is impossible to meet the water/cement ration > 0.5 and a good workability requirements at the same time unless concrete admixtures are used.

Contractor may use admixtures and shall use if required by the Engineer admixtures such as:

- Retarder
- Accelerator
- Plasticizer or super plasticizer
- air entraining agent
- water proofing admixtures
- Fluid admixtures
- Anti freeze admixtures

Plasticizer and super plasticizer gives good workability and correct consistency (even for pumped concrete with extended working times) to enable the concrete to be compacted as fully as possible in as short a time as possible with a high reduction in the water/cement ratio.

Retarder

- By the use of suitable retarder the Contractor must obtain that the start of the setting process be delayed from a few hours to a day or more.
- This will permit to fresh concrete to be transported, poured and vibrated over longer periods of time.
- The controlled retardation of the initial set, must not be in no way slow down the subsequent hardening process.
- The period of time during which the concrete can still be vibrated is known as the retardation time.
- The choice of retarder dosage will be made by referring to the dosage chart of the furnisher, preliminary trials may be asked by the Engineer to ascertain the correct dosage for planned retardation.

- Dosage can varies with the type of structure (foundation slab or walls...) and with temperature (ambient air and/or concrete) the Contractor must consult with the Engineer to either avoid construction joints (cold joints) or to work out a concreting schedule where entire mass of concrete is required to set simultaneously.

Water proofing concrete admixture

A concrete admixture in liquid or powder form can be used by the Contractor as highly efficient water proofing principal agent with a secondary function as plasticizer.

The dosage will correspond to % of the weight of cement.

The admixture must be compatible with the type of cement.

The admixture will be dispensed directly into the mixing water (liquid admixture) prior to its addition to the aggregates /or/ added directly to the dry mixed aggregates.

Other Admixtures

The Contractor will relate to the technical specifications of the admixtures Supplier. Admixtures that contain chlorine will be forbidden.

Admixtures used shall be furnished by the Contractor and the cost of the materials and all costs incidental to their use shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately.

202.2.4 Aggregates

Fine and coarse aggregates shall be as defined by and be of the quality and nature required by BS 882 and BS 1201 whichever is applicable. In addition they shall be chemically inert to alkali reaction.

Prior to acceptance of an aggregate as inert to alkali reaction the report of a qualified geologist, appointed by the Engineer on the suitability or otherwise of materials shall be obtained following examination of all types of material that the proposed sources will yield during the course of the contract. The Engineer may require that samples be taken from boreholes and for large contracts or contracts extending over a long period then more than one report is to be obtained.

Aggregates shall conform to the requirements of the "Acceptance Standards" of Table 2.4.

Table 2.4 Sampling, Testing and Acceptance Standards

| Materials | Test | Site Sampling | Testing | Accepted Standards | Remarks |
|------------------------|--|-------------------------|-----------------------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| CEMENT | Ordinary Portland Rapid Hardening Sulphate Resisting | | BS 4550 | BS 12 BS 12 BS 4027 | Manufacturer's Test Certificates |
| AGGREGATES | Description and Classification | | BS 812 Section 2 | BS 882 | Whichever is applicable |
| | Particle size | BS 812 Sec.1 | BS 812 Sec.3 | BS 882 |) |
| | Particle Shape | BS 812 Sec.1 | Visual & BS 812 Sec.3 | |)) Mix Design |
| | Sp. Gravity | BS 812 Sec.1 | BS 812 Sec.3 | |) Requirements |
| | Density | BS 812 Sec.1 | BS 812 Sec.3 | |) |
| | Voids | BS 812 Sec.1 | BS 812 Sec.4 | |) |
| | Absorption | BS 812 Sec.1 | BS 812 Sec.4 | BS 8007 Cl. 6.2.2. | See Freeze-thaw Test in this Table |
| | Organic Impurities | BS 812 Sec.5 | | | |
| | Moisture Content | BS 812 Sec.5 | | | For adjustment of added water for concrete making |
| | Mechanical Properties | BS 812 Sec.6 | BS 882 | | Ten per cent fines value |
| WATER | Suitability | BS 3148 | BS 3148 | BS 2138 | Not required for potable water |
| CONCRETE | Compacting Factor | BS 1881 | BS 1881 | |) |
| | Slump | Pt 101 | Pt 103 BS 1881 Pt 102 | |)) Workability Test) |
| | Crushing | | BS 1881 | BS 5328, BS 8110 | Cube test |
| | Water Absorption | | BS 1881 Pt 122 | BS 340 Para 19 (b) | Precast concrete Cl. 3.8 |
| | Freeze-thaw | BS 1881 | | | Durability test for aggregate not complying with moisture absorption requirements of BS 5337 Cl. 21.2 |
| | Electrolytic Efflorescence | | | | As required for salt containing aggregate or saline water |
| | Cores | BS 1881 Pt 6 BS 1881 | BS 1881 Pt 6 BS 1881 | BS 1881 Pt 120 with strength specified on drawings | |
| ADMIXES with cement | Compatibility by Laboratory | As required | | | Tests to be carried out by independent Laboratory as required. |

(a) General:

Aggregates for concrete shall be fine aggregate and coarse aggregate and shall be supplied by the contractor from approved sources, but the approval of any source by the Engineer shall not be construed as approval of all materials taken from that source, and the Contractor will be held responsible for the specified quality of all materials used in the work and for their being equal to the approved samples.

The Engineer, at the Contractor's expense, will test the aggregates and the Contractor shall provide such facilities as may be necessary for procuring representative test samples. The Contractor shall submit, for preliminary tests and approval, representative samples of 100 kg each of fine aggregate and of each size of coarse aggregate proposed for use in the work at least 30 days before the aggregates are required for use.

Should the Engineer reject any sample furnished by the Contractor, the Contractor shall immediately supply a sample or samples from some other source until all samples are approved by the Engineer.

Those samples which have been finally approved by the Engineer as meeting the requirements of the Specification shall be kept on the Site until the completion of all

concrete work and all aggregates brought to the Site shall be compared with such approved samples.

Any aggregate rejected by the Engineer shall be immediately removed from the Site, unless the Engineer shall permit its use after undergoing further treatment by washing and or screening in order to bring it up to standard.

The aggregates shall be brought to the Site in separate loads, each containing aggregates of one size. The aggregates shall be stored in such a way as to prevent aggregates of different sizes from being mixed together in storage. Aggregates mixed either in transport or on Site will be rejected.

(b) Fine Aggregate:

Fine aggregate for concrete shall be natural sand (but not beach sand) or a mixture of natural sand and fine crushed stone. It shall meet the requirements of B.S. 882 and its grading shall be within the limits of one of grading zones 1, 2 or 3 given in Table 2 of B.S.882. In addition, it shall have a specific gravity of not less than 2.5, shall not contain more than 5 percent by volume of shells or shell fragments. The fine aggregate delivered to the batching plant shall have a uniform and stable moisture content.

When necessary, or when required by the Engineer, all fine aggregate shall be washed in clean water, before being incorporated in the Works.

(c) Coarse Aggregate:

The coarse aggregate for concrete shall be natural gravel or crushed stone. It shall consist of hard, dense, durable uncoated rock fragments and shall meet the requirements of B.S. 882.

Coarse aggregate for reinforced concrete shall be either graded aggregate or made up of a number of single size aggregates, with the largest particles not exceeding the following sizes:

- (i) 40mm, or
- (ii) 1/3 of the smallest thickness of concrete members, or
- (iii) 3/4 of the smallest space between reinforcement bars, whichever is the smallest.

Coarse aggregate for non-reinforced concrete may contain particles up to 3”

The grading of coarse shall lie within the limits given in Table 1 of B.S. 882. The exact sizes of the coarse aggregate and the grading to be used shall be determined as part of the mix design in accordance with Subsection 202.1.3.

All aggregates shall be approved by the Engineer.

202.3 BATCHING AND MIXING

202.3.1 Batching

The Contractor shall provide equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. For concrete Class C20P and higher, the amounts of sand, bulk cement and each size of coarse aggregate entering each batch of concrete shall be determined by weighing, and

the amount of water shall be determined by weighing or volumetric measurement. Where sacked cement is used, the amount of cement entering the mixture shall be determined on the basis of integral sacks of cement and the use of cement from torn bags shall not be permitted.

For concrete Class C15P and lower, the Engineer may permit volumetric measurement of aggregates.

All weighing equipment shall be subject to the Engineer's approval. An accuracy to within 0.4 percent of the scale capacity will be satisfactory, and the equipment shall be capable of ready adjustment for compensating for the varying weight of any moisture contained in the aggregates and for effecting changes in concrete mix proportions. The Contractor shall make such adjustments, repairs, or replacements as may be necessary to meet the specified requirements for accuracy of measurement. Each dial, indicator and other measuring device shall be in full view of the operator.

Where batching by volume is permitted by the Engineer, only precisely dimensioned gauge boxes approved by the Engineer shall be used for the sand and different sizes of aggregates. After filling the box the aggregate shall be struck off level with the brim. Sand shall be poured or shovelled into the gauge boxes without compacting. All gauge boxes shall bear marks in red oil paint showing the kind and size of aggregate for which each box is to be used. No boxes similar in shape and appearance but different in volume from the approved gauge boxes shall be kept on the Site.

202.3.2 Mixing

The materials shall, unless otherwise directed by the Engineer, be mixed in approved mechanical batch mixers. In each case, the number and capacity of mixers employed shall be sufficient for the concreting operations being undertaken, shall allow for sufficient reserve capacity at all times and shall be subject to the approval of the Engineer.

The mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall the mixing be for less than 2 minutes after all the ingredients are in the mixer. Water shall be added prior to, during and following the mixer-charging operations. Overmixing requiring the addition of water to preserve the required concrete consistency will not be permitted.

No dry material shall be introduced into a mixer until all material from the previous batch has been removed and the interior of the mixing drum has been cleaned of encrustations of concrete or mortar. Remixing of concrete or the addition of water to a mixture that has already begun to set or that is otherwise unsuitable for casting shall not be permitted and such concrete shall be wasted. When a concrete mixer has been out of use for more than 20 minutes, or when the type of cement is changed, the mixer shall be thoroughly cleaned before a fresh batch of concrete is made in it.

The Engineer may in exceptional cases permit hand mixing of lean and other non-reinforced concrete. No hand mixing shall be done unless authorised in writing by the Engineer. The batches in hand mixing shall not exceed 1/6 of a cu.m. Hand mixed concrete shall not be used until the mixing of the whole batch has been completed and the concrete is of uniform colour and consistency. Hand mixing shall be done twice on dry aggregate, and at least twice wet, on a clean and even surface, which will prevent the loss of water during mixing. The water added shall be measured in order to prevent the use of an excessive quantity of water.

When mixing by hand, the quantity of cement shall be increased by 10% above that specified above in Section 202.3.

202.4 PLACING AND CURING

202.4.1 Preparations for Placing

No concrete shall be placed until the Engineer has approved the formwork and reinforcement. The Contractor shall give at least 48 hours notice to the Engineer of the times he proposes to concrete and no concreting shall take place unless either the Engineer or his Representative is present.

Concrete shall be placed only in the presence of the Engineer or his duly authorized Representative, unless written permission has been given by the Engineer to place concrete without himself being present or represented. The Contractor shall give the Engineer not less than 48 hours notice before the day on which he intends to commence placement of concrete in any structure or substantial part thereof.

No concrete shall be placed until all reinforcement, formwork, parts to be embedded, and preparation of surfaces involved in the placing have been approved.

All surfaces of forms and embedded materials shall be clean and free from dried mortar which may have encrusted them from previously placed concrete.

All surfaces of foundations and areas upon or against which concrete is to be placed shall be free from standing water (except for concrete required to be placed under water), mud, debris, oil, objectionable coatings and loose, semi-detached or unsound fragments. Absorptive surfaces shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. On surfaces of rock upon or against which concrete is to be placed, a 2 cm layer of 1:3 cement mortar shall be spread immediately prior to placing concrete and shall be well worked into the surface with the aid of brushes. Care shall be taken that the mortar does in no case set before concrete is placed on it. The cost of such mortar and its spreading shall be deemed to be included in the rates for concrete.

202.4.2 Transporting and Placing

The methods and equipment used and the speed required for transporting concrete shall be such that concrete having the required composition and constancy will be delivered into the work, without objectionable segregation, loss of slump, and delay. Except as otherwise specified for ready-mixed concrete, the time elapsed between the first wetting of concrete ingredients and the completion of placing the concrete in the work shall in no instance exceed 30 minutes. Re-tempering of concrete will not be permitted. Any concrete which has become so stiff that proper placing cannot be assured shall be wasted.

Concrete shall be deposited as far as practicable directly in its final position and shall not be placed in a manner permitting or causing segregation. The Contractor shall provide suitable openings in the formwork and/or drop chutes and baffles to confirm and control the falling of concrete, and to limit its free drop to a maximum of 1.50 meters.

Except as intersected by joints, all formed concrete shall be placed in continuous approximately horizontal layers, the depths of which shall not exceed 60 cm, in such a manner that no layer of concrete will begin setting before the next layer is placed on top of it. In no case shall the delay between the placing of any two adjacent layers be such that the vibrating unit will not readily penetrate of its own weight the concrete placed before the delay.

Concreting shall be carried out continuously between and up to joints, the position and arrangement of which shall be predetermined and no interruption of placing other than at these joints will be permitted. To this end, the Contractor shall take all necessary measures, such as preparing a sufficient stock of materials, stand-by equipment, shift-work, lighting for night-work, etc.

In the event of unavoidable stoppage in positions not predetermined, the concrete shall be terminated on horizontal planes and against vertical surfaces and construction joints shall be prepared according to Subsection 202.5.1. Where required the Contractor shall also provide keyways, dowels, and/or waterstops to ensure a perfect bond and/or watertightness at the joint.

Where the concrete abuts against earth or any other material liable to become loose, the greatest possible care shall be taken to avoid falls or run of such or other materials upon the surface of the concrete, and if any such falls or runs occur the surface of the work soiled thereby shall be removed until a new and clean surface shall have been obtained, and all spaces left by such falls or runs beyond the prescribed dimensions of the work, or caused by the negligence or for the convenience of the Contractor, shall be built up with concrete at the dimensions of the work, or caused by the negligence or for the convenience of the Contractor, shall be built up with concrete at the discretion of the Engineer, and the additional cost so incurred shall be held to be included in the Contractor's rates in the Bill of Quantities for work within the original Contract limits.

No concrete shall be placed in water, except with the written permission of the Engineer, and the method of depositing the concrete shall be subject to his approval. Concrete shall not be placed in running water and shall not be subjected to the action of running water until after the concrete has hardened.

Surfaces of rock upon or against which concrete is to be placed, shall be prepared and cleaned as specified and placing of concrete shall be carried out as detailed below for construction joints.

No concrete shall be placed when the ambient temperature at the time of placing and/or 2 hours thereafter is expected to be below 4°C. The temperature of the concrete when being placed shall not exceed 32°C.

In hot weather when the temperature of the concrete is liable, in the opinion of the Engineer, to rise above 32°C, the Contractor shall, at his own expense, employ effective means, to the satisfaction of the Engineer, for reducing the temperature in the mix, such as sprinkling of water on the aggregate, protection of the water lines from the sun, painting of mixers and water tanks with light-reflecting paint and/or placing them in shadow, or by adding crushed ice to the water in a proportion not exceeding 50% of the water. The addition of ice will be permitted only if it has been proved to the satisfaction of the Engineer's Representative that all other means for the reduction of temperature are insufficient.

1) Hot weather concreting

Heat accelerates the hydration reaction of cements, thus it increases the heat of hydration and accordingly, shrinkage and cracks are likely to occur. It is necessary to abide by the following measures:

- a) Use concrete as compact as possible.
- b) Use cement of low heat of hydration.
- c) Reduce the cement dosage as far as practicable according to the requested characteristics of concrete.
- d) Use a water reducing plasticizer in order to reduce the quantity of mixing water (0.5 to 0.75 in weight of cement).
- e) Use a setting retarder which increases the heat of hydration time.
- f) Cool concrete constituents. This is an expensive method, but gives the best results.
- g) moisturize the hardened concrete on which fresh concrete shall be placed in order to avoid loss of water.
- h) Cover the structures after concreting, in order to prevent water evaporation from fresh concrete.
- i) Use Antisol-E which protects concrete from desiccation (suppress the use of damp coverings, watering, etc...).

2) Cold weather concreting

When concreting in cold weather, and in order to prevent having a frozen and porous concrete, plasticizers and water reducing admixtures shall be used to reduce the quantity of mixing water, while preserving the workability of fresh concrete at an acceptable degree.

Low temperature slows down the reaction of hydration of cement and therefore, delays formworks removal. The following precautions shall be taken:

- a) Use a quick setting cement
- b) Increase the C/W ration (plasticizer - water reducer)
- c) Heat the materials (water + aggregates). However, the temperature of concrete shall not exceed 30°C.
- d) Use isolating formworks (wood, panels coated with expanded polystyrene, etc..)
- e) Protect fresh concrete with thick dry covers.
- f) Heat concrete eventually (hot formworks).
- g) Use antifrost products (1% in weight of cement).

No concrete shall be placed when the ambient temperature is -0°C.

Placing concrete at a temperature below + 5°C is allowed provided that the above mentioned precautions are respected and upon the prior approval of the Engineer.

3) Concreting under water

When fresh concrete is to be placed under a water in motion (currents, waves,...) adequate measures shall be taken to prevent the washing out of concrete and carrying away of mortar.

Concrete shall be conveyed via a tight chute avoiding the contact of concrete with water and placed inside an underwater formwork. In this way, only the upper section of concrete shall be wasted out and it is removed once hardened by a pneumatic drill.

While concreting, the Contractor shall control the height of concrete at the bottom of the formwork and in the chute as well as the length of chute entering in the poured concrete mass in order to prevent any sudden depositing of concrete which might cause water intrusion and stoppage of work. Throughout concreting works, the chute shall be raised progressively.

4) Concreting under sea water (Not applicable)

202.4.3 Consolidation of Concrete (Vibration)

Each layer of concrete shall be consolidated to the maximum practicable density, so that it is free from pockets of coarse aggregate and closes snugly against all surfaces of forms and embedded materials.

Concrete Class C15P and less may be consolidated by spading, hand-tamping, or by mechanical vibration as described below. All concrete Class C20P and higher shall be consolidated by power-driven immersion (“needle”) type vibrators having a frequency of not less than 9000 oscillations per minute. The vibrators shall be inserted into the concrete at intervals not exceeding 50 cm and shall be allowed to penetrate and revibrate the concrete in the upper portion of the underlying layer.

On slabs not exceeding 25 cm in thickness the use of flat surface tamping vibrators with a frequency of not less than 5000 oscillations per minute will be permitted, provided that it is supplemented by immersion vibrators adjacent to the forms and to concentrations of reinforcement bars.

On walls not exceeding 20 cm in thickness external vibrators, fixed to the forms, will be permitted. External vibrators shall be raised in lifts as the filling of the forms proceeds each lift being not more than the height of concrete visibly affected by the vibration. They shall be placed horizontally, at distances not greater apart than the radius through which the concrete is visibly affected.

The types, sizes and numbers of vibrators shall be subject to the approval of the Engineer.

At least one stand-by unit of each vibrator type and ample spare parts for all types employed shall be available on Site during placing of concrete to ensure continuous placing with no stoppage due to breakdowns.

The vibrators shall be applied in each position for as long as required for the concrete to become uniformly plastic and shall be withdrawn as soon as water appears on the surface. Systematic spacing of insertion of the vibrators in the concrete shall be established to ensure that no concrete remains unvibrated. Care shall be exercised to avoid contact of the vibrating heads with the surfaces of the forms and the reinforcing bars or other embedded material. The vibration shall everywhere be supplemented by hand spading. Vibration shall never be used to cause concrete to flow in a lateral direction, as this will lead to segregation.

The cost of all consolidation shall be deemed to be included in the Contractor's rates for concrete.

202.4.4 Finishing of Concrete Surfaces

Formed concrete surfaces, i.e. surfaces cast against forms, shall receive the required smoothness and texture by the use of appropriate forms as specified under Section 202.10. After removal of forms and the specified curing all fins and offsets caused by misaligned or defective form boarding shall be removed. Tie wires shall be cut back to at least 15 mm below the concrete surface and the resulting depressions as well as the holes left after the removal of tie rod fasteners shall be filled with non-shrinking cement mortar and finished flush with the surrounding areas.

Where the concrete surfaces will be permanently exposed to view, the ground and filled areas shall have the same colour, texture and degree of smoothness as the surrounding concrete surfaces. Honeycombed areas and other major defects in concrete shall be repaired as specified in Section 202.7 hereinafter, and the repaired areas given the required finish.

Unformed concrete surfaces that are to be covered shall require no other finishing than sufficient levelling and screeding to produce an even uniform surface. Unformed concrete surfaces that are to remain permanently exposed shall be given a floated surface, unless a trowelled finish as described below is required. Floated finish shall consist of levelling and screeding to even and uniform surfaces followed by floating without the addition of any topping as soon as the screeded surface has stiffened sufficiently. Floating shall be done to the minimum required to produce a surface that is free from screed marks and is uniform in texture. The finish shall be given a final touch-up with a wooden float at an appropriate time after completion of the initial floating.

Trowel finish shall be applied to unformed concrete surfaces that will be in contact with liquids and elsewhere as shown on the Drawings or ordered by the Engineer. When the surface screeded and floated as described above has hardened sufficiently to prevent excess of fine material to be drawn to the surface, steel trowelling shall be started. Steel trowelling shall be performed with firm pressure, such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Where required, trowelling shall be done with the addition of a certain amount of cement as specified in the Particular Specification or Bill of Quantities.

Unless otherwise specified or shown on the Drawings, all exterior angles shall be chamfered to the approval of the Engineer. The cost of Floated Finish, Trowel Finish and Chamfers shall be deemed to be included in the unit rates for concrete work and shall not be paid for separately.

202.4.5 Curing of Concrete

From casting until the end of the specified minimum curing period, the concrete shall be kept constantly moist and adequately protected against damage due to fluctuation in surface temperatures. Immediately after casting, the exposed surface of the concrete shall be covered to prevent drying and to minimize temperature variations, until the commencement of curing at an age of not more than 20 hours. Curing of formed surfaces shall commence as soon as the formwork is removed. During curing the concrete shall be kept suitably moist by:

1. Direct application of water at ambient temperature, e.g. by spray or by ponding, or,
2. Covering with absorptive material, e.g. sand or hessian, kept constantly damp. Ventilation of any gap between the material and the concrete should be prevented so as to maintain near-saturated conditions in the air within the gap, or
3. When specifically permitted in writing by the Engineer, by sealing the surface of the concrete, before it has lost any of its original water by evaporation, by means of a sealing membrane which will effectively prevent any loss of water from the concrete. The sealing compound shall be white-pigmented and shall conform to Standard Specification for Liquid Membrane forming Compound for Curing Concrete, ASTM Designation C309 latest edition, or to another standard acceptable to the Engineer. The type and make of sealing compound and its form of application and use shall be subject to the approval of the Engineer. Membrane curing shall not be used on surfaces upon or against which concrete is to be cast or which are to be plastered or painted.

The cost of curing shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately.

202.5 CONTRACTION AND EXPANSION JOINTS

202.5.1 Contraction Joints

The position of construction joints will be as specified in the drawings by the designer. If there is a need on site to revise any specified position /or/ to have additional construction joints the proposed positions should be agreed with the Engineer.

Full structural continuity must be assumed in design at a construction joint. Reinforcement will be fully continuous across the joint, and the concrete is taken to be as nearly monolithic as possible.

The concrete at the joints should be bonded with the one subsequently placed against it, without provision for relative movement between the two.

Concrete should not be allowed to run to a feather edge, and vertical joints should be formed against a stop end. Particular care should be taken when framing the joint.

The surface of the first pour should be roughened to increase the bond strength and to provide aggregate interlock.

With horizontal joints, the joint surface should be roughened without disturbing the coarse aggregate particles, by spraying the joint surface approximately 2h to 4h after the concrete is placed, with a fine spray water and/or brushing with stiff brush.

Vertical joints can be treated similarly, if the use of a retarder on the top is authorised, to enable the joint surface to be treated after the stop end has been removed.

If the joint surface is not roughened until the concrete has hardened, the larger aggregate particles near the surface should be exposed by sand blasting or by applying a scaling hammer or other mechanical advice.

Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against the old one. It may need to be dampened prior to the new concrete being placed, to prevent excessive loss of mix water into it by absorption.

Particular care should be taken in placing of new concrete close to the joint to ensure that it has adequate fines content and is fully compacted and dense.

N.B. When instructed by the Engineer in designing construction joints for retaining aqueous liquids it is necessary to incorporate waterstops in properly constructed joints.

Construction joints shall be formed only in the positions shown in the drawings or indicated by the Engineer and concreting shall be carried out continuously between and up to joints.

All intersections of construction joints, permanently exposed, shall be made absolutely straight and level or plumb and matching with adjacent members.

Construction joint shall be formed at right angles to the axis of the member concerned, by the insertion of rigid stopping-off forms in the case of horizontal or inclined members.

The upper surface of lifts of concrete in walls and columns shall be horizontal. The surface of the stopping-off form /or/ the horizontal surface shall be indented to produce a key the old and new work.

The face of the horizontal joints brushed and roughened shall be rendered with a 1.0 to 1.5 cm thick layer of cement-sand mortar having the same relative proportions of cement and sand (without coarse aggregate) and the same water-cement ratio as the concrete to be placed upon it, and the new concrete shall then be laid immediately upon it and thoroughly punned in.

Where joints will be permanently visible, the mortar shall be kept back at least 25mm from the exposed face.

In the case of vertical joint the face shall be rendered with a coat of neat cement placed immediately before each fresh lift of new concrete.

NB: No Day Joints /or/ Stopping-off joints will be permitted in water retaining structures. Pouring operations shall be continuous between joints as shown in the drawings.

The Contractor shall have sufficient materials and standby equipment to meet these requirements.

Where due to accident or breakdown it is impossible to continue concreting, the Engineer /or/ his Representative shall be immediately notified and his verbal instructions which shall be

confirmed in writing as soon as possible, regarding either the making of a construction joint /or/ the taking out of new concrete back to the last construction joints, shall be complied with immediately.

Construction joints in wall

Where the wall is designed to be monolithic with the base slab, a kicker should be cast at the same time as, and integrally with the slab.

The height of the kicker should be at least 75mm to enable the next lift of formwork to fit tightly and to avoid leakage of cement grout from the newly deposited concrete.

The joint in this position will be a construction joint, and although it is recommended that wall panels are cast in one lift, any necessary extra horizontal joints will be construction joints when approved by the Engineer on site.

Circular Structures retaining liquid

One of the predominant forces from the liquid pressure is horizontal hoop tension (circular tension). For structural design purposes the horizontal reinforcement should be completely continuous at vertical joints.

A central waterstop should be used together with sealing compounds on both faces, whether or not any attempt is made to achieve concrete continuity.

Joints in roof

Roof slab when designed as flat slab has generally all interior joints treated as construction joints so that the slab is structurally monolithic and early thermal effects and subsequent temperature effects should be considered.

If the roof is connected monolithically to the wall the subsequent temperature effects may be disregarded.

If provision is made by means of sliding joints for movement between the roof and walls, correspondence of joints in roof and walls is not to be considered eventually.

202.5.2 Expansion Joints

For concrete structures retaining aqueous liquid, all eventual expansion joints are designed to accommodate repeated movement of the structure without loss of liquid.

The joint is designed to suit the characteristics of the material available and should also provide for the exclusion of grit and debris that would prevent the closing of the joint.

Detailing of places where the joint changes direction /or/ intersects with another joint should be uncomplicated.

The expansion joint:

At an expansion joint the Contractor shall provide a complete discontinuity in both reinforcement and concrete.

An initial gap should be provided between adjoining parts of the structure to accommodate the expansion /or/ contraction of the structure.

Waterstop, joint fillers and joint sealing compounds are essential.

The Joint Filler

An elastic joint filler material cut in sheets of the thickness specified and/or shown on the drawings, shall be:

- either placed in the forms before the first placed concrete is cast.
- or, may be attached to the first placed concrete surface means approved by the Engineer.

The elastic filler materials shall be of a quality approved by the Engineer and shall conform to US Federal Specification H-H-F-341a, or to a similar approved standard.

Where the exposed sides of the joint are filled with an elastic joint sealant approved by the Engineer, sheets of foamed polystyrene may be substituted for the above described elastic filler.

The sheet of filler material, shall be cut to fit the entire contact surfaces of the complete side of the joint.

Where a waterstop is installed in the joint, the filler materials shall be placed on both sides of the waterstop so as to fit snugly about the bulb of the waterstop.

Except where a groove for joint sealant is to be formed, the edges of the filler materials shall be placed flush with the finished surface of the concrete /or/ the bottom of the chamfers.

Joints in the filler shall be made tight so that mortar from the concrete will not seep through to the opposite concrete surface.

N.B.: Joint sealing compound cannot be expected to provide a liquid-tight seal for more than a proportion of the life of the structure and waterstops should always be provided in movement joints by the Contractor and installation must follow the recommendations of the manufacturer.

202.5.3 Elastic Joint Sealant

Where shown in the Drawings, the groove formed on the exposed side of contraction or expansion joints shall be filled with an elastic joint sealant meeting the requirements of ASTM Designation D-1850. The joint sealant is supplied in two components, base and accelerator, which are mixed together only immediately before use. Flow type sealant shall be used on horizontal or nearly horizontal surfaces, and heavy type on inclined and vertical surfaces. If required by the manufacturer, a suitable primer shall be applied on the joint surfaces prior to the filling of the groove and the time elapsing between the application of the primer and the placing of the joint sealant shall not exceed the maximum prescribed by the manufacturer. Care shall be taken that the mixed compound is used before the expiry of its pot-life as indicated by the manufacturer.

Prior to the application of the primer (if any) and the placing of the joint sealant, the groove shall be thoroughly cleaned, flushed with a jet of water and finally cleaned and dried with compressed air. The joint sealant shall be placed immediately after mixing of the two components, by means of a caulking gun so as to fill the joint groove completely and tightly, without leaving any depressions, voids or air bubbles. The joint filling shall be finished neatly and flush with the concrete surfaces by means of a spatula or similar tool.

202.5.4 Payment for Joints

Unless specific items are included in the Bill of Quantities, the cost of all work and materials for making construction, contraction and expansion joints shall be deemed to be included in the rates for the concrete work and shall not be paid for separately.

202.6 TOLERANCES FOR CONCRETE STRUCTURES

The maximum permitted variation from the design dimension shown on the Drawings or ordered by the Engineer shall be as follows :

- | | | | | | | | | | |
|---|---|------------------|------|-------------------|-------|--------------------|-------|-----------------------|-------|
| 1. Variation from the plumb : | | | | | | | | | |
| a- In the lines and surfaces of columns, piers, walls and arises | <table border="0"> <tbody> <tr> <td>In any storey or</td> <td></td> </tr> <tr> <td>5 m maximum</td> <td>10 mm</td> </tr> <tr> <td>15 m or more</td> <td>25 mm</td> </tr> </tbody> </table> | In any storey or | | 5 m maximum | 10 mm | 15 m or more | 25 mm | | |
| In any storey or | | | | | | | | | |
| 5 m maximum | 10 mm | | | | | | | | |
| 15 m or more | 25 mm | | | | | | | | |
| b- For exposed corner columns, construction-joint grooves, and other conspicuous | 1/2 of the above amount | | | | | | | | |
| 2. Variation from the level or from the grades indicated on the Drawings : | | | | | | | | | |
| a- In floor and beam soffits | <table border="0"> <tbody> <tr> <td>In 3 m</td> <td>5 mm</td> </tr> <tr> <td>In any bay or</td> <td></td> </tr> <tr> <td>5 m maximum ...</td> <td>10 mm</td> </tr> <tr> <td>In 10 m or more</td> <td>20 mm</td> </tr> </tbody> </table> | In 3 m | 5 mm | In any bay or | | 5 m maximum ... | 10 mm | In 10 m or more | 20 mm |
| In 3 m | 5 mm | | | | | | | | |
| In any bay or | | | | | | | | | |
| 5 m maximum ... | 10 mm | | | | | | | | |
| In 10 m or more | 20 mm | | | | | | | | |
| b- For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines | 1/2 of the above amount | | | | | | | | |

| | |
|--|---|
| 3. Variation of the building lines from established position in plan and related position of columns, walls and partitions | In any bay or 5 m maximum 5 mm In 10 m or more 20 mm |
| 4. Variation in the size and location of sleeves, floor openings and wall openings | 10 mm |
| 5. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls | Minus 5 mm Plus 5 mm |
| 6. Footings : | |
| a- Variation of dimensions on plan | Minus 10 mm Plus 10 mm |
| b- Misplacement or eccentricity | 2 percent of the footing width in the direction of misplacement but not more than 50 mm |
| c- Reduction in thickness | Minus 5 percent of specified thickness but not more than 50 mm |
| 7. Placing of Reinforcement Steel : | |
| a- Variation of protective cover | With cover up to 8 cm 5 mm 8 cm and more 10 mm |
| b- Variation from indicated spacing, provided that average spacing and total quantity of steel are not affected | 25 mm |

202.7 REPAIR OF CONCRETE

202.7.1 General

Repair of concrete where permitted by the Engineer shall be performed. The Contractor shall correct all imperfections on the concrete to the satisfaction of the Engineer.

202.7.2 Concrete Repairs in “Rehabilitation Works” (Not Applicable)

202.7.3 Concrete Repairs in News Concrete Works

Any concrete which in the opinion of the Engineer fails to comply entirely with this specification shall be declared defective and shall be cut out, removed from the site and replaced, and any steelwork reinforcement or other material damaged by the cutting and shall be replaced, all at the Contractor expansion.

The Contractor will submit to the Engineer, details of his proposal for rectifying the defects, and shall comply with the Engineer’s instructions, regarding the procedure of carrying out the work.

Notwithstanding the Engineer approval, should the remedial work prove unsatisfactory, the Contractor shall make good the work and bear the whole cost occasioned by the defective work.

Immediately after the forms have been removed, all fins and projections and all timber works at joints shall be removed and rubbed smooth with a carborandum block.

All holes and honeycombing in the surface shall be cleaned out and roughened up to give a good key. These holes shall then be filled with 1:2 cement/sand mortar and after it has thoroughly hardened, the surface shall be rubbed down with a carborandum stone to an even finish.

Concrete filling shall be used for holes extending entirely through the concrete, for holes in which no reinforcement is encountered, and which are greater than 0.20 m² and deeper than 10 cm and for holes with reinforcement concrete which are in area greater than 0.05 m² and which extend beyond reinforcement.

Plastering of smooth concrete surfaces will not be permitted.

All mortar and concrete filling must be non shrinkable and shall be kept constantly moist and protected from drying due to surface temperature and natural ventilation.

All materials, procedures and operations used in the repair of concrete shall be subject to the Engineer direction. All fillings shall be bonded tightly to the surface of the holes and shall be sound and free from shrinkage cracks and drummy areas after the fillings have been cured and dried.

All repairs of concrete executed by the Contractor shall be deemed to be included in the unit rates for concrete work in the Bill of Quantities and shall not be paid separately.

202.8 TESTING OF CONCRETE

202.8.1 General

Prior to the commencement of work, trial mixes shall be prepared and preliminary tests for workability, compressive strength and impermeability (where required) will be made at an authorized laboratory. The results of these tests will be used in specifying the mix design to be used by the Contractor. During the progress of work, daily slump tests will be made to ensure that the concrete is dense and of an adequate workability.

With the commencement of concrete placement and on each day concreting, samples shall be taken for testing for compressive strength at the ages and frequencies as prescribed hereafter. Where required, samples shall be taken for impermeability tests. The Engineer shall determine the elements from which concrete samples shall be taken for testing.

202.8.2 Slump Tests

The slump measured in accordance with B.S. 1881 shall not exceed 5 cm in concrete for foundations and horizontal or inclined slabs and shall not exceed 10 cm in other parts of the

structures, unless otherwise specified or directed by the Engineer. Slump tests shall be made as directed by the Engineer.

202.8.3 Compressive Strength Tests

For testing the compressive strength of concrete, samples of fresh concrete shall be taken and used for preparing test cubes. The cubes shall be tested for compressive strength after 7 days and 28 days. The dimensions of the cubes and the methods of sampling and testing shall be in accordance with B.S. 1881. The cubes shall be marked and dispatched to the laboratory according to the instructions of the Engineer and at such intervals as may be specified by him.

Unless otherwise specified or directed by the Engineer, at least three samples shall be taken from different batches on the same day of casting. Out of every sample, at least two test cubes shall be prepared for testing at 7 and 28 days, respectively. The number of samples taken from hardened concrete which for any reason was not taken while the concrete was fresh or of which the strength obtained did not meet the requirements, and taking and testing of such samples shall be in accordance with B.S. 1881.

The average strength of the cubes or more tested at each age may be taken as the works cube strength of the concrete. This works cube strength may be accepted as complying with the specified requirement for works cube strength, if none of the compressive strengths of any of the cubes is below the specified works cube strength, or if the average strength is not less than the specified works cube strength and the strength of the weakest cube is not less than that listed in the following table. The table details the required cube strengths of work cubes and trial mixes for the various grades of concrete.

Compressive Strength Requirements (for all types of Concrete)

| Grade | Characteristics compressive strength (kg/cm ²) | Cube strength at 28 days (kg/cm ²) ** | | |
|-------|--|---|--------------|---------------|
| | | Works cubes * | | Trial mixes * |
| | | Average | Weakest Cube | Average |
| C10 | 100 | 133 | 85 | |
| C15 | 150 | 200 | 128 | 215 |
| C20 | 200 | 275 | 170 | 315 |
| C25 | 250 | 325 | 213 | 365 |
| C30 | 300 | 375 | 255 | 415 |
| C40 | 400 | 475 | 340 | 515 |
| C50 | 500 | 575 | 425 | 615 |

* Strength requirements may be adjusted in accordance with CP110, if and as detailed in the Particular Specification.

** Concrete may be provisionally accepted on the basis of the days' cube strength, provided the average strength is at least 70% of the required 28 days strength and provided 28 days' cubes will be tested and will meet the requirements.

If for any part of a structure the works cube strength does not reach the required values at the age of 28 days, or if the concrete has hardened and samples have not been taken while the concrete was still fresh, the Engineer may permit the cutting of at least six cylinders out of the same part of the structure, and the cylinders shall be tested in accordance with the requirements of B.S. 1881. The concrete shall be deemed to comply with the specification if its strength, as

deduced from the cylinder tests, meets the compressive strength requirements detailed in the above table and the results of the previous samples shall not be taken into account. Should the concrete also fail to meet the requirements in the testing of the cylinders as above, all the concrete from which the samples have been tested will be considered defective. In such a case, the Engineer may at his own sole discretion, order the carrying out of additional tests by any method he may deem fit, and if such additional tests show the concrete meeting the requirements he may accept it. Should the concrete not meet the strength requirements in the test of samples as above, or in the additional tests that the Engineer may have permitted, then it shall be dealt with according to one of the following two methods, chosen at the sole discretion of the Engineer.

- a) The Contractor shall demolish and re-construct the part of the structure made of the defective concrete.
- b) The Engineer will accept the defective concrete but reduce its price as defined hereinafter. This provision shall apply only to concrete in which the average compressive strength of the samples taken is not less than the Characteristic Compressive Strength listed in the table. In such an event, the Engineer may accept the concrete, but reduce 2% of the unit rate per cubic meter of the defective concrete for every kg/cm^2 of the difference between the required strength and the average strength. (For example: C130 concrete was required. The strengths of all samples were above 255 kg/cm^2 but the average strength of the samples was 367.5 kg/cm^2 instead of 375 kg/cm^2 . In this case the Engineer may, at his sole discretion, accept the concrete and reduce its unit rate by 15%).

Concrete that has not met the requirements as stated above and concrete that the average compressive strength of the samples of which is below the nominal strength shall be rejected in every case. The part of the structure made of the rejected concrete shall be demolished and re-built by the Contractor at his own cost.

202.8.4 Impermeability Tests

Where required on the Drawings or the Specification, or where directed by the Engineer, the concrete shall be tested for impermeability. Samples for the impermeability tests shall be in the form of 20×12 cm plates and shall be prepared, cured and tested in accordance with DIN 1048. Unless otherwise stated in the Particular Specification or elsewhere in the Contract, the requirement for impermeability shall be that, when a water pressure of 2 kg/cm^2 is applied to one side of the test specimen, no moisture shall appear on the other side.

202.8.5 Payment for Tests

The costs of sampling and performing the tests in accordance with this Section, including all labour, equipment, transportation and ancillary works, shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately, unless specific items for testing are included in the Bill of Quantities.

202.9 STEEL REINFORCEMENT

202.9.1 General

Reinforcement steel for concrete shall meet the requirements of the relevant British Standards listed in Subsection 202.1.2 of this Specification.

The Contractor shall supply the Engineer with certificates from the makers of the steel showing that it has complied under test with the appropriate Standard Specification, stating the process of manufacture and if required the chemical analysis, and such test sheets shall be forwarded to the Engineer one week before the dispatch of such steel to the Works.

The steel shall be stored off the ground and kept scrupulously clean and free from loose mill scale, loose rust, oil and grease or other harmful matter. Any bar adversely affected by storage or for any other reason shall be cleaned or removed from the Site and replaced by the Contractor at his own expense.

202.9.2 Bar Schedules

Where reinforcement bar schedules are shown on the Drawings to assist the Contractor in preparing and placing the steel reinforcement, the Contractor shall carefully check such bar schedules for compliance with the structural drawings and shall correct the bar schedules as necessary. Where no bar schedules are incorporated in the Drawings, the Contractor shall prepare such schedules at his own cost and responsibility. In any case, the Contractor will be solely responsible for the correct preparation and placing of steel reinforcement in accordance with the Drawings. Any bars bent and prepared according to incorrect schedules, and not suitable for placing in the structure will be rejected and will not be paid for.

202.9.3 Bending Reinforcement

All bending shall be done cold, by an approved bending machine, in a manner that will not injure the material. Welded joints shall not be permitted in any bar. Only experienced steel benders, to the approval of the Engineer, shall be employed in bending. All bending shall be in accordance with British Standard 4466. The internal radius of all cranks and bends shall be at least three times the diameter of the bar. Heating of mild steel bars only to facilitate bending, especially of large diameter bars, will be permitted, provided the temperature of the steel does not exceed 850°C (cherry-red heat) and provided further that the cooling rate is low and uniform (normal still-air cooling). Quenching of hot-bent bars in water will not be permitted. Reinforcement bars depending on cold working for their strength, such as cold drawn or twisted bars shall not be bent hot.

202.9.4 Placing Reinforcement

The number, size, form and position of all steel bars, ties, links etc.. shall be in exact accordance with the Drawings and in the placing and fixing the function of each bar shall be borne in mind.

The greatest care shall be taken to ensure that the steel is laid out correctly in accordance with the Drawings and fixed rigidly within the forms. Sufficient temporary ties of annealed iron wire shall be provided to prevent any displacement before or during the placing of concrete and to ensure that the specified amount of cover is everywhere maintained. Concrete shall be rammed firmly with spatulas around the steel and compacted against it and against the shuttering.

No pieces of metal or blocks or wood shall be used on the bottom surface or against the sides of formwork to keep the reinforcing bars in position. For this purpose specially prepared precast concrete blocks shall be used of a thickness equal to the concrete cover specified hereafter. The use of plastic spacers is also accepted.

Unless otherwise shown on the Drawings or directed by the Engineer, the cover reinforcement, including cover stirrups and distribution bars, shall be at least equal to the diameter of the principal reinforcement bars plus

- at least 1 cm in the case of solid interior slabs, or
- at least 1.5 cm in all other cases, or
- at least 1 cm in addition to the above in the case of elements exposed to climatic influences.

In any case, all parts of a structure in direct contact with the earth or water shall have at least 3 cm cover over reinforcement, including stirrups and distribution bars.

The minimum cover stipulated above shall be increased, if necessary, up to 5 cm wherever a structure is particularly liable to danger of corrosion or abrasion, and up to 8 cm where concrete is placed directly against earth, without formwork.

Bars, generally, shall be of the required lengths and the lapping of main bars will not be permitted, except as indicated on the Drawings. Where bars are required or permitted to be lapped, the parts along the lap shall have a clear space between them equal to 1cm or the diameter of the bar, whichever is the greater. The minimum length of overlap will be 40 times the diameter of the bars for hooked bars and at least 60 times the bar diameter for bars without hooks. Laps of adjacent parallel reinforcement bars shall be staggered. Ends of ties shall be cut back 1.5 cm from face and covered with mortar. Fabric reinforcement shall be lapped at least 40 diameters or two squares, whichever is the greater.

All laps of bars are to be tied tightly with six laps of 1.5 mm annealed iron wire at intervals of ten diameters of the bars. All crossings of steel are to be secured with three laps of wire. Splicing of bars by butt welding will be permitted, provided that the resulting joint is not inferior in strength to the rest of the bars. Bars depending for their strength on cold drawing or twisting shall not be spliced by welding. Crossings of steel bars may be secured by tack welding instead of tie-wires, provided that burning or other damage to steel at tack-welds is prevented. All welds shall be done in a thoroughly workmanlike manner by qualified welders either by the oxy-acetylene method to BS 693 or by the metal arc method to BS 5135. Splices of bars having a diameter of 26 mm and more shall be done by butt-welding only.

The Contractor shall not pour any concrete before the Engineer has inspected and approved the placement of reinforcement. Such approval shall, however, not affect the Contractor's responsibility for the correctness of the reinforcement in accordance with the Drawings, reinforcement schedules, Specifications and/or directions given by the Engineer.

202.10 FORMWORK

202.10.1 General

The Contractor shall design, supply and fix all necessary formwork, together with its attendant scaffolding, timbering, shoring, strutting, etc., required for the placing of the concrete.

The Contractor will be permitted to use timber boarding as formwork or forms lined with plywood, hardboard of approved manufacture or steel sheets. Where timber boarding is used, the formwork surfaces coming in contact with wet concrete shall be made of properly seasoned timber. Full size plywood or hardboard sheets shall be used except where otherwise required or where smaller pieces will cover the entire area. Forms shall be so placed that markings shall be symmetrical.

All formwork shall be of sufficient strength to resist movement of men or equipment and the pressure of the wet concrete while it is being placed and vibrated, without distortion. Where plywood, hardboard or steel lining is used, particular care shall be taken to ensure that the forms are adequately braced and stiffened.

The formwork for successive vertical lifts must make such perfect contact with concrete in the preceding lift that there shall be no excrescences, bulges, tears or other outward signs of faulty junction. The formwork must be constructed so that there shall be no leaked of mortar. Whenever it is unavoidable, the Contractor shall prevent leakage of any kind through open joints by means of suitable caulking.

The repeated use of forms of all descriptions will be at the discretion of the Engineer, who will require the forms to be reconditioned or surfaced from time to time. After repeated use, the old forms will be replaced with new ones at the direction of the Engineer.

All exposed concrete shall have the external angles chamfered 20 mm or as directed by means of moulding strips fixed to the formwork. Interior angles on such surfaces and edges at formed joints will not require bevelling unless requirement for bevelling is indicated on the Drawings.

The height of all erected at any one time shall be subject to the approval of the Engineer.

The surface of the forms shall be free from encrustation of mortar, grout, or other foreign material. Before the form panels or boards are erected in place, the surfaces of the forms shall be oiled with an approved commercial form oil that will effectively prevent sticking and will not stain the concrete surfaces.

202.10.2 Types of Forms

The surfaces of formwork to give a desired finish of formed concrete will be classified as follows :

- a) Unwrought Formwork of unwrought timber will be permitted in formwork for concrete surfaces or portions thereof which will receive plaster or other facing, or which will be covered up below ground level.
- b) Wrought Formwork (for Smooth Internal and External Surfaces) made of new plywood or new steel sheets or timberboarding planed on both sides to equal thickness, shall be used on all exposed concrete surfaces except where plaster or another facing or fairface concrete are provided for. The formwork shall ensure that a regular and smooth finish is obtained, free of excessive bulges, irregularities or unsightly markings or defects of any kind.
- c) Fair-face Concrete Formwork shall be employed where shown on the Drawings, required in the Specification or directed by the Engineer. This type of formwork shall

include use of new plywood or new steel sheets equal thickness, joined by torque and groove joints in parallel and vertical or horizontal alignment, arranged so as to achieve concrete surfaces of the textures and patterns required.

Where the surfaces formed in wrought or fair-face formwork are defective, the Engineer may order repairs to be made in accordance with Section 202.7 above and, if large surfaces should be found honeycombed or otherwise impaired, he may order all such surfaces to be plastered with cement plaster. Repairs to fair-face concrete, where required, shall be made in accordance with Section 202.7 above, but if in the Engineer's opinion such repairs would be insufficient to restore the external appearance of the surface, he shall order surfaces destroyed and cast anew.

The cost of all above-mentioned repairs to concrete surfaces, including application of cement plaster, and re-casting shall be deemed to be included in the unit rates for concrete work in the Bill of Quantities and shall not be paid for separately.

202.10.3 Form Ties

Embedded metal rods or sleeves used for holding forms shall remain embedded and shall terminate not less than 2½ cm from the face of the concrete. Embedded wire ties for holding forms will not be permitted in concrete walls which are to come into contact with liquids or where the concrete surfaces through which the ties would extend will be permanently exposed. Wire ties may be used for concrete walls to be plastered, stone faced or covered with earth. Wire ties shall be cut back at least 1.5 cm from the face of the concrete. The holes left in the concrete surfaces after cutting back of wire ties and removal of fasteners or holding rods or sleeves, and the insides of sleeves where sleeves are used, shall be completely filled with an approved non-shrinking mortar, and the mortar shall be finished flush with the concrete surfaces. This operation will be carefully carried out. The hole formed by the cutting process will be thoroughly cleaned and wetted before filling. Time mortar will be of damp, not wet, consistency. The patch will be properly towelled smooth to match the surrounding concrete surfaces and shall be thoroughly cured by keeping it moist continuously for at least three days. After the patch has hardened, the Engineer may require the patch and the adjacent concrete surface to be ground down smooth. Any patches that are loose or hollow on completion must be re-done. Water stop tie rods shall be used for liquid retaining structures.

All costs for complying with the requirements of this Subsection shall be deemed to be included in the unit rates for formwork and shall not be paid for separately.

202.10.4 Embedded Metal Parts

Parts of metal work, such as fixtures for wall brackets, hooks and similar parts that are to be embedded in the concrete shall be attached to the forms in their proper position prior to placing of concrete.

All costs for and in connection with the installation of metal parts shall be deemed to be included in the unit rates for formwork and for concrete and shall not be paid for separately, except where specific items shall be included in the Bill of Quantities.

202.10.5 Striking of Forms

To facilitate satisfactory progress with the specified curing and to permit earliest practicable repair of surface imperfections, forms shall be struck as soon as the concrete has hardened sufficiently to prevent damage by careful form removal. Forms shall not be struck until the strength of the concrete is such that form removal will not result in perceptible cracking, breaking of surfaces, or other damage to the concrete and that the concrete can sustain the loads to be borne at the time of striking. Forms shall be struck with care so as to avoid injury to the concrete, and any concrete so damaged shall be repaired at the Contractor's expense.

No forms shall be removed without the express permission of the Engineer's Representative, but the Contractor shall, nevertheless, accept sole responsibility for the removal and consequences thereof.

In no case shall forms to soffits be struck until test cubes from the actual concrete concerned have yielded the 7 days strengths specified.

As a guide to the Contractor and subject to the foregoing requirements the followings minimum striking times, from the completion of concrete placing, may be assumed:

- | | |
|---|------------|
| – For sides of Foundations, slabs, etc. | - 24 hours |
| – For sides of Beams in suspended work, sides of walls and columns | - 48 hours |
| – For sides of Retaining Walls | - 36 hours |
| – For soffits of Beams and Slabs in suspended works (spans up to 3 meters) | - 10 days |
| – For soffits of Beams and Slabs in suspended works (spans 3 to 6 meters) | - 12 days |
| – For soffits of Beams and Slabs in suspended works (spans over 6 meters) | - 14 days |
| – For the soffits of beams having a span of more than 5.0 m, at least one support and for those of slabs having a span exceeding 6.0 m, at least one row of supports shall be left in place for an additional period of seven days. | |

If the striking times stated above are not sufficient to permit the unsupported concrete to sustain superimposed loads (such as support for the shuttering of an upper floor, storing of building materials, etc.). Such loads will require special supports to sustain them.

202.11 MISCELLANEOUS CONCRETE WORKS

202.11.1 Openings and Holes in Concrete

Openings in concrete walls or slabs or reservoirs shall be predetermined and subject to the approval of the Employer. No openings shall be made after formworks removal. The Contractor shall be responsible for the co-ordination of all requirements of his sub-contractors as regards provision of openings, holes and fixings, and prepare shop drawings.

Holes left after the removal of formwork shall be filled with a compensating epoxy-based mortar or any similar product. For water retaining structures water stop tie rods shall be used when filling the holes to ensure watertightness.

Where it is impracticable, as determined by the Engineer's Representative, to install metal parts in the forms as required under Subsection 202.10.4 suitable holes or recesses shall be formed in

the concrete structure into which the metal parts can be placed and grouted in. The shape and dimensions of such holes shall be as shown on the Drawings or as determined by the Engineer's Representative, and they shall be formed with wooden core boxes, fabricated in such a manner that they can be completely withdrawn or broken up and removed after the concrete has set. All such core boxes shall be set with great accuracy with the aid of templates and securely fixed to prevent displacement during concreting. The supply and installation of all such core boxes and their removal when the concrete has hardened sufficiently shall be deemed to be included in the unit rates for formwork and concrete work and shall not be paid for separately.

Where the holes or openings have not been formed in the concrete during placement, the Engineer may either order the tearing down and rebuilding of the structure or the part thereof concerned, or permit such holes or openings to be cut in the hardened concrete to the dimensions shown on the Drawings or as directed by the Engineer. Such cutting shall be kept to the minimum necessary dimensions and shall be done by drilling, chiselling or the use of a power tool, all as approved by the Engineer and in such a manner as not to cause any damage to the concrete structure.

Reinforcement bars passing through such holes or openings shall not be cut without the express written permission of the Engineer's representative.

Where the forming of the openings or holes has been omitted by the Contractor's neglect, all tearing-down and rebuilding or cutting of holes and openings in the hardened concrete as aforesaid shall be done by the Contractor at his own expense, in all other cases the cost thereof shall be borne by the Employer and shall be paid for as extra work under Clause 51 of the Conditions of Contract.

202.11.2 Manholes and Chambers

Manholes and chambers shall be constructed in the positions and to the details shown on the Drawings. The grades of concrete and types of formwork shall be as shown on the Drawings, as required in the Specification or as directed by the Engineer. The inside dimensions, unless otherwise specified, will be after plastering or to otherwise finished surfaces.

A base slab of concrete, supporting the walls, shall be cast on firm ground foundations (so as to prevent any differential settlement), on a blinding layer of Lean Concrete (Grade C10). Where shown on the Drawings, smoothly constructed U-shaped channels, to carry and direct the flow, shall be formed integrally with the concrete base, or may be constructed separately by benching. Adjacent floor areas shall slope to drain to the channel with a gradient of about 5% to 10%. All transition curves shall be smooth.

The whole of the floor areas and channel surfaces shall be finished with a smooth coat of cement mortar.

The walls of the manholes shall be made of cast-in-situ concrete or of precast concrete rings, all as shown on the Drawings. The construction of walls shall not start sooner than 24 hours after slab had been cast. Cast-in-situ concrete and precast concrete shall be Grade C30 for floors, walls; ceilings and Grade C15 for benching. Precast concrete Chamber and Shaft rings shall conform to requirements of B.S. 556, shall be of the tongue and groove type and shall be assembled with cement-mortar joints to ensure complete water tightness of the joints.

Internal surfaces of Manholes and Chambers shall be absolutely smooth. This shall be achieved by the use of wrought formwork or by plastering with cement mortar 1:1½ and steel trowel

finish with the addition of cement in the proportion of 1 kg per square meter as shown on the Drawings or as directed by the Engineer.

Aluminium or galvanized steel steps, or a ladder if so shown on the Drawings, shall be provided in all manholes 1.25 m deep and over. The steps shall be staggered and spaced at about 25 cm vertically, or as shown on the Drawings. They shall be solidly embedded in the walls prior to the plastering. The top step shall always be located to accommodate the right foot. Step irons for manholes shall comply with B.S. 1247 type A and shall be hot-dip galvanized. All steps shall be built in as the work proceeds. Cutting out completed work for inserting steps or other fittings shall only be permitted where it is impossible to built them in as the concrete is being cast. Unless otherwise specified, in manholes with depths greater than 5.25 m, ladders shall be installed instead of steps. The ladders shall comply with the Drawings or shall be as specified or directed by the Engineer.

Where shown on the Drawings or directed by the Engineer, pipe stubs for future connections shall be installed. The stubs shall extend at least 50 cm beyond the outside of the walls of the manhole and shall be plugged watertightly. Appropriate channels for the future connections shall also be prepared in the benching.

Unless otherwise indicated, manhole and chamber covers shall be suitable for heavy duty and shall be made of cast-iron to B.S. EN124 or concrete with cast-iron frames, of a type approved by the Engineer. Suitable lifting keys of mild steel shall be provided with the covers at a rate of 1 set of keys for each 10 covers. After the completion of the work, cast iron parts of the covers and the frames shall be thoroughly cleaned and painted with bitumen paint.

Manholes shall be watertight. The Contractor shall, if so required, test them in the presence of the Engineer. The Contractor shall provide all water labour, drains, stoppers, bends and other needful appliances for carrying out tests and no manholes or other work must be covered up until they have been seen and passed by the Engineer. The test to be applied to manholes and chambers shall be their filling with water to 10 cm below the slab or to finished ground level and after allowing due time for saturation of the concrete, by topping up to the original level. Thereafter the loss of water shall not be greater than the equivalent of 2 cm over the whole area of the chamber in 24 hours.

202.11.3 Thrust and Anchor Blocks

Concrete thrust and anchor blocks shall be formed at bends, tees and valves in accordance with the details shown on the Drawings or as directed by the Engineer. Excavation shall be made after pipelaying, and the blocks concreted immediately after excavation. The back of supports and blocks shall abut on to solid ground with all loose material being removed before concreting.

No pressure shall be applied in any section of main until the concrete has achieved adequate strength and at least three day's curing.

Flexible joints shall not normally be cast in. Where the size of the block does not make this possible, additional flexible joints shall be provided no greater than half a pipe diameter beyond each face of the block.

202.11.4 Concrete Surround to Pipes

Where pipelines pass under streams and rivers or where directed by the Engineer, the pipeline shall be surrounded with concrete as shown on the Drawings.

Concrete surround shall be broken at all pipe joints to retain flexibility in the pipeline. No joints shall be concreted in without the prior approval of the Engineer.

202.11.5 Precast Concrete

All precast concrete members to be used in the works, such as covers, lintels, sills, slabs, stairs, etc., shall be manufactured on site or obtained from approved manufacturer. In either case casting shall be done under the supervision of the Engineer, whose approval of the place and method of casting must be obtained before starting work. If casting is done on the site, the Contractor shall prepare a suitable area near the structure for which the precast parts are intended, and samples of the precast work shall be submitted to the Engineer for approval before proceeding with the manufacture on site. Casting of the precast parts shall be completed in due time so as not to delay the completion of the structures and everything connected therewith.

Unless otherwise directed, precast elements shall be of concrete Grade C30P. All precast elements shall be true to dimensions and shapes as shown on the Drawings. Concrete surfaces shall be smooth and all corners square or chamfered, as shown on the Drawings or directed by the Engineer. Lifting lugs and similar metal parts, whether part of the reinforcement steel or not, shall be incorporated in the elements during manufacture. Precast elements shall not be transported or otherwise handled until the end of the curing period, which shall be at least 14 days.

Any precast concrete element becoming defective during casting or placing or from any other cause, and rejected by the Engineer, shall be removed from the Site by the Contractor who shall cast new elements to replace the rejected ones, and all expenses in connection therewith shall be borne by the Contractor.

202.11.6 Cast-in-situ Reinforced Concrete piles (Not Applicable)**202.11.7 Hourdis Slabs**

A Hourdis slab is a monolithic reinforced concrete slab consisting of embedded beams and ribs separated by rows of hollow blocks (Hourdis blocks).

The reinforcement bars of the beams and ribs as well as the hourdis blocks shall be placed on the formwork prior to start concreting.

The hourdis slabs shall be carried out in accordance with the details and dimensions shown on the Drawings.

202.12 JOINT SEALS WITH ELASTOMERIC SEALANTS

202.12.1 Major Components

The major components of a good joint seal are:

- The substrate,
- The joint filler,
- The bond breaker, and
- The sealant.

a) The substrate:

The more common substrates are masonry concrete, metal, and glass; these are generally classified as porous /or/ non porous.

- Some substrate may not be suitable for achieving a bond unless, treated mechanically, chemically, or both.
- When the substrate has a coating, this coating must be compatible with the sealant and its bond to the substrate and sealant must be adequate.
- The Contractor must consult both substrate and sealant manufacturers for suitable joint preparation methods and primers to be used before applying joint materials.
- Adhesion testing of trial applications in the site is recommended.
- Surface laitance and incompatible or bond-inhibiting form release agents on concrete surfaces, must be removed.
- Substrates must be clean, dry, sound, and free of loose particles, contaminants, foreign matter, water-soluble material, and frost.
- Joints in masonry and concrete should be sealed before cleaning exposed surfaces and applying required protective barriers.

b) Primer:

The purpose of a primer is to improve the adhesion of a sealant to a substrate. Many sealant require primers on all substrate; some on only certain substrate or on none at all. Most require a primer for maximum adhesion to concrete and masonry surfaces.

c) Joint Fillers:

A joint filler is used to control the depth of sealant in the joint and permit full wetting of the intended interface when tooled.

Some joints fillers may be incompatible with the substrate and sealant, causing stains, on either one of them or both. Some may be factory coated with a suitable material that provides a barrier to staining.

The Contractor must confirm this suitability, i.e. that the barrier coating must be acceptable to both, the sealant and the joint filler manufacturers.

Joint filler for vertical application may be flexible, compatible, closed cell plastic foam /or/ sponge rubber rod stock, and elastomeric tubing of such materials as:

- neoprene,
- butyl, and
- E.P.D.M.

They should resist permanent deformation before and during sealant application, be non absorbent to water or gas, and resist flowing upon mild heating since this can cause bubbling of the sealant.

- Open cell sponge type materials such as urethane foam may be satisfactory, provided that their water absorption characteristics are recognised. The sealant should be applied immediately after joint filler placement to prevent water absorption from rain.
- Elastomeric tubing of neoprene, butyl, or EPDM may be applied immediately as a temporary seal until the primary sealant is put in place, after which they serve to a limited degree as a secondary water barrier.

Joint filler for horizontal application (for floors, pavements, sidewalks, patios and other light-traffic areas may be compatible, extruded, closed cell, high density flexible foams, corkboard, resin-impregnated fiber board /or/ elastomeric tubing /or/ rods).

- These joint fillers should remain resilient in cold temperature, exhibit good recovery, not cause the sealant to bubble in the joint because of heat, and be capable of supporting the sealant in traffic areas.
- They should not exude liquids under compression, which could hydraulically cause sealant failure by forcing the sealant from the joint.
- Combination of joint filler may be used to form a joint in concrete and an additional filler material may be installed under compression across the width and to the proper depth just before the sealant is applied to provide a clean, dry, compatible backup.

d) Bond breaker:

A bond breaker may be necessary to prevent adhesion of the sealant to any surface or material where such adhesion would be detrimental to the performance of the sealant.

- The use of a joint filler to which the sealant will not adhere may preclude the need for a bond breaker.
- The bond breaker may be a polyethylene tape with pressure-sensitive adhesive on one side /or/ various liquid applied compounds, as recommended by the sealant manufacturer.

e) Sealant

Sealants are classified as:

- single component /or/ multicomponent
- non sag /or/ self leveling,
- traffic /or/ non traffic use

as well as according to movement capability.

- Characteristics of common elastic sealants are listed in the following Table 2.5:

Table 2.5

CHARACTERISTICS OF COMMON ELASTOMERIC SEALANTS

| | ACRYLIC (SOLVENT RELEASES) | POLYSULFIDE | | POLYURETHANE | | SILICONE |
|--|--|---|---|---|--|--|
| | (ONE PART) | TWO-PART | ONE-PART | TWO-PART | ONE-PART | (ONE PART) |
| Chief ingredients | Acrylic terpolymer, inert pigments, stabilizer, and selected fillers | Polysulfide polymers, activators, pigments, plasticizers, inert fillers, gelling, and curing agents | | Polyurethane prepolymer, inert fillers, pigments, plasticizers, accelerators, activators, and extenders | Polyurethane prepolymer, inert fillers, pigment, and plasticizers, | Siloxane polymer pigment, and selected fillers |
| Percent solids | 85-95 | 95-100 | 95-100 | 95-100 | 95-100 | 95-100 |
| Curing process | Solvent release and very slow chemical cure | Chemical reaction with curing agent | Chemical reaction with moisture in the air | Chemical reaction with curing agent | Chemical reaction with moisture in all, also oxygen | Chemical reaction with moisture in all |
| Curing characteristics | Skins on exposed surface; interior remains soft and tacky | Cures uniformly throughout; rate affected by temperature and humidity | Skins over, cures progressively inward; final cure uniform throughout | Cures uniformly throughout; rate affected by temperature and humidity | Skins over, cures progressively inward; final cure uniform throughout | Cures progressively inward; final cure uniform throughout |
| Primer | Generally not required | Manufacturer's approved primer required for porous surfaces, sometimes for other surfaces | | Manufacturer's approved primer required for most surfaces | | Required for most surfaces |
| Application temperature (°F) | 40-120 | 40-100 | 60-100 | 40-120 | 40-120 | 0-120 |
| Tackfree time | 1-7 days | 6-24 hr | 6-72 hr | 1-24 hr | Slightly tacky until weathered | 1 hr or less |
| Hardness, Shore A Cured 1 to 6 months Aged 5 years | 0-25 45-55 | 15-45 30-60 | 25-35 40-50 | 20-40 35-55 | 25-45 30-50 | 20-40 35-55 |
| Toxicity | Nontoxic | Curing agent is toxic | Contains toxic ingredients | Toxic; gloves recommended for handling | | Nontoxic |
| Cure time (days) | 14 | 7 | 14-21 | 3-5 | 14 | 5 |
| Joint movement capability (max.) | ± 12.5% | ± 25% | ± 15% | ± 25% | ± 15% | ± 25% high modulus ± 50% low modulus |
| Ultraviolet resistance (direct) | Very good | Poor to good | Good | Poor to good | Poor to good | Excellent |
| Dirt resistance cured | Good | Good | Good | Good | Good | Poor |
| Use characteristics | Excellent adhesion; poor low-temperature flexibility; not usable in traffic areas; unpleasant odor 5-12 days | Wide range of appropriate applications; curing time depends on temperature and humidity | Unpleasant odor; broad range of cured hardnesses available | Sets very fast; broad range of cured hardnesses; excellent for concrete joints and traffic areas | Excellent for concrete joints and traffic areas, but substrate must be absolutely dry; short package stability | Requires contact with air for curing; low abrasion resistance; not tough enough for use in traffic areas |

202.12.2 Joint Design

The design geometry of a joint seal is related to numerous factors including:

- desired appearance,
- spacing of joints,
- anticipated movement in joint,
- movement capability of sealant to be used,
- required sealant width to accommodate anticipated movement,
- and tooling methods.

a) Sealant width

The required sealant width relative to thermal movement is determined by:

- the application temperature range of the sealant
 - the temperature extremes anticipated at the site location
 - the temperature at the time of sealant application, and
 - the movement capability of the sealant to be used.
- 1) In the absence of specific application temperature knowledge, an ambient application temperature from 4°C to 38°C (40° to 100°F) should be assumed in determining the anticipated amount of joint movement in the design of joints.
 - 2) Although affected by ambient temperatures, anticipated joint movement must be determined from anticipated building material temperature extremes, rather than ambient temperature extremes.
 - 3) Many other factors can be involved in building joint movement including but not limited to:
 - a) material mass
 - b) color
 - c) insulation
 - d) differential thermal stress (bowing)
 - e) residual growth or shrinkage of materials
 - f) building sway and
 - g) seismic forces
 - 4) The design joint width should be calculated taking all possible movement and tolerance factors into consideration.
 - 5) A simplified method (but no as accurate) is to use the accompanying graph.

b) Joint depth:

The sealant depth, when applied, depends on the sealant width; the following guidelines are normally accepted practice

- 1) For a recommended minimum width of $\frac{1}{4}$ in, the depth should be $\frac{1}{4}$ in
- 2) For joints in concrete, masonry, or stone, the depth of the sealant may be equal to the sealant width in joint up to $\frac{1}{2}$ in
 - a) for joints $\frac{1}{2}$ in to 1 in wide, the sealant depth should be one-half of the width.
 - b) for joints 1 to 2 in wide, the sealant depth should not be greater than $\frac{1}{2}$ in.
 - c) for widths exceeding 2 in, the depth should be determined by the sealant manufacturer.
- 3) For sealant widths over $\frac{1}{4}$ in and up to $\frac{1}{2}$ in in metal, glass and other nonporous surface joints the minimum of $\frac{1}{4}$ in in depth applies, and over $\frac{1}{2}$ in in width the sealant depth should be one-half the sealant width and should in no case exceed $\frac{1}{2}$ in.

When determining the location of the joint filler in the joint, consideration should be given to the reduction in sealant depth with concave and recessed tooled joints, and the joint should be designed accordingly.

202.12.3 Application

To obtain proper adhesion, it is essential that:

- the sealant comes in direct contact with the substrate,
 - the sealant wets the surface of the substrate
 - the substrate is strong enough to provide a firm anchor for the sealant.
- If any of these conditions is not met, poor adherence will usually result.
- The sealant should be installed in such manner as to completely fill the recess provided in the joint.

Against a porous material, the sealant must enter the pores if goal adhesion is to be obtained. Sealants used for this application are thixotropic and will resist flow into the pores unless an external force is applied. Proper filling of the recess accomplishes this, in part, and proper tooling ensures it.

a) Joint preparation:

For a joint to receive sealant it must be cleaned out and raked to full width and depth required for installation of joint seal materials. Thoroughly cleaning all joints is by removing all foreign matter such as: dust, paint (unless it is a permanent protective coating), oil, grease, water proofing or water-repellent treatments, water, surface dirt and frost.

- Clean porous materials such as: concrete, masonry and unglazed surfaces of ceramic tile, by brushing, grinding blast cleaning, mechanical abrading, acid washing or a combination of these methods to provide a clean, sound substrate for optimum sealant adhesion.
- The surface of concrete may be cut back to remove contaminants and expose & clean surface when acceptable to the purchaser.
- Remove laitance from concrete by:
 - Acid washing
 - grinding or
 - mechanical abrading
- remove all form of oils from concrete by blast cleaning.
- remove loose particles originally present or resulting from
 - grinding abrading or
 - blast cleaning

- by blowing out joints with oil free compressed air (or vacuuming) prior to application of primer or sealant.
- Clean nonporous surfaces, such as metal, glass, porcelain enamel and glazed surfaces of ceramic tile chemically or by other means that are not harmful to the substrate and are acceptable to the substrate manufacturer.
- Remove temporary coatings on metallic surfaces by a solvent that leaves no residue. Apply the solvent with clean oil free cloths or lintless paper towels. Do not dip cleaning cloth in the solvent. Always pour the solvent on the cloth to eliminate the possibility of contaminating the solvent. Do not allow the solvent to air-dry without wiping. Wipe dry with a clean dry cloth or lintless paper towels. Permanent coatings that are to remain must not be removed or damaged.

b) Masquing Tape:

Install masquing tape at joint edges when necessary to avoid undesirable sealant smears on exposed visible surfaces. Use a non staining, non-absorbent, compatible type.

c) Primer and Joint Filler:

Install primer when and as recommended by the sealant manufacturer for optimum adhesion.

Install compatible joint filler uniformly to proper depth without twisting and braiding.

d) Sealant:

Install sealant in strict accordance with the manufacturer's recommendations and precautions. Completely fill the recess provided in the joint. Sealants are more safely applied at temperature above 40°F (≈ 5°C)

e) Tooling:

- Tooling nonsag sealants is essential to force the sealant into the joint and eliminate air pockets and should be done as soon as possible after application and before skinning or curing begins. Tooling also ensures contact of the sealant to the sides of the joint.
- Plastic or metal tools can be used. Most applicators use dry tools but they may be surface-treated to prevent adhesion to the sealant and may be shaped as desired to produce the desired joint profile. Dipping tools in certain liquids decreases the adhesion of the sealant to the tool. All liquids should be first tested and accepted for by the manufacturer. The use of some liquids may result in surface discoloration. In using tooling liquids, care should be taken to ensure that the liquid does not contact joint surfaces prior to the sealant contacting the joint surface. If the sealant overlaps the area contaminated with the liquid, the sealant bond may be adversely affected.
- Tool sealant so as to force it into the joint, eliminating air pockets and ensuring contact of the sealant with the sides of the joint. Use appropriate tool to provide a concave, flush, or recessed joint as required.
- Immediately after tooling the joint, remove masking tape carefully if used, without disturbing the sealant.

f) Field testing

In case where the building joints are ready to receive sealant and the question of adhesion of the sealant to novel or untried surfaces arises, it is advisable to install the sealant in a 1.5m (5 feet) length of joint as a test.

- It would be good practice to do this as a matter of standard procedure on all sites even though unusual conditions are not suspected.
- Following instructions of the sealant manufacturer and using primer as and when recommended, the Contractor will install the sealant in the joint and examine for adhesion after cure to determine whether proper adhesion has been obtained.

202.12.4 Bituminous sealant to waterproof horizontal joints

Once the joint sealant are approved by the Engineer, the Contractor shall submit for approval the application procedures.

Application conditions

- 1) Prior to filling the joints, the Contractor shall:
 - a) make good damaged joints,
 - b) grind or saw joints which are narrower than required,
 - c) clean by grinding and brushing joint sides,
 - d) clean with compressed air.
- 2) Bituminous sealants are hot applied under temperature ranging from 100°C to 130°C, and with a caulking gum. The nozzles shall be kept at the bottom of the joint to ensure a complete and tight filling.
- 3) In the event of a mastic creep in horizontal joints, the Contractor shall re-fill tightly the surface.

202.12.5 Surface strip joint seal (combiflex type or similar)

Surface strip joint seal, is applied, where shown on the drawings or indicated by the Engineer.

- 1) Many joints can be reliably and durably sealed with a system based on an elastomeric strip bridging the joint and bond on both sides of the joints with a special epoxy adhesive.
 - a) This is a flexible water proof seal for joints. The strip is highly flexible and fully weather-resistant elastomeric membrane (neoprene, hypalon or E.P.D.M)
 - b) The width of the strip varies from 100mm minimum to more than 500mm.
 - c) The thickness varies from 1 to 3mm.

- d) In some cases the strip must be protected.
- 2) The Contractor shall apply the whole system in accordance with the manufacturer technical data sheet.

202.13 ELASTOMERIC SUPPORT

202.13.1 General

Elastomeric supports must comply with the following criteria:

- 1) to be of simple design under normal execution procedures.
- 2) to permit:
 - a) horizontal displacement due to any cause,
 - b) rotation of the support due to bending under permanent loads, working loads and the effects of hydraulic shrinkage and thermal phenomena, without building liable stresses outside the elastomeric support.

The elastomeric support can fill all the substrate surface of the wearing walls /or/ only a part of this surface; the unoccupied surface. In this case must be filled by a compressible material to avoid the intrusion of concrete grout between the various elements of the elastomeric support.

202.13.2 Material and Application

The elastomeric support is generally constituted by a non-hooped elastomeric polychloroprene (neoprene) which under various movements and loads will sustain deformation, transmitting to the underneath wearing walls, vertical and horizontal efforts.

a) Evenness of the wearing substrate

The substrate wearing surface must be evened to avoid any accidental contact outside the designed contact surfaces; anyhow the wearing zones must be made horizontal.

The Contractor must furnish to the Engineer all necessary justifications concerning the elastomeric support and the procedures for the execution of the wearing surface.

b) Minimal characteristics

The following minimal characteristics must be submitted by the Contractor for the Engineer's approval:

- Maximal constraint which varies with the type of material used (around 30 bars /or/ 3 MPa for the non-hooped polychloroprene = neoprene)
- Minimal constraint to be obtained and which is needed to respect the condition of non-slipping of the elastomeric support on its substrate (around 15 bars or 1.5 MPa for the non-hooped polychloroprene = neoprene)

This condition may result for the elastomeric support to have a maximal dimension implicating sometime the impossibility to design a continuous linear elastomeric support. Thus needing to consider the use of strips or pads of elastomeric material.

A continuous break of ties must be then insured between the pads by incorporating between the pads of neoprene of a compressible material (polystyrene type) and making the joints between pads and polystyrene water tight to avoid concrete grout intrusion.

c) Minimal thickness of the Elastomeric Support

The required thickness of the neoprene support shall depends on the loads, the amount of sliding and permissible rotations.

The Contractor shall submit technical certificate from the manufacturer to the Engineer allowing him to control and approve the chosen sizes and thickness of the elastomeric support.

The minimal thickness is conditioned by two factors:

- the maximal distortion of the neoprene (α) which must not exceed $\alpha \leq 0.5$ radians.
- the thickness must be large enough to permit rotation of the support avoiding contact in the maximum compression corner zones.

d) Determination of the Horizontal stresses

As an example, horizontal stresses may be controlled by the following formula (DTU.20.12)

$$H = G \times S \times \frac{U}{e}$$

e = thickness of the support

S = surface of the support in contact with the substrate

G = Transversal elasticity coefficient of the neoprene (around 0.8 to 1.3 MPa or 8 to 13 bars depending of the neoprene quality)

U = displacement

The admissible displacement (U) in relation with the thickness (e) can be first estimated as follows:

| | | | | |
|-----------------------|-----|----|-----|----|
| Thickness (mm) e = | 5 | 10 | 15 | 20 |
| Displacement (mm) U = | 2.5 | 5 | 7.5 | 10 |

e) Other approved elastomeric support

The elastomeric constituting the pad may be a mix vulcanised based on Ethylene - Propylene - Diene - Monomer (E.P.D.M) which has the following average characteristics:

- A shore hardness of 60 ± 5
- Specific weight 1.06 ± 0.02 g/ml
- Ultimate resistance (rupture) ≥ 15.0 MPa
- Maximum elongation (Rupture) $\geq 400\%$
- Tearing resistance ≥ 15.0 MPa
- Permanent deformation after 24 hours at $70^{\circ}\text{C} \geq 20\%$
- Module "G" of transversal elasticity 0.8 ± 0.1 MPa

f) Compression Sollicitation

The admissible load over an elastomeric linear pads support depends of the dimensions and number of elastomeric pads constituting the support.

The average admissible constraint on every single pad is obtained for example by using the following formula

$$\text{average} = 1.2 \times \beta \leq 5 \text{ MPa}$$

Where β (form factor) = $\frac{a \times b}{2xt(a+b)}$

t = thickness of the elastomeric support

a,b = dimensions (in plan) of the elastomeric support

g) Special dispositions

In case the horizontal effort is greater than the value of friction of the interface between the elastomeric support and the substrate, the following dispositions must be taken by the Contractor:

If not otherwise specified by the Engineer the Contractor may stick the pads to avoid uncontrolled displacement when setting the different elements.

A special glue approved by the Engineer must be laid on the primed substrate and on the back side of the pad. After a maturation time, the pad shall be applied on the glued substrate with force.

202.13.3 Slip membrane

This slip membrane is constituted generally

- a protection sheet
- a slip plate around 3mm thick
- a silicone lubrication or similar
- an elastomeric pad recovered with special slipping cover adhering to it.

This system fulfills most of the usual functions of elastomeric support as:

- uniform distribution of vertical loads
- horizontal displacement by slipping of the supported construction over it.

This system will permit under small thickness, wide horizontal displacement with minimum limitation of the horizontal stresses transmitted and after the displacement it does not exert any underpinning stress on the construction at the contact interface.

The Contractor is asked to submit all technical specifications to the Engineer for approval before any purchase of the material.

202.14 METHODS OF MEASUREMENTS

202.14.1 General

Except where otherwise specified, cast-in-situ concrete will be measured and paid for by volume. Separate payment will be made for reinforcement steel (by weight) and formwork (by area).

The following items shall be measured and paid for as specified hereafter :

- Manholes and chambers - by completed units.
- Precast concrete elements - by completed units, or by length or area.
- Cast-in-situ reinforced concrete piles - by linear meters.

A detailed description of the methods of measurements and payment for the different concrete works is given in the following subsections.

202.14.2 Cast-in-situ Concrete

Concrete will be classified for payment in accordance with grades, structural elements and location in the structure.

Except as otherwise specified, all cast-in-situ concrete will be measured by volume to the neat lines and dimensions shown on the Drawings or determined by the Engineer. The volume of all openings, holes and shown on the Drawings or determined by the Engineer. The volume of all openings, holes and recesses not actually filled by concrete will be deducted, but no deduction will be made for the volume of reinforcing steel or small openings (less than 0.1 sq.m. in surface area) and metal parts embedded in the concrete. No payment will be made for concrete that has been rejected or for concrete used to fill over-excavations.

Floors and intermediate and roof slabs will be measured over the external walls. Columns will be measured from top of foundation to first floor soffit and between floor slabs. Beams will be measured between columns or walls in length, and to floor soffits in height.

The unit rates for concrete shall include for : supply and transport of all materials to the site; batching, mixing, placing, vibrating and curing of concrete; testing of concrete; finishing of concrete, except as otherwise paid for under specially provided items in the Bill of Quantities.

Binding layers of lean concrete will be measured by square meters to a stated thickness. Cyclopean concrete will be measured by cubic meters including stones.

The shotcrete concrete will be measured by cubic meters including all means of application.

The Fiber concrete will be measured by cubic meters including all necessary metallic fibers.

202.14.3 Reinforcement Steel

Reinforcement steel will be classified for payment in accordance with the type of bars or fabric.

Measurement for payment of reinforcement bars will be made only of the weight of the bars placed in the concrete, on the basis of the net lengths and sizes, in accordance with the Drawings or as directed. Overlaps not shown on the Drawings will not be measured for payment. Payment for reinforcement bars will be made at the unit rates per kilogram (or ton) bid therefore in the Bill of Quantities, which unit rates shall include the cost of furnishing the reinforcement bars, furnishing and attaching tie rods and fasteners, wire ties and metal supports, if used, and of delivering, unloading, hauling, storing, sorting, cutting, bending, cleaning, welding if necessary, placing, and securing and maintaining in position all reinforcement bars, as shown on the Drawings or as directed, as well as waste and overlaps not shown on the Drawings.

Fabric reinforcement, required, will be measured on the basis of the area of work covered and will be paid for at the unit rates per kilogram (or ton) bid therefore in the Bill of Quantities, which unit rates shall include the cost of furnishing the fabric, cutting it to the required sizes, bending, placing, binding, supplying and placing all supports that are required, as well as the cost of all laps and waste.

202.14.4 Formwork

Formwork shall be measured for payment in m², classified by type (unwrought, wrought and for fairface concrete). Measurement for payment shall be of the net area of contact of concrete with the forms, after deduction of all openings and gaps exceeding 0.25 m² in area. The unit rates shall include for the use and waste of timber and of other materials and the supply of nails, tie-wires and fasteners; erection of forms, including scaffolding, shoring and shuttering; forming of levels, fillets, rebates, recesses, openings, etc.; removal of forms and for all materials (including waste), labour and equipment necessary for obtaining the required finish of the surfaces. It will also include temporary structures necessary for execution of all structure works.

Where no specific items for formwork are inserted in the Bill of Quantities, the cost of formwork as above shall be deemed to be included by the Contractor in his unit rates for the various items for concrete work and shall not be paid for separately.

202.14.5 Manholes and Chambers

Chambers shall be measured and paid for as defined in the Particular Specification.

Sewer manholes shall be measured by the number of complete units, classified according to type and depth as defined in the Bill of Quantities. For this purpose the depth shall be taken as the difference between the level of the manhole cover and the invert of the lowest pipe where it leaves the manhole. The unit rates of manholes shall each include : the cost of the required excavation in all kinds of soil; the blinding layer under the concrete floor; construction of the floor, walls, and ceiling, inclusive of reinforcement, all in accordance with the Drawings and as specified in the Bill of Quantities; supply and fixing of hooks, step irons and/or ladders; the construction of inlets and outlets; benching of the floor as shown on the Drawings; applying the specified finish to all internal surfaces including lastering where required; supply and installation of frames and covers; supply and fixing of pipe stubs for future connections; compacted backfill around the structure and removal of all surplus spoil, and all ancillary works required to complete the manholes in accordance with the Drawings and specifications and to the Engineer's satisfaction.

The unit rates for manholes will not include for external drops, which will be measured and paid for as an extra over the rates of manholes and chambers. They will be measured by number and classified by diameter only, irrespective of depth. The unit rates shall include for the supply of all materials and all work necessary in the construction of the external drop to the details shown on the Drawings.

202.14.6 Thrust and Anchor Blocks

The thrust and anchor blocks shall be measured and paid for per cubic metre of concrete to the dimensions shown on the Drawings. The unit rate per cubic metre shall include excavation, erecting formwork, placing steel reinforcement, pouring concrete, backfilling works and all other related works.

202.14.7 Precast Concrete Elements

Precast concrete elements will be measured by number, length or area as detailed in the Bill of Quantities. The unit rates shall include for the costs involved in complying with all requirements of Section 202.11.3 and in addition all material, labour and equipment required in the manufacture, transport and placing the precast units in the structure, including also reinforcement steel and other metal parts that are part of the precast element.

202.14.8 Cast-in-situ Reinforced Concrete Piles (Not applicable)**202.14.9 Joint Seals**

Joint seals will be measured by length, and will be paid per linear metre.

The unit rates for joint seals shall include the cost of supplied materials and all necessary works to complete the joint sealing.

202.14.10 Elastomeric Support

Elastomeric supports will be measured by units and will be paid separately for each specified support as shown on the drawings.

202.14.11 Hourdis Slabs

Hourdis slabs shall be measured and paid for per cubic metre of finished monolithical slab measured to the dimensions shown on the Drawings.

The unit rate per cubic metre shall include for formwork, steel bars, hourdis blocks placing concrete and all related works unless otherwise specified in the bill of Quantities.

203- BRICKWORK AND BLOCKWORK

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203 BRICKWORK AND BLOCKWORK

203.1 GENERAL

All brickwork and blockwork to be constructed under the Contract shall comply with the provisions of this chapter. The use of the terms “brick” or “block” and their compounds shall not be limiting and the use of one term or both in the specification shall, where applicable, be interchangeable.

203.2 MATERIALS

203.2.1 Bricks and Blocks

Bricks and blocks shall comply with the provisions of the following standards and codes of practice :

| | |
|-----------------------------------|--------------------|
| Concrete Bricks and Fixing Bricks | B.S. 1180 |
| Precast Concrete Blocks | B.S. 2028 and 1364 |
| Brick and Block Masonry | C.P. 121 Part 1 |

All bricks and blocks shall be new and unused, free from any defects, and entirely in conformity with samples submitted to and approved by the Engineer. Where no specific instruction is given as to grade of block, the Contractor shall supply blocks of the highest quality.

Blocks and bricks used in fair-faced walls (“neat” brickwork) shall be specially chosen by the Contractor, to ensure uniformity of aggregate size, colour, shape and freedom from defects, and the block manufacturer shall be advised of their intended use.

Special decorative blocks shall conform in all respects with approved samples as submitted to the Engineer prior to commencement of the work.

Hollow or blind concrete blocks shall be of first grade quality manufactured in an approved factory, made of vibrated and compressed concrete and thoroughly watered.

Hollow concrete blocks shall be mechanically manufactured on site or in an approved factory by means of moulds.

| | |
|------------------|--------------------------|
| Mix proportion : | 50 kg of cement |
| | 120 l of stone chippings |
| | 90 l of sand |

Characteristics : Weight : 1500 to 2000 kg/m³

Concrete blocks shall be left to dry for nearly one month in a well ventilated shelter. They shall have the thickness specified on the drawings.

Concrete blocks shall be 40 days old minimum and show, after 28 days, a crushing strength (measured on the whole block surface) equal to 40 kg/cm².

203.2.2 Sand for Mortar

The sand shall be natural sand, or sand from crushed stone, which in respect of quality and classification, shall comply with the provisions of B.S. 1200.

203.2.3 Water

The water for mortar shall be of potable quality in accordance with B.S. 3148.

203.2.4 Cement

The cement shall be Portland Cement complying with B.S. 12.

203.3 MORTAR FOR BRICKWORK**203.3.1 Proportions for Mortar**

The different types of mortar shall be proportioned by volume as follows, unless otherwise specified :

Cement Mortar, 1:3 - One part cement, and three parts sand or other fine aggregate.

The type of mortar to be used shall be as specified hereafter and as directed by the Engineer. For the purpose of proportioning by volume, a sack of cement shall be assumed to be 37 litres in volume (50 kg in weight).

203.3.2 Mixing of Mortar

The dry ingredients shall be measured in suitable containers and mixed by hand or by mechanical mixer and then the required quantity of water shall be added in the form of a spray. Mixing by hand shall be done in special boxes. Mixing shall not be done on the bare earth. Cement mortar shall be used within one hour of mixing.

203.4 BRICKLAYING WORKMANSHIP**203.4.1 General**

All bricks and blocks shall be thoroughly wetted before use, except where the capacity of absorption of concrete bricks or blocks is less than 5% by weight, and the Engineer is so informed in advance.

A perfectly rectilinear wooden ruler, a plumb line and an air level shall be permanently kept on site for verification of masonry. The Contractor shall demolish and re-build at his own expense every wall that is not in accordance with the stipulated requirements.

According to the used material, and whether masonry will be rendered or kept exposed, surface evenness tabulated hereinafter shall be measured by means of:

- 10 m long line
- 2 m ruler
- 0.20 m ruler

203.4.2 Workmanship

Bricklaying shall progress upwards in an orderly and continuous manner, and so that no portion will rise more than one meter above adjacent sections, unless special considerations rule otherwise. Should it be necessary to stop work without the courses being completed, courses shall be racked back at an angle of 45°. On resumption of work, the top course shall be cleaned and wetted prior to laying of additional brickwork. All courses shall be horizontal, and vertical joints shall be staggered, alternate joints being in one vertical line. The use of broken blocks will not be permitted, but half-blocks, specially prepared will be used when and as required. Wherever a closing piece not to standard dimensions is required, the closing shall be done by neatly casting concrete. The bond will be as shown on the Drawings; where not shown, English Bond shall be used unless otherwise approved by the Engineer.

Masonry using exposed concrete blocks

Exposed surfaces shall meet the following tolerances:

- Total evenness measured with a 10.00 m line : 2 cm
- Alignment of horizontal joints lines (over 10.00m) : 1 cm

Masonry with concrete blocks to be rendered

There are two types of masonry:

- ordinary workmanship
- wrought workmanship

Ordinary workmanship shall be reserved to walls which do not require any wrought finish or those which shall receive either a traditional thick rendering or a finish applied indirectly to the surface.

The wrought workmanship shall have the same application as the ordinary one but its workmanlike quality limits eventual coating works.

| Type of workmanship | Overall evenness under 2.00 m ruler (cm) | Out of flush and local evenness under a 0.20 m ruler (cm) | Appearance |
|---------------------|--|---|--|
| Ordinary | 1.5 | 1 | Levelled joints Repair of scratches or accidental lack of material that cannot be concealed with traditional rendering works After repair, residual local imperfections that can be concealed with normal rendering works shall not exceed 10% of placed blocks. |
| Wrought | 1 | 0.7 | Idem, but the percentage of defective blocks equals 5 |

203.4.3 Joints

All joints shall be filled with mortar to a thickness of 10 mm over their entire surface of contact. The thickness of the mortar shall be even throughout the joint. The variation in thickness of any joint from the determined thickness shall not be greater than 2 mm. The overall height of any four courses shall be equal to the nominal height of four building elements (blocks or bricks), plus four times the specified thickness of the joint, ± 2 mm.

During the laying of bricks (or blocks) the joints shall be wiped flush with the face of the wall. Racking out of joints in preparation for pointing, or for forming special facing joints, shall be done after partial setting of the mortar. Special facing joints shall be formed at the time of racking out.

203.4.4 Scaffolding

Scaffolding shall be stable and conform entirely with all requirements of the law. No building work at a height of more than 2 meters shall be carried out without scaffolding. Scaffolds shall be secured to the wall through holes left in it by omission of blocks. These holes shall be carefully filled with blocks after the scaffolds have been removed.

203.4.5 Blockwork Filled with Concrete

Hollow or channel blocks intended to be filled with concrete so as to serve as pillars or beams shall be accurately laid to allow easy placing of reinforcement steel. The bars be tied to the reinforcement of the building framework. Joints shall be made in accordance with Subsection 203.4.3.

203.4.6 Cavity Walls

Cavity walls shall be built in cement mortar or cement-lime-mortar, in accordance with the Drawings. Walls of less than one brick thickness shall be constructed in stretcher bond. During construction precautions shall be taken to prevent course for cleaning purposes, shall not be filled in until the completion of the wall.

In the absence of any special detail for the drainage and ventilation of the cavity, every third vertical joint in the bottom course of the outer wall shall be left open. Precautions shall be taken that these joints remain open plastering.

The ties between the walls shall be made in accordance with details shown on the Drawings or approved by the Engineer. Where ties consist of bricks or blocks, their ends projecting into the inner wall shall be covered with bitumen to prevent the passage of moisture from the outer leaf. Metal ties shall be of non-rusting material, or shall be protected against corrosion.

203.4.7 Fair Face Work

Fair-face brickwork shall be built of specially selected bricks or blocks. Only straight, clean flawless blocks shall be chosen. The blocks shall be inspected again immediately prior to laying and any damaged blocks shall be rejected.

Joints in fair-face blockwork or brickwork shall be pointed according to the details shown on the Drawings or to the Engineer's instructions. Pointing shall be done with an approved special tool using a special cement mortar (2: 3) made with white or coloured cement and with added pigments as required or directed by the Engineer. Pointing of joints shall commence at the top of the wall, shall proceed downwards and shall be carried out immediately prior to the removal of the scaffolding. As the pointing progress the wall shall be thoroughly cleaned of all excess mortar. All joints shall receive the same treatment and final shape and colour in order to present a neat uniform appearance.

203.4.8 Chases

Pipe chases shall not be cut in lime-sand brick partitions of half brick thickness or less and shall not be cut in walls until the mortar in the joints has hardened sufficiently. The chases shall be filled with 1:3 cement mortar, after the pipes have been fixed in them.

203.5 BUILDING JUNCTIONS

203.5.1 Junctions Between Walls and Partitions

Unless otherwise specified, corners and junctions between walls and/or partitions with courses of the same height shall be built in continuity in proper bond across the corner or junction.

When the walls and/or partitions meeting at the corner or junction are not built in continuity or if their courses are of different heights, the junction shall be formed by a concrete column, jointed to the walls by tothing the blockwork in accordance with the detailed Drawings. The concrete junction column shall be cast in sections as the walls progress in height.

203.5.2 Junctions Between Brickwork Walls and Concrete Columns

Where the column is to be cast after the wall has been built, a suitable gap shall be left in the wall which shall be finished in tooth formation on both sides of the gap. The column shall be cast between formboards fixed to either side of the wall. The gap in the wall shall be such as

will leave the minimum required width of the column between protruding teeth. The depth of the socket between teeth shall be at least 10 cm. Where the wall is to be built after the concrete column has been cast, especially if the depth of the column is larger than the thickness of the wall, the junction shall be effected in accordance with the details shown on the Drawings, either by leaving a groove in the side face of the column into which the bricks or blocks are built, or by casting a small connecting column between the main column and the toothed end of the wall as described in Subsection 203.5.1 above.

203.5.3 Junctions Between Walls and Concrete Soffits

The gap at the joint between the top of the top most course and the concrete soffit shall not be greater than 1.5 cm and shall be filled with 1:3 cement mortar. The wall shall be secured to the joint. The filling of the joint and the wedging shall be done after the mortar in the wall has properly set and hardened and, preferably, just before plastering.

203.6 MISCELLANEOUS BRICKLAYING WORK

203.6.1 Brick facing on walls

Bricks and blocks for wall facing (remaining exposed to view) shall be selected as required under Subsection 203.4.7 for fair face walls. The mortar used for laying facing bricks shall be cement lime mortar 1:2:6 or cement mortar 1:3. Making and pointing of joints shall be done as required in Subsection 203.4.7. Bricks or blocks used in facing shall be fixed to the wall by means of mortar having as dry a consistency as possible. Where anchors are shown on the Drawings they shall be of non-corrosive metal and shall penetrate at least 3 cm into the wall.

203.6.2 Composite Walls

Walls consisting of brickwork or blockwork with a concrete backing, shall be built as required in Section 203.4, except that they shall be constructed in lifts not exceeding 5 courses of blocks or 10 courses of bricks. Bricklaying in any lift shall not begin until the backing concrete in the lift below it has been allowed to set. Unless otherwise specified, the backing concrete shall be Class C15P in accordance with Division 204.

203.7 PREFABRICATED AND PRECAST ELEMENTS

203.7.1 General

This section shall apply only to those prefabricated and precast elements which have no structural function and are not part of the load-bearing structure. Included are those elements of concrete, asbestos-cement and similar materials, used as ventilating louvers, light partitions in bathrooms, banisters to stair-ways and balconies, etc..

203.7.2 Supply and Erection

The Contractor shall supply the required elements only after samples submitted by him to the Engineer have been approved.

Elements such as ventilation louvers shall be supplied and built in during building of the wall. All elements supplied shall be clean, free from flaws and complete in all details in accordance with the Drawings or instructions and shall include anchor damage during the course of the work.

203.7.3 Concrete Elements

Concrete for precast elements shall be Class C15P at least, unless specifically stated otherwise. Reinforcement shall be included as required, in order to facilitate safe haulage, erection and use.

203.8 METHODS OF MEASUREMENT AND PAYMENT

203.8.1 Walls and partitions

Brick and block walls and partitions will be measured by m² or built area according to the Drawings and classified by type and thickness of wall, all openings, beams, columns, precast elements etc.. being deducted from the area measured; however, tooth work as required under Section 203.5 will not be deducted. The cost of making all openings in the brick or blockwork shall be deemed to be included in the rates for the brickwork and shall not be paid for separately.

Unit rates shall be deemed to include for supply of all building materials such as blocks, bricks, cement, sand, etc.. and the waste involved in their use, the erection and removal of scaffolding, the cost of making all openings and connections to the walls, partitions and concrete structures. Where connection of blockwork wall to an existing building (i.e., one not built under this Contract) is required, payment will be made for the connection measured in accordance with the net length of the connection between one old and the new structures.

203.8.2 Columns and Beams

Columns and beams of hollow blockwork filled with concrete will be measured and paid for extra over the prices for blockwork. Measurement will be in accordance with the net lengths of the columns or beam and the unit rate shall cover all costs of special blocks, concrete work, steel reinforcement, etc..

203.8.3 Fair face

Neat work (fair face) will be measured separately by area, in m², extra over the unit rates for brick or blockwork; neat work on both faces will be paid for at the same unit rate, for each face separately.

203.8.4 Precast Elements

Precast elements will be paid for separately in accordance with size and type of complete elements. The unit rate will include for the supply of the elements and all accessories required for building-in as well as the actual erection of the element. The unit rate for precast units shall allow for cement wash rendering should the Engineer request it, in order to obtain a more uniform and harmonious appearance to the wall in which the element is built.

204- MASONRY AND STONWORK

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204 MASONRY AND STONEMWORK

204.1 GENERAL

This chapter deals with all stone work with or without mortar bedding, constructional and/or decorative, such as retaining walls, pavings, filters, covering the supply of all specified materials as well as laying, jointing and constructing of all elements shown on the Drawings and described in the Specifications.

Stones shall come from selected quarry layers to the approval of the Engineer. They shall be homogeneous, frost resistant, flawless, free of any crack, solid, and of equal grain and shall have the required qualities to give a regular facing. They shall give out a clear sound when hit with a hammer. Those which give out a dull sound due to soft parts and crumble into sandy grains instead of breaking into sharp splinters shall be rejected.

Stones shall have a minimum density of 2.5, bear a crushing load superior to 600 kg/cm² and conform to the approved sample submitted by the Contractor. Stones shall have sizes (length or width) reaching 20 to 50 cm. Their width shall be as shown on the drawings, and they shall have beds and joints perpendicular to the facing.

204.2 MASONRY CONSTRUCTION

204.2.1 Masonry in Mortar

Where shown on the Drawings, retaining walls, abutments, wing walls and similar structures shall be constructed of masonry in mortar.

All building stone shall be free of decomposition, ironbands, sandholes, flaws and other imperfections. All building stone shall be approved by the Engineer before use. Stratified stones shall be laid in their natural bedding planes when incorporated in the Works.

Mortar shall be cement-mortar, as specified in Section 203.3 of the Specification.

All stones shall be thoroughly wetted before use and shall be laid in full mortar beds. They shall be placed so as to bind firmly in all directions. Selected stones roughly pitched to line shall be used at all corners. The rear face of wingwalls, abutments and retaining walls shall present an approximately plane surface and no voids shall be permitted in any part of the walls shall not exceed 2 cm in depth and vertical joints shall not exceed 2 cm in width.

Within twenty-four hours after construction all exposed faces shall be raked clear of loose mortar. The walls shall be kept moist during this operation and for a period of three days thereafter.

Weepholes shall be constructed of the size and in the positions shown on the Drawings or as directed on Site. Construction and Expansion joints shall be inserted in the positions and to the details shown on the Drawings or as directed by the Engineer.

204.2.2 Grouted Rubble Masonry

Where shown on the Drawings or directed by the Engineer, grouted rubble masonry shall be used in pavings, slope protection and similar works.

Grouted rubble masonry shall consist of approved building stone thoroughly wetted and laid in full mortar beds each course being grouted with 1:3 cement mortar as specified in Section 203.3 of the Specification.

204.2.3 Dry Rubble Masonry

Dry rubble shall consist of approved building stone, selected stones with flat faces as nearly parallel as practicable being used for this work. The different sizes of stones shall be evenly distributed over the whole face of the wall, generally the largest stones being placed in the lower part of the wall.

The work shall be well bonded using as many long stones as can be obtained and shall present a reasonably true and smooth surface free from large holes or projections. Retaining walls of dry rubble shall be built in advance of the embankments.

Natural stones masonry

Natural stones shall be laid on a mortar bedding proportioned at 1:3 cement mortar. Mortar must now flow out to the external surface of the wall; it shall be brushed and removed before setting.

For painting the joints in a wall, the following directions shall be respected:

- 1) while building, the joint shall be raked out to a depth of 4 cm
- 2) before pointing, clean again and wet the joints
- 3) fill the joint well with a rich plastic mortar (400 kg of cement per each cubic meter of clean, coarse sand)
- 4) smooth the mortar with a pointing blade
- 5) as soon as the mortar slightly dries out, gently scrape the mortar with a brush or a dry cloth in order to remove the marks left by the trowel and to roughen the joint
- 6) once the mortar is set, brush the stone surfaces with a metal brush.

In any case, the construction shall be carried out according to the general and detailed drawings, to the satisfaction of the Engineer and true to a sample of built wall, approved by the Engineer and kept at the site until the completion of masonry works.

204.2.4 Methods of Measurement and Payment

Masonry construction shall be measured for each type by area or square meters to the neat lines and dimensions shown on the Drawings. The area of all openings, holes and recesses, except for weepholes will be deducted. The unit rates for masonry construction shall include for the supply, on site of all stone, mortar, grout and all other required materials; erection and

dismantling of scaffoldings, where required; and wetting of stone, spreading of mortar beds, and laying, jointing and grouting of masonry.

Unless otherwise specified, all excavation required for masonry construction shall be deemed to be included in the various unit rates and shall not be paid for separately.

204.3 RUBBLE STONE PAVING

204.3.1 General

Rubble stone paving shall consist of layers of stone placed on a gravel blanket, to the lines and thickness shown on the Drawings or directed by the Engineer. The stones shall conform to the requirements of Subsections 204.3.2 and 204.3.3 hereafter and the gravel blanket to the requirements of Section 204.4 hereafter.

204.3.2 Quality of Stone

Rubble stone for paving shall consist of clean frost resistant, hard sound and durable natural cobbles or quarried stone fragments of roughly cubic shape. The stones shall be free of cracks, seams and other defects. Elongated and flat slablike stones shall not be permitted. Not less than 75% of the stones shall have the dimensions of the faces perpendicular to the paved surface approximately equal to the nominal thickness of the paving and none shall be smaller than three quarters of the nominal thickness in the said direction. The stones shall be approved by the Engineer before laying.

204.3.3 Laying

Before laying the stone paving, earthworks shall be completed to final grades and lines, and the bedding shall be excavated and compacted to the finished slopes and levels. The gravel bedding shall then be placed and compacted as specified in Sub-section 204.3.4. The stones for rubble paving shall be placed on the gravel blanket and shall be hand packed as closely as possible to each other with their smallest side parallel to the paved surface and the exposed face flush with it. The joints shall be broken and no through joints will be allowed. The stones shall be bonded on all sides. The spaces between stones shall be filled either by a 1:3 cement-mortar or with rock chinking hammered into place. The paved surface shall be stable and reasonably flat and even, without any abrupt projections and/or depressions.

204.3.4 Gravel Blankets

Gravel blankets shall be placed as beddings under rubble stone pavements or, by themselves, as surfacing on soil areas, as shown on the Drawings or as directed by the Engineer. Material for gravel blankets and surfacings shall consist of natural river gravel or crushed stone in accordance with requirements of B.S. 882, Part 2 and to the satisfaction of the Engineer. Unless otherwise shown on the Drawings or directed by the Engineer, the size of the gravel, as specified in B.S. 882, Part 2, table 1, for single sized aggregates, shall be as follows:

- (a) For gravel blankets under rubble stone pavements - nominal size of 40 mm
- (b) For gravel surfacings on Soil areas - nominal size of 20 mm.

The gravel shall be placed in layers not exceeding 15 cm in thickness on a well-levellled and compacted subgrade. Each layer shall be thoroughly consolidated and compacted to the satisfaction of the Engineer. The finished blanket shall have a stable and even surface and be true to the lines and grades shown on the Drawings.

204.3.5 Methods of Measurement and Payment

Rubble stone pavements shall be classified by thickness of gravel blanket and stone layers and shall be measured for payment by m² of surface area of completed pavement. Unit rates for rubble stone pavements shall include for all materials and labour required for the completed pavement in place, including all excavation; supply and spreading of gravel blanket; supply and laying of stone and filling of joints with cement-mortar of rock-chinkings; and all other works and materials required to make the pavement complete.

Gravel surfacings shall be classified by thickness of gravel layer and shall be measured for payment by m² of surface area of completed surfacing. The unit rates for gravel surfacings shall include for all materials and labour required for the completed surfacing in place, as specified in this Subsection, above, for rubble stone pavements.

204.4 GRAVEL AND SAND FILTERS

204.4.1 Materials

Filter materials shall be supplied by the Contractor from approved sources and shall consist of natural washed sand and gravel or clean broken rock which does not break down into finer particles when it is placed. They shall be free from silt, clay and organic matter or other impurities or deleterious substances. Filter materials shall conform to the requirements of B.S. 882 - Coarse and fine aggregates from natural sources. The grading shall be as shown on the Drawings and as defined in the Particular Specification, and shall always be such that all permitted sizes are represented and there is no undue preponderance of any one fraction.

The Contractor shall furnish for testing and shall test, at his own cost, such representative samples of filter materials as may be required by the Engineer and shall have them tested in approved laboratories. The Engineer reserves the right to inspect the sites from which filter materials are obtained. The approval of materials from a particular source shall not be construed as constituting an approval of all materials taken from that source, and the Contractor will be held responsible for the specified quality and gradation of gravel and sand delivered to the work site. If, in the Engineer's opinion, the filter material supplied by the Contractor fails to meet the requirements he shall be entitled to instruct the Contractor to take remedial steps such as washing the material, re-sieving it, etc., or to reject it completely and have other material brought in by the Contractor, at no additional cost.

204.4.2 Workmanship

The filters shall be made to lines, shapes and dimensions shown on the Drawings.

Overexcavation will not be permitted and any material outside of the required lines which has been distributed shall be removed and replaced and the level made up again under the direction

of the Engineer with sound and suitable soil material carefully compacted or with concrete, solely at the Contractor's expense.

Placement of filters shall be carried out in the dry. When dewatering will be needed it shall continue and the water level kept below the level of the excavation until the placement of filters, pipes, if any, and every other appurtenance has been completed and the Engineer has inspected the works and signified his approval for stoppage of dewatering. Dewatering shall be carried out in accordance with the requirements of Section 201.1 and Subsection 201.1.4 and any other directions given in the Particular Specification, and/or by the Engineer.

The sand and gravel shall be placed and tamped so as to prevent segregation and/or mixing of sand with gravel in the filter or with foundation or backfill material.

In placing horizontal filters, soil will be levelled and smoothed, but not compacted, before the first layer is placed. The top of each layer shall be smooth and levelled before the succeeding layer is placed. In placing vertical filters, the different layers shall be separated by vertical forms or boards which shall be gradually lifted as the placing of the filters progresses.

After the graded sand and gravel in the filter have been shaped and compacted to the required depths, surfaces of the filter shall be protected from entry of foreign matter into the filter, as shown on the Drawings. Filter surfaces over which concrete is to be placed shall be covered with a layer of 1:3 cement-sand mortar 2.5 cm thick to prevent the filter material from being displaced during the pouring of the concrete. The mortar coating shall be applied carefully to the required thickness. The consistency of the mortar and methods of application shall be such as to avoid unnecessary filling of the voids in the filter material.

204.4.3 Methods of Measurement and Payment

Filters shall be measured for payment by cubic meters of filter material placed to the lines and dimensions shown on the Drawings. The unit rates shall be uniform for all sizes of filter material and for vertical and horizontal filters and shall include for supply of filter material and its placing and shaping as specified and shown on the Drawings.

The cost for supply and placing of filter material shall be deemed to include excavating and digging out the material at its source; crushing, screening, mixing, washing, hauling, and dumping on the site of the work; placing, tamping, levelling and smoothing the layers of material; supplying installing and lifting forms and boards; supplying and spreading mortar layers and all other work and materials required to complete the filter in place.

Unless specific items for excavation and/or dewatering are included in the Bill of Quantities, excavation for the filters and dewatering as specified shall be deemed to be included in the unit rates for supply, placing and shaping of filters and shall not be measured and paid for separately.

204.5 DUMPED RIP-RAP (NOT USED)

204.6 HAND PLACED RIP-RAP (NOT USED)

204.7 GABIONS (NOT USED)

204.8 ROCKFALL PROTECTION NETTING (NOT USED)

205 - PLASTERING

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205 PLASTERING

205.1 GENERAL

205.1.1 Miscellaneous Requirements

Surfaces

i) Nature of surfaces

Plasterworks specified in this Section shall be applied to the following surfaces:

- traditional masonry made of stones, bricks, concrete blocks, traditional floors or with precast small girders.
- ordinary aggregate concrete or lightweight concrete.
- plaster tiles and plates including cellular plaster tiles.
- Plaster plates and perforated cardboard.
- metal lathing.

ii) Condition of Surfaces

All surfaces to be plastered shall be dry, clean, free from soot, efflorescence, dust and oil. They shall be rough and unevenness of joints shall not exceed one third the plastering thickness.

Plastering frozen surfaces is not permitted.

Plastering work shall be classified into internal and external work, each of which may be applied in one-coat or two-coat work as indicated on the Drawings and/or in the Particular Specification or as directed by the Engineer.

The Contractor shall not carry out any plastering on days of extremely dry weather without the prior approval of the Engineer, who may require special precautions to be taken by the Contractor to prevent the early drying out of the plaster. Each layer of plaster shall be wetted prior to placing the next layer and at least 24 hours shall elapse before an additional layer is placed. All corners, whether internal or external, shall be neat and true, special care being taken to ensure a true, straight line at the junction of walls to the ceilings. All finished plastered surfaces shall be even, smooth, straight, plumb, with true angles (except where curved surfaces are shown on the Drawings) and free from trowel marks, cracks and other blemishes. Plane surfaces shall contact a 3 m straight edge with not over 3 mm deviation either way. Plaster showing cracks, blisters, pits or discoloration will not be accepted. It shall be removed by the Contractor and made up again at his own expense to the complete satisfaction of the Engineer.

205.1.2 Samples

Samples of each type of plaster to be used in the Works shall be prepared, each sample covering at least 1 square meter. Each sample shall be subject to approval by the Engineer, prior to actual commencement of plastering.

205.1.3 Scaffolding

Scaffolding shall be of sturdy and stable construction. Where a decorative spray or thrown finish is required to the plaster, the scaffolding shall not be connected to the wall to be plastered.

205.1.4 Repairs to Finished Plaster

Repairs of plaster, at skirting and elsewhere, as for instance around pipework, passages and channels, after the completion of other trades, shall be done in a neat manner so that all repairs will have a uniform appearance, indistinguishable from the general area of the plaster.

205.1.5 Levelling Course

A levelling Course shall be applied under all plasterwork and where called for on the Drawings and/or in the Particular Specification or directed by the Engineer, in order to straighten or correct imperfections in the base (brickwork, concrete, etc.). The levelling course shall consist of a cement-sand mix containing not less than 400 kg cement per meter cube of material. The course shall be applied as a thick paste with the aid of trowels, the minimum thickness being not less than 3 mm. Should the thickness be 10 mm or more, reinforcing wire mesh shall be used.

205.2 MATERIALS

Lime shall comply with the requirements of BS 890.

Lime shall be stored in a dry place protected from excessive temperature and wind.

Water shall be of potable quality, clean, fresh, free of salts, chemicals and impurities.

Sand shall be natural sand or quarry sand, free from dust, dirt and organic and foreign matter, complying with B.S. 1198 and 1199. Quarry sand shall not contain fines passing a No. 200 sieve in a quantity exceeding 6% - 8%. The sand for the first coat in two-coat work shall be coarse and graded. For the top-coat the sand shall be fine and well-screened, except where a special plaster made of coarse sand is required. Dune sand shall only be used for the top-coat of smooth internal plaster. The sand shall be supplied to the Site and stored according to type, each type separately. Sand in storage shall be placed on a layer of suitable material or any other stable surface in order to prevent contact and mixing with earth. The use of siliceous sand instead of calcareous sand is advisable.

Additives to control the workability or setting time of plaster may be used only with the prior approval of the Engineer, and shall be suited, in quality and quantity, to the type of cement used. No additional payment will be made to the Contractor for the use of any additive.

Coloured plaster shall be obtained by adding pigmenting powders to white or gray cement or by using coloured cement. Such cement shall comply in all respects with the requirements of the standards for ordinary Portland cement. Pigmenting powders shall be mineral oxide of metals. The use of compounds of organic origin will not be permitted. The pigmenting powders shall be obtained from approved manufacturers. They shall be thoroughly mixed with the dry cement before being introduced into the mixing machine.

Metal Lathing for plastering on false ceilings and partitions shall be expanded metal (XPM), at least 0.6 mm thick, with mesh size openings of at least 12 mm and the opened mesh weighing at least 1 kg per square meter. Wire Mesh used for plastering chases in brick or block work shall be XPM as above or chicken wire with a thickness of 0.7 mm and a mesh of at least 12 mm.

205.3 WORKMANSHIP

205.3.1 Preparation of Surfaces

Plastering shall be done only after all other finishing works such as window sills, terrazzo work, electrical work, drain pipes, etc., has been completed. Only with the Engineer's consent in writing will the Contractor be allowed to carry out plaster, prior to the completion of all other works. In exterior plasterwork, care shall be taken to avoid staining or damaging any completed elements of the building.

No plastering shall be done until at least two weeks have passed since completion of the brickwork or concrete on which the plaster is to be placed. All surfaces to be plastered shall be thoroughly brushed down with stiff brushes to remove any efflorescence and all loose and flaky particles. Grease and oil patches must be removed.

Prior to commencement of plastering, all necessary repairs shall be made to the base, protrusions shall be removed and any exposed steel reinforcement shall be covered with a 1:3 cement-sand mortar.

Considerable holes or local unevenness shall be patched with mortar, plaster mortar or plaster. Where holes or local unevenness exceed 5cm, they shall be filled with parts of brick and hollow blocks, as well as, with lime mortar or plaster mortar.

Patching on plaster masonry shall be carried out with plaster or plaster mortar.

Junctions between two different materials (e.g., concrete and blockwork) shall be covered with 15 cm wide strips of XPM mesh. No mesh will, however, be required where junction between brickwork and concrete is toothstepped.

Pipe chases containing two or more pipes shall be covered with wire mesh, the mesh being stretched across the chase with a 5 cm minimum overlap on each side, and fastened down with galvanized nails. The mesh shall be covered with a 1:3 cement-sand mortar. Minor chases, holes, etc., need not be covered with wire mesh, but shall be carefully filled with a 1:3 cement-sand mortar, the face of which shall be slightly roughened.

All repairs shall be thoroughly cured and allowed to dry, and moistened prior to commencing the plastering.

All smooth surfaces, such as concrete, shall be scarified in order to increase the bond of the plaster to the wall or ceiling. In blockwork the joints shall be raked out to a depth of 1 cm and all exterior surfaces shall be spatterdashed in 1:2 cement sand mortar to provide a key for the plastering. The spatterdash shall be wetted an hour or two after application to ensure adequate hydration and shall be allowed to harden thoroughly for 3 days during which time it shall be covered up for protection against the sun and kept moist by watering.

Surfaces to be plastered shall be cleaned and moistened, prior to application of plaster. Where necessary, ingrained dirt and other foreign materials shall be removed by wire brushing. Twenty-four hours prior to application of plaster the surface shall be soaked with a light spray of water, but not to an excess causing water to flow down the face of the wall to be plastered. During warm, dry weather the area shall be lightly wetted for a second time immediately before commencing the plastering.

205.3.2 Plastering

a) General

It is not allowed to re-mix plastering having began to dry out with or without adding fresh plaster.

Plaster mix shall consist of the following:

- cement mortar: 300 to 350 kg of cement per cubic meter of dry sand
- lime mortar: 350 kg of mix (one part of lime to two parts of cement) per cubic meter of dry sand
- plaster mortar: 300 to 350 kg of plaster per cubic meter of dry sand.

Smooth surfaces shall be roughened and cleaned from loose particles or treated with a sand cement or plaster sand mix to which an admixture is added to increase the bond (acetate or vinyl propionate).

b) Type of Plastering

Plastering shall be applied and smoothed by hand in two coats to a metal lathing.

c) Application of fine structural plaster or coarse structural plaster rendering

Plastering shall be applied in two coats, the first is a coarse structural plaster. The mix contains at least 100 kg of plaster per 100 liters of water.

The base coat shall be applied to the levelling course with a trowel but not smoothed. As soon as this coat hardens it shall be scarified with a special tool and the top coat applied.

The mix of the second layer shall be at least equal to that of the first applied. The total thickness shall reach 12mm with a tolerance of 2mm. Where a metal lathing is to be placed plastering shall be 6mm thick.

205.3.3 Condition of surfaces

After the surface preparation (wire brushing and removal of loose particles) plastered surfaces shall show no cracks, holes flakes nor streaks of more than 1mm deep. Moreover, the number of holes and streaks of less than one mm deep shall also be limited. Surface unevenness shall be repaired by traditional surface preparation work taken into account the type of paint to be applied and the required finishing quality.

The deflection under a 0.20m long ruler drawn over the surface in all directions shall not exceed 1mm (local evenness). A two meters long ruler drawn over the surface shall not show a deflection exceeding 5mm (general evenness).

The tolerance on verticality shall be 5mm maximum for one floor.

205.3.4 Reinforcement of Corners

External corners at intersections of plastered surfaces shall be reinforced by means of special approved angle beads of galvanized steel, aluminium or plastic, all as specified or shown on the Drawings. The height of the angle beads shall be not less than 1.8 m measured above the top of the skirting. The angle beads shall be securely fastened to the base wall under the plaster by use of galvanized nails. Plaster of the type used on the wall shall be carefully filled under and around the angle bead. The apex of the angle shall coincide exactly with the edge of the corner with regard to position and plumb.

205.4 METHODS OF MEASUREMENT AND PAYMENT

205.4.1 General

The unit rates for plastering shall include for the use of all tools scaffolding, labour and materials, including supply, processing and use of cement lime - slaked or otherwise - sands, gravels, additives and colouring pigments, mica flakes, and including for metal lath, all as specified and as applicable. Unless otherwise specified, the unit rates shall include for the use of ordinary Portland cement. The unit rates shall also include for all cleaning and wetting of all surfaces prior to plastering and the protection and curing of the plaster, inclusive of all surface treatments required.

205.4.2 Measurement

Measurement will be in all cases be net in square meters, as measured on the Drawings, all openings, tiling, skirtings and other areas not covered by plaster being deducted with no allowance for waste, overlap, etc. Reveals, jambs, and rebates to openings (doors, windows, etc.) will be measured for payment together with the general area of the plaster and no special rates will be paid for them.

For purposes of measuring external plaster, the bottom edge will be taken as being 10 cm below final external ground level, unless otherwise shown on the Drawings.

205.4.3 Payment

Samples, making good to other trades and repairs will not be paid for separately and the cost thereof shall be included in the unit rates for plastering, which shall also allow for the supply of wire mesh for covering pipe chases, etc., where required.

Internal or external plaster will be paid under the same item in the Bill of Quantities.

206 - RENDERING

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206 RENDERING

206.1 GENERAL

Rendering with hydraulic binders mortars shall be governed by related B.S. Standards. Rendering shall only be carried out on completed masonry works. It shall be made sure that rain and water have no pernicious action on the good hold of the rendering. It is advisable to render only on elements that have completed the major part of their shrinkage.

Rendering works shall not be started prior to the installation of electric and sanitary equipment, woodwork, metalwork, and all metal fittings. Works include, in addition to rendering, the fill-in of holes caused by the installation of electric and sanitary equipments, metal fittings, etc.. Fill-in shall be carried out with a mortar proportioned at 350 kg of cement per cubic meter of sand.

All finished surfaces shall be even and to the thickness required by the Engineer. They shall be, where specified, straight, plumb with true angles. Rendering showing defects shall be removed by the Contractor and made up again at his own expense to the complete satisfaction of the Engineer.

Samples of rendering to be used in the works shall be prepared, each sample covering at least 1 square meter. They shall be subject to the prior approval of the Engineer. Samples shall be kept on site until the completion of works. All finished rendered surfaces shall comply with the samples.

Markers shall be placed at the rate of one marker by square meter of wall to be coated. Rendering shall be carried out using a plumb line and a ruler.

Unless stated otherwise, rendered surfaces shall be brought even and smooth by using a felt. No rough patches, ridges, nor any imperfections shall be accepted. Connection with woodwork, skirtings, or metallic structures etc... shall be neatly finished and flawless.

Rendering shall be conducted and low-angled light will used so that any flaw such as undulations, ridges, blusters be detected and repaired.

Edges, salient angles, etc... shall be sized and rectified by means of straight wooden or metallic rulers.

Should several elements be set out at a stretch, they must be, after rendering, perfectly aligned and their dimensions rigourously unchanged.

A straight wooden ruler, a plumb line, an air level, a square, and an electric lamp shall be kept continuously on site.

The Contractor shall provide and install at his own expense all scaffoldings and ramps necessary for an easy and safe access to all surfaces to be rendered.

Prior to application of rendering and finishes, surfaces should be thoroughly cleaned and wetted for several hours.

Rendered surfaces shall be wetted after application to ensure adequate hydration and shall be allowed to harden thoroughly for 3 days during which time it shall be kept moist by watering.

Construction joints in rendering works shall be done in a neat manner so that the surface will have a uniform appearance, after having dried and shrunk, indistinguishable from the general area of the rendering.

206.2 MIXING OF MORTAR

Mortar can be mixed either manually or by means of mechanical mixers. Should mixing be done by hand, the dry solid constituents shall be mixed first, before water is added, in a very clean area to prevent contact and mixing with earth or other materials. Sand shall be measured in volumes by means of gauge boxes, in such a manner that each batch requires a whole number of 50 Kgs cement bags. Mortar shall be used half an hour maximum following its preparation.

206.3 RENDERING

Prior to the commencement of rendering, surfaces should be duly prepared.

Rendering generally includes:

- a roughcasting
- an intermediary coat
- a top coat which contributes partially to the structure waterproofing, and could be replaced or covered with a decorative plaster.

206.3.1 Roughcasting

External and concrete surfaces, especially if they are smooth, shall be roughcast. Internal rough surfaces shall not be roughcast (e.g. masonry with concrete blocks). This coat shall consist of a cement-sand mix containing 550 kg Portland cement per cubic meter of sand or one part of Portland cement for three parts of sand.

Grading of sand shall be 0.25/3.15 mm and shall contain 10% of fines maximum. Mortar shall be watered to obtain a good workability, and spatterdashed by means of a broom or a mechanical tool. The surface shall be rough and shall not undergo any other process whatsoever. The roughcast shall cover uniformly the surface. It shall be kept moist by watering for three days at least and shall adhere strongly to the surface. Any roughcast which did not harden thoroughly during the three day time and disintegrates, shall be entirely removed and replaced at the expense of the Contractor. Intermediary and top coats shall be applied, in principle, in two distinct coats.

206.3.2 Intermediary coat

The intermediary coat shall give rendering its final shape, the required evenness and waterproofness. It shall be homogenous and compact and consists of lesser quantities of

binders than in the roughcasting coat in order to limit its fissurability. Grading of sand shall be 0.1/3.15mm, contain 5% min. of fines < 0.089 mm and be graded.

Intermediary coat shall consist of 450 kg cement per cubic metre of dry sand graded 0.1/3.1 mm. Moisture expansion of sand which is conditional upon the water content and grading shall be taken into account when preparing the mix. This coat shall be applied only after the roughcasting coat has partially shrunk.

The intermediary coat shall not be applied until three days at least have passed since completion of the last coat. However, this period is conditional upon the atmospheric conditions.

Mortar shall be proportioned to a thick workable paste. This coat shall be applied either by hand or mechanically on a moistened roughcasting, in two or more passes depending on the thickness. The surface shall be finished with a float to an even and compact surface.

Smoothing the surface with a trowel is not permitted. It shall be roughened by using a ruler and meet the requirements of finished rendering (evenness, straight angles, round grooves etc...).

Average thickness of both roughcasting and intermediary coats shall range between 15mm and 20mm according to the tolerances on the substrate in such a way as to cover the entire surface by 10mm at least.

206.3.3 Top coat

Top coat or finishing coat is decorative but also protects the intermediary coat and preserves its waterproofness.

Since the colour of grey content is not always uniform, it is advisable, to provide cement from the same source and date of manufacture in order to improve the uniformity of shades. The same applies to sand.

This coat shall be made with an ordinary or decorative hydraulic binders mortar.

Grading of sand shall be 0.1/2mm and contains fines in considerable quantities and free from impurities (clay, gypsum, coal, organic matters, etc...)

The coat shall consist of 350 kg or 400kg of binder per cubic meter of dry sand graded 0.1/2mm.

The top coat shall not be applied until eight to fifteen days have passed since completion of the intermediary coat (average atmospheric conditions).

top coat shall cover the surface uniformly and, in no case, improve the evenness. Troweling, as well as powdering with lime or cement shall not be permitted.

The thickness of the top coat will be 5 to 7 mm.

206.3.4 Rendering on metal lathing

The metal lath shall be well blasted 24 hours at the latest after application of the roughcasting coat and securely fastened using rustproof staples or other suitable fasteners. The metal lath shall be a rustproof wire mesh with square openings of at least 30mm x 30mm.

206.4 INTERIOR RENDERING

Interior rendering shall comply with previous clause requirements and consist of 350 kg of cement per cubic meter of sand.

It consists of two-coat rendering applied as follows; roughcasting and top coat.

206.5 EXTERIOR RENDERING

It consists of three coat rendering applied as follows; roughcasting - intermediary coat-top coat.

206.6 EXTERIOR ADMIXED RENDERING

It shall have the same characteristics and specifications as those of the ordinary rendering coat (see rendering) and shall consist of 450 kgs of cement per cubic meter of sand and an additive to control plasticity and waterproofness according to a technical sheet and a technical certificate submitted for approval prior to commencing the works.

This coat shall mainly protect external walls subject to infiltrations and run-offs.

206.7 COLOURED CEMENT RENDERING

Coloured cement rendering shall consist of:

- a roughcasting coat
- a first coat, 10 mm thick, containing 400 kg of white cement per cubic meter of sand, scratched in both directions.
- a second coat, 8mm thick maximum, containing 400 kg of white cement per cubic meter of chippings, powder and pigments where called for on the Drawings and as directed by the Engineer.

Mix proportions, quality and colours of chippings, powder and pigments shall be determined subsequently by the Employer. Rendered surfaces shall be smooth and even as shown on the Drawings and as specified by the Employer.

The second coat shall be wetted three days after application to ensure adequate hydration.

Any rendered surface showing imperfections such as: unevenness, cracks, disintegration of white cement mortar, scratches (especially along arises) etc... shall be removed and re-rendered at the expense of the Contractor and under his responsibility. Repair or rendering shall be done

in a neat manner so that all repairs have a uniform appearance, indistinguishable from the general area of the rendering.

Coloured white cement rendering shall be consistent with the approved sample kept on site until completion of the works.

206.8 DECORATIVE SPATTER MORTAR (TYROLEAN)

Top coat of mortar shall be applied by hand (Tyrolean brush) or mechanically. The top coat shall be applied in two or three layers, having an average thickness of 3 to 5mm. The finished surface is conditional upon the water content, the number of layers, the spatter angle and any eventual finishing treatment. Top coat shall have the same mix proportion as that used in a coloured or white cement top coat, and be applied as follows:

- a roughcasting coat
- a second coat
- a third coat with decorative mortar

Mix proportions are as mentioned previously.

206.9 RENDERING OF BASEMENT WALLS

N.B: Rendering applied to basement walls shall take into account the destination of the premises delimited by the walls, the soil nature and shape, as well as climatic conditions, the nature of support surfaces and the structure design.

Rendering of buried surfaces

General

Rendering applied to external facing of buried basement walls shall comply with the following paragraph.

Technical Specifications for exterior rendering

Minimum layers:

Rendering shall consist of at least:

- a roughcasting coat
- an intermediary coat

Minimum thickness:

Each coat shall be 8 to 15mm thick. The average thickness of both coats shall be 20 to 25mm according to the tolerances of each type of surface so as to ensure a uniform covering of at least 15mm.

Rendering

Rendering shall be applied by hand or mechanically. It shall consist of 450 to 550 kg of cement per cubic meter of dry sand. A waterproofing admixture shall be used according to the manufacturer specifications. Rendering applied to buried structures shall extend to about 20 cm above ground level.

Specifications for interior rendering

Interior rendering shall be ruled by the same conditions specified for 3 or 2 layer-rendering.

Rendering of non-buried surfaces

Rendering non-buried surfaces of basement walls shall comply with the conditions set for rendering exposed surfaces.

206.10 RESPONSIBILITY OF THE CONTRACTOR

All rendering which have started to set before application shall be removed from site. Those falling, cracking or suffering any damage whatsoever in the year following the taking over shall be removed and made up again at the expense of the Contractor. He shall take all necessary measures during surface preparation, rendering and setting time so as to ensure quality work, namely, by protecting rendered surfaces with dampened hessian coverings if need be.

These constraints are included in the incidental expenses of the Contractor.

N.B: The use of lime as a plasticizer shall only be permitted upon the written approval of the Employer.

206.11 CHARACTERISTICS

Tolerance

Tolerance is checked by measuring deviation under a 2.00m ruler or a 0.20m ruler. The deviation shall not exceed the following values.

| | Under 2.00 m ruler | Under 0.20 m ruler |
|--------------------|--------------------|--------------------|
| Spatter rendering | 1 cm | - |
| Between wall lines | 0.5 cm | 0.2 cm |

Plumb

Rendering applied to vertical surfaces shall have a maximum tolerance of 0.01m for each three meters.

This tolerance is only applicable to renderings between wall lines.

Bond

Rendering shall bond to the surface and shall not give a hollow sound when hammered. The rate of bond shall be equal to 0.3 megapascal (3 bars) after 28 days of application.

Three core samples crossing the whole rendering thickness shall be taken randomly from surfaces 50m² at least. The rate of bond shall be the arithmetic average of rates of bond measured in the various points. (The rate of bond shall never be less than 0.2 megapascal (2 bars)).

206.12 METHODS OF MEASUREMENT AND PAYMENT

206.12.1 General

The unit rates for rendering shall include for the use of all tools scaffolding, labour and materials, including supply, processing and use of cement, or otherwise - sands, gravels, additives and colouring pigments, mica flakes, and including for metal lath, all as specified and as applicable. Unless otherwise specified, the unit rates shall include for the use of ordinary Portland cement. The unit rates shall also include for all cleaning and wetting of all surfaces prior to rendering and the protection and curing of the render, inclusive of all surface treatments required.

Measurement

Measurement will be separate for the various types of render, and in all cases be net in square meters, as measured on the Drawings, all openings, tiling, skirtings and other areas not covered by render being deducted with no allowance for waste, overlap, etc. Reveals, jambs, and rebates to openings (doors, windows, etc.) will be measured for payment together with the general area of the plaster and no special rates will be paid for them.

For purposes of measuring external plaster, the bottom edge will be taken as being 10 cm below final external ground level, unless otherwise shown on the Drawings.

206.12.2 Payment

Samples, making good to other trades and repairs will not be paid for separately and the cost thereof shall be included in the unit rates for rendering, which shall also allow for the supply of wire mesh for covering, etc., where required.

Types of render will be itemized separately in the Bill of Quantities. The types will be further subdivided into render on plane surfaces and on curved surfaces.

Types of render to be paid for under separate items include (but are not limited to):

- a) Interior rendering
- b) Exterior rendering
- c) Exterior admixed rendering
- d) Coloured cement rendering
- e) Decorative spatter mortar
- f) Basement wall rendering.

207 - PAINTING

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207 PAINTING

207.1 MATERIAL & APPLICATION

The following subsections deal with paint work on all exposed surfaces such as walls, ceiling, woodwork or metalwork both indoor and outdoor. The term “paint” as used herein shall include:

- Stains,
- Varnishes,
- Emulsions,
- Enamels,
- Pain washes,

and all materials as:

- Oils,
- Putties,
- etc..

All paint materials shall meet the requirements of the relevant British Standards and shall be of an approved manufacturer.

- a) The entire paint system used for painting a structure shall be of the same manufacturer. Mixing of paints of different manufacturers on the same structure shall not be permitted.
- b) All paints used shall be subject to prior approval of the Engineer’s Representative.
- c) The Contractor shall submit for the Engineer’s approval a detailed list of the paints he intends to use on the job, stating:
 - the name of the manufacturer
 - the type of paint
 - full specification of manufacturer including directions for handling and use, instructions for thinning (if any) and minimum drying time.

All paints shall be kept on the job site in the original unopened factory containers and shall be protected against the entry of air, water, dirt, or any other foreign matter.

- Paint shall be stored at shaded locations. Storage of paints, their mixing, thinning, etc., shall be carried out in a special paint shed provided by the Contractor for this purpose; on no account will the building under construction be used as paint store.

All paint work shall be performed by experienced and qualified painters, in accordance with the standards of practice.

- Prior to commencement of painting the Contractor shall clean the area and its surroundings and remove all waste building materials, cement bags and dirt. Care will be taken to avoid dropping paint on floors, sanitary installations, and other areas or objects not intended to be painted. All such areas and objects shall be covered for this

purpose with sacking or other suitable protective material. Freshly painted surfaces of metal and woodwork shall be suitably protected.

Ironmongery, fittings and other attached fixtures such as:

- doors knobs,
- fasteners,
- locks,
- electric fittings,
- signs,

will be removed whenever possible from all windows, doors, walls, and suitably stored until completion of the paint work and then be properly re-attached to their original positions.

Application of final coats of paint shall be done only after completion of all other building works. No work will be undertaken under adverse weather conditions, in heavy mist, during dust storms, or in case of external paint work, during or immediately following rain.

The choice of every type of paint material shall be in conformity with the specific recommendations of the manufacturer specially concerning the different finishing conditions requested and nature of substrate.

207.1.1 General conditions of intervention

Norms applicable are the relevant British Standards requirements, the paintworks include but limited to the following works:

- the preparation of surfaces,
- the material supply needed for the paint work execution
- the supply of the necessary stock of tools, ladders and scaffoldings etc.,
- the paint application on reference surfaces and sample specimen.
- the application of paint on all prepared substrates in conformity with BS, and the prescriptions of these specifications.
- obtaining of the required quality, the finishing aspect, the degree of brilliance, the coloring and the necessary set off colors as prescribed in the specifications.
- the cleaning of all dirt, caused by the painter intervention.
- etc.

207.1.2 General co-ordination

The Contractor is instructed to maintain a perfect co-ordination between his paintworks and the other concerned works, aiming to execute in the right time all necessary scheduled works.

- All supply and application constraints shall be due for a complete finishing as defined in the specifications.
- It is strictly forbidden to the Contractor to start the paintworks before the execution of the tile-flooring and the first passage of the pouncing machine being executed and before all having dried perfectly.

- Only the wall preparation and the first paint coats (primer) can be executed before the pouncing machine passage be done. The Contractor can achieve the ceiling paints and wall paints leaving the last coat (only on walls) to be achieved once the polishing of tile-flooring is done.
- A perfect co-ordination must be achieved between all involved parties.

207.1.3 General execution conditions

The Contractor must insure a perfect execution of all paintworks

- All paint material and products used and their application procedures must be of such quality to satisfy the Engineer requirements.
- In particular the Contractor must present to the Engineer approval and before any commencement of paintwork a sample of each approved material to use. The Engineer preserve for himself the right to proceed to testing and analysing of the materials at the reception and in the course of execution.
- If the controls operated reveal defects in the quality of products used or in the procedures of application, the Contractor must proceed to the complete reparation at his own cost and responsibility of all the disapproved works.
- The Contractor must bear all execution costs of such works as necessary sampling to determine on the job site the tint to be chosen after agreement of the Engineer.

207.1.4 Particular execution conditions

The application of paints, varnishes, emulsions, mastics etc., shall start only when surface to be painted has thoroughly dried out, provided that at least one dry (or summer) month and two wet (or winter) months have elapsed since plaster or concrete have been placed.

- Ambient temperature of application must be higher than 18°C and the ambient atmosphere must not be too humid favouring condensation or too dusty.
- The substrate must not be overheated or frozen.

Cement renders and concrete shall not be painted before at least one week after the execution.

Ceilings in particular, receivant oil paint must receive previously a layer of isolation product necessary to avoid absorption difference in the render substrate and uneven discoloration in careful finishing.

All ironmongery works must be chemically clean before painting with no trace of calamine, rust, humidity, grease and dirt, etc.,

- Decalamination must be obtained by natural oxidation, it must be later on followed by hammering and rubbing down.
- Calcium deposit shall be removed by hammer or abrasive disc if necessary.

- Rust must be cleared of by dry rubbing with a metal brush, by hammering, by rotative brush or by glass-paper.
- Mortar dirt must be cleaned by rubbing down with a metal bross.
- Grease will be removed by cleaning with “white spirit”.
- Pouncing will be done with pouncing stone, so that it does not subsist on the surface no grain or roughness.
- No painting will be applied unless on a surface perfectly brushed, and all sandy particles or any non adherent mortar or any trace of dust has been removed.
- During painting works, the Contractor must ensure a suitable and complete protection of the soil, woodworks, glazery, piping system, etc., and the gradual cleaning of all finished works.
- When instructed by the Engineer and for carefully finished surface, the paint will be applied on these surfaces with special preparation such as:
 - refitting,
 - filling up of all cracks, holes, pits or other surface imperfections,
 - cleaning all dirt and concrete traces,
 - etc.,

207.1.5 Cleaning after painting

At the end of painting works, and when reception of these works is made possible, the contractor must proceed to the complete and perfect cleaning of all construction elements such as:

- floors
 - walls
 - plinth
 - pipes
- All precautions must be taken by the Contractor to avoid damaging the places, using procedures or products nonadapted to a perfect execution of the cleaning works. If the cleaning is not realised as instructed, detailed and approved, the Engineer will reserve for himself the right to undertake new cleaning works by another special enterprise of his choice, all expenses for these operations being beared by the Contractor.

207.1.6 Selection of paint materials

All paints to be used shall comply with the requirements of the relevant British Standards, or where specified in any other standard or specification, and shall be subject to prior approval of the Engineer's Representative.

- The Contractor shall attach to his approval request a detailed list of the paints he intends to use on the site. This list shall contain the following informations:
 - name of manufacturer
 - type of paint
 - full manufacturer original specification, including directions for handling and use, instructions for thinning (if any) and minimum drying time.
 - full original catalogue of the whole products form the manufacturer.
 - etc.,
- All paints shall be kept on the job site in the original unopened factory containers and shall be protected against the entry of air, water dirt, or any other foreign matter.
- Paints shall be stored in shaded locations.
- Thinning of paints will not be permitted except to manufacturer's instructions, if any.

Manufacturer's instructions as to storage, handling, thinning and application of paints shall be strictly adhered to.

- The entire paint system used for painting accessories of the same installation unit or structure shall be of the same manufacture.

Choice of product by the Contractor must take in account:

- the aptitude of the product to fulfil its function,
- the kind of protection needed,
- the finishing surface projected,
- all prescriptions of the specifications.

The following requirements shall apply to the different types of paints: (steel pipe installations and steel structures)

| No. | Type of paint | Standard | Drying time |
|-----|---|--|---|
| 1 | Oil-based red lead primer | /BS/2521 and /B.S./2523 | 24 hours minimum |
| 2 | Synthetic red lead primer | Federal specification: TT-P-86G type II | 24 hours |
| 3 | Iron oxide paints | B.S./2524 | 12 hours minimum between coats |
| 4 | Aluminium paints for cover-coats | M/69 | 24 hours minimum |
| 5 | Cover-coats paints, (other than Aluminium paint) | These paints shall be synthetic paints for steel structures, and shall meet the requirements of the relevant B.S. standard and shall be of an approved | As specified in Particular Specification and/or directed by the Engineer |

| | | | |
|--|--|--------------|--|
| | | manufacturer | |
|--|--|--------------|--|

N.B.: When more than one coat is specified (of primer or of the same paint) successive coats shall be of different, easy distinguishable tints.

Generally all surfaces to be painted shall be:

- clean,
 - dry,
 - smooth and
 - free from dust, grit, and other foreign matter
- All nails shall be countersunk and stopped with putty, prior to painting.

Concrete and plaster surfaces: concrete and plaster surfaces receiving paint finishes shall be thoroughly cleaned of:

- dirt
 - laitance
 - incrustations, and
 - foreign matters
 - etc...
- Cracks, holes pits or other surface imperfections shall be neatly and smoothly filled.

Metalwork: preliminary substrate preparation shall be done in accordance with Section 207.8 of these Specifications.

The primer coat shall be applied to cleaned surfaces within four hours from the completion of the cleaning.

207.1.7 Preparation of Surfaces

a) General

All surfaces to be painted shall be clean, dry, smooth, and free from dust, grit and other foreign matter. All nails shall be countersunk and stopped with putty prior to painting.

b) Concrete and Plaster Surfaces

Concrete and plaster surfaces receiving paint finishes shall be thoroughly cleaned of dirt, laitance, incrustations and foreign matter. Cracks, holes, pits or other surface imperfections shall be neatly and smoothly filled.

c) Metalwork

Preparation of steel work at the works shall be either:

- Hot dip galvanised to BS 729 with a median thickness of 85 microns (0.0034") or
- Grit blasted to BS 7079 Grade SA 2.5 and zinc sprayed within 4 hours to BS 2569 Part 1 to a thickness of 125 microns (0.005") followed by one coat of approved etch primer.

Typical finishes (with compatible primers) based on BS 5493 are given below.

- Steel work and ferrous castings exposed above water/sewage level

Either high build micaceous iron oxide or chlorinated rubber to give a minimum total dry film thickness of 300 microns or, one coat of two pack epoxy primer and further coats of epoxy paint to give a total dry film thickness of 270 microns.

- Steelwork below water/sewage level

Either epoxy system as above or coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns.

- Ferrous castings and fittings without substrate below water level.

Coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns. These coatings shall be subject to the Holiday test.

the surface of all non-ferrous parts usually painted shall be cleaned, rubbed down, stopped, filled and given one priming coat of paint.

Anti-corrosion coatings for any steel or iron used in pipework, pumps, valves, etc. in contact with potable water, shall be either a compatible bitumen material to BS 3416 or a polymeric anti-corrosion coating complying with Water Industry Specification WIS 4-52-01.

Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed. Any finish coat applied on site shall be considered for decorative purposes only.

Manufactured articles to be galvanised shall be hot dip galvanised after complete fabrication and no bending, cutting, drilling, riveting or threading shall be permitted after galvanising.

The care of galvanised articles when transporting, storing and erecting them shall be in accordance with the recommendations of BS 729. The renovation of small areas of damaged coating not exceeding 40mm² shall be in accordance with Appendix D of BS 729 and subject to the Engineer's approval.

207.2 PAINTING APPLICATION

207.2.1 General

All paint application shall meet the requirements of the relevant British Standards and shall be applied in conformity with the manufacturer's recommendations.

- All paint cans must not be open before application, the product homogeneity must be insured by extended mixing with appropriated tools.
- In case the product is transferred to another can, it must be mixed before utilisation and it must to remain any deposit in the original can.
- Products shall be delivered with sufficient fluidity to permit normal application.
- Solvent additional or dilution of the product is forbidden unless approved by the Engineer.
- A detailed technical leaflet will be submitted to the approval of the Engineer before any application.
- A quality control of the surface will proceed any paint or primer application.
- All surfaces must be dry and drying time between coats must be respected by the Contractor.

207.2.2 Primer or undercoat application

See preparation of surfaces.

207.2.3 Intermediate coats

These layers aim to constitute a lining which thickness and resistance can insure an effective protection system.

- Mode of application of the intermediate coat is left to the Contractor choice (Brush, roll, gun)
- In the case of several intermediate coats, each coat must be of different color easy to check and the product must ensure good adhesion to the finishing paint coats.

207.2.4 Finishing paint coats

The finishing coat(s) must answer:

By the nature of the applied lining, to the particular conditions of the ambient in which the protected surface exist.

In particular, the immersed surface must be protected against parasitic attacks from animals or vegetals.

By the choice of conventional colors, to the relevant existing security prescriptions. colors fixtily is then required so as to satisfy imposed visibility conditions.

207.3 INTERIOR PAINTS: LATEX BASE CONCRETE AND MORTAR SUBSTRATE

All interior paints must conform to the relevant British Standards.

- The interior room partitions will be covered by a washable LATEX -BASE paints, wherever indicated in the Drawings or ordered by the Engineer.
- The Contractor shall submit samples of the paints he intends to use to the Engineer's approval.
- Paints shall be washable, of a perfect solidity and shall allow a flawless application.
- A perfect resistance of the color so the effect of light is also required.
- Surfaces to be painted shall first be cleaned, and sand papered before the application of the first coat or sealer. A second sanding shall be followed by the application of a primer coat.
- Then two (2) paint coats shall be applied in conformity with the color and sample approved by the Engineer.

207.4 EXTERIOR PAINTS

For exterior surfaces a plastic paint ready to use under the form of a unctuous thixotropic paste will be used.

- This product is composed of vinylmaleate resins or similar, in water dispersion of noble pigment (Titane rutile, or similar), and siliceous charges, and fungicide agents.
- Tints area obtained with pigments resistant to the effects of exterior light (U.V. specify).
- The product must adhere perfectly and be totally waterproof offering a perfect resistance to chemical agents, to heat and fire.
- The Engineer reserve for himself, the right to proceed to any chemical analysis of his choice to insure the quality of all components. All costs to be beard by the Contractor.

Exterior surfaces must be: neat and clean, without grease dustless after brushing.

- Before any commencement of application of the paint, the Contractor shall apply a primer coat (undercoat) acting as substrate surface regulator insuring an homogenous substrate which is extremely important when applying a plastic paint on these surfaces.

- The Contractor shall use in preference an alxeol roll that it soaks in the product paste garnishing all the cells of the roll.
Application must be in thick layer and always starting from down toward upper zones.
The product must be applied in important quantities but not spread.
- A compressor can be used for application of not less than 2.2 kg/m².

A technical detailed leaflet must be submitted by the Contractor to the Engineer approval.

Intermediate coat remains a facultative one when dealing with new works, but the durability of the paint will be improved by the application of:

- One (1) layer when new works are involved.
- Two (2) layers when dealing with rehabilitation works.

The finishing exterior layer aspect will be as approved by the Engineer:

- mat, poach, in elementary finishing
- mat, satinated, poached in current finishing
- mat, satinated or shinning in careful finishing,
- etc.

N.B.: for exterior works, quality criteria for protection and durability will prevale on finishing aspect criteria.

207.5 INTERIOR PAINT - LATEX BASED WITH PUTTYING

This type of paint shall be used in specially neat surfaces and where indicated on the Drawings, the specifications, and where ordered by the Engineer.

- The paints to use shall be of the same type and shall have the same specifications as those in Section 207.3.
- The mastic shall be of a quality approved by the Engineer. It shall be delivered to the site in closed boxes, or composed on the basis of 60 to 70% of zinc and linseed oil.
- After cleaning and sanding the surfaces to be painted a first coat of sealer shall be applied. The mastic shall then be applied in two coats along two perpendicular directions. Once dry the first coat shall be sanded and rubbed with sand paper. Then an undercoat shall be applied, followed by the latex based paint coats as specified in Section 207.3.

207.6 SPECIAL PAINTS

These paints shall be used in places that are exposed to knocks and dirt. They shall be washable, resistant to sand jet No. 1 at a pressure of 125 kg. Their colors shall be permanent and inorganic pigment based, the support being a polyester based synthetic resin without an evaporative solvent or alcoholized or toxic matters, and hardener by polymerisation.

They shall be applied by means of a spray gun or by roller and shall have a granular texture obtained by application of a fiber glass reinforcement. The application shall be in accordance with the manufacturer's instructions. At least two coats shall be applied, not counting the fiber glass reinforcement.

207.7 VARNISHING ON WOOD (NOT USED)

207.8 OIL PAINT ON WOOD OR PLASTER

All interior wood carpentries such as doors, panels, cupboards, etc.. as well as all surfaces shown on the Drawings or specified, shall be coated with two oil paint coats on the undercoat together with all surface preparations: brushing, sanding, dusting, etc.

Undercoats shall be applied before the installation and after reception of the carpentry by the Engineer. All carpentries shall be perfectly undercoated on all faces, frames, and rebates. All necessary touch-ups shall be executed before starting the works. The paint coats shall be applied successively. Colors shall be as instructed by the Engineer.

Oil paints shall be of the best quality. They shall be composed of zinc oxide, turpentine and well purified linseed oil. Siccatives shall be turpentine-based.

The theoretical composition of paints shall be as follows:

| | | |
|-------------------------|--|--------------|
| - Fat dye: | | |
| Zinc oxide | | 0.600 |
| Linseed oil | | 0.270 |
| Turpentine and siccativ | | <u>0.130</u> |
| | | 1.000 |
| - Thin dye: | | |
| Zinc oxide | | 0.550 |
| Linseed oil | | 0.187 |
| Turpentine and siccativ | | <u>0.263</u> |
| | | 1.000 |

Before installation, all iron fittings shall be coated with red lead paint, after brushing off the rust, degreasing and dusting.

The zinc oxide shall be 98% pure and shall not contain more than 2% of plumbiferous impurities.

The mastic, of an approved composition, shall be applied in two layers spread in opposite directions. Once the wood surface is perfectly equalized, the oil paint is applied in two layers according to the approved color and sample.

207.9 OIL PAINT ON METAL

Metal works to receive oil paint shall be shown on the Drawings, specified herein, or where indicated by the Engineer. They shall include but not limited to sheet metal doors, gratings, metal chassis, balustrades.

- Surface preliminary works shall include:
 - removing the rust
 - degreasing
 - dusting
 - etc.

- Surface preparatory works shall include: two protective coats either of red paint or zinc chromate.

Then, two oil paint coats shall be applied. The shades shall be selected by the Engineer from samples submitted by the Contractor on site.

207.10 LIQUID EPOXY COATING

This coating shall be based on liquid, chemically cured epoxies. The curing agent may be an amine, amine-adduct, or polyamide. Materials used in both the primer and finish coats shall be products of one manufacturer.

The coating shall be suitable for use in irrigation water. It shall be used for:

- steel sluice gates,
- pipes,
- mechanical couplings,
- flanges,
- similar appurtenances for steel pipe fittings, nuts, bolts
- and other items used in conjunction with connections and attachments.

Surface preliminary works

- The surfaces shall be first cleaned to remove:
 - oil
 - grease, or
 - other foreign matters.

- Only approved procedures and solvents (that do not leave a residue) shall be used.

- The surface shall be abrasive blast-cleaned with sand, steel shot or grit to achieve a near white metal surface.

Application of epoxy coating system.

- The coating system shall be applied as recommended by the manufacturer. It shall consist of at least:
 - a two part chemically cured epoxy primer as a preparatory surface coat.
 - two coats of a different two components, chemically cured epoxy top coat.

207.11 PAINTING - MEASUREMENT AND PAYMENT

Painting shall be measured for payment by m² of net area of surface which has actually been painted, after the deduction of all openings and areas which have not been painted. Painting shall be classified according to the types of paints and number of coats. Each unit rate shall include for the supply of all paints and materials, cleaning and preparation of all surfaces, application of all necessary painting and all extra work on corners and edges, and for all materials, equipment and labour necessary for the completion of painting in accordance with the Specification and Drawings and to the satisfaction of the Engineer.

Unless otherwise specified, painting of all steel structures, and structural elements, exposed steel pipe installations, non-structural metalwork and wood joinery in buildings shall not be paid for separately and the cost thereof shall be deemed to be included by the Contractor in his unit rates for the supply, installation, erection and fixing of these items.

209 - METALWORK

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209 METALWORK

209.1 GENERAL

209.1.1 Scope

The work required under this Chapter includes doors and windows in buildings, gratings, hand-railings and miscellaneous non-structural metalwork and shall be in accordance with British Standards.

The Contractor shall supply all the metal, ironmongery, paints and auxiliary materials required, shall manufacture the metalwork and shall install them in the required positions and paint them - all in accordance with the Drawings and the Specification, or as directed by the Engineer.

Alternatively, the Contractor shall supply and install standard factory-made elements, approved by the Engineer. Such elements shall also meet all requirements of this Division.

Steel for doors, windows and other metalwork shall be new, first-grade quality mild steel, without mill defects, cracks, grooves or rough surfaces and shall comply with all requirements specified on the Drawings and/or in the Particular Specification.

Hardware, metal fittings and accessories

These elements shall comply with standards and be of first grade quality and approved manufacture. They shall be carefully installed, all notches having the required sizes and depths so as not to impair the solidity of rolled sections.

209.1.2 Metalwork

All shapes, bars and plates shall be cut, drilled, bent and otherwise worked to the exact lines and dimensions shown on the Drawings. All burrs resulting from cutting and drilling shall be neatly removed. Where cutting is done by oxyacetylene torch, cut surfaces shall be clean and smooth.

Hinges and locks shall be secured by means of metal-screws for any eventual unmaking. Other accessories may be welded. Unless otherwise specified, bolts, casement bolts, locks, etc, shall be mortised. Hinges shall be solid and of quantity corresponding to door leaves size and weight. They shall have the exact required sizes and allow an easy setting and replacement. Locking devices such as locks, buttons, crutch handles, bolts, etc.. shall immobilize totally the door leaves in closed positions.

Metal fittings are integral parts of each door or hatch even when not explicitly stated in the work description.

The Contractor shall take on site all dimensions deemed necessary for metalwork and remain wholly responsible for their good adaptation to the concrete and masonry works in the building.

Jointings shall be notched and angles mitred. Electric welding shall be as continuous as possible along the joint after filing the metal elements.

After soldering, burrs and slags shall be trimmed completely. Holes shall be drilled by means of an electric drill fitted with a bit having a smaller diameter than the hole, then with another having the same diameter as the hole.

Distances between holes shall be as follows:

- Distance between hole edge and section edge \geq hole diameter
- Distance between axes of two consecutive holes $\geq 3 \times$ hole diameter
- Axes of aligned holes : a size margin equal to one tenth the hole diameter
- Irregularities in distance between holes $\leq \frac{1}{10} \times$ hole diameter.

The Contractor shall supply and install any material whether specified or not on the Drawings, but necessary for the good execution of the works.

Surface finishing

Surface finishing of works shall be in strict accordance with the General Technical Specification and shall include the protection of materials and the surface treatment.

Exposed surfaces shall have no unevenness, burrs, or metal run-out. Salient angles and projecting parts shall be rounded off. Welds shall be carefully ground. Screws shall be inserted and then painted. Accessible bolts shall be covered. Element showing appearance or assembly defects shall be rejected. It is expressly forbidden to cover and hide these defects.

Protection of metals against corrosion

No metal part shall be accepted on site unless previously protected against corrosion. Elements shall be in-factory protected according to relevant applicable standards. Unprotected iron parts shall be painted after removal of calamine, rust, and oil, with a rust proof zinc chromate paint, 60 microns thick, compatible with the top coat specified in the relevant Section (or eventually with two coats of red lead). Immediately after installation, any painted surface showing imperfections due to impacts or handling shall be wire brushed and repainted.

Contact between different metals

All measures shall be taken to avoid electrolytic corrosion caused by the contact between metal parts and accessories (screws, bolts, washers, etc ...) of various natures.

Greasing

Upon the completion of works, the Contractor shall grease all mobile metal fittings such as hinges, locks, etc ...

209.2 WORKMANSHIP

209.2.1 Manufacture

Details and profiles shown on the Drawings constitute the basic Drawings. Works shall be solid, rigid and have a perfect finish. The components shall be one-piece. Connections shall be

right-angled in such a manner as to resist, without deformation nor rupture, mechanical tests and the efforts imparted to them.

Jointings shall be notched and angles mitred so that sections join at right angles without overlapping. Welding shall be continuous along the joint after bevelling the metal. Holes shall be drilled by means of a drill fitted with a bit having the same diameter of the hole. Elements shall be cleaned of all slag and burrs.

209.2.2 Assembly

Metalworks shall be fixed to their support (concrete and masonry works, partitions) by welded inserted plates, holdfasts, screws and expansion bolts or any other approved system. The use of a stud gun SPIT is prohibited. Anchor bolts shall only be used in concrete works or hollow blocks masonry; only traditional anchoring means are permitted for other surfaces. Anchors shall be screwed, bolted or welded on locks. Their section, shape, length and number are conditional upon the element sizes and installation conditions.

Fixing devices proposed by the Contractor shall be shown on shop Drawings. Fixing devices shall be placed close to hinges in order to diminish stresses.

All welding shall be done by the shielded electric-arc method by experienced welders, to the highest standards of workmanship and to the satisfaction of the Engineer. Electrodes for steel welding shall be of a kind and class approved by the Engineer. All surfaces of parts to be welded shall be well cleaned of dirt, rust, slag, and paint. All slag and splatter adhering to metal shall also be removed.

209.2.3 Installation

Prior to installation, the Contractor shall wedge and adjust the different elements so as to ensure perfect plumb, alignment and levelling.

He shall ensure all required sealings and caulking for fixing the works. He shall set out all his works and verify the location of openings left in the structure.

209.2.4 Tolerances

a) Tolerance on setting out

Maximal variation between the real position of each axis of metalwork and each axis of an opening in a wall shall not exceed 1 cm.

b) Tolerance on installation

Rectitude and plumb errors in door frames, stiles, and posts shall not entail a deviation exceeding 2 mm, provided that stiles and posts be parallel to ± 2 mm in all points and planes.

Rectitude and levelling errors in crosspieces shall not exceed 2 mm for the first meter and 1 mm for each additional meter with a maximum of 4 mm.

c) Tolerances on leaves play

The play between leaves and the finished ground shall vary between 5 and 10 mm regardless of the opening position.

d) Sealing

Air and watertightness between the structure and the metalworks shall be ensured by stable and 10 year guaranteed sealants. They shall be easily replaced. The unit rates of metalwork shall include the cost of all sealants.

209.2.5 Handling and storage

Unloading and handling of elements shall be done without causing any permanent deformation or defect that might impair the good functioning of mobile parts, or their resistance to corrosion.

Elements shall be stored in dry premises on appropriate horizontal and vertical devices avoiding any deformation whatsoever.

209.2.6 Samples and mock-ups

Samples of hardware to be used shall be as shown on Drawings.

Prior to any serial manufacture, a mock-up of each type of work shall be submitted for approval, namely:

- Ventilation grilles
- Handrails
- Guard-rails
- Protection bars
- Etc ...

The Contractor shall submit to the satisfaction of the Employer all varnish samples.

209.2.7 Locks

Locks shall be supplied with 3 keys bearing each a permanent label indicating the premises they are intended for. The loss of a key on the day of taking over entails the changing of the relevant lock at the cost of the Contractor. Prior to installation, all types of locks shall be submitted to the Employer for approval. The outside locks shall be resistant to atmospheric conditions.

209.2.8 Sections, painted wrought iron

Hatches, balustrades, guard-rails, angle-irons for antennas, handrails, stiles, posts and crosspieces, rungs, ladders, etc, ... shall be made of sectional irons, flats, pipes, etc ... and have

the dimensions shown on the Drawings. Works shall be carried out according to the above-mentioned specifications. Paint shall be consistent with the specifications mentioned in the relevant Section.

209.2.9 Ladders

Ladders shall be of galvanized tubes or sections to the dimensions shown on the Drawings. They shall be painted according to the relevant Section.

Ladders shall be fixed to the upper platform and to the floor taking into account all works to be performed under other Sections (ex: waterproofing works, ...) as well as all above-mentioned conditions. Where specified, ladders shall be fitted with safety hoops.

209.2.10 Metal shutters

Rolling shutters with fastened metal blades shall be of cold-rolled and galvanized steel, with a minimum thickness of 7/10 mm, with lateral bolting of each blade. The steel curtain should withstand without deformation a load of 400 kg/m².

Scroll axes, gears, winches, etc ... shall be of stainless metals or metals that are especially treated against rust by galvanization or any other approved process.

Guide bars shall be hot-rolled and galvanized channel irons of 30 mm minimum depth and embedded in the masonry or the concrete.

Operation shall be by winch and built-in crank, with a lock system constituted of six-turn brass lock with 35 cm cylinder. The scroll axis shall be fitted with springs that balance the curtain at any height.

The shutter case shall be of galvanized sections and 7/10 mm sheets with all necessary reinforcement to ensure a perfect rigidity and easy dismantling and maintenance. Components shall be galvanized, coated with an epoxy primer and painted, as specified in the relevant Section.

209.2.11 Glazing (Not used)

209.3 MISCELLANEOUS METALWORK

Miscellaneous metalwork shall comprise grating, handrailing, hatches and other metal parts as shown on the Drawings or directed in the Particular Specification. The work shall be carried out to the exact details shown on the Drawings, to the highest standards of workmanship and to the satisfaction of the Engineer.

209.4 METHODS OF MEASUREMENT AND PAYMENT

Metalwork shall be measured either by number, according to type, size, etc. or by square meter, or by kilogram, all as shown on the Drawings and/or as specified. Each unit rate shall include for the manufacture, supply, transport, handling, fixing, glazing ironmongery, painting, and anodizing, and for all materials, equipment and labour necessary for the completion and

installation of all metalwork item in accordance with the Drawings and the Specification and to the Engineer's satisfaction.

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212 GLAZING

212.1 GENERAL

All types of glass shall be in accordance with British Standards.

All elements necessary for glazing works shall be supplied and installed by the Contractor.

Window panels shall be placed on internal or external woodwork, aluminium and steel works. The Contractor shall be fully responsible for ensuring a perfect co-ordination among all the Sections concerned by glazing such as woodwork, metalwork and painting. Installation of glazing shall be carried out by experienced workmanship.

Unless otherwise specified on the Drawings, the thickness of glass is conditional upon the panels size and shall be:

- 4 mm for panels which perimeter does not exceed 200 cm
- 6 mm for panels which perimeter is between 200 cm and 450 cm.

Window panels shall be supplied and installed so as to meet the installation requirements of each type of glass and to perform the works under the best conditions of practice.

Prior to glazing, the Contractor shall locate and repair any defect in the rabbet, carpentry, that could jeopardize solidity of glass or installation conditions.

He shall also make sure that elements to be glazed and later painted have already been primed. Should these obligations be unfulfilled, the Contractor shall bear the consequences.

Any work not carried out to the satisfaction of the Engineer shall be rejected and the Contractor shall be bound to resume the work, at his own expense.

Materials shall be stored under the specified conditions and with the usual precautions. The Contractor shall be liable for any broken or damaged glass and shall replace it at his own expense.

212.2 ORDINARY GLASS

Glass shall be of high-grade, approved manufacture, 4 and/or 6 mm thick as specified above.

They shall be free of air bubbles, streaks, scratches, undulation, or other defects. They shall not deform the reflected image or that seen through them; and particularly, images of objects located at 0.25 m and seen at 20° angle.

Samples shall be submitted to the Engineer for approval.

Glass shall be cut to the final sizes taking into account any eventual expansion (the play between the glass and the framework shall not exceed 2 mm). Glass panels shall be mounted on glazing beads with a putty or as shown on Drawings. Glazing beads shall be delivered mounted on the structure.

Putty shall be first grade quality pure linseed oil complying with the various conditions of application. The use of bituminous putty is not permitted.

Wedging of glass is mandatory by means of isolated and small wedges placed between the window rabbet and sill. They shall be made of an elastic material such as softwood. Two wedges maximum shall be placed for each glass support.

After completion of work, all glass shall be washed, cleaned and polished on both sides and the Contractor shall remove all wastes.

All broken, cracked, or defective glass shall be removed and replaced by the Contractor at his own expense.

Glass shall be transparent, translucent, or of special type as specified on the Drawings.

212.3 COLOURED GLASS

Where specified on Drawings, coloured glass shall be installed according to the requirements of both previous paragraphs.

Coloured glass shall meet the required heat absorption and daylight reduction characteristics.

Samples shall be submitted to the Engineer.

212.4 6 MM MIRRORS

Mirrors shall be cut to the sizes required on the Drawings and secured with concealed fasteners. They shall be back-coated with PVC plastified silvering.

Glass used for mirrors shall have at least the same characteristics of above-mentioned glass.

Mirrors shall be installed as shown on the Drawings, in strict accordance with the construction rules and to the satisfaction of the Engineer.

212.5 DOUBLE GLAZING

It is an isolating glazing having specific acoustic and thermal characteristics, composed of two glass sheets separated by a dehydrated air gap. A double peripheric string made of elastic organic binders only shall act as a separator, a dehydrant and a waterproofing element.

It can be replaced by an aluminium separator containing a dehydrant; peripheric waterproofness being ensured by two organic joints.

The nature and thickness of both glass sheets shall be determined according to the required criteria (acoustic and/or thermal and to relevant technical data sheets).

212.6 MISCELLANEOUS GLASS

Miscellaneous glass shall comprise all types of glasses not indicated above and asked for in the Particular Specification and for Drawings. The work and the material shall be carried out to the satisfaction of the Engineer.

212.7 METHODS OF MEASUREMENT AND PAYMENT

In general the price of glass is included in the unit prices of metalwork, joinery or aluminium work. In case of independent glass to be delivered, the glass shall be measured in square meter according to type, thickness, etc., all as shown on the Drawings and/or as specified. Each unit rate shall include for the manufacture, supply, transport, handling, fixing, and for all materials, equipment and labour necessary for the completion and installation of the glass in accordance with the Drawings and the Specification, and to the Engineer's satisfaction.

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213 DAMP-PROOFING

213.1 GENERAL

The provisions of this division shall apply only to the:

- damp-proofing of new or existing building basements, protecting these structures against water infiltration from the ground.
- damp-proofing of back filled new concrete retaining walls against infiltrated water.
- damp-proofing below slab and over walls of concrete structures retaining aqueous liquids against infiltrated water.
- damp-proofing of cut-off walls and tunnels in catchment structures.

N.B.: Damp-proofing under water table pressure (tanking) is not included in this division.

213.2 DAMP-PROOFING MATERIALS

Damp-proofing materials are intended to provide a resistance against water and sometimes against humidity and water vapor.

213.2.1 Bituminous Coating

This material is recommended for use on the exterior wall basement of plant rooms (excluding electrical equipment) in some workshops and retaining walls where water infiltration pressure is low (permeable earth foundation) and where the performance level of protection tolerates some damp patches.

Ground water should be checked previously by the Contractor for chemicals which may have a deleterious effect on the structure or internal finishes.

The Contractor must obtain the previous approval of the Engineer on the support as well on the type of material proposed.

(Type B for reinforced concrete design in accordance with B.S. 8110).

The bituminous coating for damp-proofing should be cold applied emulsion in two coats (of at least 0.750 kg/m² each) and cross applied.

Bitumen primer should be of the same cold bitumen emulsion compound diluted to 50% with water and applied at a minimum rate of 0,400 kg/m². The damp-proof bituminous coat shall be applied around 24 hours after the primer application.

213.2.2 Preformed Bitumen Sheeting (SBS or APP bitumenous membranes)

This type of membranes is intended to provide no water penetration and no moisture vapour in basement of workshops and in plant rooms requiring drier or totally dry environment (working areas, archives, stores requiring a controlled environment) etc.

The form of construction must be conformed to type A structure (BS 8102, 1990) or type B reinforced concrete design (in accordance with BS 8007).

The Contractor shall previously obtain the Engineer agreement on the support (type A or B) and the kind of membrane proposed.

213.2.3 Cement Based Waterproof Render

This material is recommended to be applied on the inner side of existing structures or on the external side of the new structures to stop any infiltration or seepage or damp patches.

Cement based damp-proof renders consist of fresh cement, well graded sharp sand, water and a waterproof admixture.

Generally these renders are applied in multi-coats when seepage is widespread, but they can allow some vapour penetration.

213.2.4 New Materials

The Contractor may propose to the Engineer's approval other materials and systems of damp-proofing below ground structures, which are not included in this division.

The Engineer will contemplate then to recommend that inquiries be made regarding the following:

- Certification by the British Board Agreement (BBA)
- Performance characteristics compared with established BBA criteria.
- Certification from overseas national bodies,
- Results from independent test houses,
- Established performance in the U.K. and overseas.

213.2.5 Flexible Sheet

a - Physical properties

The sheets shall be of E.P.D.M. (Ethylene Propylene Diene Monomer) conforming to the following specifications:

| PHYSICAL PROPERTIES | ASTM TEST METHOD | SPECIFICATION |
|--|------------------|--------------------------------|
| Thickness, mm | D751 | 1 ± 10% |
| Width, cm | D751 | 25, 50, 75, 100, 125 ± 5 cm |
| Length, m | D751 | 150, 300 ± 30 cm |
| Tensile Strength, min. Kg/cm ² | D412 Die C | 90 |
| Elongation, Ultimate, min.% | D412 | 300 |
| Tear Resistance, min. Kg/cm | D624 Die C | 27 |
| Brittleness Point at -49°F | D2137 | Does not break |
| Ozone Resistance 168 hours/100 PPHM/104°F/40°C./50% ext. | D1149 | No cracks @ 7 x magnifications |
| Water Absorption, max.Mass% 168 hours @ 157°F./70°C. | D471 | -2.0, + 8 |
| HEAT AGING 28 DAYS AT 240° F | | |
| Tensile Strength, min Kg/cm ² | D412 Die C | 85 |
| Elongation, Ultimate min.% | D412 | 200 |
| Tear Resistance, min Kg/cm | D624 Die C | 23 |
| Linear Dimensional Change, max.% | D1204 | ± 2 |

Before the installation of these sheets the Contractor shall submit, for the approval of the Engineer, manufacturer's certificate and the warranty in addition to shop drawings showing all details of installation.

b- Product delivery, storage, handling, and installation

- A. Deliver material in original, unopened packages and containers.
- B. Containers are to be labeled with manufacturer's name, product name, description and identification.
- C. Store materials between 60° and 80° F. If exposed to lower temperatures, store at 60°F. minimum temperature for three days before using.
- D. Store materials in a dry area and protect from water and direct sunlight.
- E. Any materials damaged in handling or storage shall not be used.
- F. The installation made of E.P.D.M. membrane shall be, where possible, fully adhere to Substrates.

c- Related materials

1- Primer activator

Primer Activator shall be a fast drying, solvent based primer designed to prepare E.P.D.M. surfaces for splicing with Seam Tape and/or Splice Adhesive.

Primer Activator shall have the following physical properties:

| | |
|---------------------------------|----------------|
| Base | Synthetic |
| Color | Clear |
| Solids - Weight, % | 5.00 % |
| Solids - Volume, % | 4.10 % |
| Viscosity, cps | 20 - 120 |
| Brookfield RVT Spindle No. 2 at | 50 rpm |
| Specific Gravity | 0.8292 |
| Flash Point °F (SETA) | Less than zero |

2- Water cutoff mastic

Water Cut-off Mastic shall be a butyl-based, one component sealer designed to stop water penetration into the roof system. It shall provide a positive water seal when applied between the roofing membrane and the substrates. The solids content shall be high enough to allow Water cut-off Mastic to stay very flexible.

Water Cut-off Mastic shall have the following physical properties:

| | |
|------------------------------|-----------------|
| Base | Butyl |
| Color | Gray |
| Solids - Weight, % | 85.00 % |
| Solids - Volume, % | 71.00 % |
| Viscosity, cps | 4,000,000 |
| Brookfield RVT Spindle TE at | 2.5 rpm |
| Specific Gravity | 1.68 |
| Flash Point °F (SETA) | 106° F |
| Solvents | Mineral Spirits |

3- Splice adhesive

Splice Adhesive shall be a black, butyl-base contact adhesive designed for field splicing of E.P.D.M. membrane lap seams and/or membrane flashing details. It shall have a high initial green strength and long term durability.

Splice Adhesive shall have the following physical properties:

| | |
|-------------------------|-----------------|
| Base | Butyl |
| Color | Black |
| Solids - Weight, % | 24.5 % |
| Solids - Volume, % | 21.00 % |
| Viscosity, cps | 1,800 |
| Brookfield RVT No. 4 at | 10 rpm |
| Specific Gravity | 0.86 |
| Flash Point °F (SETA) | Less than 20° F |

4- Bonding adhesive

Bonding Adhesive shall be a synthetic rubber adhesive designed specifically for the installation of fully or partially adhered membrane systems. It shall be used to bond E.P.D.M., neoprene and other single-ply membranes to substrates.

Bonding Adhesive shall have the following physical properties:

| | |
|---------------------------------|----------|
| Base | Neoprene |
| Color | Amber |
| Solids - Weight, % | 25.00 % |
| Solids - Volume, % | 18.30 % |
| Viscosity, cps | 2,500 |
| Brookfield RVT Spindle No. 3 at | 20 rpm |
| Specific Gravity | 0.871 |

5- Splice wash

Splice Wash shall be designed for thorough cleaning of E.P.D.M. seams and splices prior to the application of primers or splice adhesives.

Splice Wash shall have the following physical properties:

| | |
|----------------------|---------------|
| Base | Solvent Blend |
| Color | Clear |
| Solids, % | 0.00 % |
| Viscosity, cps | Less than 50 |
| Specific Gravity | 0.768 |
| Flash Point °F (TCC) | 15° F |

6- Seam tape

Seam Tape shall be a black, butyl-based splicing tape for adhering sheets of E.P.D.M. membrane together. It shall be easily applied, avoiding the inherent solvent hazards associated with adhesives.

Seam Tape shall have the following physical properties:

| | |
|-------------------------|---|
| Base | Butyl |
| Color | Black |
| Cure State | Cured |
| Tensile Strength | 6 K/cm ² (4 K/cm ² min) |
| Elongation | 1,000 % (800 % min) |
| Brittleness Temperature | Below - 50° F |
| Permeability | 0.6 perm mils |
| Heat aging at 300°F | No appearance change after 180 hours |

7- Black lap sealant

Lap Sealant shall be a single component elastomeric sealant for sealing exposed edges of field fabricated membrane lap seams against the effect of weathering. It shall provide protection against heat, moisture, ozone resistance and UV light penetration. It shall adhere well to E.P.D.M. membranes and concrete.

Black Lap Sealant shall have the following physical properties:

| | |
|-------|-----------------|
| Base | E.P.D.M. Rubber |
| Color | Black |

| | |
|---|-----------|
| Solids - Weight, % | 58.00 % |
| Solids - Volume, % | 45.05 % |
| Solvents | Aliphatic |
| Viscosity, cps | 600,000 |
| Brookfield RVT Spindle No. 2 at No. TF at 10 rpm | |
| Specific Gravity | 0.988 |
| Flash Point °F (SETA) | 54° F |

8- One sided substrate bonding adhesive

One sided Substrate Bonding Adhesive shall be a fast drying, adhesive designed for bonding single ply membranes to approved substrate. Bonding Adhesive shall be applied to the base substrate only. It shall be a self curing adhesive offering high heat resistance, excellent green strength and high peel and shear values.

One sided Substrate Bonding Adhesive shall have the following physical properties:

| | |
|--------------------|-------------------------|
| Base | Neoprene |
| Color | Yellow |
| Solids - Weight, % | 38.00 % |
| Solids - Volume, % | 28.90 % |
| Viscosity, cps | 3000 - 4000 cps |
| Cure time | Complete cure 2-3 weeks |

9- Flashing

Shall be 1,5 mm thick uncured E.P.D.M. or Neoprene.

213.2.6 Geotextile

a) Non woven

1-General

The geotextile shall be of the nonwoven type, needle punched or needle entangled and shall consist of long chain polymeric filaments of polypropylene, polyester or nylon. The fabric shall be a stable network of fibers which retain their position relative to each other. Heat bonding on one side is acceptable.

2- Physical properties

The geotextile shall meet the following physical properties:

| Propriety | | Test reference |
|-----------------------|-------|----------------|
| Grab strength * | : 113 | ASTM D4632 |
| Kg., Min. | | |
| Elongation, Minimum | : 50 | ASTM D4632 |
| (at peak load) % Min. | | |
| Puncture strength | : 52 | ASTM D3787 |

| | | |
|--|-------|------------|
| Kg., Min. | | |
| Permitivity Sec ⁻¹ , Min. | : 0.7 | ASTM D4491 |
| Burst strength | : 25 | ASTM D3786 |
| Kg/cm ² , Min. | | |
| Ultraviolet resist | : 70 | ASTM D4355 |
| % strength retained @ 500 Weatherometer hours | | |

* Minimum roll average in the weakest principal direction

3- Identification

Geotextile shall be furnished in rolls wrapped with protective covering to protect them against ultraviolet radiation and abrasion. Torn wrappers shall be repaired within 48 hours, using an approved protective covering.

Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width and production identification number.

b) Woven

1- General

Woven geotextile shall consist of long chain polymeric monofilaments, slitfilm tapes, or multifilament of tape and nonwoven yarn of polypropylene, polyester or nylon. The fabric shall be woven into a stable network and the edges of the fabric shall be selvaged or surged in such a way that fabric will not unravel or fray during installation or usage.

2- Physical Properties

The geotextile shall meet the following physical properties:

| Propriety | | Test reference |
|--|--------|----------------|
| Grab strength * | : 123 | ASTM D4632 |
| Kg., Min. | | |
| Elongation, Minimum (at peak load) % Min. | : 25 | ASTM D4632 |
| Puncture strength | : 50 | ASTM D3787 |
| Kg., Min. | | |
| Permitivity Sec ⁻¹ , Min. | : 0.02 | ASTM D4491 |
| Burst strength | : 35 | ASTM D3786 |
| Kg/cm ² , Min. | | |
| Ultraviolet resist | : 70 | ASTM D4355 |
| % strength retained @ 500 Weatherometer hours | | |

* Minimum roll average in each direction

3- Identification

Geotextile shall be furnished in rolls wrapped with protective covering to protect them against ultraviolet radiation and abrasion. Torn wrappers shall be repaired within 48 hours, using an approved protective covering.

Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width and production identification number.

213.2.7 Bituminous Putty

The putty is furnished either in tins or as ovolos. It shall be elasto-plastic conforming to the following requirements:

- Black color
- Temperature for use : 100°C to 130°C
- Stable at : -30°C to 60°C
- Penetration at 25°C : around 55
- Softening temperature : around 145°C
- Practical elongation : 10%
- Non-toxic

a. Application of the sealant:

Before proceeding with filling the joint, the Contractor shall complete the following works:

Widening the joint by grinding or sawing when the joint width is less than required.
Cleaning by grinding and brushing the sides of the joint all along its length.
Final cleaning shall be done by blowing air immediately before starting the filling.

The putty is applied at a temperature ranging between 100°C and 130°C. It shall be filled in the joint from the bottom up. In case the putty spreads slowly when applied, especially in horizontal joints, more material is immediately added until the joint is completely filled.

213.3 DAMP-PROOFING OF BUILDINGS (WALLS & SLABS)

All external building wall bases are to be provided with damp-proof course (d.p.c.) made of special material strip (P.V.C. or bituminous membrane) of width equal to the total thickness of the wall and any external rendering.

- The d.p.c. is to be lapped with the damp-proof membrane of the substructure and bedded in the mortar specified for the type of block used.
- The greater lengths possible are to be used for the d.p.c. but any end laps required are to be at least 200mm long and made dry without intervening mortar.
- Piers are to have complete d.p.c.'s lapped with the wall d.p.c.

Damp-proof membranes shall be laid, as directed by the Engineer beneath all floor slabs resting on the ground. They shall be composed of single sheets of minimum thickness 0.300mm black polythene sheet film of an approved manufacturer specially made for use as damp-proof membrane.

- The film shall be laid on a sand-course and turned up around all edges of the slab and with 150mm margin above the top of the slab to be tucked into the perimeter wall of the building.
- Where the building size is too large as to exceed the maximum sheet size available, several sheets shall be used and the joints shall be lapped 150mm and fused together using a welding tool designed for that purpose.
- Every care shall be taken by the following trades to prevent perforation of the membrane but in the event of puncture, the perforation shall be covered by a patch of similar material of dimensions exceeding the area of the puncture by 300mm and the two sheets welded together as described above.

213.4 DAMP PROOFING BELOW WATER RETAINING RESERVOIR SLABS

A polythene sheet film of an approved manufacture will be laid over the blinding concrete.

- Damp proof membrane, shall be approved and laid as directed by the Engineer beneath all floor reservoir slabs.
- Damp proof membranes composed of single polythene sheets of minimum thickness 0.3mm shall be laid as specified in Section 213.3

213.5 DAMP PROOFING FOR UNDERGROUND CATCHMENT STRUCTURE

A flexible waterproofing membrane will be placed between two layers of a non woven geotextile in order to achieve the cut-off walls and this before concreting.

Technical sheets must be submitted, all technical points and fixing must be clearly stated. Specifications of the flexible membrane and geotextile shall be determined in preamble to bill of quantities according to drawings.

213.6 MEASUREMENT AND PAYMENT

Damp-proofing shall be measured to payment by m² of net area of surface on which damp-proofing has actually been applied, after deduction of all openings and areas which have not been damp-proofed.

Damp-proofing shall be classified according to destination regardless of the inclination of the damp-proof surface (whether vertical, inclined or horizontal).

Each unit rate shall include for the supply of all materials, cleaning and preparation of all surfaces, application of primer, bituminous coating or membrane including overlaps and all extra works on corners and edges and for all materials, equipments and labour necessary for

the completion of damp-proofing in accordance with the Specification and Drawings and to the satisfaction of the Engineer.

Damp-proofing of catchment structures shall be measured to payment by m² of flexible membrane and geotextile placed and fixed for the cut-off walls.

216 - STEEL STRUCTURES

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216 STEEL STRUCTURES

216.1 GENERAL

The work required under this Chapter includes the fabrication and erection of structural steelwork such as steel columns, beams, trusses, platforms and the like. Non-structural metalwork such as doors, windows, gratings, handrails, etc. is treated in Divisions 209 and 210.

All steel structures shall be fabricated and erected or installed in strict accordance with the dimensions and details shown on the Drawings or determined by the Engineer and shall comply with the best accepted standards of workmanship to the complete satisfaction of the Engineer.

The Contractor shall supply all required materials, shall fabricate the steel parts, shall transport them to the Site of Works and shall erect and install them in their proper position and paint them.

216.2 MATERIALS

All materials used in fabrication, erection and painting of structural steelworks shall be new, of first-grade quality without rolling defects, cracks, grooves or rough surfaces and shall comply with the requirements specified on the Drawings and/or in the Particular Specification, and with the requirements of B.S. 4360 Grade 40, B.S. 4848 and other relevant British Standards.

216.3 WORKMANSHIP

216.3.1 Preparation of Members

All steel shapes, bars, plates, pipes, etc. shall be cut, drilled, bent and otherwise worked to the exact lines and dimensions shown on the Drawings. All burrs resulting from cutting and drilling shall be neatly removed. Where cutting is done by oxyacetylene torch, cut surfaces shall be clean and smooth.

Steel shall be worked either cold or red-hot, but not at medium (blue) temperature. Bolt holes shall be made by drilling only, and shall be accurately positioned so that bolts can be easily inserted.

Parts requiring machining shall be worked to the exact required dimensions in accordance with the Drawings and the finish shall be as marked on them, or, in the absence of such markings, shall be suitable to the purpose for which that parts are intended.

216.3.2 Weld Connections

All welding shall be done by the shielded metal-arc method by experienced welders qualified in accordance with B.S. 4871 to the highest standards of workmanship and to the satisfaction of the Engineer. The electrodes for steel welding shall be of a kind and class approved by the Engineer. The electrodes shall be stored in the original unopened containers. Electrodes in open containers shall be protected from dirt and moisture. The surfaces of the parts to be

welded shall be well cleaned of dirt, rust, slag, and paint. All slag and splatter adhering to the metal shall also be removed.

All metal parts and the electrodes shall be completely dry during welding. In case of rain or wind, all outdoor welding shall be stopped unless the metal parts are suitably protected to the satisfaction of the Engineer. Welding shall be carried out to ensure full penetration to the root of the joint in case of butt joints and in all events complete fusion of the weld metal with the base metal and with other layers of weld metal. In case of multi-layer welding, each completed layer shall be cleaned of all slag and dirt before applying the next layer.

Special care shall be taken in cleaning the root bead of butt welds. The completed welds shall be free of defects, such as gas pockets, slag inclusions, undercuts, incomplete penetration or incomplete fusion. The shape and dimensions of the welding shall be as shown on the Drawings.

No quenching of welds by means of immersion in water or flushing or other means shall be permitted, but the welds shall be allowed to cool off gradually to the ambient temperature. Where required, welded elements shall be stress relieved.

216.3.3 Bolt Connections

All holes in parts for bolt connections shall be accurately matched in order to permit easy insertion of the bolts. In case of small inaccuracies reaming with a suitable reamer will be permitted.

Before making the connection, burrs shall be removed from the hole edges and the areas of contact cleaned. Fitting together parts by force or insertion of bolts by hammer blows will not be permitted. The bolts used for connection of the parts shall be of a standard whitworth or metric thread, with hexagonal head and nut. Suitable washers shall be used, and bolt ends shall protrude about 5 mm. from the nuts. The length of thread inside the connected part shall not exceed 3 mm. Tightening up of the bolts shall be done so as to ensure a rigid and permanent connection between the connected parts, without exceeding the permissible stresses. The contact surfaces of the parts to be connected by bolts shall be painted with red lead before the connection is made.

216.3.4 Assembly

The parts of the structural steel work shall be completely shop assembled unless otherwise marked on the Drawings or directed by the Engineer in consideration of traffic needs. In such cases, site assembly will be permitted and the Contract shall prepare in the workshop all holes, bolts, welding bevels, etc., required for the assembly on site. All parts subject to site assembly shall be marked and matchmarked in black paint, and shall be trial assembled at the shop before shipment.

the Engineer will check the parts after their assembly, but before their final connection, and will accept them if found satisfactory and conforming to the requirements of the Specification and Drawings. The Contractor shall not connect the parts together and shall not embed them in concrete until the receipt of the Engineer's approval to do so.

216.3.5 Erection

All structural steelwork shall be erected and installed to the exact lines and positions shown on the Drawings or directed by the Engineer and shall be well anchored to the concrete structures.

After the Contractor has presented the parts of structural steelwork for the Engineer's inspection and obtained his approval, he shall transport them to the Site and set them in the required positions. When transporting such parts, the Contractor shall take care to prevent any damage or distortion to the frames or to the primary coat of paint already applied at the place of fabrication. Embedding into concrete, setting into position, etc. shall be exact and correct in accordance with the best accepted standards of workmanship. Setting the parts of the structure in position and their adjustment shall be first checked by water level and plumb line and the final setting shall be checked by surveyor's level.

The cranes, derricks, scaffolds, temporary supports and temporary connections used in the erection of the structural elements shall be such as will ensure the stability of the structure and safety of persons and prevent any damage, distortion, dislocation or undesirable stresses being caused to the structural elements. Temporary supports and connections shall not be removed until the final connections have been made and approved by the Engineer, but such approval shall not relieve the Contractor of his responsibility for the correct erection, stability and safety of the structure.

Unless installation by grouting-in anchor bolts or use of expansion anchors in previously prepared recesses is approved, anchor bolts and metal parts to be embedded in concrete shall be placed in position before casting of concrete and shall be held firmly and accurately in position while the concrete is being placed.

216.3.6 Painting

Painting of metal parts shall be in accordance with Subsections 207.1.7(d) and 207.9 above.

Cleaning and priming of metal parts shall be done at the workshop prior to transporting to the Site. Parts intended to be welded on the Site during erection may be painted with a weldable primer approved by the Engineer.

The application of specific paints, such as epoxy or rubber base shall be according to the Particular Specification and/or the Engineer's instructions.

216.3.7 Glass Coated Steel Tanks

- i) Tanks shall be constructed of glass-coated steel panels erected on a concrete base or of other approved construction. The structural design, materials and construction of the tanks is to be in accordance with all British (or foreign) Standards and Codes of Practice current at the date of Tender.
- ii) Imposed loads due to snow and wind shall be in accordance with BS 6399. The tank walls shall be designed to support any roof structure, bridges, scrapers or other appurtenances to be fitted to the tanks.

- iii) The installed glass coatings shall have the following properties:
- adhesion bond strength of at least 34500 kN/m²
 - thickness between 0.18mm and 0.28mm each side
 - no permeability and zero moisture absorption
 - resistance to pH solutions in the range 3 to 9
 - ability to flex with the steel substrate without sapling or cracking
 - the ability to be repaired on site.
- iv) All holes and openings in panels greater than 25mm shall be made before glass coating, and non-destructive testing shall be carried out for dry film thickness and porosity before leaving the factory. Test certificates shall be supplied before delivery.
- v) Panels shall be jointed with suitably protected bolts and shall be sealed with polyurethane or other approved sealant which shall be applied to all joints and edges of plates.
- vi) Each tank shall be provided with all necessary factory made pipework and instrumentation connections as shown in the Drawings or specified.

216.4 METHODS OF MEASUREMENT AND PAYMENT

Measurement of structural steel for payment shall be per unit of measurements shown in the Bill of Quantities such as: weight, unit, length etc.

The unit rates for the fabrication and erection of steel structures shall include for the cost of all labour and materials, including but not being limited to: supply of all steel and auxiliary materials, transport to workshop, fabrication of parts, workshop painting as specified, transport to Site, storage, and erection according to Drawings and Specification or as directed by the Engineer and final painting of erected structure.

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217 PIPELINES AND PIPEWORKS

217.1 SCOPE

This part of the specification shall apply to the supply, delivery, laying, jointing and testing of all pipes, fittings and accessories, and includes:

- Concrete pipes
- Asbestos-Cement pipes
- Steel pipes
- Cast Iron and ductile Iron pipes
- G.R.P. pipes
- P.V.C. pipes
- HDPE pipes

217.2 CONCRETE PIPES

217.2.1 Quality Requirements

Concrete pipes, fittings and junctions shall comply in all respects with B.S. 5911 or ASTM C76M for reinforced concrete pipes or with B.S.5911 or ASTM C14M or DIN4032 for non reinforced concrete pipes. The pipes shall be truly circular and have bell joints, or spigot and socket joints, or rubber gasket joints, as noted on the Drawings or in the Bill of Quantities, and as specified hereafter.

Concrete pipes, fittings and junctions shall be tested for compliance with B.S. 5911 (and BS EN681-1:96 or DIN 4060/2 for jointing system) in approved laboratories or in their place of manufacture. The pipes shall be subjected to Hydraulic and Crushing Tests. The number and selection of samples for testing, the test procedures and the requirements shall all be as specified in B.S. 5911.

The selection of samples and the Tests shall be witnessed by a representative of the Engineer, who shall be informed at least 48 hours in advance of any sampling or testing.

The cost of samples, their transportation to the test site and their testing shall be deemed to be included in the unit rates and shall not be paid for separately.

Alternatively, the Contractor may submit to the Engineer certificates from approved laboratories certifying that the pipes have been subjected to and have satisfactorily undergone the required tests according to the specified standards. In that case the Engineer shall be entitled (but shall not be bound) to renounce any further testing.

The concrete pipes should be protected by HDPE lining, (according to DIN 50 049-2.2) or PVC lining or should have an epoxy coal tar interior coating not less than 1000 microns thick.

217.2.2 Hauling and Handling of Pipes

The entire curing period of the pipes shall be completed before any pipe shall be loaded and transported. The Contractor shall check each pipe before loading and shall reject all damaged or defective pipes. The Contractor shall load with the greatest care and properly secure the pipes on the vehicles for transportation and take all necessary measures to prevent any damage to the pipes during transport. The Contractor shall be responsible for the quality of the pipes and for their condition upon and after delivery to the Site. The Engineer will check the pipes upon their delivery to the Site and the Contractor shall forthwith remove from the Site all rejected pipes and replace them at his own expenses by pipes acceptable to the Engineer. Only pipes inspected and accepted on the Site by the Engineer shall be incorporated in the Works.

The Contractor shall ensure that all pipes are properly handled by his staff. During transport, pipes shall not be allowed to rest on their joints, narrow cross-members of vehicles, or anything else that might give rise to concentrated loads due to the weight of the pipe or bumping of the vehicle but shall be properly supported on soft material. Sufficient labour and equipment shall be on hand before loading and unloading is commenced and under no circumstances shall any pipe be dropped from a vehicle. For storage on site, the ground must be level and free from loose stones.

The Engineer shall have the right to reject consignments or stocks of pipes from which failed pipes have been drawn, or order them to be pressure-tested outside the pipelines, even though no defects are apparent, if there is reason to believe that mishandling has taken place. All costs incurred in this respect shall be borne by the Contractor.

217.2.3 Laying of Pipes

After the excavation and preparation of a section of pipe trench has been completed by the contractor, it shall be inspected by the Engineer. No pipe shall be laid before the excavation has been approved by the Engineer. Just before pipelaying, the trench shall be cleaned of all stones, soil and other debris that might have fallen therein.

All pipelaying shall be carried out by experienced pipe-layers well skilled in this work. Pipes shall be laid true to line by means of a line stretched along the side of the pipes and true to level by means of a straight edge of 4 meters in length kept inside the pipes and pulled forward to pegs boned in at suitable intervals between sight rails set to the proper levels.

Immediately before being laid, each pipe and fitting shall be carefully examined both inside and outside for any damage, and all dust, dirt and foreign matter shall be removed. Care shall be taken to ensure that they remain clean during laying. The use of a badger will be ordered by the Engineer, if, in his opinion, dirt is not being satisfactorily excluded. The badger on a sound rope is to remain within the bore of the pipe previously laid and jointed and is to be drawn forward as the work proceeds throughout the whole length of the conduit. The badger is to be of soft material which will not damage the internal surfaces of the pipes.

In order to prevent stones, soil or small animals from entering the pipe, a suitable cap end or plug shall be provided with which the last pipe laid shall be sealed when pipelaying is not actually in progress. The plug shall be of the screw-up expanding type or of tapered wood.

The completed section between two manholes shall form one continuous tube well supported over its entire length and with a straight and even invert according to the lines and grades shown on the Drawings. The straightness of each section between manholes shall be checked externally by means of a string stretched parallel to the designed invert line and supported at intervals not exceeding 7.5 m, and internally by means of a beam of light. The maximum permissible deviation in invert level in one section shall not exceed 2.0 cm or 1 mm per pipe, whichever is less. The alignment and location in plan shall not deviate by more than 20 cm from the design line. The axial displacement of pipes entering any manhole and issuing from it shall not exceed 2 cm. Pipelaying shall proceed upstream with the bells or sockets of the pipes pointing upstream.

Where shown on the Drawings or required by the Engineer, concrete pipes shall be laid on a sand bedding, or concrete bedding or with concrete surround.

217.2.4 Jointing

Rubber Gasket Joints - Where pipes with bell and spigot joints and rubber sealing gaskets are approved by the Engineer, the following provisions shall apply to jointing: rubber gaskets shall be of synthetic rubber resistant to oils and fats, and shall meet the requirements of (B.S. EN681-1 or DIN 4060/2) - Elastomeric Joint Rings for Pipework and Pipelines (Types 1 and 2) or of I.S.O. 1398.

All pipes, and especially the bells and spigots, as well as the rubber gaskets shall be carefully inspected before being incorporated into the work, and no defective pipes or gaskets shall be used. Before making any joints, the rubber gaskets, spigot and bell shall be well cleaned and thoroughly covered with a special lubricating compound not harmful to rubber, as approved by the Engineer. After lubrication, the rubber gasket shall be stretched around the spigot of the pipe to be laid and fitted into the groove, care being taken to ensure uniform tension and to prevent twisting of the gasket. The spigot with the gasket on it shall then be inserted into the bell of the previously laid pipe and the new pipe shoved into position. Shoving-in may be done while the pipe is still suspended from the crane or lifting tackle to minimize friction between pipe barrel and trench bottom.

The bell, spigot, and gasket shall be protected from contact with earth, dirt, or any other deleterious matter until the joint is completed. The use of undue force to overcome improper fitting of the gasket into the spigot groove shall not be permitted, since this may cause twisting or dislocation of the gasket resulting in a faulty joint. If the pipes are properly aligned, the gasket properly fitted and the gasket and bell well lubricated, the pipe should slide in smoothly without the application of much force.

217.2.5 Cast-in-Situ R.C. Conduits

Cast-in-Situ R.C. conduits shall conform to all relevant sections of this Specification with regard to concrete, reinforcement, shuttering, etc. All cast-in-situ R.C. conduits shall be made of grade C30P, unless otherwise noted.

Cast-in-situ R.C. conduits shall be perfectly true to dimensions in cross section. Construction joints shall be installed along the conduit at intervals shown on the Drawings and between joints the conduit shall be cast continuously, with no interruption.

The bottom of the trench shall be excavated by hand to the longitudinal slope of the conduit, and to the exact shape of the bottom of the conduit, moistened and well compacted. On the ground, a 5 cm blinding layer of lean concrete grade C7P shall be cast, to the longitudinal slope of the conduit, as a base for the bottom horizontal and inclined surfaces of the conduit, as shown on the Drawings.

Generally, conduits shall be cast in two vertical lifts, with a keyed construction joint separating these lifts, in accordance with the Drawings. Great care shall be exercised in pouring the lower lift, to ensure that the space directly under the interior form is completely and densely filled with concrete. In pouring the upper lift, concrete shall be placed equally on both sides of the form, to minimize lateral pressures on it. The internal surface of the conduits shall be smooth, perfectly true, and free of any irregularities.

Where permitted in writing by the Engineer, precast elements may be incorporated in cast-in-situ R.C. conduits. Such precast elements shall be manufactured and installed in the cast-in-situ conduit in accordance with the specification and the instructions of the Engineer.

217.2.6 Inspection and Testing of Concrete Gravity Pipelines

- (a) General - After the laying and jointing of a section of pipeline (defined as the length of pipeline between two adjoining manholes) has been completed, that section shall be inspected and tested, as specified hereafter. The joints shall remain exposed, joint grooves shall not be filled and any bedding or surround or backfill shall be carried no higher than the invert of the pipe until all inspections and tests have been completed to the satisfaction of the Engineer and until he has given permission in writing to proceed with the covering-up of the pipeline.

The following inspections and tests shall be carried out:

Visual Inspection, in which the Engineer shall inspect the section for grade, direction, line, appearance of inner surface, depth and correct jointing.

Hydrostatic Test, as specified hereafter, which will be carried out in the presence of the Engineer.

After the completion of the above inspection and test to the satisfaction of the Engineer, any required beddings and/or surrounds shall be completed and backfilling shall be carried out as specified in Part 2 Section 201.3 of this Specification.

The Contractor shall inform the Engineer at least 24 hours before a section is ready for inspection and testing.

- (b) Hydrostatic Test - The water tightness of every completed section between two manholes shall be tested by a hydrostatic test as hereinafter described. The section to be tested shall be cleared of any material or object that may be lying in it and all bellholes shall be cleaned so that the joints may be observed from the outside. The two ends of the section shall be hermetically sealed by suitable temporary plugs provided with pipe nipples. The upstream plug shall be connected to a standpipe extending at least 4 m above the top of the highest pipe. Water shall then be introduced through the opening in the lower pipe end to fill the pipe and expel the air through the standpipe, until the water level in the standpipe is 4 m above the top of the highest pipe. The section shall then be permitted to absorb water for

24-48 hours and all visible leaks in the joints shall be repaired. After this period the water level shall be restored and the pipe observed for 2 hours, while the water level in the standpipe is being maintained at 4 m above the highest pipe. The quantity of water that must be added to maintain the water level in the standpipe shall be measured and this will be considered as the leakage of the tested section. The leakage under test, for pipeline diameter ≤ 400 mm, shall not exceed 0.8 litre/m² of internal wall pipe area per hour and for pipeline diameter > 400 mm, the leakage shall not exceed 0.8% of inside pipe volume per hour. If the leakage during the test period exceeds the permissible rate, the Contractor shall search for and make good all defects causing such leakage. The test and repairs shall be repeated as often as necessary until all visible leaks have been repaired and the leakage does not exceed the permitted limit.

All necessary testing apparatus, expanding plugs, stoppers, bladders etc., labour, water and any other materials necessary shall be provided by the Contractor at his own expense.

- (c) Infiltration Test - Where the line has been laid in groundwater, after the trench has been backfilled, the interior of the pipe shall be tested for infiltration of external water through the joints into the interior of the pipe. Any leak so detected shall be repaired as instructed by the Engineer and to his entire satisfaction and the pipeline shall be retested, all at the Contractor's own expense.

217.2.7 Final Cleaning and Inspection

Before the works are accepted by the Engineer, the entire pipe system, including all structures, shall be thoroughly cleaned by flushing or by passing a brush, sphere or other suitable tool through it, or by any other approved method, to ensure that it is clean, and free of obstructions and that pipe runs are perfectly straight. Before taking over, the pipeline will be finally inspected by the Engineer.

217.2.8 Methods of Measurement and Payment

Precast concrete pipes and cast-in-situ R.C. conduits shall be classified for payment according to type and diameter and shall be measured for payment in linear meters of completed pipeline in place, measured along the crown of the pipeline, between internal surfaces of manholes or chambers and the length measured for payment shall include the lengths of all fittings, specials, junctions, bends, etc. installed in the pipeline.

The price of fittings, specials, bends, junctions, etc. for precast concrete pipes and cast-in-situ R.C. conduits shall be, unless otherwise specified in the particular specifications or the B.O.Q. considered as included in the cost of pipes.

Alternatively, if so stated in the Particular Specification and/or in the Bill of Quantities, precast concrete pipes and fittings may be measured by number of pipes of defined net lengths and by number of fittings.

Payment for precast concrete pipes and for fittings, specials, etc., shall include:

- (a) Supply, hauling, handling, unloading and stacking of pipes and fittings including all necessary jointing materials.

- (b) Removal from stacks; hauling and stringing alongside trench; laying, jointing and testing at any depth of trench; connections to manholes and chambers; and final cleaning and flushing of pipeline. The unit rates for this item, for each type and diameter of pipe and fitting, shall be the same for all depths of trench in which the pipes and fittings are to be installed.

Payment for each type and diameter of cast-in-situ R.C. conduits shall be made under a single item in the Bill of Quantities and payment for each type and diameter of bend, junction etc. for cast-in-situ conduits shall be made under a single “extra-over” item in the Bill of Quantities, and each of these unit rates shall include for the blinding layer, formwork, concrete, reinforcing steel, joints, curing, testing and all labour and materials necessary to construct and complete the cast-in-situ R.C. conduit.

The unit rates for constructing each type and diameter of cast-in-situ conduit and fittings, junctions etc. shall be the same for all depths of trench in which the conduits and fittings are to be constructed.

Only pipes, fittings, junctions, bends, etc. actually laid in trench, and tested and accepted by the Engineer, shall be measured for payment above, and no allowance whatsoever will be made for any breakage, loss, etc. en route.

Excavation and backfill, special beddings, surrounds and manholes shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

217.3 ASBESTOS CEMENT PIPES AND FITTINGS

217.3.1 Quality Requirements

All asbestos cement pipes, joints, specials and fittings shall be supplied by the Contractor unless otherwise stated. They shall be made by an approved manufacturer and shall be of the class and nominal diameter as shown on the Drawings and shall comply in all respects with the following standards:

Gravity Flow Pipes - for conveying fluids at working pressures up to but not exceeding 1.0 kg/cm^2 - B.S. 3656 or I.S.O. R-881

Pressure Flow Pipes - for conveying fluids at working pressures exceeding 1.0 kg/cm^2 - B.S. 486 or I.S.O. R-160

The standard joint used on the A.C. pipes shall be the “Simplex”, or “Supersimplex” (Comet, kaltite, Reka or similar) type coupling consisting of asbestos-cement sleeves and self-sealing rubber gaskets, and complying with the above standards.

Cast iron detachable joints and long collar detachable joints and other cast iron fittings for use with asbestos cement pipes shall comply with the requirements of B.S. 486 and shall be supplied with rubber rings, bolts and nuts, etc. The external diameters of all cast iron joints and fittings shall be adapted to the external diameter of the asbestos cement pipes of the corresponding nominal diameters.

Unless otherwise stated, A.C. pipes shall be coated and lined as provided under Clause 2.3 of B.S. 486. Cast iron joints and fittings for A.C. pipes shall be coated and lined as specified for C.I. pipes.

Rubber gaskets shall be of synthetic rubber and shall meet the requirements of B.S. 2494 or I.S.O. 1398, for water pipes or drainage, whichever is applicable.

The Contractor shall supply all the necessary asbestos-cement and cast iron fittings, such as reducers, bends, tees, crosses, end caps, adaptors, etc. All such fittings shall match the pipes they are to be connected to in diameter and class. All pipes, fittings, couplings, and gaskets shall be obtained from approved manufacturers who shall supervise the transportation and laying of the pipes and shall guarantee the quality of the pipes and fittings for a period not less than the period of maintenance specified in this Contract.

The Contractor shall submit to the Engineer certificates from approved laboratories that the pipes have been subjected to and have satisfactorily undergone the tests specified in the above-mentioned standards and have satisfied all their requirements.

217.3.2 Hauling and Handling of Pipes and Couplings

No pipe shall be loaded for transportation or transported until after the end of the curing period. The Contractor shall check each pipe before loading and shall reject every pipe found to be damaged or defective. The Contractor shall properly secure all the pipes on the vehicles and take all necessary measures to prevent any damage to the pipes. The Contractor will be held responsible for the quality of the pipes and for their condition after delivery to the Site. The loading, transportation and unloading of the pipes shall be done with the greatest care. Under no circumstances shall pipes be thrown down on the ground or dragged along it. Pipes up to 6" in diameter may be unloaded by two workmen standing on the vehicle and handing them down to two other workers standing below who shall place them and stack them gently on the ground. Alternatively these pipes may be unloaded by rolling them down gently and carefully from the truck on two strong planks and placing them alongside the trench in which they are to be laid. Larger pipes shall be handled by suitable cranes. Care shall be taken not to damage the edges of the pipes during unloading operations. The rubber rings of the joints shall be supplied separately from the couplings and shall be stored in the shade and in dustproof containers. Where conditions do not allow for the stringing of pipes alongside the trench into which they are to be laid, they may be unloaded at a central point, stacked on planks and secured by stop blocks until they are required in the Works.

The Engineer will check the pipes on the Site and the Contractor shall mark all defective or damaged pipes in accordance with the Engineer's instructions and shall remove them from the Site immediately and replace them with acceptable pipes at his own expense. Only pipes marked as accepted by the Engineer after inspection on the Site shall be incorporated in the Works.

217.3.3 Mounting of Joint Couplings

The rubber gaskets shall be brought to the Site separately and shall not be inserted into the joint couplings until immediately before the mounting of the joint. As far as practicable, the coupling shall be mounted on the pipe end before the pipe is lowered into the trench. Before assembly, the coupling grooves, rubber gaskets and pipe ends shall be thoroughly cleaned and lubricated with a lubricant provided or approved by the pipe manufacturer. One sealing gasket and the central spacing ring (or spacers) shall be inserted in their respective grooves. Since the sealing gaskets have a special asymmetric cross section, care shall be taken to insert them in the correct direction. Gaskets and spacing rings shall be placed in their grooves neatly and

evenly without twists, distortion or bulges. The coupling shall then be slipped on to the pipe end until the spacing ring or spacers rest against the edge of the pipe. On large diameter pipes (450 mm and above) a mounting tool operated by a screwed rod or similar device shall be used to pull the coupling over the pipe end. Where no spacing rings or spacers are provided a special fixing clip shall be used to keep the coupling in place while the next pipe is inserted into it.

217.3.4 Laying and Jointing of Asbestos-Cement Pipelines - General

Attention is drawn to the necessity of ensuring a perfectly even bed for the pipes. Where shown on the Drawings or required by the Engineer, asbestos-cement pipes shall be laid on a sand bedding placed in accordance with Part 2 Section 201.3.7. Bellholes sufficient in size to permit jointing of pipes as described hereinafter shall be excavated in the trench bottom, bedding and trench walls as necessary. No pipe shall be laid until the surface of the excavated trench bottom or that of the sand bedding, as the case may be, has been inspected by the Engineer and approved for pipelaying.

Before the line is handed over to the Employer, the inside of all pipes shall be cleaned of all dirt, mortar and other foreign matter. At the end of each work day and after a pipeline section is completed, the open pipe ends shall be suitably plugged to prevent entry of dirt or small animals.

All pipes shall be placed in position carefully and shall be laid true to line and grade. Under no circumstances shall pipes be thrown into the trench. Lowering shall be carried out manually or by means of lifting tackle and/or ropes. Before any pipe is lowered into the trench, it shall be cleaned and examined for cracks and flaws. If undamaged it shall be placed in position ready for jointing in accordance with the requirements hereinafter.

217.3.5 Laying A.C. Gravity Flow Pipes

Asbestos-cement pipes in gravity flow lines shall be laid consecutively in straight lines between adjacent inspection manholes. Special joint couplings shall be built into the walls of the manholes to ensure a tight joint between pipe and manhole. After being laid and jointed the completed section between two manholes shall form one continuous tube, well supported over its entire length and with a straight and even invert according to the lines and grades shown on the Drawings. The straightness of each section between manholes shall be checked externally by means of a string stretched parallel to the designed invert line and supported at intervals not exceeding 7.5 m, and internally by means of a beam of light (either torch or sunlight reflected by a mirror).

All pipes and manholes shall be laid and constructed according to the lines and grades shown on the Drawings, or as instructed by the Engineer, with the following tolerances:

The maximum permissible deviation in invert level in one section shall not exceed 2.0 cm or 1 mm per pipe, whichever is less. The alignment and location in plan shall not deviate by more than 20 cm from the design line. The axial displacement of pipes entering any manhole and issuing from it shall not exceed 2 cm.

217.3.6 Laying A.C. Pressure Pipes

In pressure lines the pipes shall be laid in straight lines where possible, but curves of long radius may be required, and these shall be obtained by deflection at the joints. Such deflections, however, unless specifically otherwise ordered by the Engineer, shall comply with the following:

| | | | | | |
|-------------|----------|-----------|-----------|------------|--------|
| ND (mm) | 80 - 250 | 300 - 350 | 400 - 600 | 700 - 1200 | ≥ 1300 |
| α Less than | 4° | 3° | 2° | 1 ½° | 1° |

Where a change in direction cannot be made by deflection at the joints of ordinary straight pipes, prefabricated bends shall be used. The approximate locations of such bends and other specials are indicated upon the Drawings, and their exact positions will be determined by the Engineer on the Site.

217.3.7 Jointing Asbestos-Cement Pipes

Before jointing a new pipe to one already laid in the trench, the second gasket shall be installed in the free end of the coupling mounted on the pipe in place, in the manner described above. The new pipe, with the joint coupling mounted on it shall be lowered into the trench, its free end cleaned, lubricated and inserted into the open end of the coupling on the pipe already in place. The pipe shall then be shoved home until its end abuts against the central spacing ring or spacers in the coupling. Small to medium size pipes may be shoved home by hand with or without the aid of crowbars. Larger size pipes, which are handled by means of cranes or hoists, may be shoved in while being suspended at balance point slightly lifted above the ground, thus eliminating friction with the trench bottom. Large size pipes may require the use of a special pulling device. Jointing shall always be done coaxially, any deflection in the joint as described in Subsection 217.3.6 above being produced after the joint has been completed.

217.3.8 Cutting of Asbestos-Cement Pipes

For closing lengths it will be necessary to cut asbestos-cement pipes. For this purpose, the Engineer may allow, at his discretion, the use of pipes with damaged ends but otherwise sound. Asbestos-cement pipes shall be cut by a suitable cutting machine, care being taken that the cut ends are truly perpendicular to the pipe axis and that no breaking or cracking occurs. Cutting by hammer and chisel will not be allowed.

For jointing, the outside diameter of the pipe ends shall then be reduced to the required distance, unless special pipes turned to the correct diameter are supplied by the manufacturer. Such reduction of outside diameter of pipe ends shall always be done with an approved machine mounted on or inside the pipe barrel; filing down by hand shall not be permitted. In every case the edges of the cut pipe ends shall be given the correct shape required for jointing.

217.3.9 Backfilling

As each pipe is placed in its final position and jointed, the trench shall be filled, leaving only the joints uncovered. The materials used for backfilling and their placing and compacting shall be in accordance with the Drawings and the requirements of the Specification. The joints shall

be left uncovered until the hydrostatic tests have been successfully completed and the Engineer has given permission to cover the joints.

217.3.10 Testing of Asbestos-Cement Pipelines

A.C. pipelines shall be tested in accordance with standard I.S.O. 4483, and as specified hereafter and as directed by the Engineer:

- (a) Gravity Pipelines - Gravity pipelines shall be subjected to the tests and shall meet the requirements prescribed for concrete gravity lines in Subsection 217.2.6.
- (b) Pressure Pipelines - Pressure pipelines shall undergo a hydrostatic pressure test. They shall be tested in sections not larger than 500 m, or as may be directed by the Engineer, and tests shall be made only on sections which are completed, except for backfilling over joints and fittings which are to be left exposed for inspection. Weights and thrust blocks intended to prevent lateral and vertical displacement of the pipes or specials must be completed and must have attained their design strength before tests are commenced.

Test sections shall be preferably carried out between shut-off or sectioning valves. Where this is not practicable, test sections shall be sealed off by suitable bulkheads, properly braced.

Prior to testing, air shall be evacuated from the line by filling it with water with all valves and taps open. After the first filling and the closing of all valves and taps, the water shall remain in the line for at least 48 hours to allow for absorption, and water being added as required to make up for losses. During this period the Contractor shall inspect the line and all fittings and valves installed on it for leaks. Any leaks found shall be promptly repaired by the Contractor, who shall then proceed with the test, unless otherwise noted on the drawings, in the particular specifications, or by the Engineer, the "Test pressure" measured at the lowest point of the section shall be equal to one of the following values:

For pressure gravity driven pipelines:

- (a) (1.5 x Rated Working Pressure) for rated working pressure equal to or less than 10 kg/cm² or the static pressure whichever is higher.
- (b) (Rated Working Pressure + 5.0 kg/cm².) for rated working pressures exceeding 10kg/cm² or the static pressure whichever is higher.

For lift pipelines:

Rated working pressure plus calculated water hammer surge plus 2Kgf/cm². The water hammer surge will be calculated as follows: $\Delta H = \frac{a \Delta V}{g}$

where:

ΔH = Water hammer surge

ΔV = design velocity as indicated on the drawings expressed as meter per second.

a = surge velocity expressed as meter per second ($a = 1100\text{m/s}$).

g = acceleration due to gravity in meters per second per second = 9.81 m/s².

The pressure shall be slowly raised by pumping to the required "Test Pressure". Pumping shall then be discontinued, the pump disconnected, and the line kept under pressure for at least 15

minutes. For the line to be accepted, the pressure shall not drop by more than 10% during the said 15 minute period and there shall be no visible leaks at joints, fittings, valves, etc. Should the drop of pressure exceed this value, the Contractor shall search for the defects causing such pressure drop, shall make all necessary repairs and repeat the test until the section under test meets the requirements. Provided always that all visible leaks must be repaired whatever the loss of pressure. The Contractor shall at his own cost provide all necessary test pumps, pressure gauges, cocks and other accessories and shall make such temporary connections as may be required for filling and testing the line in the manner herein specified.

The water used for pressure testing shall be provided by the Contractor and shall be free from impurities and of such a quality which will not pollute or injure the pipeline. The Contractor shall be responsible for obtaining the water, transporting it and for its safe disposal on completion.

217.3.11 Methods of Measurement and Payment

Asbestos-Cement pipes shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place measured along the crown of the pipeline as follows:

- In gravity flow lines: between internal surfaces of manhole or chambers.
- In pressure flow lines: between stations.

The length measured for payment shall include the lengths of all fittings, valves and specials installed in the line.

The price of fittings, specials, junctions, bends, etc. shall be considered as included in the cost of pipes, unless otherwise specified in the particular specifications or the B.O.Q.

Alternatively, if so stated in the Particular Specification and/or in the Bill of Quantities, pipes and fittings may be measured by numbers of pipes of defined net lengths and by number of fittings.

Payment for asbestos-cement pipes and for fittings, specials, etc. shall include:

- Supply, hauling, handling, unloading and stacking of pipes and fittings including all necessary A.C. joints and jointing materials for pipes and all A.C. and C.I. joints and jointing materials for fittings, specials, valves, etc.
- Removal from stacks; hauling and stringing alongside trench; laying and jointing of pipes and fittings at any depth of trench; connections to manholes and/or chambers, and final cleaning and flushing of pipeline. The unit rates for this item, for each type, class and diameter of pipe and fitting, shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of complete pipeline:
 - For gravity pipelines: the cost of testing shall be included in the unit rates for pipes and shall not be paid separately.
 - For pressure pipelines: the cost of testing shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid in trench and tested and accepted by the Engineer shall be measured for payment under the above items, and no allowance whatsoever will be made for any breakage, loss, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers and site test shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

217.4 STEEL PIPES AND FITTINGS

217.4.1 Quality Requirements

Steel pipes for use in the Works shall be made by an approved manufacturer and shall meet the requirements of B.S. 534, 1387, 3600 and 3601 or American Water Works Association Standard C202, or equivalent European standards, carbon content shall not exceed 25 percent. Unless specified otherwise all steel pipes shall have minimum pipe wall thickness schedule 40 for nominal pressures up to PN 40, for higher pressures NP 64 and more wall thickness should comply with schedule 80.

Pipe ends shall generally be plain squared for jointing with Viking-Johnson type couplings, or bevelled for butt welding joints or flanged with flanges according to B.S. 4504 for flanged joints or with a bell on one end for fillet welded lap joints.

Unless otherwise specified or directed by the Engineer, fittings, bends, branches, specials etc. for use with steel pipes shall be prefabricated, factory made and shall be equal in quality and strength to steel pipes. Ends of fittings etc. shall be plain squared, bevelled or flanged to fit pipe ends.

Steel pipes and specials intended for laying below ground shall be cement-mortar lined or epoxy lined internally, and epoxy or bitumen coated externally not less than 150 micron thick. The hot bitumen of the coating shall be wrapped with bitumen saturated asbestos felt or glass-fibre mat and whitewashed. Other types of linings or coatings which may be required shall be as detailed in the Particular Specification. The ends of pipes shall be left uncoated for jointing. Sufficient lining, coating and wrapping materials and implements thereto shall be provided to complete coating on uncoated sections after jointing and to make good after laying of pipes.

Steel pipes and specials to be laid above ground in open air shall be epoxy or cement mortar on the inside and painted on the outside not less than 150 micron thick.

Steel pipes and specials to be laid inside buildings shall be epoxy coated internally and externally 150 microns minimum thickness.

Mechanical joints for use with steel pipes shall be of the Viking-Johnson sleeve type made by an approved manufacturer. The joints shall be watertight when assembled and shall be sufficiently flexible to permit small deflections without impairing their watertightness. Rubber rings to be used with joints shall comply with the requirements of B.S 2494. The Contractor shall supply sufficient quantities of specially sized pipes for cutting of closure pieces and of Johnson Couplings without centre register to permit the insertion of closing sections in the pipelines.

Galvanized and black iron pipes and fittings shall comply with B.S. 1387 (Steel Tubes and Tubulars Suitable for Screwing to B.S. 21 pipe threads). Fittings not included in B.S. 1387

shall comply with B.S. 143 (Malleable Pipe Fittings) heavy quality. Pipes and fittings ordered galvanized shall comply with the requirements of the applicable Clauses of the above-mentioned British Standards.

The Contractor shall submit to the Engineer certificates from approved laboratories certifying that the pipes and fittings supplied comply with the requirements of the relevant specifications.

217.4.2 Hauling and Handling of Pipes and Fittings

Pipes and fittings shall not be allowed to drop, roll freely or strike objects which may damage them. When fitting pipes or fittings by their open ends, special hooks or plates shaped to fit the wall shall be used. Chaining will be allowed on bare pipes only; wrapped pipes shall be lifted by padded straps at least 20 centimeters wide. Care shall be exercised in transporting, handling or storing pipes and fittings in order to avoid distortion, flattening, denting, scoring or any other damage to pipes and fittings and to their outer coating and/or inner lining.

217.4.3 Stringing of Pipes

Pipes of the various diameters and wall thickness shall be strung along the alignment as closely as possible to their final position.

Pipes and fittings strung along the alignment shall be protected against intrusion of earth, mud, dirt and other foreign bodies, and against damage to the outer coating. Pipes shall not be strung on the side of the trench where excavation material has been or is to be placed. Where necessary or as directed by the Engineer gaps shall be left in stringing in order to allow movement of vehicles or men across the alignment. Wrapped pipes shall be whitewashed unless they have been supplied with whitewash and the latter is in good condition after stringing.

217.4.4 Handling of Mortar-Lined Steel Pipes

No internal hooks or similar equipment likely to damage the mortar lining shall be used. Excessive bending of the pipe that may cause cracking of the mortar lining shall be prevented.

217.4.5 Repairs of Defective Pipes

Should laminations, cracks or other defects be discovered on any pipe or its coating or its lining, the Engineer will issue instructions as to whether such defects shall be repaired or the defective part cut out or the defective pipe removed. Where the pipes were supplied by the Employer, he will pay the Contractor the cost of the repairs or other extra work necessitated thereby, but otherwise pipes shall be repaired or replaced by the Contractor at his own cost.

217.4.6 Welding of Pipes

(a) Welding Methods - All welds shall be made by the manual shielded metal-arc method. The welding procedure to be applied by the Contractor shall be submitted to the Engineer for approval, before the commencement of the work. All welding works shall be carried out by

welders having passed the welders qualification tests in accordance with B.S. 4871 part 1 and B.S. 4872 part 1, whichever is applicable. Welds will be either butt welds for plain-ended pipe joints or fillet welds for lap joints (bell and spigot). The use of welding machines with two outlets will not be permitted; every welder shall work with a separate machine.

- (b) Electrodes - Electrodes used for welding shall meet the requirements of B.S. 639 and B.S. 4215. Generally, with D.C. generators, Class E-100 (DCRP) electrodes shall be used. In any case, the electrodes proposed by the Contractor shall be subject to the Engineer's approval prior to their use.

Electrodes shall be stored in the unopened original containers in such a manner as to prevent absorption or loss of moisture or mechanical damage to the coating. Electrodes in open containers shall be protected against moisture. Electrodes that have been damaged, moistened or otherwise deteriorated, shall be rejected.

- (c) Cleaning of Pipes - Pipe ends to be welded together shall be thoroughly cleaned of any dirt, oil, residues of paint and asphalt, and any other foreign matter that may adversely affect the quality of the weld. Paint and oil residues shall be removed with kerosene or gasoline.
- (d) Welding of Joints - The number of beads in each weld seam shall be not less than two, and their thickness shall not exceed 3.0 mm.

In butt welds, the thickness and number of the beads shall be so adjusted that the height of the weld reinforcement shall be not less than 0.8 mm and not more than 1.5 mm above the pipe surface. The width of the cover bead shall be approximately 3.0 mm more than the width of the groove before welding. In fillet welds the thickness of the throat shall be at least $0.5\sqrt{2}$ (= 0.707) of the pipe wall thickness. Cutting back of the edge of the bell shall be kept to a minimum. All weld metal shall be thoroughly fused to the parent metal and to the previously placed weld metal.

After the completion of each bend, the weld shall be thoroughly cleaned of all scale, slag, or dirt. All spots on the weld where electrodes are changed shall also be cleaned. A peening hammer and steel brush may be used for cleaning, provided it is done to sound and bright metal. The finished seam shall be thoroughly cleaned by means of steel brushes.

- (e) Fitting -up of Pipes - In butt joints the root opening between the pipes shall be such as will ensure full penetration without burn-through in accordance with the approved welding procedure. When aligning pipes, the offset between pipe ends about to be joined shall be reduced to a minimum. External line-up clamps shall be used to centre pipes. Internal clamps may be used when approved by the Engineer.

The external line-up clamp may be removed only after 50% of the root bead has already been welded, in segments equally distributed around the pipe, not shorter than 7 cm each; their quality and thickness shall not be inferior to those required for root welding. The internal clamp may be removed only after the whole of the root bead has been welded.

In lap joints the plain end of one pipe shall be shoved in until it abuts against the shoulder of the bell, so that the gap between the mortar lining of the two pipes is reduced to a minimum.

- (f) Welding Positions - The welds shall be made either by roll welding or position welding. Roll welding will be permitted, provided alignment is maintained by the use of skids and

roller dollies supporting two or more lengths of pipe. Position welding shall be done with the pipes resting on skids at the proper height over or alongside the trench, so as to permit the completion of the weld on the whole circumference. All requirements as to the quality of the welds shall apply equally to roll welding and position welding.

- (g) Jointing of Line Sections - Pipes shall be connected to each other by welding as specified above, while they are placed on suitable supports on the trench bottom or on the ground beside the trench.

The length of sections to be welded together before lowering them into the trench shall be as directed by the Engineer. The position of every pipe or elbow in the section shall be such that, when the section has been lowered to the trench bottom the longitudinal seams will be located between the figures 10 and 2 on the clock face, so that repairs on the seams can be done in the trench without necessitating deep excavation.

Before being connected to the line, the inside of each pipe and each elbow shall be cleaned.

- (h) Welding Mortar-lined Pipes - When butt-welding mortar-lined pipes, the Contractor shall take steps to ensure the continuity of the lining at the joints. The materials and methods employed to this end shall be as recommended by the manufacturers of the pipes, and approved by the Engineer or as directed by the Engineer. The cost of all materials and work required to ensure the continuity of the cement-mortar lining shall be deemed to be included in the unit rates for supply, laying and jointing of the pipes and shall not be paid for separately.

In pipes with lap joints which are not accessible from the inside, a sufficient quantity of mortar shall be placed in the bell just before the new pipe is shoved in. After the new pipe is laid in place, excessive mortar shall be removed and the inside of the joint finished by pulling a rubber ball or equivalent through the joint. Where the inside of the pipe is accessible, the mortar lining at the joint shall be completed by plastering on with a good bond to the existing lining and trowelling smooth and flush with the adjacent mortar lining. The mortar employed as specified above shall conform in all respects to requirements of Subsection 217.4.9 of this Specification.

- (i) Repair of Weld Defects - The Engineer may permit repairs of defects in the root or filler beads to be made, but any weld that shows evidence of repair work having been done without such permission may be rejected. Pinholes and undercuts in the final bead may be repaired but such repairs shall be subject to the Engineer's approval. Undercuts not exceeding 1.0 mm in depth will not be considered as defects.

Before repairs are made, the defective areas shall be removed by chipping, grinding, or flame gouging. Any slag and scale shall be removed by wire brushing. When cracks are found, the entire seam shall be cut away and rewelded.

The Contractor shall clearly mark with oil paint on top of the pipe any defect that has been discovered in the pipe or weld.

217.4.7 Miscellaneous Welding Works

- (a) Cutting and Preparing Pipes for Welding - The plane of square cuts shall be perpendicular to the pipe axis. Oblique cuts shall be accurately made to the required angle and in such a

manner that the cut edge is in one plane. Pipe ends for butt welding shall be bevelled to an angle of 30° with the plane of the edge, with a permissible deviation of 0° to +5°. All cutting shall be done by mechanical tools, or by acetylene flame-cutting by means of a special cutting device or by Arc-air (carbon electrode with air jet). Flame cut surfaces shall be perfectly clean, and where necessary, the cut surfaces shall be filed smooth. Mortar-lined pipes shall always be cut by Arc-air cutting equipment. After the metal has been cut through to the mortar lining, the latter shall be carefully broken along the cut and the pipe edge prepared for welding as required above.

- (b) Welding of Flanges - The welding of flanges to pipes shall be of the same quality as that specified for pipe welds. Slip-on flanges shall receive an interior weld inside the flange opening, in addition to the external weld. Weld-neck flanges shall be attached to pipe ends as specified above for the welding together of pipes, care being taken to ensure a perfect concentric alignment between pipe and flange.

Flanges shall be welded to pipes very carefully, so that the faces of the flanges shall be truly perpendicular to the pipe axes. Flange faces shall be kept free from weld material or other defects such as splutter, dirt, etc. All defects in flange faces that may interfere with the proper sealing of flanges shall be repaired.

- (c) Fabricated Fittings - Where shown on the Drawings or where directed by the Engineer, fabricated fittings, specials, etc., as specified hereafter, will be used instead of factory-made fittings.

Welded elbows shall consist of suitable obliquely cut pieces of pipe (“mitres”) welded together. The mitres shall be cut to the exact dimensions shown on the Drawings and accurately fitted together so that after welding the completed elbow will have the exact shape and dimensions shown on the Drawings. The ends of mitres shall be bevelled for welding as specified above. In all elbows of 12” (300 mm) diameter and larger the seams between mitres shall also receive an internal weld pass which shall be made after the weld root has been thoroughly cleaned.

Fabricated T and Y branch connections shall be produced by cutting the branch pipe to the correct intersection fitting the curvature of the main pipe, cutting the required opening in the main pipe and welding the branch to the main pipe. Where shown on the Drawings or instructed by the Engineer the fabricated T and Y branches shall be reinforced by welded saddles. The saddle shall be cut and bent to the required shape and slipped over the branch, its outside edges shall be welded to the main pipe while the edge of its opening shall be welded to the branch pipe.

The quality of welds shall be as specified for pipe connections. The inside of the pipe intersection shall be cleaned and smoothed to ensure unobstructed flow in the pipe.

Pipe reducers shall be fabricated from steel plate properly cut, rolled and welded or by cutting out wedge-shaped pieces from a length of pipe the diameter of which shall be equal to the larger diameter of the required reducer, squeezing the pipe together to the shape of the reducer and welding along the cut edges, which shall be straight and bevelled for welding, the gap between them being of uniform width over the whole length. On reducers of 12” (300 mm) diameter and larger an internal pass shall be added to each weld, which shall not protrude more than 1.5 mm into the inside of the pipe. The end planes of the reducer shall be parallel to each other and truly perpendicular to the pipe axis and shall be bevelled for butt welding.

In all fabricated fittings, the quality of welds shall be as specified for welded pipe connections and the insides of intersections shall be cleaned and smoothed to ensure unobstructed flow in the pipe.

- (d) Prefabricated Fittings - Prefabricated elbows, tees and reducers shall be jointed to pipes by square butt welds or by lap welds or by flanges, all as specified above for pipe-welding, care being taken that the true alignment and correct position of the fitting are ensured.

217.4.8 Installation of Valves and Fittings

- (a) General - Before being installed, valves, fittings, and especially valve seats, shall be cleaned of any dirt. The correct positioning of valves shall be ensured by means of a spirit level. Flanges shall be welded to the pipes in accordance with the requirements of Subsection 217.4.7 (b) above.

Fitting the valves to pipes shall be done accurately, but without using force. Fitting of valves by tightening bolts forcibly or by any other method that may cause internal stresses in valves or flanges will not be permitted.

- (b) Bolts - Only bolts of the correct diameter shall be used. All bolts used on a valve shall be of equal length, which shall be such that after the nut has been tightened not less than one thread and not more than three threads of the bolt will protrude from the nut. Bolts shall be tightened crosswise, gradually and uniformly.
- (c) Gaskets - Only one sealing gasket shall be used between each pair of flanges. Gaskets shall be of the ring type, i.e. their outer rim shall just touch the bolt holes and their inside diameter shall be equal to that of the corresponding pipe.

Gasket material shall be either fabric reinforced rubber or compressed asbestos sheets of a type and make approved by the Engineer. Gaskets shall be fabricated by cutting from sheets. Cutting gaskets by hammering on the flange will be strictly prohibited. When being installed, the gaskets shall be absolutely clean. Each gasket shall be used only once.

- (d) Gate Valves - Before installation, each valve shall be fully opened and cleaned on the inside with a clean rag soaked in kerosene. Then the valve shall be completely closed and the flange faces also cleaned with kerosene. After cleaning, the flange faces shall be protected with wooden or cardboard covers, which may be removed only just prior to installation of the valve.
- (e) Butterfly Valves shall be installed between companion flanges welded to the pipe ends, in accordance with manufacturer's instructions.
- (f) Mechanical Couplings shall be of the "Dresser", "Viking-Johnson" or "Victaulic" type, as shown on the Drawings. Ends of pipes to be jointed by Victaulic couplings shall be fitted with accurately machined rings. Ends of pipes to be jointed by Dresser couplings shall be clean of paint, coating or other foreign matter and shall be sufficiently round for at least 20 cm from the pipe edge so that joint rings and couplings shall slide freely onto pipes; no forcing on rings by hammer blows will be permitted. All joint components and pipe ends shall be cleaned and inspected before installation of joint. Rubber gaskets shall be kept in a clean and dry place and protected against sunshine until immediately before installation.

Coupling bolts shall be tightened evenly and gradually with sufficient force to attain a tight joint but without causing undue stresses in bolts or joint components. All mechanical coupling shall be bonded and bridged for electrical continuity.

217.4.9 Lining, Coating and Painting of Pipes

- (a) General - Where noted on the Drawings, and/or required in the Specification or Bill of Quantities and/or directed by the Engineer, steel pipes, fittings and specials shall be protected against corrosion by internal linings or external coatings or by both internal linings and external coatings. Internal protection shall be provided by cement-mortar, or bitumen linings. External protection shall be provided by reinforced bitumen, or point coatings. Other types of linings and coatings may be required in the Particular Specification.
- (b) Cement-Mortar Lining -Where required, steel pipes, fittings and specials shall be internally cement-mortar lined in accordance with the provisions of B.S. 534. Cement-mortar lining for specials and short unlined pipe sections, and repairs to damaged existing lining shall be carried out by hand, to the approval of the Engineer.

Where hand applied lining is approved by the Engineer, the materials, the preparation and the application of the cement-mortar shall conform in all respects to B.S. 534. The mixing of mortar shall be done in a suitable mechanical mixer until a homogeneous mixture of uniform colour and of the required consistency is obtained. The quantity of mortar prepared at a time shall not exceed that required for a half an hour's work.

The steel surfaces to be lined with cement-mortar shall be cleaned thoroughly from dirt, oil, grease, traces of paint or mortar, slag, heavy rust and mill scale. Light rust adhering to the steel surface can be left. Immediately before applying mortar, the steel surface shall be wetted.

Cement-mortar shall be applied to the inter surface of the pipe or special by a steel trowel to the thicknesses specified in B.S. 534. The cement-mortar lining shall be given a smooth surface with a steel trowel and shall be finished off flush with the ends of the pipe or special. Curing compound shall be applied to the lining immediately after its completion to prevent its rapid drying.

The cement-mortar lining at pipe ends shall be of full thickness and shall end flush with the pipe edge. Small defects and depressions not exceeding 1.5 mm in depth are permissible, provided that their aggregate length does not exceed half the pipe circumference. When larger defects or cracks are found in the lining, the pipe will be rejected unless the Engineer permits repair of the lining or cutting away of the defective sections of the pipes. To repair defects in the cement-mortar lining, the defective portion of lining shall be removed to sound and undisturbed mortar, the metal shall be cleaned and new cement-mortar shall be applied as specified. The thickness of the new lining shall be equal to that of the existing lining and shall be finished smooth and flush with it. The mortar of the repair shall be well bonded to the pipe metal and to the existing lining.

- (c) Bitumen Lining - Where required, steel pipes, fittings and specials shall be internally bitumen-lined in accordance with B.S. 534 and B.S. 4147.

- (d) Bitumen Coating on Underground Piping - Underground steel pipes shall be externally protected by a fiberglass reinforced bitumen coating, in accordance with B.S. 534, B.S. 3415 and B.S. 4147.

The coating will be of the Single Wrap or Double Wrap, or Multiple Wrap type as indicated on the Drawings or in the Particular Specification. Pipe ends to be welded shall be bare. All valves, fittings and pipe to be laid below ground and which have not been factory-coated shall be supplied with an anticorrosive priming and receive a bitumen coating in-situ.

The Contractor's work under this Subsection shall include coating of weld joints; the repair of defects in factory-applied coating and the coating of primed or bare pipes, fittings and valves.

In-situ coating applied by the Contractor shall be equal in all respects to factory-made coatings. Repairs, coating of welds on coated pipes and the coating of bare pipes and fittings shall be bonded to the existing pipe coating so that a continuous uninterrupted coating over the entire length of pipeline is achieved. No joint shall be coated before the Engineer's approval to proceed with coating has been given.

After all joints, bare sections, valves and fittings and defects in coating have been coated and repaired as specified and before lowering the coated steel pipe into the trench, the continuity and integrity of the coating shall be tested by means of an electric Holiday detector, in accordance with A.W.W.A. Specification C203-62 Section 3.13, in application to a single bitumen coat. Test voltages for multiple coats shall be specified by the Engineer.

All defects in coating shall be repaired and retested.

- (e) Painting of Exposed Piping - The metal surfaces of all pipes laid above ground together with valves, straps and supports as well as all steel structures shall be painted as specified in Subsection 207.1.7 of this Specification.

The outside surface of coated bitumen pipes shall be given a coat of water-resistant whitewash to protect the bitumen from sunlight and overheating.

217.4.10 Laying of Steel Pipelines

Steel pipes shall be laid underground in trenches, or above ground on supports, or built-in in earth or concrete works, as shown on Drawings or directed by the Engineer. All joints between pipes and between pipes and fittings shall be done by welding or by flanges or by mechanical joints, as shown on Drawings or as directed by the Engineer.

Before lowering in, the pipe coating shall be inspected and all defects repaired. Lowering the pipes into the trench shall be done by pipelayers or other equipment acceptable to the Engineer, so that no damage or deformation is caused to the pipes or the coating and lining. Welded pipes shall be laid on the finished trench bottom, so that each pipe is supported over its entire length.

Where valves, or flanges or mechanical joints are to be installed, or overhead welds are to be made in the trench, the latter shall be widened and deepened by additional excavation around

the pipe in order to provide working space (bell holes). Before joining each pipe to the line a cleaning swab with a cable attached to it shall be introduced into the pipe last welded before the new pipe. When the welding to the line has been completed the swab shall be pulled forward by means of the cable through the new pipe, thus cleaning and removing all slag, metal, dirt and foreign matter which may have accumulated inside the pipe. Where pipes are large enough to be entered by workmen, the said cleaning shall be done by hand.

At the end of each working day and whenever work is discontinued for a considerable time, the ends of each welded section whether in or alongside the trench shall be closed by a suitable cover snapping onto the pipe end.

Lowering-in of pipes or placing them on permanent supports shall be done carefully to prevent damage to pipe coating or paint. To prevent pipes from slipping out of mechanical joints or excessive stresses building up in welds as a result of temperature changes, lowering-in of pipes and joining of sections shall be carried out in the early morning only.

The first stage backfill of the trench shall be done before the final tie-in welds or bolted connections (in the case of mechanical joints or flanges) are made, leaving a stretch of about 20 m uncovered on either side of such final joint.

217.4.11 Weld Inspection and Tests

- (a) General - The Engineer will exercise a continuous control of the welding work and will inspect the quality of the welds. In addition to routine supervision and visual inspection of the completed welds, the Engineer will have the right to request samples to be cut out from welds for destructive tests and to order the welds to be tested by radiography.
- (b) Destructive Tests - Destructive tests shall include all or some of the following, at the discretion of the Engineer:
- Break Test
 - Bend Test
 - Tensile Test (in special cases only)

Both the Contractor and the Engineer will endeavour to ensure the proper execution of welds, so as to avoid altogether or minimize the number of destructive tests.

Should one of the samples taken for the destructive tests fail to meet the standards of acceptability set out below, the Contractor will be required to cut additional samples from the same weld or from other welds made by the same welder. If any of the new samples fails to meet the requirements, the Contractor will cut more samples for testing until a clear picture of the extent of defective welds is obtained.

Should such additional tests show that the quality of the welds is unacceptable, as determined by the Engineer, the Engineer may require the Contractor to remove and reweld all welds made by the welder concerned.

Unless otherwise specified, the cost of cutting the sample and preparing and testing the specimens, and that of patching the pipe where the sample has been cut out, as well as the cost of all additional tests that may be required to determine the extent of defective welds as aforesaid, shall be borne by the Contractor and deemed to be included in the various unit rates.

Samples for Bending, Breaking and Tensile Tests shall be cut out from the pipe in the form of strips 5 cm wide, perpendicular to the weld seam and extending 10 cm on either side of the weld, so that the weld will be located in the centre of the sample. The opening resulting from cutting the sample shall be closed by welding on a patch of steel plate having a thickness not less than that of the pipe wall. The cost of patching up openings as herein described shall be included in the cost of taking samples as specified above.

The bend test samples shall be bent in a suitable jig in the field or in the shop. The bend shall be located exactly over the weld with the weld face on the convex side. The sample shall be considered to have met the requirements if it does not break and no cracks larger than 3 mm in any direction appear on the convex side of the bend.

The break test samples shall be hacksaw-notched on both edges across the centre of the weld to ensure breaking of the sample in the weld. The sample shall be supported on both sides of the weld and broken by a strong hammer blow. For the weld to be acceptable, the broken surface shall show full penetration of the weld and no burns or

excessive slag inclusions. The broken surface shall show no more than one gas pocket per square centimeter, provided that no gas pocket has a diameter larger than 1.5 mm.

Samples for tensile strength and elongation tests shall be sent for testing to an authorized laboratory. These tests will serve as a control of the welding procedure and of the quality of the electrodes, but not to test the welder's ability. In this test the samples shall show a tensile strength not less than that required of the steel of which the pipes are made.

- (c) **Radiographic Tests** - Where required, radiographic tests shall be performed in accordance with B.S. 2910. Unless otherwise specified, 10 (ten) percent of all weld seams shall be radiographed. If these primary tests should not give satisfactory results, the Engineer will conduct additional radiographic tests to ascertain the quality of the welding work. All weld defects discovered by the tests shall be repaired as directed by the Engineer and all repaired welds shall be retested.

The cost of the routine radiographic test (10 percent), as well as any additional tests which the Engineer may think it necessary to conduct because of the defective quality of the welds, shall be borne by the Contractor and deemed to be included in the various unit rates. The Contractor shall also bear the cost of repair of all welds found defective under test as well as the cost of retesting such repaired welds.

217.4.12 Hydrostatic Pressure Test

After pipelaying, casting of concrete structures on the line and partial backfill have been completed, the pipeline shall be subjected to a hydrostatic pressure test. The line shall be tested over its entire length or, in the case of long lines, in sections, as approved by the Engineer. Pressure tests shall be performed only in the presence of the Engineer.

The magnitude of the test pressure, the testing procedure and all other requirements shall be as described in Subsection 217.3.10 (b) of this Specification, except that the Hydrostatic Pressure Test can commence 24 hours after the completion of filling, if permitted by the Engineer.

217.4.13 Methods of Measurement and Payment

Steel pipes shall be classified for payment according to type of joint, diameter and nominal pressure, and shall be measured in linear meters of completed pipeline in place measured along the crown of the pipeline. The length measured for payment shall include the lengths of all fittings, valves and specials installed in the line.

Price for fittings, bends, junctions, specials, detachable joints, flanges (where not an integral part of pipe or fitting), etc., shall be considered as included in the cost of pipes, unless otherwise specified in the particular specifications on the B.O.Q..

Payment for steel pipes and for fittings, specials etc... shall include:

- Supply, hauling, handling, unloading and stacking of pipes and fittings including all necessary jointing materials, electrodes, gaskets, nuts and bolts etc. for pipes and fittings and factory coating and lining up of all pipes and fittings.

- Removal from stacks; hauling and stringing alongside trench; laying and jointing of pipes and fittings by welding (including square and mitred welds, both in and above trench) and/or mechanical joints; field coating and lining of joints and of pipes and fittings where required and all repairs to factory coatings and linings, including supply of all necessary materials; inspection and testing of coating, weld inspections and welders' qualification tests; and final cleaning and flushing of pipeline. The unit rates for this item, for each type, wall thickness and diameter of pipe and fitting, shall be the same for all depths of trench in which the pipes and fittings are to be installed.

Only pipes, fittings, junctions, bends etc. actually laid in trench and tested and accepted by the Engineer shall be measured for payment under the above items, and no allowance whatsoever will be made for any waste, loss, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

- a) Testing of completed pipeline - the cost of carrying out hydrostatic pressure test, as specified, shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.
- b) Valve Assemblies for which items have been included in the Bill of Quantities shall be classified according to their diameter and measured for payment by the number of complete units as described.

The unit rate for a valve assembly shall include for: the supply of the valves complete with counter-flanges and accessories; supply of gaskets, bolts and nuts, all welding electrodes, paints and coating materials; cleaning and complete installation of the assemblies, inclusive of all cuts and welds; fitting up of flanges and fittings, placing them in their exact position and completing the joints, inclusive of tightening of bolts and anchors; bridging of mechanical joints; making good of paint and coating and sealing off pipes passing through chamber walls.

- c) Pipe Assemblies that are described as such in the Bill of Quantities shall, for purposes of payment, be measured by the number of complete units within the limits shown in the Drawings and/or defined in the relevant items of the Bill of Quantities.

The price of each assembly shall include for the necessary excavation and backfill; supply of all pipes, accessories, joints, valves, supports and all other parts of the assembly; cutting, fitting, welding, jointing and installation of pipes in position; fixing of supports for pipes; internal and/or external coating as required; testing of welds; pressure tests of the assembly and all other works required for the fitting of the completed assembly between the limiting points.

- d) Various Welding and Installation Works - In case of measurement of welding and installation works - whether as separate items in the Bill of Quantities or for the purpose of varying any of the rates for complete assemblies under Subsection (d) and (e), or if the Engineer should deem such separate measurement necessary for any other reason - such works shall be measured and paid for as provided in the following paragraphs (1) and (5).

The necessity for such measurement will in each case be determined by the Engineer. Measurement will be by number, classified by type and size as detailed in the Bill of

Quantities. The unit rates shall include everything as detailed below and in addition also the supply of all materials and all additional excavation necessary for installation.

- 1) Square and Mitre Welds: The unit rates shall include for the necessary cutting, bevelling, fitting-up and welding of pipes as specified.
- 2) Welding of Tee, Y and Weld-O-Let Outlets: The unit rates shall include for cutting, shaping, bevelling, and welding the outlet pipe to the main pipe, as well as for cutting the opening in the main pipe.
- 3) Welding Flanges: The unit rate shall include for squaring the pipe end as required, welding-on the flange to the pipe at right angles to the pipe axis and for both the external and the internal welds. Welding of weld-neck flanges will be considered as a square weld under (1).
- 4) Fabrication of Pipe Reducers: The unit rate for fabricating a pipe reducer shall include for cutting the pipe to required length, cutting out wedges in the pipe wall, tapering the reducer to the correct shape and welding the longitudinal seams.
- 5) Making of Flanged Connection and Mechanical Joints and Installation of Valves and Fittings: The work shall include cleaning and fitting-up of flanges, joints, valves, etc., installation of joint rings, gaskets etc.; insertion and tightening up of bolts, nuts and washers; and welding on of anchor lugs and installing of threaded rods in anchored "Dresser" couplings, where required.

The cost of the work described in Paragraphs (1)-(5) above shall be deemed to be included in the various items of supply, laying and jointing of steel pipes and fittings and shall not be paid for separately.

- e) Inserting of Line Pipe in Casing shall be measured, separately for each diameter of line pipe, in linear meters by the length of the casings and shall be paid as an extra over the price for pipelaying. The unit rate inserted in the Bill(s) of Quantities for inserting line pipes in casing shall be deemed to cover the cost of the supply and hauling of casing pipe, welding of casing pipe sections, supply and spacing of spacers, coating of casing pipe where practicable, installing line pipe in casing and sealing of openings at both ends of casing pipe.

217.5 CAST IRON AND DUCTILE IRON PIPES AND FITTINGS

217.5.1 Quality Requirements

All cast iron and ductile iron pipes and fittings to be supplied under this Specification shall be obtained from approved manufacturers. They shall be of the class and shall have joint ends as shown on the Drawings or as specified and shall otherwise comply in all respects with B.S. 4622 - Grey Iron Pipes and Fittings, and B.S. 4772 - Ductile Iron Pipes and Fittings.

- External Coating: pipes and fittings shall be given an external coating of zinc in accordance with ISO 8179 or BS 4772 and a finishing coating of either cold applied bitumen complying with the performance requirements of BS 3416 Type II material, or hot applied bitumen to BS 4147 Type I Grade C.

- Internal Lining: All pipes and fittings shall be lined internally with cement mortar and shall comply with ISO 4179 or BS 4772. The inside of the sockets shall be coated with bitumen as used for the finishing coating to the pipes.

While the pipes are still suspended over the trench before lowering or before mounting, they shall be inspected for defects and rung with a light hammer to detect cracks. Defective pipes shall be dismantled, removed from the site and replaced by flawless pipes. Only pipes inspected and accepted on the site by the Engineer shall be incorporated into the works.

217.5.2 Hauling and Handling of Pipes

The Contractor shall check each pipe before loading and shall reject all damaged or defective pipes. The Contractor shall load and properly secure the pipes on the vehicles and take all necessary measures to prevent any damage to the pipes during transport. The Contractor shall be responsible for the quality of the pipes and for their condition upon and after delivery to the site, and shall immediately remove from the site any damaged or defective pipes and replace them at his own expense.

No pipes or fittings shall be allowed to drop, roll freely or strike objects which are likely to damage them. Special care shall be taken not to spoil the tar or bitumen coating.

217.5.3 Laying and Jointing

- (a) Laying - Before C.I. or Ductile pipes are laid, all dirt and foreign matter shall be removed from inside and all lumps blisters, excess coal tar, oil, grease and moisture shall be eliminated from the surfaces of the joints. After the pipe is laid and mounted, care shall be taken to avoid entrance of dirt, water and foreign matter from the trench or from elsewhere by the use of tight bulkheads.
- (b) Jointing of cast iron pipes and fittings - Joints shall be flanged; or mechanical joints; or rubber gasket "push-in" flexible joints, all as specified and/or shown on Drawings.
- (c) Jointing of ductile iron pipes and fittings - Joints in ductile iron pipes and fittings shall be of one of the following types according to the Drawing and the Particular Specification:
 - Spigot and socket joint with rubber gasket
 - Flanged joints
 - Mechanical joints

All joints shall conform to B.S. 4772.

217.5.4 Testing

Testing instructions and requirements for Cast Iron and Ductile Iron pipelines shall be as specified in Subsection 217.4.12 for steel pipelines.

217.5.5 Methods of Measurement and Payment

Cast Iron pipes and Ductile Iron pipes and fittings shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place, measured along the crown of the pipeline. The length measured for payment shall include the lengths of all fittings, valves and specials installed in the line.

The price for fittings, bends, junctions, specials, detachable joints, flanges (when not integral part of pipe or fitting) etc. shall be considered as included in the cost of pipes, unless otherwise specified in the particular specifications or the B.O.Q.

Alternatively, if so stated in the Particular Specification and/or in the Bill of Quantities, C.I. and Ductile Iron pipes and fittings may be measured by number of pipes of defined net lengths and by number of fittings.

The payment for C.I. and Ductile Iron pipes and (under separate items) for fittings, bends, junctions etc. shall include:

- Supply, hauling, unloading and stacking of pipes and fittings including all necessary joints and jointing materials.
- Removal from stacks, hauling and stringing alongside the trench, laying and jointing of pipes and fittings at any depth of trench, connections to manholes and/or chambers and final cleaning and flushing of pipeline. The unit rates for this item for each type, class and diameter of pipe and fitting shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of completed pipeline
 - For pressure and gravity pipelines shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid, jointed and tested and accepted by the Engineer shall be taken into account for payment under items and no allowance whatsoever will be made for any breakage, loss, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

217.6 G.R.P. PIPES

217.6.1 Quality Requirements

a- Manufacturers Pre-qualification

GRP pipes and fittings shall be manufactured by an established pipe Manufacturer in a purpose-built facility for the production of such materials. The Manufacturer shall have at least 5 years experience at the facility in the production of the full range of pipe diameters (25 - 3000 mm) pipe, fittings and related products. Evidence of previous experience shall be presented. The Manufacturer shall have an approved Quality Management System complying with ISO 9001 which shall cover all activities being undertaken during the manufacturing, supervision and installation of the subject pipe systems.

b- Applicable Codes and Standards

The following internationally accepted standards are the minimum requirements for the manufacture of GRP Pipe Systems and should be referenced throughout the Project Specification where appropriate.

| | |
|------------|--|
| AWWA C950 | Glass Fiber Reinforced Thermosetting Resin Pressure (Latest Edition). |
| ASTM D3262 | “Fiberglass” (Glass - Fiber - Reinforced Thermosetting - Resin) Gravity Sewer pipe. |
| BS 5480 | Glass reinforced plastics (GRP) pipes, joints and fittings for use for water supply or sewerage. |
| ASTM D3517 | Specification for Glass Fiber Reinforced thermosetting resin pressure pipe. |
| ASTM D3754 | Specification for GRP sewer and industrial pressure pipe. |

c- Product Description**c.1- General**

The GRP pipe shall consist of a corrosion resistant liner, a structural wall and a resin rich exterior layer. The resin to be used is of the Isophtalic type.

Liner

Pipe and Fittings shall have a resin rich liner consisting of a 0.25mm thick resin rich layer and “C” glass backed by a 0.75mm thick layer with a resin glass ratio of 70:30.

Structural Wall

The pipe structural wall shall be as specified in AWWA C950-01 Sec. 4.3 cell classification system with the resin systems to be the appropriate grade of Isophtalic as required by the system type and operating conditions.

External Layer

Pipe shall have a 0.01” (0.30mm) thick resin rich exterior surface impregnated with Isophthalic resin as required by the system type and operating conditions.

c.2- Materials

- Glass Reinforcements shall be compatible with the impregnating resin used.
- Resins used shall be a commercial high grade thermosetting Isophthalic type as specified under Section c.1 above.
- No dark pigments shall be used in the GRP pipe or joints. No additives shall be used except when required for viscosity control.
- Aggregates and Fillers use shall be limited to 30% maximum for any Pressure Application. Care should be taken to ensure no aggregate becomes embedded in the resin rich liners.
- All GRP pipes and fittings conveying potable water shall be certified and listed for potable water use by internationally recognized independent water authority such as the Water Research Council “WRc”, the DVGW, KIWA, Lyonnaises Des Eaux, or NSF etc..

d- Requirements

d.1- Wall Thickness

GRP pipe systems up to and including 2000 mm diameter shall be of the solid wall type. The wall thickness required for each size/pressure and stiffness class shall be established by the Manufacturer to meet the design requirements but in no case shall wall thickness be less than $(0.010 \times ND)$; where ND is the nominal pipe inside diameter. The pipe working pressure class shall be based on the Hydrostatic design basis (HDB) of the pipe with a design (service) factor of 0.5.

d.2- Length

GRP (Standard = 6 or 12 Meters) pipe shall be manufactured in standard laying lengths of not greater than 12 meters. Random short lengths, if supplied, shall not exceed 5% of the quantity supplied of each size. The tolerance on the Manufacturer’s declared laying length shall not exceed ± 25 mm.

d.3- Diameters

Pipe shall be manufactured in standard metric sizes based on the pipe nominal inside diameter in sizes 25mm and larger. The actual inside diameter shall not vary from the nominal inside diameter by more than 1.5% or 4 mm whichever is greater.

d.4- Stiffness

The pipe stiffness shall be determined by the Manufacturer to meet the design requirement with particular regard to installation method, burial depths, deflection limits, buckling and vacuum requirements, in accordance with AWWA M45. However, stiffness shall be at least 5000 N/m² or as stated in the drawings or in the particular specifications.

d.7- Joints

Standard buried pipe with unrestrained joints shall be filament wound GRP coupling, with two rubber ring gaskets. Rubber rings shall be suitable for the intended application. Joints shall allow for at least 0.75 degree deviation while remaining water tight at 1.5 times the pipe operating pressure. The rubber rings shall be the sole element depended upon for water tightness. This system will require thrust blocks at changes in direction to accommodate thrust loads.

d.8- Workmanship

- GRP pipe, fittings and joints shall be free from de-laminations, cracks, bubbles, pinholes, pits, blisters, foreign inclusions and resin-starved areas that due to their nature, degree or extent detrimentally affect the strength and serviceability of the pipe. No glass fiber reinforcements shall penetrate the interior surface of the pipe wall.
- Joint sealing surfaces shall be free of dents, gouges, de-laminations, or other surface irregularities that will affect the integrity of the joints.
- GRP pipe, fittings and joints shall be as uniform as commercially practicable in color, capacity, density and other physical properties.

d.9- Fittings

- GRP fittings such as bends, tees, junctions and reducers shall be equal or superior in performance to the GRP pipe of the same diameter and pressure. All fittings shall be have a smooth internal surface with similar wall construction.
- For GRP fittings, the deviation from the stated value of the angle of change of direction of a bend, tee, junction etc. shall not exceed ± 1 degree.
- The tolerance on the Manufacturer's declared length of fitting shall be ± 10 mm taken from the point of intersection to the end of the fitting or ± 10 mm on a straight fittings.
- All GRP fittings shall be fabricated in the factory to ensure Quality Control (under no circumstance shall fabrication of fittings be allowed on site by Contractor). Complex fittings arrangements may be pre-assembled by the pipe Manufacturer in the factory such that field joints are kept to a minimum.

e- Design Parameters

Pipe shall meet the following minimum design requirements:

- | | |
|---|--|
| – Operating Pressure (Pw) | As specified; Min 1000 Kpa for Pressure pipes |
| – Surge Pressure (Ps) | 40% of 'Pw' unless otherwise specified. |
| – Vacuum (Pc) | As specified. |
| – Minimum Earth Cover | 1.0 m or as shown on drawings for buried pipe. |
| – Initial Installed Deflection for Buried pipe | 2.0% Max. |
| – Long Term Installed Deflection for Buried Pipe | 5.0% Max |
| – Safety factors | |
| Pressure Rating | ≥ 1.8 |
| Ring Bending Strain (stress) | ≥ 1.5 |
| Combined Strain (stress) | ≥ 1.5 |
| Buckling | ≥ 2.5 |

The Contractor shall be responsible for implementing / installing the correct design for each GRP pipe system.

f- Inspection & Testing

- f.1- The Manufacturer shall take adequate measures in the production of the GRP pipes and fittings covered by this specifications to assure compliance with the requirements herein. An Inspection and Testing Plan (ITP) should be established by the Manufacturer. Plant inspection by the Engineer and/or the Contractor's qualified

personnel or the omission of such inspections shall not relieve the Manufacturer of the responsibility to furnish products complying with the requirements of the minimum manufacturing requirements given herein.

- f.2- Production and Testing Notice - When plant inspection is required by the Engineer or the Contractor, the Manufacturer shall provide adequate advance notice of when and where production and testing of ordered products will commence.
- f.3- The Engineer and the Contractor shall have free access with reasonable advance notice to the Manufacturer's plant areas that are necessary to assure that products comply with all requirements herein.
- f.4- As a minimum the following tests shall be performed at the indicated intervals unless otherwise agreed-upon, and shall form a part of the Manufacturers overall quality control program.

The following tests shall be conducted on every pipe;

- Visual Inspection, as per manufacturer standard
- Dimension Measurements, as per manufacturer standard
- Resin cure (Barcol Hardness), ASTM D2583
- Hydrostatic Pressure test for pipe up to 2000 mm in diameter, ASTM D3517

The following tests shall be conducted on pipe samples at a frequency of not less than one per 50 pipes (one lot) of the same Diameter and Pressure.

- Stiffness, ASTM D24313 or BS5480 App. H.
- Hoop Tensile Strength by split disc, ASTM D2290 or BS5480 App. C or D.
- Longitudinal Tensile Strength, ASTM D638 or BS5480 App. A
- Loss on ignition (composition), ASTM D2584

The Supplier shall submit to the consultant qualification test reports for the following test:

- HDB in accordance with ASTM D2992 procedure B or BS5480 App. E
- HDB reconfirmation in accordance with ASTM D2992 section 12
- Cyclic test
- Long term ring bending test in accordance with ASTM D5365-93
- Coupling tightness in accordance with ASTM D4161 or BS5480 App. M

The supplier shall give evidence that the GRP pipe produced in his own plant has successfully passed the above mentioned tests. All these tests should be conducted in the plant and witnessed by a third party. If so directed by the Engineer, the selection of samples and the tests shall be witnessed also by a representative of the Engineer, who shall be informed at least 48 hours in advance of any sampling or testing.

Test methods shall be in accordance with AWWA C950-01 and BS 5480 or other relevant standards. Copies of all test reports shall be submitted to the Engineer for each lot delivered to Site.

The cost of samples, their transportation to the laboratory and their testing shall be deemed to be included in the unit rates and shall not be paid for separately.

f.5- Pipe Data Sheet should be as follows:

| | | |
|---|------------------|-------------------|
| <u>Nominal Diameter (ND)</u> | | (mm) |
| Service (Specify) Underground / Aboveground | | KPa |
| Rated Working Pressure | | KPa |
| Allowable Vacuum | | Kpa |
| <u>Pipe Wall</u> | | |
| Nominal total thickness | | mm |
| Inner Liner | Thickness | mm |
| | Resin Type | |
| | Glass Type | |
| Structural Wall | Thickness | mm |
| | Resin Type | |
| | Glass Type | |
| | (Aggregate type) | |
| Exterior Layer | Thickness | mm |
| <u>Mechanical Properties</u> | | |
| Minimum initial specific stiffness STIS | | N/M ² |
| Initial longitudinal tensile strength | | KN/M ² |
| Initial Hoop tensile strength | | KN/M ² |

217.6.2 Hauling, Handling and Storage

GRP pipes shall be handled, stored and installed in strict accordance to the Manufacturer written instructions.

Rough handling of pipes shall at all times be avoided, pipes shall not be dropped or thrown on the ground. Severe impact with other pipes or object must be avoided. All pipes should be lifted at their mid-point. Pipes must not be lifted with chains, wire ropes etc, a suitable textile sling must be used.

During unloading the pipes, joints and specials must be carefully inspected to verify the following:

- a) Products are not damaged
- b) Joints are positioned correctly
- c) Classification is as specified

Attention shall be paid to stack heights to avoid the possible deformation of the pipe diameter. No stacking of pipe larger than 1.8m in diameter shall be allowed on site or during transport.

217.6.3 Laying and Jointing

After the excavation and preparation of a section of pipe trench has been completed, it shall be inspected by the Engineer. Just before pipe laying, the trench shall be cleaned of all stones, soil and other debris that might have fallen therein.

All pipe laying shall be carried out by experienced pipe-layers, well skilled in this work.

The Contractor shall submit the pipe Manufacturer's Installation Manual and associated Data for Engineer review. A site meeting to include Engineer, Contractor and Manufacturer is to occur to clarify any outstanding issues / questions on the given installation procedures.

The pipe installation procedures and practices chosen shall meet the design requirements specified.

Immediately before being laid, each pipe and fittings shall be carefully examined both inside and outside for any damage, and all dust, dirt and foreign matter shall be removed. Care shall be taken to ensure that they remain clean during laying.

In order to prevent stones and soil from entering the pipe, a suitable cap or plug shall be provided with which the last pipe laid shall be closed when pipelaying is not actually in progress. The plug will be of the screw-up expanding type or of tapered wood.

Where bends are required, performed bends of the desired radius shall be used. Hot bending on site is not permitted.

All joints shall be flexible, with approved rubber rings. Rubber rings shall comply with B.S. EN681-1 (Elastomeric Joint Rings for Pipework and Pipelines) and shall be of the type designated on the Drawings, or in the Particular Specification, or as directed by the Engineer.

Prior to laying, the pipe and joint must be thoroughly inspected. Check for damage, joint position, pressure classification and cleanliness.

To ensure clean assembly and to prevent the weight of the pipe being taken on the joint, a hole should be excavated at the joint position prior to laying the pipe. When the joint has been made, fill and compact the hole with bedding material to provide continuous support to the pipe along its entire length.

Reinforced Concrete Thrust Blocks shall be used at all changes in direction, size reduction / expansion. Thrust blocks shall encase the entire GRP fitting at the directional change and should be constructed to fully absorb all thrust loads.

Pipe Deflection readings shall be taken and recorded on all buried pipe at two meter intervals. Initial deflections shall not show a reduction in internal vertical diameter for over 2.0 percent of the pipe ID.

For standard buried unrestrained pipeline sections, a flexibly jointed short pipe shall be incorporated outside rigid structures to provide pipeline flexibility against differential settlement. A minimum of two (2) flexible joints on either side of a rigid structure is required. The length of the short pipe shall be in accordance with the Manufacturers recommendation.

217.6.4 Testing

Testing instructions and requirements for GRP gravity pipelines shall be as specified in Subsection 217.2.6 for concrete pipelines. Testing instructions and requirements for GRP pressure pipelines shall be as specified in Subsection 217.3.10 (b) for A.C. pressure pipes,

except that the Hydrostatic pressure test can commence 24 hours after the completion of filling if permitted by the Engineer.

217.6.5 Methods of Measurement and Payment

GRP pipes shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place, along the crown of the pipeline, as follows:

- In gravity flow lines: between internal surfaces of manholes or chambers.
- In pressure flow lines: between stations.

The length measured for payment shall include the length of all fittings, valves and specials installed in the line.

Payment for GRP pipes and for fittings; specials etc. shall include:

- Supply, hauling, handling, unloading and staking of pipes and fittings including all necessary GRP joints and jointing materials for pipes and all GRP joints and jointing materials for fittings, specials, valves, etc.
- Removal from stacks; hauling and stringing alongside trench; laying and jointing of pipes and fittings, at any depth of trench; connections to manholes and/or chambers and final cleaning and flushing of pipeline. The unit rates for this item, for each type, class and diameter of pipe and fitting, shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of completed pipeline
 - For gravity pipelines: the cost of testing shall be included in the unit rates for pipes and shall not be paid for separately.
 - For pressure pipelines: the cost of testing shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid in trench and tested and accepted by the Engineer can be measured for payment under the above items, and no allowance whatsoever will be made for any breakage, loss, waste, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise stated.

217.7 P.V.C. PIPES

217.7.1 Quality Requirements

P.V.C. pipes and fittings shall comply in all respects with the following standards:

- B.S. 3506 Unplasticized P.V.C. pipes for industrial uses.
- EN1452 Outside Diameters and Pressure Ratings of Pipe of Plastics Materials.
- EN1329 Unplasticized P.V.C. Underground Drain Pipe and Fittings.

- EN1401 Unplasticized P.V.C. Pipe and Fittings for Gravity Sewers.

All pipes and fittings shall be supplied by approved manufacturers. Class of pipes shall be as stated in the Drawings or in the Particular Specification. The nominal length of pipes shall be not less than 6.0 m and not greater than 9.0 m.

P.V.C. pipes shall be factory tested and shall be subjected to Hydraulic and to Impact (Falling Weight) Tests. The number and selection of samples for testing, the test procedure and the requirements shall all be as specified in the relevant EN. If so directed by the Engineer, the selection of samples and the Tests shall be witnessed by a representative of the Engineer, who shall be informed at least 48 hours in advance of any sampling or testing.

The cost of samples, their transportation to the laboratory and their testing shall be deemed to be included in the unit rates and shall not be paid for separately.

217.7.2 Hauling, Handling and Storage

Rough handling of pipes shall at all times be avoided, especially at low temperatures. During storage and transport, rigid P.V.C. pipes shall have as near continuous support as possible at all times, and care shall be taken to avoid damage to pipe by sharp edged angle irons, exposed nail heads, etc.

For long term storage in average ambient temperature, attention shall be paid to stack heights to avoid the possible deformation of the pipe diameters. A maximum stack height of 1 meter is recommended. For temporary storage on site, care shall be taken to ensure that the ground is level and free from bricks, stones and sharp edges. At high temperatures, rigid P.V.C. pipes shall be kept in the shade during long term storage. P.V.C. pipes with spigot and socket shall be stacked with the sockets protruding in alternate layers. Pipes bent, deformed in any way or changed in colour shall be rejected and no payment whatsoever shall be made for such pipes.

While transporting, the pipes shall not overhang the vehicle by more than 0.6 m. Pipe loads shall not be stacked higher than 2.0 m.

Where pipes are transported one inside another, care shall be taken that:

- (a) The pipes are clean and free from grit.
- (b) Suitable covering be provided over the exposed ends of the pipes to prevent the entry of grit during transport.
- (c) The pipes in the lower layers are not excessively loaded to such a degree as would cause damage or undue distortion.

217.7.3 Laying and Jointing

After the excavation and preparation of a section of pipe trench has been completed, it shall be inspected by the Engineer. Just before pipelaying the trench shall be cleaned of all stones, soil and other debris that might have fallen therein.

All pipelaying shall be carried out by experienced pipe-layers, well skilled in this work.

Immediately before being laid, each pipe and fittings shall be carefully examined both inside and outside for any damage, and all dust, dirt and foreign matter shall be removed. Care shall be taken to ensure that they remain clean during laying. The use of a badger will be ordered by the Engineer, if in his opinion, dirt is not being satisfactorily excluded. The badger, on a sound rope, is to remain within the bore of the pipe previously laid and jointed and it is to be drawn forward as the work proceeds throughout the whole length of the sewer. The badger is to be of soft material which will not damage the internal surface of the pipes.

In order to prevent stones and soil from entering the pipe, a suitable cap or plug shall be provided with which the last pipe laid shall be closed when pipelaying is not actually in progress. The plug will be of the screw-up expanding type or of tapered wood.

Where bends are required, performed bends of the desired radii shall be used. Hot bending on site is not permitted.

All joints shall be flexible, with approved rubber rings. Rubber rings shall comply with B.S. EN681-1 (Elastomeric Joint Rings for Pipework and Pipelines) and shall be of the type designated on the Drawings, or in the Particular Specification, or as directed by the Engineer.

Pipe lengths and fittings shall be supplied with a chamfer on the spigot end. Where pipes have to be cut to length, the pipe shall be cut square and a chamfer formed on the spigot end using a medium file. Any saw flushing shall be scraped off with a knife. The spigot and socket shall be free from mud or grit, and the ring correctly located in its groove. A lubricant approved by the Engineer shall be applied to the chamfered portion of the spigot before its insertion in the socket.

Flanges complying with B.S. 4504 (flanges and Bolting for Pipes, Valves and Fittings, metric units) shall be used for the jointing of P.V.C. pipes with steel pipes and for the connection of valves and other appurtenances. The joint shall be made by compression of a gasket or ring seal set in the face of the flange.

Pipes shall be laid true to line by means of a line stretched along the sides of the pipes and true to level by means of a straight edge of suitable length kept inside the pipes and pulled forward to pegs boned in at suitable intervals between sight rails set to the proper levels.

217.7.4 Testing

Testing instructions and requirements for P.V.C. gravity pipelines shall be as specified in Subsection 217.2.6 for concrete pipelines except that the leakage under test shall not exceed 0.08 litre/m² of internal wall pipe area/hour. Testing instructions and requirements for P.V.C. pressure pipelines shall be as specified in Subsection 217.3.10(b) for A.C. pressure pipes, except that the Hydrostatic pressure test can commence 24 hours after the completion of filing if permitted by the Engineer.

217.7.5 Methods of Measurements and Payment

P.V.C. pipes shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place, along the crown of the pipeline, as follows:

- In gravity flow lines: between internal surfaces of manholes or chambers.
- In pressure flow lines: between stations.

The length measured for payment shall include the length of all fittings, valves and specials installed in the line.

The price for fittings, specials, junctions, bends, detachable joints, valves, etc., shall be classified for payment according to type, diameter and class; shall be considered as included in the cost of pipes, unless otherwise specified in the particular specifications or the B.O.Q.

Alternatively, if so stated in the Particular Specification and/or in the Bill of Quantities, pipe and fittings may be measured by number of pipes of defined net lengths and by number of fittings.

Payment for P.V.C. pipes and for fittings; specials etc. shall include:

- Supply, hauling, unloading and staking of pipes and fittings including all necessary P.V.C. joints and jointing materials for pipes and all P.V.C. joints and jointing materials for fittings, specials, valves, etc.
- Removal from stacks, hauling and stringing alongside the trench, laying and jointing of pipes and fittings at any depth of trench, connections to manholes and/or chambers and final cleaning and flushing of pipeline. The unit rates for this item for each type, class and diameter of pipe and fitting shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of completed pipeline
 - For gravity pipelines: the cost of testing shall be included in the unit rates for pipes and shall not be paid for separately.
 - For pressure pipelines: the cost of testing shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid, in trench and tested and accepted by the Engineer shall be measured for payment under the above items, and no allowance whatsoever will be made for any breakage, loss, waste, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

217.8 HIGH DENSITY POLYETHYLENE PIPES (HDPE)

217.8.1 Quality Requirements

HDPE pipes and fittings shall comply in all respects with the following standards.

BS 6572 Specification for blue polythylene pipes up to nominal size 63 for below
- 1984 - ground use for potable water.

- WIS 4-32-02 Specification for polyethylene pressure pipe for cold potable water (underground use).
- WIS 4-32-04 Specification for polyethylene socket and spigot fittings, saddles and drawn bends for fusion jointing for use with cold potable water PE pressure pipes.
- WIS 4-32-06P Specification for polyethylene electrofusion couplers and fittings for cold - 1989 - potable water supply for nominal sizes up to and including 180.
- WIS 4-32-13P Interim specification for higher performance blue polyethylene (PE/MRS 100) - 1991 - pressure pipes (nominal sizes 90 to 500) for underground or protected use for the conveyance of water intended for human consumption.

(WIS Water Industry Specifications UK).

DIN 8074/ DIN 8075 or the most recent ISO standards or European Norms (EN12201 part 1 and part 2).

All pipes and fittings shall be manufactured from approved raw materials and shall be supplied by approved manufacturers. Manufacturers shall have and maintain permanent Quality Control program and records.

Unless otherwise stated, pipes with OD up to 63mm must be produced from PE80 (MDPE) or PE100 (HDPE) material. Pipes with OD 75 mm and up must be produced from PE100 (HDPE) material. Pressure class for all diameters should be PN16.

Pipes with OD up to 63mm shall be supplied in coils where the inside diameter of the coil is 30 times OD. Pipes with OD 75mm and up shall be supplied in coils if possible or in straight length not less than 6 m.

The pipes shall be clearly and indelibly marked to show the name of the manufacturer, nominal diameter, wall thickness, PE designation, pressure class, standard (BS, DIN, EN, ...) and date of manufacture. The marking shall remain legible during normal handling, storage, installation, and service life and shall be applied in a manner that will not reduce the strength nor otherwise damage the products. The marking shall not initiate any defects in the surface and will not provide leakage channels when elastomeric gasket compression fittings are used to make joints. Both hot tape marking and Ink Jet printing are acceptable.

For instant identification as potable water service pipes, PE pipes shall be colored blue or black permanently color-coded with blue stripes. Stripes shall be provided by co-extruding four (or more) equally spaced blue color stripes into the pipe outside surface. The striping material shall be the same material as the pipe material except for color. Stripes printed on the pipe outside surface shall not be acceptable.

For applications other than potable water, i.e. Irrigation and drainage, pipes are to be colored black.

Pipes and fittings intended to be used for the conveyance of potable water shall be approved by an internationally recognized independent water authority such as WRC, DVGW, KIWA, Lyonnaise Des Eaux, etc... The effect on water quality test shall fulfill the requirements of BS 6920 or equivalent.

HDPE pipes shall be factory tested and shall be subjected to Hydraulic, Impact (Falling Weight) and acceptance Tests. The number and selection of samples for testing, the test procedure and the requirements shall all be as specified in the relevant EN. If so directed by the Engineer, the selection of samples and the Tests shall be witnessed by a representative of the Engineer, who shall be informed at least 48 hours in advance of any sampling or testing.

The cost of samples, their transportation to the laboratory and their testing shall be deemed to be included in the unit rates and shall not be paid for separately.

217.8.2 Hauling, Handling and Storage

Rough handling of pipes shall at all times be avoided, especially at low temperature, and care should be taken to prevent damage to pipes and fittings at all stages of handling, transporting and storage.

Pipes must be transported by a suitable vehicle and properly loaded and unloaded. Straight pipes should be supported along their full length.

When lifting with slings, only wide fabric choker slings shall be used to lift, move, or lower pipe and fittings. Wire rope or chains shall not be used. Slings shall be of sufficient capacity for the load, and shall be inspected before use. Worn or defective equipment shall not be used.

During storage, care must be taken to ensure that pipes do not become distorted or damaged. This can occur if pipe stacks are not properly constructed and are not limited in height. Pipe stacks must not exceed 1.5m and storage areas must be flat throughout the entire length of the pipe.

Pipes must be protected from materials which may soften or damage polyethylene, such as strong solvents.

Pipes must not be dragged across ground, which might damage the surface.

Similar precautions should be taken with fittings and these should be kept in protective wrappings until required for use. This is particularly important for all electrofusion fittings, each one of which should be individually wrapped and sealed immediately after manufacture.

It is similarly important to protect spigot ends of pipes and fittings to be jointed by Electrofusion or Mechanical jointing methods.

217.8.3 Weathering

Blue and yellow polyethylene should not be permanently installed above ground where it is exposed to direct UV light.

217.8.4 Laying

After the excavation and preparation of a section of pipe trench has been completed, it shall be inspected by the Engineer. Just before pipelaying the trench shall be cleaned of all stones, soil and other debris that might have fallen therein.

All pipelaying shall be carried out by experienced pipe-layers, well skilled in this work and in the presence of the Engineer unless prior permission has been received.

Immediately before being laid, each pipe and fittings shall be carefully examined both inside and outside for any damage, and all dust, dirt and foreign matter shall be removed. Care shall be taken to ensure that they remain clean during laying. The use of a badger will be ordered by the Engineer, if in his opinion, dirt is not being satisfactorily excluded. The badger, on a sound rope, is to remain within the bore of the pipe previously laid and joined and it is to be drawn forward as the work proceeds throughout the whole length of the pipe. The badger is to be of soft material which will not damage the internal surface of the pipes.

In order to prevent stones and soil from entering the pipe, a suitable cap or plug shall be provided with which the last pipe laid shall be closed when pipelaying is not actually in progress. The plug will be of the screw-up expanding type or of tapered wood.

Where bends are required, performed bends of the desired radii shall be used. Hot bending on site is not permitted.

Additional general installation details for HDPE duct for telemetry cables

The line and level of the duct formation shall be kept as straight as possible. Bends will be required for duct formations to be routed around corners at intersecting roads. (For safety reasons manholes shall usually be planned and located away from intersections).

The configuration of the duct formation shall be as shown on drawings.

All ducts shall be located in accordance with applicable roads and municipal Standards. In the absence of relevant Standards, the Engineer must be consulted to ensure compliance with the appropriate standard which may vary depending upon the nature of the undertaking.

Ducts shall be watertight between manholes. Installation methods shall prevent sand and soil from entering the ducts.

At manhole, the bond between the outside surface of the duct and the wall shall be watertight.

Ducts shall be terminated flush to manhole inside walls. Edges shall be bevelled off.

Ducts entering manholes, shall be plugged and watertight. The plugging mechanism or material shall be readily removable to allow for future cable installation.

Ducts shall leave a manhole in a standard formation and enter the subsequent manhole with each duct in the same relative location.

At location between manholes where the duct formation must be modified due to obstructions the formation shall be altered to minimise the movement of each duct.

The separation either longitudinal or perpendicular, to other services, should be minimum 150mm. Where such is not possible a separating/retaining layer of 50 mm of concrete is required.

The Engineer shall have the authority to change the construction method to HDPE in concrete or steel ducts, should the circumstances indicate such a requirement.

If two ducts are to be laid, they shall be supported by spacers so that the formation will maintain the standard spacing between ducts throughout the length of the installation. Sand, to the appropriate highway specification, shall be placed to fill all spaces between ducts, and compacted.

The duct formation shall be covered with 200 mm of sand. This is to be followed by approximately 200 mm of suitable backfill and a plastic warning tape. Warning tape shall be 70mm wide, yellow PVC, durably marked with the text 'WARNING - TELEMETRY CABLE' at no more than 50 cm intervals. Backfill and compaction shall follow.

HDPE tubes shall have minimum 2" inside diameter and minimum 5mm thickness with manholes maximum 100 meters apart.

217.8.5 Jointing

Jointing of HPDE can be one of the following systems:

a) Electro-fusion Fittings and Saddles

Electro-fusion can be used for all polyethylene pipes irrespective of size and pressure rating as long as pipe and fitting are manufactured from polyethylene resin of the same class and series. It is possible to use fittings with higher pressure rating than pipe, but the opposite is strictly forbidden.

- All fittings shall be injection moulded from recognised top quality PE 100 or PE 80 resin.
- All fittings must conform with the requirements of the related standard EN, BS, ..
- All fittings must be packed in such a way to allow instant use on site without additional cleaning.
- Each protective package must clearly indicate its contents.
- The heating coils contained in each individual fitting and saddle should be so designed that only one complete process cycle is necessary to fully electro-fuse the fitting to the adjoining pipe or pipes.
- No heating coil may be exposed and is to be fully imbedded into the body of the fitting for protection purposes during assembly.
- The pipe fixation device shall be an integral part of the fitting body in the sizes up to and including nominal diameter 63 mm.
- An individual magnetic card containing a magnetic strip and an appropriate barcode for data transfer purposes must be supplied with each fitting.
- All fittings must have moulded-in identification and product information.
- Process voltage of all fittings must not exceed a maximum of 40 volts.
- Insulated contacts for the terminal pins are to be provided.
- Terminal pin size shall be 4 mm in diameter.
- A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle should be incorporated in the body of the fitting.
- The design of the indicators must prevent the escape of fusion melt.
- All couplers in the sizes up to and including nominal diameter 160 mm must have an easily removable center stop not requiring tools for removal.
- All internal or externally threaded transition adaptors in the nominal sizes up to and including 2" must be designed with an integral polyethylene collar form PE 100 or PE 80 not relying on rubber or synthetic seals.
- Threaded adaptor bodies may be from brass or stainless steel and should be of the modular principle not being supplied moulded into an electro-fusion fitting socket.
- Electro-fusion machines used in the electro-fusion process must be supplied by the same manufacturer of fittings. It is strictly forbidden to fuse one manufacturer fitting with another manufacturer machine.

Additional Requirements for Electro-fusion Saddles

- All saddles up to nominal diameter 250 mm should be designed with two separate halves having a single hinge type attachment and are to be correctly processed without specialized external spring-loaded tooling.

- The top half of the saddle shall be equipped with an outlet which can accept various other system components such as tapping tees, adopters, valve tees, stop-off attachments etc., that are simultaneously fused together with the saddle to mains joint in one operation.
- Each branch outlet is to be equipped with an integral clamping device.
- The branch spigot of tapping tees must be long enough to allow a second joint if necessary.
- All pipe saddles sizes above nominal diameter 63 x 20 mm are to allow a 360° rotation of the branch outlet.
- Safe tapping into a main must be possible under the defined allowable maximum water pressure according the respective pipe series and ambient temperature.
- The tapping saddle cutter is to be designed to seal-off the central passage in the uppermost position.

b) Butt-fusion:

Butt-fusion jointing is a thermofusion welding process which involves the simultaneous heating of the annular end surfaces of two components to be joined until a melt state is attained on each contact surface. The two surfaces are then brought together under controlled pressure for a specified cooling time and a homogeneous weld is formed upon cooling.

The resultant joint is end thrust resistant and has comparable performance under pressure to the unwelded pipe.

In the fabrication and installation of a butt-welded polyethylene system, it is essential that all items which are to be butt-welded are made from compatible material.

The compatibility is dependent upon the process of manufacture, density and melt flow index.

It is also important that proper butt-welding machines are used to make welds and that these are maintained in good condition as welding pressures and temperatures are critical to achieving satisfactory welds.

c) Compression Fittings

All fittings must be manufactured of pure virgin compounded PP ensuring the best performance as to mechanical properties and flexibilities.

- All fittings must be Push-fit type: to assemble, the installer must just cut the pipe square and clean (no need to chamfering), loosen the nut, push the pipe all the way through the stroke and close the nut. The fittings should be easily disassembled without the need for a special tool.
- All fittings must have a floating split clamp ring to compensate thermal and mechanical stress on the pipe. (Ring must be made of acetalic resin or C-PVC).
- All fittings must have a heavy-duty thrust ring to ensure axial compression of the gasket on ovalized, undersized and scratched pipes.
- All fittings must have a gasket. giving the gasket a broader contact surface with the pipe, allowing a tighter grip and a higher resistance in case of vacuum or suction. Also, permitting higher protection against pipe pullout (Gasket must be made from EPDM or NBR Rubber).
- All female offtakes must be reinforcing with metal rings (Rings must be made of stainless steel).
- All fittings must have an easy traceability of the production batch. The production date must appear on the fitting's body and/or nut.

Certificates and Approvals:

All fittings must pass the testing requirements of ISO 3458/3459/3501/3503. At the time of submission, Manufacturers of fittings must hold valid certificates of conformity in respect to the following:

Toxicological requirements:

- WRc * Low sensitivity to bacteria migration
- DVGW * Low sensitivity to chlorine absorption
- KIWA * Alimentary compatibility as ATA test for color, odor, taste and toxic components in concentrations - BRL-K533

Ageing Test requirement:

- DVGW * 95° C - 1,000 hours - 0.5 x Nominal Pressure (PN)

Pullout Test requirement:

- WRc * For sizes up to 63 mm Diam.
- UNI9562 * for sizes greater than 63mm Diam.

Pressure test requirement:

- IIP * 3 x Nominal Pressure (PN) - 1 hour - 20°C Water Temperature

Clamp Saddles

All clamp saddles must be manufactured of pure virgin compounded PP ensuring the best performance as to mechanical properties and flexibility.

- Clamp saddles could be used on distribution lines of 63mm and below, for section rated at PN16 bars or less.
- All saddle off-takes must be reinforced with metal stiffeners.
- All saddles must have a feature to prevent bolt's rotation during assembly.
- All saddles over 40 mm and outlets ½" to 2" must have flat gasket to ensure added flexibility on ovalized, undersized or scratched pipes and to prevent gasket's pulling-out in case of water hammer.
- All bolts and nuts should be from stainless steel (series 400).

217.8.6 Testing

Testing instructions and requirements for HPDE gravity pipelines shall be as specified in Subsection 217.2.6 except that the leakage under test shall not exceed 0.08 litre/m² of internal wall pipe area/hour. Testing instructions and requirements for HPDE pressure pipelines shall be as specified in Subsection 217.3.10 (b) for A.C. pressure pipes, except that the Hydrostatic pressure test can commence 24 hours after the completion of filling if permitted by the Engineer. Manufacturer's recommended procedure of testing should be submitted to the Engineer who could accept to take it into consideration or not.

217.8.7 Methods of Measurement and Payment

HPDE pipes shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place, along the crown of the pipeline, as follows:

- In gravity flow lines: between internal surfaces of manholes or chambers.
- In pressure flow lines: between stations.

The length measured for payment shall include the length of all fittings, valves and specials installed in the line.

Payment for HPDE pipes and for fittings; specials etc. include:

- Supply, hauling, handling, unloading and staking of pipes and fittings including all necessary HPDE joints and jointing materials for pipes and all HPDE joints and jointing materials for fittings, specials, valves, etc.
- Removal from stacks; hauling and stringing alongside trench; laying and jointing of pipes and fittings, at any depth of trench; connections to manholes and/or chambers and final cleaning and flushing of pipeline. The unit rates for this item, for each type, class and diameter of pipe and fitting, shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of completed pipeline
 - For gravity pipelines: the cost of testing shall be included in the unit rates for pipes and shall not be paid for separately.
 - For pressure pipelines: the cost of testing shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid in trench and tested and accepted by the Engineer can be measured for payment under the above items, and no allowance whatsoever will be made for any breakage, loss, waste, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise stated.

217.9 WATER SERVICE CONNECTIONS

217.9.1 Scope

Service connections shall consist of pipes and fittings of small diameters which distribute water from the mains to the consumers.

The nature of these connections shall vary according to the main pipes material.

For DI mains, service connections shall include the following:

- Tapping collars

- Ferrules (Self-sealing fittings for vertical under pressure tappings)
- Stop valves
- Pipes and fittings

and shall end up with:

- House connection accessories

For HDPE mains, the tapping collars and ferrules shall be replaced with saddles and tapping tees respectively. The remaining components (stop valves, pipes and fittings and house connection accessories) shall be identical to those used for DI mains.

217.9.2 Ductile Iron Mains

217.9.2.1 Tapping Collars

Tapping collars shall be used for connecting DI mains to service lines. They shall be made from coated ductile iron with anti-corrosive bolts and shall have large threaded boss on which ferrules shall be vertically mounted.

Elastomer gaskets of appropriate shapes shall ensure the seal between the mains and tapping collar.

217.9.2.2 Ferrules (Self-sealing fittings for vertical under pressure tappings)

They shall be mounted on large threaded boss tapping collars for connecting mains to service lines.

They shall consist of:

- a body, ductile iron, threaded at its lower part, and screwed on under pressure tapping collars. A polyurethane gasket shall allow to obtain the required orientation of the fitting once the fitting is completely screwed to the collar.
- an ABS float valve (Acrylonitrile - Butadiene - Styrene)
- a ductile iron seat coated with elastomer and screwed inside the body.
- a ductile iron cap fitted with a polyurethane gasket
- an internal threaded outlet on which a nipple for polyethylene or PVC pipe shall be mounted. No need for nipple if stop valves are directly connected to ferrules.

217.9.3 HDPE mains

217.9.3.1 Saddles

HDPE mains shall be connected to the service lines through electrofusion saddles, which are made from HDPE and consist of:

- An upper semi-cylindrical piece having a small cylindrical neck incorporated at the center of its convex face; a tapping tee shall be vertically mounted on this upper part through the above-mentioned neck.

The seal between the upper part of the saddle and the main pipe shall be effected through electrofusion. To this effect, this upper part shall include two ports used to connect the electrofusion machine to the saddle. Two limited path fusion indicators shall also be present to indicate the point beyond which no more sealing is necessary. One of these ports shall be located on the semicylindrical surface of the upper saddle part and the other on the saddle neck to seal the saddle to the main and the tapping tee to the neck, respectively.

- A lower semi-cylindrical part that shall be attached to the upper one via two pin connectors from one side, the other side being joined together by the means of a hook, formed through appropriate fashioning of the upper and lower saddle ends. This lower part is used to fix the upper one in place prior to sealing this latter to the main through electrofusion.

217.9.3.2 Tapping Tees

They shall be mounted on the above-mentioned saddles for connecting HDPE mains to service lines.

They shall be made from HDPE and shall consist of:

- A lower cylindrical branch to be inserted in the saddle neck specified above.
- An upper threaded branch that could be closed with a screw cap of the same material (HDPE).
- An outlet branch that could be joined to the service pipe via a coupler, or could be directly connected to the stop valve.
- An O-ring sealed screw cap made from HDPE.

The seal between the tapping tee and the saddle shall be effected through electrofusion as above. The saddle neck shall also be equipped with two pin connectors to be tightened after inserting the tapping tee and orienting it in the right direction, and prior to sealing it to the neck.

As for the coupler connecting the outlet tee branch to the service pipe, it shall be sealed to these through electrofusion as well but shall include four pin connectors for better control before sealing, as well as two limited path fusion indicators.

217.9.4 Stop Valves

Stop valves shall be equipped with two push-in fittings for connecting standard polyethylene or PVC pipes (this could be applied either for DI or HDPE mains) or they shall be equipped at one end with a threaded nose for direct connection to tapping collars or ferrules installed on the DI mains, and on the other end with a push-in fitting for standard polyethylene or PVC pipe in accordance with NFT 54-003, NFT 54072, ISO 161-1, ISO 3607 or any equivalent.

Stop valves shall consist of :

- a ductile iron body coated with powder epoxy or copper alloy, drilled for automatic draining of service line (after closing of the ferrule).
- a rotary inverted plug, copper alloy, ¼ turn, fitted at its upper part with an operating cap.

- a ductile iron base coated with powder epoxy and screwed to the body lower part. The base and the body shall be of the same material.
- a stainless steel spring supported by the screwed base and pushes the inverted plug against the body.

Stop valves shall be protected by complete systems of surface boxes for operation from the surface. These boxes shall consist of a lower protective hood which shall contain the valve and isolate it from the surrounding soil. The hood shall be surmounted by a PVC extension tube which shall house the spindle used to operate the stop valve (Each stop valve shall be equipped with such a spindle). Finally, the extension tube shall be topped by a surface box made of ductile iron, the cover of which shall be flush with the sidewalk surface and the entire assembly (stop valve, spindle, hood, tube, surface box) located outside the property line.

The stop valve shall be at least 60cm beneath the road surface.

217.9.5 Service Pipes

Service pipes shall be from HDPE. For further information, refer to section 217.8.

217.9.6 Test Pressure

Service connection fittings shall undergo a double hydrostatic test:

1. a mechanical strength test, in opened position, under the maximum allowable pressure increased by 50%:
2. a seal test, in closed position, under the maximum allowable pressure increased by 10%:

Test certificate from factory or from approved laboratory shall be submitted with the equipment.

217.9.7 House Connection Accessories

House connection accessories for each consumer shall consist of a ball valve followed by a water meter and then a pollution check valve including all necessary fittings.

House connection accessories shall be protected by adequate water meter boxes. These boxes shall have generally three sizes: first size for individual consumers, second size for three subscribers and a third size for five subscribers. In these two latter cases, a collector linked to the downstream end of the service line shall distribute water to each house connection.

For pricing purposes, this collector shall be considered an integral part of the water meter box(es) it is supplying.

Water meter boxes shall be watertight, and equipped each with a lock to prevent unauthorized access. These locks shall be identical for a given number of boxes. This number may vary according to the Engineer's request. In addition, a sight glass shall be installed on each meter box cover to provide a proper reading of the water meter measurements without having to open the meter box.

For each group of similar locks, shall be provided a corresponding set of 5 identical keys.

The boxes shall be located inside the concerned property, and shall be provided by the Contractor. Their exact location shall be approved by the Engineer.

217.9.8 In Situ Testing and Method of Payment

Service lines shall be from HDPE, equipped where required with a ferrule mounted on the tapping collar installed on the main (for DI mains) or with a tapping tee on a tapping saddle in the case of HDPE mains, a stop valve installed on the service line and a ball valve installed at the end of the service line directly upstream the water meter.

Hydrostatic tests are conducted in two stages on service connections and DI mains at the same time:

1. The main is put under test pressure with ferrules and/or stop valves closed - The network tightness is monitored.
2. Ferrules and stop valves are opened and ball valves closed, the seal of service connections, under the same test pressure as stage 1, is monitored.

The same procedure shall be followed for HDPE mains (use tapping tees in place of ferrules).

Service connection testings shall be paid separately by unit of service connection.

217.10 MICROTUNNELLING SYSTEM

217.10.1 Reinforced Concrete Jacking pipes

217.10.1.1 Static Strength Calculation

The static strength calculation must be done for all expected load cases in axial direction of the pipes (jacking force for straight or curve drives) and perpendicular to the pipe axis (pipe weight, ground load, internal and external water pressure, traffic load etc.) based on actual valid rules such as general rules for concrete works (DIN 1045), special rules for pipe design and pipe manufacturing (DIN 4035) and detailed rules for the static strength calculation for the specific system of pipe installation (open trench installation or pipe jacking).

Structural calculations for jacking pipes must be according to worksheet ATV-A161- (Driven pipes, Edition I/90).

217.10.1.2 Concrete and Reinforcing Steel

Reinforced concrete pipes, to be manufactured according to DIN 1045 and DIN 4035, using approved steel, aggregates, cement (sulfate resistant if need), admixtures and water.

1. Reinforcing steel must be of weldable quality (BSt 500 P / BSt 500 S or similar), fulfilling all tests after cage welding procedure according to DIN 488.
2. The reinforcing cages have to be produced by automatic welding machine according to the structural strength calculation and pipe design.
3. For pipes of a wall thickness of 120 mm or more, two layers of concentric cages must be foreseen, which should be completely embedded in the concrete.

4. A minimum of 30 mm concrete cover must be secured, using special polymer-concrete spacers with roughened surface securing homogeneous adherence to the concrete.
5. Cage design, rod and coil sizes, spiral spacing and relevant dimensions must be as per ATV-A161.

217.10.2 Pipe Design and Geometry

1. Jacking pipes should be spigot/socket type, where the spigot includes an incorporate precast groove, allowing for the installation of a rubber seal joint, whereas the socket must be a steel collar including a prewelded steel water stop.
2. The steel grade of the collar should be corrosion resistant to the soil and water at the installation level. Such resistance to be calculated as per DIN 50929 / P3 considering the soil and water analysis. If the pipes are installed near the sea on coastal areas the collar should be stainless steel.
3. Standard mild construction steel according EN 10025 or steel containing chrome and molybdenum, to be selected depending on the corrosion resistance calculations.
4. The thickness of the collar must not be less than 8 mm for mild steel and not less than 6 mm for stainless steel, respecting the corrosion resistance standard, but in any case should be designed to resist the physical forces resulting from the allowed angular deviations.

217.10.3 Handling Anchors

Each pipe must include 4 anchors, whose load resistance must be approved, two of which to allow for pipe handling at site and for transport, whereas the other two to be used for lifting and titling the pipes upon production. (DEHA anchors or similar).

217.10.4 Pipe Particulars

1. At least each third pipe of the jacked sequence should be a special pipe including three outlet nozzles to allow for external surface lubrication during pipe jacking. These nozzles to be precast during production.
2. Special pipes of long-sockets to be foreseen, as per design, to allow for the use of intermediary jacking stations.
3. As a compression absorber, each pipe, must include at the socket side a wooden ring of a thickness of 20 mm.

217.10.5 Joint seals

1. For the pipe joint sealing a slip-ring seal made of elastomer rubber of dense structure for permanent sealing has to be used. The seal compression should be of a minimum of 25%.

2. The pipe joint design, (spigot groove, rubber seal and steel collar) shall be designed to resist the internal and external hydrostatic pressures at the installation zone, but in any case should resist an internal pressure of at least 1 bar and an external pressure of at least 2.0 bars.
3. Joint of pipes used for storm water, do not need any internal treatment.
4. Joints of pipes for clear water transport, (eventual potable use), must be sealed with approved polyurethane base mastic, as recommended by the manufacturer.

217.10.6 Internal Pipe Lining for Sewage Pipes

1. The reinforced concrete pipes used for sewage shall be produced with 360° - Lining to prevent from corrosion due to the sewage and gas inside the tunnel.
2. The lining must cover the full pipe length, where the joint zone must also be sealed using thermoplastic hot air extrusion welding, applied by an automatic (satellite) device.
3. Minor repairs and patching the outlet nozzles, could be carried out by manual hot air thermowelding, using the welding rods as recommended by the manufacturer of the liner.
4. A joint strip of the same lining material has to be welded to both sides of the joint (recess joint system). This strip must be of a thickness of at least 3mm.
5. The lining to be of HDPE with minimum thickness of 2.0 mm.
6. The lining must be of the stud type securing resistant adherence (embedment) into the concrete resisting an external pressure of at least 2.0 bar.

217.10.7 System Pipe Length

Jacking pipes to be of a length of 3 meters. Shorter pipes could be used to allow for curved drives, as per ATV 161, as well as for length compensations at the connections to manholes and others.

217.10.8 Pipe Manufacturing

The pipes shall be manufactured according to the above mentioned standards in best quality, using special pipe molds with hydraulic shrinkable internal cores and expandable external molds.

The pipes should be kept for at least 4 hours inside the pipe molds to get high quality concrete and smooth pipe surface. During the first 10 hours after pouring the concrete curing shall be carried out by covering the pipes completely to conserve the humidity and avoid fast drying.

After production, the pipes should be sprayed with water for 2 days securing high surface concrete strength.

217.10.9 Microtunneling System and Machines

1. The tunneling machine and relevant logistics must be an integral system supplied by the same manufacturer, where the steering and guiding system are to be operated from the computerized, above ground, control room.

The cutting wheel, its tools, and relevant selection of rock cutting and / or clay handling - etc must be adequately selected considering the soil condition, water table and ground cover.

2. The control plc / ddc system must control all the equipment, as well as their components, where a selectable manual / auto mode is allowed.

3. The computer, and display monitor, must sense and process the mechanical and hydraulic components, as well as the laser beamer, but not limited to:

3.1. Cutting wheel, torque and rpm, both variable and controllable.

3.2. Steering cylinders: course control and pressure indication.

3.3. Roll and yaw display, and limiting levels control.

3.4. Pitch and level sensing and control.

3.5. Driven length indication.

3.6. Main jacking cylinders pressure and speed control.

3.7. Intermediary jacking station, pressure and course control.

3.8. Lubrication and slurry pressure control.

3.9. Laser magnitude and intensity control.

3.10. Oil level and temperature control.

3.11. Slurry flow and pressure at both supply and return lines (valid for slurry system).

218 – ROAD WORKS

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218 ROAD WORKS

218.1 ROADS AND PAVED AREAS

218.1.1 General

Road construction under this division shall include construction of new roads and paved areas and repairs to existing roads and paved areas where such repairs are necessitated by the performance of the Works, and the term “road” as used in this division shall also include other areas on which a road surfacing is required.

All roads shall be constructed to the lines, levels and cross-sections shown on the Drawings and as detailed in the Particular specification. Road surfacing may consist of compacted local soil, gravel, laterite or similar suitable material, with or without a stabilizing spray of bitumen, or of asphalt concrete placed on a bearing course of compacted gravel, laterite or other suitable base course material.

All roads shall be fitted with a stormwater drainage system, sidewalks, etc.

218.1.2 Earthworks for Road Construction (Subgrade)

All excavation and fill required for road construction shall be carried out in accordance with the applicable requirements of Division 201. The materials to be used and the degree of compaction to be obtained in each layer of the road structure shall be as shown on the Drawings or as required in the Particular Specification.

218.1.3 Sub-Base and Base Courses

Sub-base preparation shall consist of the following:

- Scraping of the natural ground
- Earthworks and levelling of the surface
- Compaction with a pneumatic roller.

Unless otherwise specified, sub-base material shall consist of hard, durable particles or fragments of stone or gravel, screened and crushed to the required size and grading or an equivalent material, subject to the Engineer’s approval. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base shall be levelled, watered, rolled and compacted to 96% of the Modified AASHTO Density. In case it consists of non-rock ground, the California Bearing Ratio CBR shall be greater than 30. The Material shall have a specific weight greater than 2.45 kg/dm³.

If the bearing of the foundation soil be inadequate, the top soil shall be stripped to a 20cm depth. The stripped area shall be backfilled with material that meets the requirements and have a minimum CBR of 15 when compacted to 96% of Modified AASHTO Density. The frequency of tests shall be determined by the Engineer.

The sub-base course material layer shall conform to the following grading:

| A.S.T.M.Sieve Designation | Percentage by Weight Passing Square Mesh Sieves |
|---------------------------|---|
| 1"½ | 100% |
| 1" | 60-100 |
| ¾" | 55-85 |
| No. 4 | 35-60 |
| No. 10 | 25-50 |
| No. 40 | 15-30 |
| No. 200 | 0-15 |

The material shall have the following properties:

- Plasticity Index (AASHTO T90) 4-8
- Plastic Limit (AASHTO T89) 25 maximum
- Sand Equivalent (AASHTO T176) 50 minimum

Unless otherwise specified, base course material shall be crushed aggregate which shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size, and a filler of sand or other finely divided mineral mater. When produced from gravel, not less than 50 percent by weight of the coarse aggregate shall be particles having at least one fractured face and, if necessary to meet his requirement or to eliminate an excess of filler, the gravel shall be screened before crushing. All suitable oversize material less than 10 inches in diameter shall be crushed. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base and base courses shall consist of a minimum of 20 cm thick each course of compacted layers of screened and crushed material.

The sub-base shall be watered prior to the placing of the base course. The material shall then be laid, watered and compacted with a pneumatic roller to 98% of Modified AASHTO Density.

The last base course shall be levelled to ± 1 cm according to the levels shown on the drawings or specified by the Employer. Newly placed base courses shall not be opened to traffic.

The base course material shall have a specific weight greater than 2.45 kg/dm³ and shall conform to one of the following gradings:

| A.S.T.M.Sieve designation | Percentage by Weight Passing Square Mesh Sieves | | | | | | | | |
|---------------------------|---|-------|---------|-------|---------|-------|---------|-------|---------|
| | A | B | B-1 | C | C-1 | D | D-1 | E | E-1 |
| 3 inch | 100 | - | - | - | - | - | - | - | - |
| 2 inch | - | 100 | 100 | - | - | - | - | - | - |
| 1 1/2 inch | - | - | 70-100 | 100 | 100 | - | - | - | - |
| 1 inch | - | - | 55-85 | - | 70-100 | 100 | 100 | - | - |
| 3/4 inch | - | - | 50-80 | - | 60-90 | - | 70-100 | 100 | 100 |
| 3/8 inch | - | - | 40-70 | - | 45-75 | - | 50-80 | - | - |
| No. 4 | 15-45 | 20-50 | 30-60 | 25-55 | 30-60 | 30-60 | 35-65 | 35-65 | 45-80 |
| No. 10 | - | - | 20-50 | - | 20-50 | 0 | 25-50 | - | 30-60 |
| No. 40 | - | - | 10-30 | - | 10-30 | 0 | 15-30 | - | 20-35 |
| No. 200 | 0-10 | 0-10 | 5-15(*) | 0-10 | 5-15(*) | 0-10 | 5-15(*) | 0-10 | 5-15(*) |

(*) For gradings B-1, C-1, D-1 and E-1, the fraction passing the No. 200 sieve shall not be greater than two-thirds of the fraction passing the No. 40 sieve.

If no specific grading is specified, the grading shall comply with C above.

If fine aggregate or filler in addition to that naturally present in the base-course material is necessary in order to meet the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base-course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer and shall be free from hard lumps.

That portion of the base course material passing No. 40 sieve shall be nonplastic.

The base course material shall be tested for abrasion in accordance with B.S. 812 and the following maximum values shall be acceptable.

| <u>Aggregate fraction</u> | <u>Maximum abrasion (%)</u> |
|---------------------------|-----------------------------|
| 3/4" - 1" | 40 |
| 1/2" - 3/4" | 35 |
| 3/8" - 1/2" | 30 |
| 1/8" - 3/16" | 28 |

Sub-base and base courses shall be placed in layers not exceeding 15 cm in thickness, after compaction. Unless otherwise specified, base course materials shall be placed only by means of spreader boxes or equivalent equipment. Placing base course materials directly by means of trucks, shovel dozers and other loading or hauling equipment will not be permitted. Blending material, where required, shall be added by means of spreader boxes or other approved equipment and the whole base course layer shall be thoroughly mixed to its full depth by means of graders, mixers or other approved equipment.

During placing and mixing, water shall be added in the amount necessary to provide the optimum moisture content for compacting.

Compaction shall be carried out in accordance with the applicable parts of Section 201.7.

Unless otherwise specified, the following densities shall be required:

- For sub-bases: 96% of the Modified A.A.S.H.T.O. Density
- For base-courses: 98% of the Modified A.A.S.H.T.O. Density

218.1.4 Bituminous Prime Coat and Tack Coat

Unless otherwise specified, a prime coat of medium curing cut-back bitumen of grade MC-70 shall be applied on top of finished base course, at the rate of 1.0 kg/m², and a tack coat of rapid curing cut-back bitumen of grade RC-250 shall be applied between asphalt concrete layers (where more than one wearing course is specified), at the rate of 0.25 kg/m².

Bituminous coats shall be applied one day before the next layer is placed on top of them. Prior to applying bituminous coats, the road surface shall be thoroughly cleaned of all dirt, oil, grease and other objectionable matter, to the satisfaction of the Engineer. The bitumen shall be heated in boilers of an approved type and spreading shall be carried out by means of mechanical pressure distributors.

218.1.5 Asphalt Concrete Wearing Courses

The number of asphalt concrete layers to be placed in the road surfacing and the thickness of each of them shall be as shown on the Drawings and/or required in the Particular Specification.

All aggregates and bituminous materials to be used in asphalt concrete shall be subject to approval by the Engineer. Samples of the materials shall be submitted to the Engineer at least 30 days prior to their use.

All aggregates, except natural sand, shall be obtained by crushing natural quarry stone, and the use of river gravel, whether crushed or not, will not be permitted. Coarse aggregate shall be of uniform quality, with the particles as nearly cubiform as possible, clean of dust or foreign matter, and shall comply with the requirements of Subsection 218.1.3 above for base course aggregate. Quarry sand shall be clean and free of clay, silt or other deleterious matter; it shall all pass sieve No. 10 and not more than 10 percent of it shall pass sieve 200. The grading of the aggregates shall be if not specified in the Particular Specification as follows:

| A.S.T.M. Sieve Designation | Percentage by Weight Passing Square Mesh Sieves |
|----------------------------|---|
| 3/4" | 100% |
| 1/2" | 80-100 |
| No. 4 | 50-70 |
| No. 10 | 32-47 |
| No. 40 | 16-26 |
| No. 80 | 10-18 |
| No. 200 | 4-10 |

Mix design shall be carried out as follows. The proposed aggregate mixture shall be mixed with 5.5% bitumen (if no other percentage is required in the Particular Specification). This sample shall be subjected to a set of Marshall tests (A.S.T.M.-D-1559 and A.S.T.M.-D-1188) at a laboratory in order to determine the optimum bitumen content. The Engineer may change the grading of the aggregates and the bitumen content according to the results of laboratory

tests conducted on samples of materials supplied from time to time by the Contractor at the request of the Engineer.

Placing of asphalt concrete, unless otherwise specified, shall be carried out by means of paving finishers, specially designed for that purpose. The asphalt concrete layers shall be compacted by tandem rollers, heavy pneumatic rollers and three-wheeled rollers, in that order to reach a density not less than 97% of the Marshall density. Parts of the layers inaccessible to heavy mechanical rollers shall be compacted by small vibratory tampers. Rolling shall proceed from the outer edges towards the centre of the road and the whole area shall receive a uniform compaction throughout and shall be finished accurately to the required lines and levels. When asphalt concrete is placed in more than one layer, longitudinal joints shall be staggered by 30 cm and transversal joints by 60 cm between layers. The permissible variations of the top surface from the design levels shall be $-0 + 15$ mm. The permissible variations from the plane in the top surface shall be 5 mm over a length of 5 m.

Newly paved asphalt concrete surfaces shall be opened to traffic only after permission to do so is given in writing by the Engineer.

Placing of asphalted concrete shall ensure an inclination for drainage of stormwaters in accordance with the drawings and as specified by the Engineer.

218.1.6 Bituminous Surface Treatment

Where shown on the Drawings or required in the Particular Specification, a surface treatment shall be applied to the base course by spraying cut-back bitumen followed by a rolled blinding layer of stone chippings. Unless otherwise specified, bituminous surface treatment shall consist of the following two layers:

- Cut-back bitumen MC-3000 at the rate of 2.8 kg/m^2 , followed immediately by stone chippings of 3/4" - 1" size at the rate of 27 kg/m^2 .
- Cut-back bitumen MC-3000 at the rate of 1.35 kg/m^2 , followed immediately by stone chippings of No. 4 - 1/2" size at the rate of 22 kg/m^2 .

The second layer shall be placed after the first layer has been rolled.

Prior to application of bituminous spray the base course surface shall be checked for accuracy and any irregularities shall be repaired. The surface shall then be swept clean of all loose material, foreign matter, dust and dirt. Areas contaminated by kerosene or diesel oil shall be removed and made good with clean and stable base course material.

The bitumen shall be heated in kettles of an approved type equipped with enclosed thermometers, the heat being conducted by oil or steam. Heating of bitumen in the barrels will not be permitted.

The entire area of the base course shall be sprayed uniformly at the prescribed rate by means of approved mechanical spraying equipment. Pools of excess liquid bitumen shall be sprinkled with fine sand which shall be swept off after it has absorbed the surplus bitumen.

The stone chippings shall be uniformly applied upon the entire sprayed surface. Trucks or other equipment for spreading the chippings shall be operated backwards so that the bituminous

spray will be covered before wheels or workmen pass over it. Supplementary spreading and smoothing, where necessary, shall be done manually.

Following spreading and smoothing of chippings, each layer shall be rolled, to the satisfaction of the Engineer.

The completed road surface shall not be opened to traffic until permitted by the Engineer.

218.2 DRAINAGE SYSTEM

Stormwater discharge channels and drainage systems shall be installed as shown on the drawings.

Excavation limits of channels and pipes as shown on the drawings shall be extended by 10 cm at the bottom and 30 cm on either sides.

Such over excavations shall be backfilled with graded fills and compacted to the satisfaction of the Engineer.

Excavations shall have a longitudinal slope as specified by the Engineer to facilitate water discharge.

The concrete drainage channels shall be either of precast or of cast-in-place concrete complying with the requirements of division 202.

Where specified, construction and expansion joints shall be performed to the details shown on the drawings and as directed by the Engineer.

A collector fitted with a metallic grid shall be mounted on channels and pipes as shown on shop drawings.

218.3 SIDEWALKS

Where specified on Drawings and required by the Engineer, sidewalks shall be executed.

Prior to the construction of sidewalks, the base course shall be prepared as determined in the previous articles. The Contractor shall be held liable for any future settlement of such layer.

Pavement works shall start upon the approval of the Engineer, and as shown on shop drawings.

For concrete paving, the flags shall be of an approved colour and laid in compliance with the requirements of the division 208, and in strict accordance with the lines and levels shown on shop drawings.

218.4 CONCRETE KERB-STONES

Precast concrete kerbs, channels, etc. shall be to the types and dimensions shown on the Drawings and/or defined in the Particular Specification. They shall be whole, sound, without cracks, air bubbles or other defects, and shall comply with the requirements of B.S. 340. Where specified, kerbs, channels etc. shall be bedded and backed with C 15 P concrete. Joints between units shall be filled with a 1:2 cement mortar.

All kerbs, channels, etc. shall be aligned in strict accordance with the lines shown on the Drawings. Special terminal units shall be provided at the edges of the alignment. Where required, units shall be cast-in-situ to the lines and dimensions shown on Drawings.

Kerbs, channels, etc. in sharp curves shall be shorter than those used on straight lines, in order to ensure proper alignment.

218.5 TESTING

218.5.1 Testing on fill materials

All natural fine fills shall conform to the below listed requirements:

- i) Complete Identification Tests
 - Sieve analysis and sedimentometry
 - Atterberg limits (liquid limit, plasticity index, shrinkage)
- ii) Test on organic soils
- iii) Standard Proctor tests with complete determination of compaction diagram
- iv) Modified Proctor tests with complete determination of compaction diagram
- v) CBR tests at 95% of the maximum dry density.

The number of the aforesaid tests shall be as determined by the Engineer.

218.5.2 Tests on Backfill

Placing natural fine fill shall be controlled by the Engineer in the following manner:

Three series of the following tests shall be conducted on each backfilled layer or on every 250 m³ of placed backfills:

- Measurement of moisture content
- Measurement of compactness (dry density)

218.5.3 CBR tests on natural ground

CBR tests shall be conducted according to relevant standards.

The frequency of tests shall be as determined by the Engineer.

218.5.4 Tests on crushed aggregates

The required tests on crushed aggregates to be used for roads are the following:

- Measurement of the specific gravity
- Measurement of the compressive strength on 7 cm side cube
- Los Angeles test
- Sieve analysis
- tests on organic soils according to French Standards
- Measurement of the sand equivalent.

A series of tests shall be carried out on each 500 m³ of aggregates or as directed by the Engineer.

Following are the two density control tests to be carried out on site on each placed crushed aggregate layer:

- Either on each finished layer,
- Or on each 250 m³ of placed aggregates,
- Or as directed by the Engineer.

218.5.5 Tests on concrete asphalt aggregates

Following are the required tests to be carried out on concrete asphalt aggregates:

- Los Angeles Test
- Specific gravity
- Sieve analysis
- Loss in weight
- Sand equivalent
- Any other test as specified by standard ASTM D 693-54.

Three series of tests shall be conducted on each 500 m³ of furnished material or on any volume exceeding by 50% this number, as required in writing by the Engineer.

218.5.6 Tests on bitumen

- Penetration at 25° C
- Penetration at 163° C
- Ductility at 25° C

- Flash point
- Solubility in carbon sulphide at 20° C
- Paraffin content.

Whenever required in writing by the Engineer, the tests above shall be carried out on each furnished bitumen volume prior to manufacture of asphalt concrete, or on bitumen that is being used.

218.5.7 Tests on asphalt concrete mixture

The Contractor shall conduct:

- 1) Tests to determine the grading of aggregates and the bitumen content
- 2) Marshall tests to determine the stability and density of bitumen-covered aggregates.

These tests shall be carried out before the commencement of works and repeated to the satisfaction of the Engineer.

218.5.8 Quality Control Tests

- Control of grading
- Control of moisture content and temperature
- Control of bituminous mixture, 2 samples to be tested daily/mixing plant
- Control of mixing plant.

Grading control shall be conducted once a day on 10 kg of samples of aggregates before putting them in the mixing plant, and whenever required by the Engineer.

Control of moisture content and temperature shall be carried out twice a day; moisture content shall not exceed 0.5% and temperature variations $\pm 5^{\circ}$ C.

The control of bituminous mixture shall be carried out on the bitumen content and grading. Each tested sample consisting of four distinct samplings shall be taken from the mixing plant at short intervals as to ascertain that the proportioning remains unchanged.

The tolerance on bitumen content is relatively $\pm 5\%$ of the measurements daily average.

Permissible tolerances are:

- $\pm 5\%$ of the percentage fixed for the average bitumen content
- $\pm 10\%$ of the percentage fixed for the corrector filler content.

218.5.9 Control of placing asphalt concrete

Throughout placing and compacting aggregates works, the temperature shall be controlled permanently in order to be $\geq 135^{\circ}$ C.

After compaction, density shall be equal to 98% of the Marshall density; one core sample shall be taken of each 1000 m² of finished layer. These samples shall also be used to control the layer thickness.

Where specifically called for, the level and regularity of the surfacing shall be controlled.

No layer shall be executed by the Contractor unless the underlying one has been duly taken over by the Engineer.

218.6 ROADS - METHODS OF MEASUREMENT AND PAYMENT

Unless otherwise specified, roads constructed in accordance with the Drawings or on specific instructions of the Engineer, shall be measured for payment. Access and construction roads for the Contractor's own use and reinstatement of paved areas are referred to in Subsection 201.1.10 respectively, and shall not be paid for under this division.

Unless otherwise specified, roads, shoulders and sidewalks shall be measured for payment - each separately - by m² of completed road shoulder or sidewalk, classified by type of surface and/or by cross-section. The unit rates shall include for all necessary earthwork; supply, hauling, spreading and compaction of all sub-base and base materials, bituminous coatings, chippings and asphalt concrete; and for all materials, equipment and labour necessary for completing roads, shoulders or sidewalks, in accordance with the Drawings and the Specification, and to the satisfaction of the Engineer.

Concrete kerbstones, channels etc. shall be measured for payment in linear meters of kerbstone etc. in place, classified by type and size. The unit rates shall include for supply of units and all necessary materials for bedding and support, laying and jointing. The same unit rates shall be paid for both straight and curved alignment.

220 - MISCELLANEOUS SITE WORKS

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220 MISCELLANEOUS SITE WORKS

220.1 SCOPE

The provisions of this Chapter shall apply to the following kinds of site works:

- Fencing, including gates and wickets,
- Grassing,
- Roads and paved areas.

Other kinds of site works, if required, will be detailed in the Particular Specification.

220.2 FENCING, GATES AND WICKETS

Wherever shown on the Drawings or directed by the Engineer, the Contractor shall erect fences, gates and wickets. All fences, gates and wickets shall be in accordance with the layout and details shown on the Drawings and/or described in the Particular Specification.

The ground along the fence alignment shall be levelled so as to provide an even gap between the bottom wire and the ground surface.

All main and tie wires, all barbed wires and all other metal parts shall be hot-dip galvanized, unless otherwise specified or directed. The fence shall be stretched and fastened by means of approved fasteners, to the satisfaction of the Engineer. Stretching shall not be commenced until the concrete foundations have sufficiently hardened and in no case before 14 days from the pouring of the foundations.

Unless otherwise specified or directed, the entrance gates shall be double leaf and wickets single leaf, to the widths and heights shown on the Drawings, fabricated from standard galvanized water pipe and fittings including bracing, and covered with 5 x 5 cm wire mesh made of 3 mm diameter galvanized and plastic coated wire. The gates shall be hinged to gateposts and shall be complete with locks and stops. All wires and metal parts shall be hot-dip galvanized, unless otherwise specified or directed.

Wherever called for on the Drawings or in the Particular Specification, painting shall be carried out in accordance with Subsection 207.1.5.

Fences shall be measured for payment in linear meters of finished fence, as shown on the Drawings. Gates and wickets shall be paid for per unit. The rates under this Section shall include for all materials, equipment and labour required to complete the fences, gates and wickets in place, in accordance with the Drawings and Specification, and to the satisfaction of the Engineer.

220.3 GRASSING

Wherever specified or directed by the Engineer, the slopes of earth embankments shall be grassed. Areas to be grassed shall, unless otherwise specified, be covered with a layer of productive topsoil of 15 cm thickness, obtained from stripping as specified in Subsection

201.2.3 above. This topsoil shall be a fine sifted soil or silt, not less than 15 cm compacted thickness, and shall be raked and brought to a fine tilth. Should the stripped material be insufficient or, in the Engineer's opinion, unsuitable for grassing, the Contractor shall supply approved material for this purpose.

Grass shall be a tough, deep-rooted, hardy, local grass, approved by the Engineer. The grass shall be planted in adjacent, parallel, horizontal lines, not more than 20 cm apart. Tussock dibbling with bunches of grass roots will not be permitted. The grass shall be carefully maintained, watered and cut, until a good, healthy growth has been assured and the grass has spread all over the surface. Any roots washed out by rain water, or dead roots, shall be replaced at the Contractor's own expense. Manure and/or ammonium Sulfate shall be used to promote growth, where this is backward.

Grassing shall be measured for payment by square meters of grassed surface, as shown on Drawings. The unit rate shall include the preparation of the protective topsoil layer, planting of grass and its maintenance, cutting, watering and fertilizing, as specified above. The cost of supply and spreading of topsoil obtained from stripping shall be included in the payment for stripping, in accordance with Subsection 201.2.3, and shall not be paid for under this Subsection.



**REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
SOLIDARITÉS INTERNATIONALE**



**PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
WITH SAFE, RELIABLE, AND SUSTAINABLE WATER
SERVICES**

CONTRACT N°. CNT/SRV/LBN/WSH/001/21

**VOLUME 4
PARTICULAR SPECIFICATIONS**

**Part 1 - General Requirements
Part 2 - Civil Works**

MARCH 2023



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PART 1
GENERAL REQUIREMENTS

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101. GENERAL REQUIREMENTS

101.1 INTRODUCTION

General requirement items will not be mentioned as separate items in the bill of quantities of the project. It is the contractor's responsibility to include its cost while pricing the mentioned items in the BOQ.

101.2 APPLICATION OF PARTICULAR SPECIFICATION

This Particular Specification is to be read and construed together with the General Specification contained in Volume 3 of the Contract Documents for this Tender. In case of ambiguities or discrepancies between this Particular Specification and the General Specification, the Particular Specification shall prevail, except if and to the extent otherwise provided by the Contract or directed by the Engineer.

Whenever the term "Specification" without further qualification is used in the Contract Documents, it shall mean the General Specification together with the Particular Specification.

101.3 LOCATION OF WORKS

The works cover the construction and equipment of TLEIL water tank and water tower, an electrical room and an underground valve chamber, including all related civil and electromechanical works to ensure the proper functioning of the system.

The Contractor shall cooperate with all parties such as municipalities, Public Works Department, Electricity of Lebanon, Telecommunications Authority, adjacent plot owner and all other necessary authority (where needed) for any required work inside or outside the mentioned working area.

101.4 THE SITE

For works within TLEIL water tank and water tower, electrical room and underground valves' chamber, the limits of the Site shall be the limits of land in public ownership.

In some areas, the width of the Site will be physically restricted by physical boundaries such as boundary wall or by natural topographic features.

The Contractor shall have inspected the Site and shall have included for the provision of any additional working area that he may require outside the limits of the Site.

101.5 SCOPE OF WORK

The scope of work covered by this Contract includes the following:

A- CIVIL WORKS:

The civil works cover the following items:

- 1- Construction of a 750m³ water tank.
- 2- Construction of a 50m³ elevated water tower at 30m of height.
- 3- Construction of a pump's room.
- 4- Construction of fence and installation of access gates.
- 5- Road and asphaltting works.
- 6- Valves' chamber.
- 7- All civil works related to the project are to be included as per relevant drawings.

B- ELECTROMECHANICAL WORKS

1. Supply and installation of two surface lifting pumps (to lift water from the water tank to the elevated water reservoir).

2. Supply and installation of new pipes and hydraulic accessories (rising column, valves, air-release valves, check valves, gate valves, etc...).
3. Supply and installation of a new electrical system
4. Supply and installation of a new instrumentation and control system
5. Internal and external electrical lighting, wiring, switches, etc....
6. Subscription to EDL.
7. Conduction of semi industrial and industrial testing.
8. Operation for a couple of days prior to commissioning.

C- PIPE WORKS

Pipes works shall include connections from/to:

- 8- From proposed transmission line from saydnaya well.
- 9- To existing Tleil network
- 10- To existing elevated network (to the elevated area in Tleil).
- 11- Pumps connection from the ground tank to the elevated water tower.
- 12- Valves' chamber.

NOTE: IT IS TO NOTE THAT A NO OBJECTION (عدم اعتراض) LETTER IS REQUIRED FROM THE OWNER OF THE ADJACENT PLOT (PLOT 839 - TLEIL) STATING THAT THEY DO NOT OBJECT ABOUT NOT COMPLYING WITH THE REQUIRED SETBACK LIMITS (تراجعات).

101.6 CONDITIONS PREVAILING AT SITE OF WORKS

The Contractor's attention is drawn to his obligation to satisfy himself, before submitting his Tender, as to the conditions prevailing at the Site of Works and its surroundings and relevant sections of the General Specification.

101.7 PRIVATE LANDS

The Contractor shall not enter upon or occupy with men, tools, or materials of any nature, any lands other than the working areas shown on the Drawings, except after consent shall have been received by him from the proper parties and a certified copy of such consent shall have been furnished to the Engineer. Any rentals or damages paid for occupying private lands shall be at the Contractor's expense.

101.8 EXISTING SERVICES

In the course of works, the Contractor may encounter within the limits of the working areas and in the vicinity, miscellaneous above ground and underground services such as drains, pipes, cables, telephone and electric poles and lines, water supply and similar existing services. The Contractor's attention is directed to the provisions of Clause 101.12.4 of the General Specification with regard to such existing services.

101.9 ACCESS ROADS

The necessity of construction of Access Roads and/or temporary roads may arise, in which case it shall be executed at the contractor's responsibility and expenses in coordination with the concerned Authorities and according to the Engineer's requirements.

101.10 PROGRAM AND MONITORING

It is a primary requirement of the Employer that a comprehensive knowledge of the status of progress to date, predicted progress, costs and cash flow forecasts is available at all times. The Contractor shall be responsible of the requisite information and shall be responsible for programming the Works, preparation of cash flow estimates and measuring and reporting the progress of the works in an approved format. In order that programming, progress measurements and reporting is executed in a timely and efficient manner, the Contractor shall program the Works, monitor progress and generate cost reports and cash flow projections by utilizing a recognized industry standard approved P.C. based Project Management software package.

The Contractor's master program and cash flow estimates and subsequent updates, shall, as a minimum, detail the sequence of procurement, installing, testing and commissioning, and handing over for each of the work items including each item described in the Bill of Quantities.

At least 21 days prior to taking possession of any portion of the Site and starting of work, the Contractor shall submit a detailed construction program for that portion of the Site. The detailed construction program shall be to a level to adequately identify the intended sequence of working on each individual item of work. The minimum level of detail shall not be less than that needed to identify each individual payment item included in the Bill of Quantities.

The Engineer's obligation to measure the Works shall be dependent on the Work being programmed and progress being monitored and reported in accordance with the requirements of the Contract.

101.11 LIST OF ABBREVIATIONS

In the Contract Documents, the following abbreviations have been employed:

| | |
|--------|---------------------------------------|
| uPVC | - non-Plasticized Polyvinyle Chlorite |
| D.I. | - Ductile Iron. |
| R.C. | - Reinforced Concrete |
| D.I. | - Ductile Iron |
| G.S. | - General Specification |
| C.O.C. | - Conditions of Contract |
| B.O.Q. | - Bill of Quantity |
| DN | - Nominal Diameter |
| ID | - Inner Diameter |
| OD | - Outer Diameter |

101.12 OR EQUAL CLAUSE

Wherever references to Standard Specifications, such as British Standards, are made, they shall not be construed to restrict materials to British products. Materials from other scheduled countries will be considered provided that the producer of the material certifies its conformity to the appropriate Standard Specification.

Similarly, whenever a required material or article is specified or shown in the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article which will perform adequately the duties imposed by the general design will be considered equal and satisfactory provided the material or article so proposed is of equal substance and function in the Engineer's opinion. It shall not be purchased or installed without his written approval.

101.13 GOVERNMENT REGULATIONS

The Contractor shall comply with all provisions of the rules, regulations and orders of Government and Municipal agencies, such as the Public Works Department, Electricity of Lebanon, and Telecommunications Authority.

The Contractor shall co-operate with the Employer in promptly furnishing any information that may be required by such governmental agencies. It shall be the obligation of the Contractor to keep himself informed of these governmental rules, regulations, and orders and the Contractor shall make the requirements of this article a part of any sub-contract he may enter into.

101.14 FACILITIES FOR THE ENGINEER'S REPRESENTATIVE

The Contractor shall provide a suitably located office (in the project zone) for the resident engineer. The contractor shall provide furniture and the maintaining and cleaning of the Resident Engineer's office including all related costs. The Resident Engineer's office shall have a minimum area of 30-40 m² and shall be equipped with all the necessary items for the good performance of the supervision team, these items shall include but not be limited to:

- Tables, desks, chairs, shelves, cabinets, etc., ...
- Electrical supply, potable water supply, toilet, sewage disposal system, ...
- Air conditioners, heaters,
- Telephones and related charges.

The Contractor shall also provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and Representatives and those of any relevant authority who have reason to visit the site.

101.15 ACCESS TO WORK

The Engineer and his duly appointed representatives and the Employer or his representatives or agents may at any time and for any purpose whatsoever enter into and upon the work and the premises used by the Contractor. The Contractor shall provide free, proper, and safe facilities therefore.

101.16 SURVEY AND SETTING OUT

All levels used for construction shall be referred to the National Height Datum.

The Contractor shall be responsible for obtaining the location and values of the permanent benchmarks. In cases where such benchmarks do not exist, a site datum shall be agreed on with the Engineer.

Prior to the commencement of the work, the Engineer shall approve all plans showing benchmarks, limits of plot and auxiliary baselines. The Contractor, under the supervision of the Engineer, shall set out on-site and erect appropriate permanent markers where instructed by the Engineer.

The Contractor shall employ an experienced licensed Surveyor for the duration of the Contract. He shall furnish the Engineer with a duly signed map showing the various centerlines, baselines, reference points permitting the renewal of markers and boundaries of parcels and blocks, if destroyed. Before starting and during earthwork on the site, the Contractor shall set out a net of square coordinates at distances not exceeding 10 m in each direction. A peg shall be driven at each intersection and at other relevant points and levels of peg tops and of ground at the same spot shall be measured.

The levels of the ground and the levels and dimensions of existing features shown on the drawings are not guaranteed to be correct.

Wherever dimensions or levels are marked on the drawings, such dimensions or levels shall take precedence over dimensions scaled from the drawings. Where no dimensions or levels are shown on the drawings, instructions shall be obtained from the Engineer. Large scale drawings shall be taken in preference to drawings of smaller scale.

101.17 NOTICE BOARDS

The Contractor shall provide and erect sign boards at the sites where works are being executed, giving information to the public on the Project and the Employer and further details as will be prescribed by the Employer. The location and number of the sign boards at the sites will be indicated by the Engineer. The Contractor shall maintain, alter, move and adapt the sign boards from time to time as instructed by the Engineer. The display of any named subcontractors or any other information associated with the Works shall be to the approval of the Engineer.

101.18 MANUFACTURE'S CERTIFICATES

The Contractor shall furnish the Engineer with a manufacture's certificate confirming compliance to the specification in respect of all items of equipment.

The original and one copy of the manufacturer's certificate shall be delivered to the Engineer not later than 14 days prior to the intended date of delivery of the item to site.

101.19 PRECAUTIONS AGAINST CONTAMINATION OF THE WORK

The Contractor shall at all times take every possible precaution against contamination of the works. The site and all permanent and temporary works shall be kept in a clean, tidy and sanitary condition. The Contractor shall at all times take measures to avoid contamination of the existing water courses and drains by petrol, oil or other harmful materials.

101.20 ACCESS TO PROPERTIES

The Contractor shall not disrupt any private or public access way without first providing alternative arrangements.

101.21 TOPOGRAPHIC SURVEY

Where the Contractor gets the approval of the Engineer to execute a topographical survey, mapping shall be at 1:200 with contour lines at an interval of 1 meter. A ground profile along the centerline of the pipe route shall be provided and shall be at the same scale of the construction drawings relative to the contract.

In open areas and along water courses the mapping corridor shall be 20 meters. The mapping shall be supplied on film plotted from digital data.

All control points and heights shall be related to the National Height Datum in meters. Station descriptions with distances to reference objects and a list of coordinates and heights shall be submitted to the Engineer.

Permanent benchmarks shall be constructed from steel pins, road nails or painted marks on existing stable features. A minimum of two site benchmarks shall be established on existing stable features.

All man-made hand detail features, road edges, curbs, existing manholes, inspection covers, culverts, and underground service pipeline shall be surveyed in their true position and shown by conventional symbols. The detection of the existing services will be paid separately and must be approved by the Engineer.

Any surveyor who will subcontract topographical works from the Contractor shall be approved of by the Engineer. However, the Contractor will still be held responsible for the accuracy of the survey until it gets approved by the Engineer.

101.22 DRAWINGS AND DOCUMENTS

All drawings and documents submitted by the Contractor shall have been checked and signed, shall be ready for issue and shall bear the title of the drawing, the scale, the date, the Contract

number and name, the document number complying with an approved numbering system, the name and references of the Contractor, the name of the Employer and the Engineer, the date of approval by the Contractor and the signature of the person responsible for the approval.

Unless otherwise specified, the Contractor shall allow a minimum of 15 days for approval of drawings and documents by the Engineer.

101.23 MEASUREMENT AND PAYMENT

Unless otherwise provided for in the B.O.Q, all costs incurred in complying with the requirements of this Division 101 shall be deemed to be included by the Contractor in his unit rates in the Bill of Quantities and shall not be paid for separately.

101.24 PRE AND POST-INSTALLATION DOCUMENTS

Documentation shall include, but not limited to, the following:

- Method Statement
- Shop Drawings
- Technical Data Sheets
- Time Schedule
- As-built drawings.
- Operation and maintenance
- Test, commissioning and calibration reports.
- Acceptance certificates.
- Warranty-conditions, start dates, end dates.
- Health and safety plan, including the risk analysis
- Cable routing layouts and requirements including trenching and conduit installation and details
- Pumps Room layouts and power requirements including lighting, lighting controls, convenience power, HVAC and temperature control system, monitoring and alarm layout, and outdoor lighting/power.
- Control wiring diagrams for the pumps.
- HVAC calculations and design to maintain pumps room temperature below 30 degree Celsius.

101.25 RESTRAINTS

The main restraints to consider are, but are not limited to, the following:

- a. Convenience and safety of the Public:
The Contractor is required to observe and implement all measures required to ensure the safety, access and convenience of the Public. Such measures shall include, but shall not be limited to, proper scheduling and phasing of the work, effective provisions of uninterrupted access to properties, continuity of public services during construction such as water, power, telephone, sewage, drainage, etc., signage, barricades, warning lights and other measures, in and around construction areas and operations, for the protection of the Public, and the suppression of pollution and noise.

- b. The Contractor is to consider the maintenance of the traffic along the existing roads during the whole period of construction as well as the maintenance of utilities (i.e.: electrical supplies, water supply, sewage disposal and telecommunications). The Contractor is to incorporate all the restraints into his program of works and his contract price. Traffic flow shall be maintained along a project corridor with a minimum of 1 traffic lane per direction.
- c. Allow for the co-ordination of the above works to enable the execution to progress without disruption until the completion of the works. Submission, approval and execution stages to be included in the program of works. Allow for the provision of all necessary temporary facilities as required and afford all reasonable access and assistance to enable the completion of these works in a timely manner.

101.26 WARRANTY

A. Submittal Time:

Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy:

Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11- inch (115-by-280-mm) paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

101.27 TRAINING, TESTING AND COMMISSIONING

101.27.1 TRAINING THE EMPLOYER PERSONNEL

During the period of assembling and especially during the period of pre-commissioning operation, the Contractor shall train the personnel assigned by the Employer. The training shall be carried out at 3 principal levels:

- a) Engineers
- b) Control and maintenance technicians (assistant engineers)
- c) Skilled workers

The instruction of levels b) and c) shall be carried out with the collaboration of level a) already trained.

The training program, as well as the number of persons participating in the training shall be established by mutual agreement with the Employer, and upon his approval.

During the period of pre-commissioning, the Contractor shall hand over to the Employer's personnel the respective operating and maintenance manuals of the equipment.

101.27.2 TESTING

101.27.21. GENERAL

Pump testings shall be determined according to the pump tests carried out by an international control organisation, i.e. EUROPUMP or equivalent.

Equipment manufactured in large quantities shall not undergo in-factory tests.

The manufacturer shall produce, for the manufacture criteria and their justifications, the characteristic curves of each pump ordered by the Contractor :

- Flow curve
- Efficiency curve
- Power curve
- Suction curve (NPSH)

The complete control of operation conditions shall be carried out as soon as the equipment is installed on site.

101.27.22. TESTING ELECTRICAL PANELS IN WORKSHOPS

Tests of each electrical panel must include at least the following verifications :

- Verification of the aspect, accessibility of mechanical equipment, as well as strength and operation of mobile elements, precautions taken to prevent corrosion and protect paint, wires and cable runs, and marking operations, etc...
- Verification of the good functioning of mechanical and electrical control devices as well as efficiency of locking mechanisms.
- Verification of the electrical insulation.
- Verification of the continuation of sheathings.
- Verification of Earthing connections.

Moreover, all electrical equipment constituting the panels should have undergone in-factory tests determined by the relevant standards.

101.27.3 COMMISSIONING

At the end of the satisfactory pre-commissioning operation, and if the Contractor has started training the Employer's personnel, the commissioning of using the equipment shall start. It shall be deemed started and a report shall be drawn thereof provided that the Contractor has submitted to the Engineer a written request, along with a copy of the drawings, notices and documents necessary to the operation and maintenance of the equipment.

Starting from the commissioning operation, the Employer's personnel takes over the operation and the maintenance of the equipment under the supervision of a sufficient number of qualified technicians assigned by the Contractor.

These technicians shall supervise the personnel till the end of the commissioning.

The commissioning period is fixed to a minimum continuous duration of twenty eight days, during which the equipment shall function satisfactorily and require only minor secondary setting up or adjustment entailing no stops and revealing no systematic defect.

In case any setting up, adjustment or defect entails the stopping of the equipment during the commissioning period, the minimum period of twenty-eight days mentioned above should compulsorily restart as from the resumption of the normal commissioning operation.

During the commissioning period set above, the Contractor's supervising technicians shall continue training the personnel assigned by the Employer.

Until the taking over, and provided the operation requirements permit it, the Contractor shall carry out, at his own costs, all necessary replacements, modifications, setting up and adjustments.

101.28 DEFECTS LIABILITY PERIOD

The Contractor guarantees that all the supplies delivered according to the terms of the Contract are new, have never been used, are of the latest pattern put into service and have undergone all necessary improvements relating to design and materials.

Moreover, the Contractor guarantees that all the delivered supplies have no defects owing to their design, to the constituent material or to their use.

The Defects Liability Period remains valid for 12 months as from the date of Taking Over.

During the Defects Liability Period, the Contractor shall supervise the maintenance of the installations.

During the Defects Liability Period, the Contractor is bound to carry out all modifications, setting up, adjustments required for the replacement of the defective parts, so that the equipment meets the conditions set out in the Contract.

If during the Defects Liability Period an equipment is stopped due to defects attributable to the Contractor, especially in the case of abnormal wear, deterioration or malfunction of a main component, the Defects Liability Period for this equipment is extended to cover the period during which the equipment was out of order.

If during the Defects Liability Period, it is necessary to replace a component due to an abnormal wear, deterioration or malfunction, the Defects Liability Period of this component is counted from the moment the replacing parts are put into service. In this case, the Engineer can, at the end of the Defects Liability Period retain an amount of money equal to twice the price of the component determined at the moment of the replacement. This amount shall not be fully paid up until the end of the Defects Liability Period proper to this component, provided that the latter was proved consistent with the clauses of the Contract.

The Contractor shall afford all the expenses resulting from the above-mentioned operations including the cost of transportation, on site disassembling and reassembling and customs dues, etc...

Are excluded the expenses resulting from a deterioration owing to a negligence or an operation error and attributable to the Employer, or due to operation conditions that are not consistent with the instructions of operation and maintenance given by the Contractor. After having examined these defects not attributable to him, the Contractor shall inform the Engineer within a period of ten working days only, under a penalty of foreclosure.

The Contractor is not responsible for the components supplied, repaired, modified or replaced by the Employer or his representative without the written approval of the Contractor.

However, this does not include the cases where the Employer carries out urgent repairs or replacements in the event of non-compliance by the Contractor to the conditions mentioned hereinafter.

If it has been proved that the noticed defect is caused by a systematic error of design of equipment, the Contractor should replace or modify all identical parts used on the other equipment mentioned in the Contract, even though they did not give rise to any accident.

All works incumbent on the Contractor during the Defects Liability Period should be executed as soon as possible, taking into consideration the operation requirements.

The Contractor should, however, afford all provisional repairs to meet to the best these requirements, while reducing to the minimum the time during which the equipment is partially or totally not operational.

The end of the Defects Liability Period will be declared following satisfactory Test On Completion results.

101.29 COVID-19 PANDEMIC

101.29.1 GENERAL NOTES

101.29.11. Workers and staff

All engineers, staff and workers shall go to their private homes at the end of the day after works are done.

The offices shall not contain any dormitories nor lunch break rooms. There should be a strict policy based on the COVID-19 measures restraining and minimizing gatherings. Moreover, PPEs, including masks, shall always be worn on site.

101.29.12. Safety measures and traffic

Organizing the site and the traffic shall be done using caution tapes, cones, and guidance signboards.

101.29.2 COVID-19 PANDEMIC PRECAUTIONS:

The procedures and precautions measures set by the Lebanese Ministry of Health should always be respected in order to prevent the Covid-19 virus from spreading among the project's staff and workers, delaying the works and resulting in loss in lives.

The procedures to be taken mainly consist of the following:

101.29.21. Social distancing

The staff and workers should avoid being in crowds and try to always maintain distance (more than 1 meter at least) between them.

101.29.22. Good Hygiene

Good hygiene is one of the precautions that should be taken into consideration concerning COVID-19 virus. This includes washing hands regularly, avoiding touching nose and eyes, and using alcohol-based liquids to clean hands.

101.29.23. Protective equipment (masks, gloves, helmets ...)

Masks, helmets, and gloves should be worn by all staff and workers.

101.29.24. Health and awareness monitoring

The contractor should submit a H&S plan including all requirements and precautions against COVID-19.

PART 2
CIVIL WORK

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201. EARTHWORKS

201.1 PROGRAMME AND METHODS OF WORK

In addition to the information furnished by the Contractor with his Tender, the Contractor shall, after award of Contract but no later than two weeks prior to commencement of Works, submit for the Engineer's approval detailed proposed methods of excavating. Transporting and placing earth fill material, watering and compacting and any subsequent modifications thereof, together with a detailed list of quantities and type of plant to be used for all these operations. Amendments shall be made by the Contractor in accordance with any instructions issued by the Engineer before commencement of works and from time to time.

201.2 GEOTECHNICAL INVESTIGATION

A geotechnical investigation is performed by SAFWAN ABDUL KADER CHAHAL on 15 ferbruary 2023.

Contractor is urged to carefully analyze the site conditions and the soil investigation report.

All required additional soil investigation to design and execute foundations and road shall be at contractor's expense.

201.3 EXCAVATION WORKS

- A. This Section pertains to the earthwork generally consisting of excavation, filling, backfilling and subgrade preparation as required for construction of site retaining walls/structures, slab on grade walks, pavement surfaces, landscaped areas and the general shaping of the site as shown, described or reasonably inferred on the drawings.
- B. Contractor is urged to carefully analyze the site conditions.
- C. Construction Means, Methods, Techniques, Sequences and Procedures:
 1. The Contractor is solely responsible for, and has sole control over, construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work.
 2. Shoring that is required to complete the Work, is considered a method or technique and is the sole responsibility of the Contractor. If a regulatory agency requires a licensed engineer to design, approve or provide drawings for shoring, then it is the sole responsibility of the Contractor to engage the services of a qualified Engineer for shoring design services.

Related works:

- Clearing and Grubbing
- Trenching, Backfilling and Compaction
- Erosion and Sedimentation Control
- Asphalt Concrete Paving
- Concrete Paving
- Excavation and Fill

- Contractor shall comply with all current, applicable codes and regulations, including the Uniform Building Code.
- Contractor shall comply as applicable with Standard Specifications for Public Works Construction, Current Edition, including all site-specific City and County Amendments (herein after referred to as "Standard Specifications").

Under foundation area, the contractor shall prepare the soil before any concrete pouring:

- Clean the site completely for any debris material.
- The soil at the excavation level shall be examined thoroughly. Any unsuitable weak materials at the foundation level shall be removed.
- The bottom of the excavation (at foundation level) material should be compacted to achieve 95% degree of compaction incase rock was not encountered.

201.4 COMPACTION CONTROL

Suitable compaction equipment commonly used to meet the requirements for this type of compaction work should be used.

2. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. The surface grade shall be consistent with the drainage intent shown on the plans such that no unwanted ponding shall occur.
3. Surface shall not be more than 0.10 feet above or below the established grade, and all ground surfaces shall vary uniformly between indicated grades.
4. Cut material from the site may be used for fill material if approved by site engineer. Where cut material is used as fill, each lift of such material shall be properly mixed to obtain a uniform material, with clay being the predominant material when mixed with silt, maintaining a plasticity index less than 20.

The following are the minimum requirements for compaction of cohesive and cohesionless fill materials for both general and structural fill as presented in the following table:

| MINIMUM COMPACTION REQUIREMENTS | | | |
|---------------------------------|-----------------------|---|---|
| Type of Fill | Type of Fill Material | Minimum Relative Compaction (% of Max. Dry Density per ASTM D 1557 (D)) | Minimum Relative Density in percent, as per ASTM D 4254 |
| General fill | Cohesive | 90 | - |
| | Cohesionless | 90 | 70 |
| Structure | Cohesive | 95 | - |
| | Cohesionless | 95 | 74 |

Where :

- Structural Fill:

All types of fill material placed to support all structural elements and or piping, both vertically and horizontally.

- General Fill:

All mass earthwork, including earth embankments, placed primarily for the purpose of elevating ground levels

- Cohesive Material:

All fine-grained soils such as clayey or silty soils which exhibit cohesion properties. Additionally for purposes of this specification, coarse-grained soils containing 12 % or more fines that pass through No. 200 sieve, are also included in this category.

- Cohesionless Material: Cohesionless material includes all relatively free-draining granular material such as sands or gravels which contain less than 12 % of fines that will pass through No. 200 sieve.

For the performance of all the above-mentioned tests, the Contractor shall provide a fully-equipped field laboratory and the necessary trained personnel for sampling and testing, all subject to the Engineer's prior approval. All costs for providing the field laboratory and the necessary personnel and for sampling, testing, transportation, etc., shall be deemed to be included by the Contractor in his unit rates for the various items of earthworks in the Bill of Quantities and shall not be paid for separately.

202. CONCRETE WORKS

201.5 GENERAL

201.5.1 Life Span of Concrete Structure

New works are to be designed for a life of 60 years.

201.5.2 Codes and Standards

Complementary or new design shall as far as possible be carried out in compliance with relevant International Standards such as:

- BS Standards.
- Eurocodes
- ACI and Uniform Building code.
- BAEL 1992
- AFPS 90

or equivalent standards

201.6 SOIL PARAMETERS

The Contractor shall carry out soil investigations to satisfy himself with the prevailing soil conditions for all sites.

201.7 MATERIALS

201.7.1 Grades of Concrete

The minimum grades of concrete for the various structures are given as follows:

| Grade | Component |
|--------|--|
| C30/37 | Reinforced concrete for water tank structures, structures in contact with water including roof slab (400 Kg cement/cu.m) |
| C30/37 | Reinforced concrete for underground valve room (400 Kg cement/cu.m) |
| C25/30 | Reinforced concrete for all other structures and the pumps room (350 Kg cement/cu.m) |
| C20/25 | Mass concrete and Blinding concrete (250 Kg cement/cu.m) |

Reinforced and mass concrete must be vibrated. Cement used for structures in contact with soil shall be sulphate resisting Portland cement (BS 4027).

Cement for all other structures shall be ordinary or/and rapid hardening Portland cement (BS12).

Admixtures and mix design of the different Grades of concrete shall be submitted for approval prior to commencing the work.

201.7.2 Reinforcement

All reinforcing steels shall be Type 2 High Yield Bars and comply with the requirement of BS 8110 and shall have a specified characteristic strength of 420 N/mm².

Dowel bars and stirrups shall be Mild Steel grade 25, $f_y = 250 \text{ N/mm}^2$.

Lap lengths shall be 50 diameters. Mechanical bending for $\phi \geq 12 \text{ mm}$ is required.

201.7.3 Minimum Cover of Reinforcement

The concrete cover for all steel bars including stirrups shall not be less than 50 mm in structures where concrete surfaces are in contact with water.

Where concrete surfaces are in direct contact with soil without blinding concrete, the cover of reinforcement shall not be less than 70 mm.

For concrete surfaces in contact with soil with blinding concrete, the cover of reinforcement shall not be less than 50mm.

The cover for all other concrete structures shall not be less than 35mm.

Formwork for all concrete surfaces in contact with water and/or soil and internal surface (walls and ceilings) of technical rooms shall be of form panels (marine plywood or metallic formwork) in order to obtain a regular and smooth finish.

All concrete structures except the underground valve room should be fair faced.

201.7.4 Classes of Exposure and Crack Width

External and internal walls, columns and beams and all concrete structures in this project are to be considered as subject to severe exposure as defined in Sub-Clause 3.3.4 of BS 8110.

Concrete surfaces in contact with water are designed for a maximum crack width of 0.2 mm. (Class XC4)

The faces of structures in contact with soil shall also be considered as subject to severe exposure (class XA1) (Sulfate resisting).

For all other concrete a class of XC1/XF1 shall be adopted.

In addition, concrete environmental class exposure is based on BS EN 206 Concrete Specifications. As shown below (table 1 – exposure classes - BS EN 206) ,

Minimum required concrete compressive strength is adopted according to annex F - BS EN 206 ($f'c = 30 \text{ MPa}$ on cylindrical test and $f'c = 37 \text{ MPa}$ on cubic test)for all structures.

| Class designation | Description of the environment | Informative examples where exposure classes may occur |
|--|--|--|
| 1 No risk of corrosion or attack | | |
| X0 | For concrete without reinforcement or embedded metal: All exposures except where there is freeze/thaw, abrasion or chemical attack. For concrete with reinforcement or embedded metal: Very dry | Concrete inside buildings with very low air humidity |
| 2 Corrosion induced by carbonation | | |
| Where concrete containing reinforcement or other embedded metal is exposed to air and moisture, the exposure shall be classified as follows: | | |
| XC1 | Dry or permanently wet | Concrete inside buildings with low air humidity; Concrete permanently submerged in water |
| XC2 | Wet, rarely dry | Concrete surfaces subject to long-term water contact; Many foundations |
| XC3 | Moderate humidity | Concrete inside buildings with moderate or high air humidity; External concrete sheltered from rain |
| XC4 | Cyclic wet and dry | Concrete surfaces subject to water contact, not within exposure class XC2 |

| Class designation | Description of the environment | Informative examples where exposure classes may occur |
|---|---|---|
| 3 Corrosion induced by chlorides other than from sea water | | |
| Where concrete containing reinforcement or other embedded metal is subject to contact with water containing chlorides, including de-icing salts, from sources other than from sea water, the exposure shall be classified as follows: | | |
| XD1 | Moderate humidity | Concrete surfaces exposed to airborne chlorides |
| XD2 | Wet, rarely dry | Swimming pools; Concrete exposed to industrial waters containing chlorides |
| XD3 | Cyclic wet and dry | Parts of bridges exposed to spray containing chlorides. Pavements, Car park slabs |
| 4 Corrosion induced by chlorides from sea water | | |
| Where concrete containing reinforcement or other embedded metal is subject to contact with chlorides from sea water or air carrying salt originating from sea water, the exposure shall be classified as follows: | | |
| XS1 | Exposed to airborne salt but not in direct contact with sea water | Structures near to or on the coast |
| XS2 | Permanently submerged | Parts of marine structures |
| XS3 | Tidal, splash and spray zones | Parts of marine structures |
| 5 Freeze/thaw attack with or without de-icing agents | | |
| Where concrete is exposed to significant attack by freeze/thaw cycles whilst wet, the exposure shall be classified as follows: | | |
| XF1 | Moderate water saturation, without de-icing agent | Vertical concrete surfaces exposed to rain and freezing |
| XF2 | Moderate water saturation, with de-icing agent | Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents |
| XF3 | High water saturation, without de-icing agent | Horizontal concrete surfaces exposed to rain and freezing |
| XF4 | High water saturation, with de-icing agent or sea water | Road and bridge decks exposed to de-icing agents; Concrete surfaces exposed to direct spray containing de-icing agents and freezing Splash zones of marine structures exposed to freezing |
| 6 Chemical attack | | |
| Where concrete is exposed to chemical attack from natural soils and ground water, the exposure shall be classified as follows: | | |
| XA1 | Slightly aggressive chemical environment | Concrete exposed to natural soil and ground water according to Table 2 |
| XA2 | Moderately aggressive chemical environment | Concrete exposed to natural soil and ground water according to Table 2 |
| XA3 | Highly aggressive chemical environment | Concrete exposed to natural soil and ground water according to Table 2 |

202. METAL WORKS

202.1 PART 1 - GENERAL

202.1.1 DESCRIPTION

- A. Section specifies Metal works.
- B. Types: Industrial / Metal

202.1.2 SUBMITTALS

Shop Drawings: Show design, fabrication details, installation, connections, material, and size of members.

202.2 PART 2 - PRODUCTS

202.2.1 DESIGN CRITERIA

- A. Structural design, fabrication and assembly in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.
- B. Wind load calculation is based on basic wind speed on 35 m/s

202.2.2 MATERIALS

- A. Steel Pipe: ASTM A53, Standard Weight, zinc coated.
- B. Steel Grating: Metal bar type grating NAAMM BG.
- C. Sheet Steel: ASTM A366.
- D. Structural Steel: ASTM A36.
- E. Steel Floor Plate: ASTM 786.
- F. Steel Decking: Form from zinc coated steel conforming to ASTM A446, with properties conforming to AISI Specification for the Design of Cold-Formed Steel Structural Members.
- G. Steel Plate: ASTM A570.
- H. Iron Castings: ASTM A48, Class 30.
- I. Malleable Iron Castings: ASTM A47.

202.2.3 FABRICATION GENERAL

- A. Fasteners:
 - 1. Conceal bolts and screws wherever possible.
 - 2. Use countersunk heads on exposed bolts and screws with ends of bolts and screws dressed flush after nuts are set.
 - 3. bolts and screws material (hot-dip galvanized steel)
- B. Welding:
 - 1. Structural steel, AWS D1.1 and sheet steel, AWS D1.3.
 - 2. Where possible, locate welds on unexposed side.
 - 3. Grind exposed welds smooth and true to contour of welded member.
 - 4. Remove welding splatter.
- C. Remove sharp edges and burrs.
- D. Fit stringers to head channel and close ends with steel plates welded in place where shown.
- E. Fit face stringer to newel post by tenoning into newel post, or by notching and fitting face stringer to side of newel where shown.

- F. Shop Prime Painting: Prepare surface and apply primer as specified for ferrous metals in Section, PAINTING.

202.2.4 RAILINGS

Handrailing shall be approximately 1000mm in height with 3 intermediate horizontal rail with standards not more than 2000mm apart.

Handrailing shall be designed for a horizontal loading of not less than 220N/mm. Hoops shall be welded on where required for fixing guard chains.

Standards and rails shall be manufactured from black mild steel tube to BS 1357:1967, from steel tubing to BS 1775, from steel pipe ASTM A120 or from extruded aluminum alloy approved by the Engineer. The nominal bore of steel tubing shall be not less than 40mm.

Tubular Handrails and Ladders in contact with wastewater shall be of Stainless Steel Grade 316 – Contractor shall submit for approval prior to ordering the materials.

Adequate provision shall be made for thermal movement.

Guardrails shall be approximately 750mm in height with a single top rail. In all other respects it shall comply with the specification for handrailing.

Steel handrailing and guardrails shall be hot dip galvanized after fabrication. Chains across openings in handrails at tops of ladders shall be galvanized mild steel having 3 SWG x 3 links per 100mm and shall be supplied complete with 'S' hooks and split rings.

- A. Fabricate railings, including handrails, from steel pipe with flush.
1. Connections may be standard fittings designed for welding, or coped or mitered pipe with full welds.
 2. Wall handrails are provided under Section, METAL FABRICATIONS.
- B. Return ends of handrail to wall and close free end.
- C. Provide standard terminal castings where fastened to newel.
- D. Space intermediate posts not over six feet on center between end post // or newel post.
- E. Fabricate handrail brackets from cast malleable iron.
- F. Provide standard terminal fittings at ends of post and rails.

202.2.5 INDUSTRIAL STAIRS / LADDERS

Ladders shall comply with BS 421 1 and shall be of mild steel and shall consist of 65mm x 12mm flats and stringers 400mm apart with 20mm diameter solid rungs at a maximum of 250mm centers shouldered and riveted over. Stringers shall have welded-on feet and brackets for fixing to floors and walls, which fixings shall be not more than 2 meters apart. Brackets shall be 25 x 10mm flats.

Stringers shall be extended 1000mm above the upper platform and suitably opened out for access, or where ladders are below manhole covers, separate hand holds shall be fixed to the upper platform.

Unless otherwise shown on the drawings ladders rising 2500mm or more shall be fitted with safety hoops. The hoops shall have a diameter of 760mm and be of 50 x 8mm flats at not more than 900mm centers, fixed to the strimers and with three vertical straps of 50 x 8mm flats extending from the top to the bottom hoop.

Steel ladders shall be hot dipped galvanized after fabrication.

- A. Provide treads, platforms, railings, stringers and other supporting members as shown.

- Checked steel for treads and platforms shall not be less than 6-mm thick.
- B. Treads and platforms of checkered steel floor plate:
 - 1. Turn floor plate down to form nosing on treads and edge of platform at head of stairs.
 - 2. Support tread and platforms with angles welded to plate.
 - 3. Do not leave exposed fasteners on top of treads or platform surfaces.
 - 4. Provide flat sheet steel risers for stairs with steel plate treads where shown //.
 - C. Treads and platforms of steel grating:
 - 1. Fabricate steel grating treads and platforms in accordance with requirements of NAAMM Metal Bar Grating Manuals.
 - 2. Provide end banding bars, except where carrier angle are used at tread ends.
 - 3. Support treads by use of carrier plates or carrier angle. Use carrier plate end banding bars on exterior stairs.
 - 4. Provide abrasive nosing on treads and edge of platforms at head of stairs.
 - 5. Provide toe plates on platforms where shown.

202.3 PART 3 - EXECUTION

202.3.1 STAIR INSTALLATION

- A. Provide lateral bracing required to support the imposed lateral loads.
- B. Perform job site welding and bolting as specified for shop fabrication.
- C. Set all structural members in position and secure to existing structure as shown.
- D. Install plumb, level and true to line verification.

202.3.2 RAILING INSTALLATION

- A. Install standard terminal fittings at ends of posts and rails.
- B. Secure brackets, posts and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.
- C. Set rails horizontal or parallel to rake of stairs to within 3 mm in 3650 mm (1/8-inch in 12 feet).
- D. Set posts plumb and aligned to within 3 mm in 3650 mm (1/8-inch in 12 feet).

202.3.3 FIELD PAINTING

- A. When installation is complete, clean field welds and surrounding areas to bright metal, and coat with same primer paint used for shop priming.
- B. Touch-up abraded areas with same primer paint used for shop priming.
- C. Touch up abraded galvanized areas with zinc rich paint as specified in section PAINTING
- D. Resin painting for the internal stair inside the water tank.

203. STEEL DOORS AND FRAMES

203.1 PART 1 - GENERAL

203.1.1 DESCRIPTION

- A. This section specifies steel doors, steel frames and related components.
- B. Terms relating to steel doors and frames as defined in ANSI A123.1 and as specified.

203.1.2 TESTING

Performed by an independent testing laboratory.

203.1.3 SUBMITTALS

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturers Literature and Data:
 - 1. Fire rated doors and frames, showing conformance with NFPA 80 and Underwriters Laboratory, Inc., or Inchcape Testing Services or Factory Mutual fire rating requirements // and temperature rise rating for stairwell doors. Submit proof of temperature rating //.
 - 2. Sound rated doors, including test report from Testing Laboratory.

Contractor shall submit for approval prior to ordering all the materials, shop drawings, execution equipments and methods.

203.1.4 STORAGE AND HANDLING

- A. Store doors and frames at the site under cover.
- B. Protect from rust and damage during storage and erection until completion.

203.2 PART 2 - PRODUCTS

203.2.1 MATERIALS

- A. Stainless Steel: ASTM A167, Type 302 or 304; finish, NAAMM Number 4.
- B. Sheet Steel: ASTM A366, cold-rolled, stretcher leveled degree of flatness for panels (face sheets) of doors and panels.
- C. Anchors, Fastenings and Accessories: Fastenings anchors, clips connecting members and sleeves from zinc coated steel.
- D. Insect Screening: ASTM D3656, 18 by 18 regular mesh.
- E. Prime Paint: Paint that meets or exceeds the requirements of A250.8.

203.2.2 FABRICATION GENERAL

- A. GENERAL:
 - 1. Follow SDI A250.8 for fabrication of standard steel doors, except as specified otherwise. Doors to receive hardware specified in Section 08710, Door Hardware. Tolerances as per SDI A250.8. Thickness, 44 mm (1-3/4 inches), unless otherwise shown.
 - 2. Close top edge of exterior doors flush and seal to prevent water intrusion.
 - 3. When vertical steel stiffeners are used for core construction, fill spaces between stiffeners with mineral fiber insulation.
- B. Custom Metal Hollow Doors:
Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design, materials, construction, gages and finish shall be as specified for of standard steel doors.
- C. Tubular Steel Doors:
 - 1. Industrial type.

2. Stiles and rails minimum of 125 mm (5 inches) by 44 mm (1-3/4 inches), formed of 1.3 mm (0.053 inch) thick steel tubular design, with locked seam. Bottom rail be 250 mm (10 inches) wide.
3. Louver and glazed opening sizes as shown.
4. Door panels; consist of two sheets of 1 mm (0.042 inch) thick steel with a resilient separator, nominally 9 mm (3/8 inch) thick, interlocked into the stiles and rails.

203.2.3 METAL FRAMES

- A. General:
 1. SDI A250.8, 1.3 mm (0.053 inch) thick sheet steel, types and styles as shown or scheduled.
- B. Reinforcement and Covers:
 1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.
 2. Provide mortar guards securely fastened to back of hardware reinforcements except on lead-lined frames.
- C. Terminated Stops: SDI A250.8.
- D. Frame Anchors:
 1. Floor anchors:
 - a. Where floor fills occur, provide extension type floor anchors to compensate for depth of fill.
 - b. At bottom of jamb use 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive two 6 mm (1/4 inch) floor bolts. Use 50 mm x 50 mm (2 inch by 2 inch) 9 mm by (3/8 inch) clip angle for lead lined frames, drilled for 9 mm (3/8 inch) floor bolts.
 - c. Where mullions occur, provide 2.3 mm (0.093 inch) thick steel channel anchors, drilled for two 6 mm (1/4 inch) floor bolts and frame anchor screws.
 - d. Where sill sections occur, provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for 6 mm (1/4 inch) floor bolts and frame anchor screws. Space floor bolts at 50 mm (24 inches) on center.
 2. Jamb anchors:
 - a. Locate anchors on jambs near top and bottom of each frame, and at intermediate points not over 600 mm (24 inches) apart, // except for fire rated frames space anchors as required by labeling authority //.
 - b. Form jamb anchors of not less than 1 mm (0.042 inch) thick steel unless otherwise specified.
 - c. Anchors set in masonry: Use adjustable anchors designed for friction fit against the frame and for extension into the masonry not less than 250 mm (10 inches). Use one of following type:
 - 1) Wire loop type of 5 mm (3/16 inch) diameter wire.
 - 2) T-shape or strap and stirrup type of corrugated or perforated sheet steel.
 - d. Anchors for stud partitions: Either weld to frame or use lock-in snap-in type. Provide tabs for securing anchor to the sides of the studs.
 - e. Anchors for frames set in prepared openings:
 - 1) Steel pipe spacers with 6 mm (1/4 inch) inside diameter welded to plate reinforcing at jamb stops or hat shaped formed strap spacers, 50 mm (2 inches) wide, welded to jamb near stop.
 - 2) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass thru frame and spacers.
 - 3) Two piece frames: Subframe or rough buck drilled for 6 mm (1/4 inch) bolts.
 - f. Anchors for observation windows and other continuous frames set in stud partitions.

- 1) In addition to jamb anchors, weld clip anchors to sills and heads of continuous frames over 1200 mm (4 feet) long.
 - 2) Anchors spaced 600 mm (24 inches) on centers maximum.
- g. Modify frame anchors to fit special frame and wall construction and provide special anchors where shown or required.

203.2.4 SHOP PAINTING

Shop painting for steel frames are regulated with reference to SDI A250.

A. Prime Finish:

Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: steel beams and frames are to be cleaned, and chemically treated to insure maximum finish paint adhesion. All steel beams, frames, and frame components shall be cleaned, phosphatized, and finished with one coat of baked-on rust inhibiting primer in accordance with the ANSI A250.10

Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel beams and Frames. The prime finish is not intended to be the final layer of protection from the elements. Field painting using a good grade of paint to be provided in accordance with the recommendations of the door and frame manufacturer.

B. Paint System for exterior/ interior doors:

1. Zinc Rich Epoxy anti corrosive metal primer, factory applied.
2. Solvent based 2-component aliphatic polyurethane finish coat.

203.3 PART 3 - EXECUTION

203.3.1 INSTALLATION

- A. Plumb, align and brace frames securely until permanent anchors are set.
1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.
 2. Use wood spreaders at bottom of frame if the shipping spreader is removed.
 3. Protect frame from accidental abuse.
 4. Where construction will permit concealment, leave the shipping spreaders in place after installation, otherwise remove the spreaders after the frames are set and anchored.
 5. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured.
- B. Floor Anchors:
1. Anchor the bottom of door frames to floor with two 6 mm (1/4 inch) diameter expansion bolts. Use 9 mm (3/8 inch) bolts on lead lined frames.
 2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
- C. Jamb Anchors:
1. Secure anchors to sides of studs with two fasteners through anchor tabs. Use steel drill screws to steel studs.
 2. Frames set in prepared openings of concrete: Expansion bolt to wall with 6 mm (1/4 inch) expansion bolts through spacers. Where subframes or rough bucks are used, 6 mm (1/4 inch) expansion bolts on 600 mm (24 inch) centers or power activated drive pins 600 mm (24 inches) on centers. Secure two piece frames to subframe or rough buck with machine screws on both faces.
- D. Overhead Bracing (Lead Lined Frames): Where jamb extensions extend to structure above, anchor clip angles with not less than two, 9 mm (3/8 inch) expansion bolts or power actuated drive pins to concrete slab. Weld to steel overhead members.

204. STEEL WINDOWS

204.1 PART 1 - GENERAL

204.1.1 DESCRIPTION:

- A. Section Includes:
1. Steel // single hung // // double hung // windows, type and sizes as shown.
 2. Hardware.
 3. Accessories including, but not limited to, following:
 - a. Mullions, closures, trim, weather stripping, covers, insect screens, anchors, clips, fasteners, and other components necessary for fabrication and installation complete of windows as specified.
 - b. Provide manufacturer's standard extension pole with hook for opening windows at high window locations. Provide hook receptacle factory attached to ventilators for use with extension poles. //

204.1.2 QUALITY CONTROL

QUALIFICATIONS:

1. Approval is required of products or service of proposed manufacturer, suppliers and installers, and will be based upon submission by Contractor of certification that:
 - a. Manufacturer who regularly and presently, manufactures and installs steel window units and related accessories as one of its principal products.
 - b. Accessories required for windows shall be manufacturer's standard or those of other manufacturers regularly engaged in making window accessories and acceptable to window manufacturer.
 - 1) Items shall be of materials which shall be compatible with balance of window unit material, and construction shall be that which shall give desired functional service.
2. Installer: Approved in writing by manufacturer.

204.1.3 PERFORMANCE REQUIREMENTS:

- A. Air Infiltration Test at Weather stripped Ventilators:
1. Operable windows: Provided with weather stripping, such that when tested in closed and locked position in accordance with ASTM E283 before leaving factory, air infiltration shall not exceed 2.06 cubic meter per hour per meter (0.37 cubic foot per minute per foot) of crack length when subjected to a pressure differential across the window of 300 Pa (6.24 psf) equivalent to a wind velocity of 50 miles per hour. Fixed window areas: Maximum air infiltration shall not exceed 0.34 cubic meter per hour per meter (0.06 cubic foot per minute per square foot) of fixed window area.
- B. Water Penetration Test at Weather stripped Ventilators:
1. Operable windows: Provided with weather stripping, such that when tested in closed and locked position in accordance with ASTM E331 no water penetrates for 15 minutes when a window is subjected to a rate of flow of 5 gal./hr./sq. ft. with a pressure differential across the window at 160 Pa (2.86 psf).

204.1.4 SUBMITTALS:

- A. Submit SAMPLES AND SHOP DRAWINGS
- B. Samples:
1. Typical sash corner.

2. Typical mounting section.
3. For Initial Color Selection: Submit samples of each specified finish on 300 mm (12 inch) long sections of window members.
4. Hardware.

204.1.5 DELIVERY, STORAGE AND HANDLING:

- A. Deliver steel window units and related components in protective packaging. Use padded blankets or other approved protective wrapping for glass, decorative metal work, and other exposed elements.
 1. Do not deliver steel window units until work is ready for their installation.
 2. Inspect components for damage upon delivery. Do not install steel window units with dimples or dents. Remove and replace damaged components at no additional cost.
- C. Storage: Store steel window units and related components, in positions necessary to prevent twisting, in weathertight and dry storage facility in their original shipping containers with protective wrapping or packaging securely in place, in accordance with manufacturers written instructions.
- D. Protect finish from damage from handling, weather and construction operations before, during and after installation.

204.2 PART 2 - PRODUCTS

204.2.1 MATERIALS:

Materials Generally:

1. Frame: Formed from 2.3 mm (12 gauge) galvanized sheet steel.
2. Heavy Intermediate Ventilators: Manufactured from solid hot rolled steel shapes.
 - a. Sections made from new billet steel with flanges rolled integral at mill.
 - b. Ventilator sections shall have glazing rebates providing an unobstructed glazing surface of at least 16 mm (5/8 inch) in height.
 - c. Glazing rebate surfaces must be perpendicular to web or stem of section. Applied glazing rebate extensions and tapered rebate surfaces are not acceptable.
3. Mullions and Transom Bars: Mullions and transom bars shall withstand a uniform wind load of 960 Pa (20 psf) of window area without deflecting more than 1/175 of span.
4. Weather stripping: Pile weather strip.
5. Hardware shall be as follows:
 - a. Fastener: Standard bronze sweep lock.
 - b. Pulls: Standard bronze lift handle.
 - c. US 20D: Statuary Bronze. //
 - d. U.S. 25D: Polished White Bronze. //
 - e. Balance Arm: Spiral and extension spring sash balance.
6. Paint Finishes:
 - a. Prime Coat: After fabrication, steel windows, fins, mullions, cover plates and associated parts shall be cleaned, properly treated, prime painted with manufacturer's standard prime paint.
 - b. Factory Finish: After fabrication, for type of factory finish selected, steel windows and associated components shall be cleaned, and given following treatments:
 - 1) Pretreatment: Zinc phosphate treated.
 - 2) Primer: Manufacturer's special epoxy primer and oven cured.

- 3) Finish Coat: Manufacturer's standard color coat finish and oven cured.
- 4) Color: Refer to Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULE.
 - a) Windows in // boiler house // // ___// shall be given a factory applied finish coat of fume resisting paint. //
 - b) Color of finish coat is specified in Section 09050, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULE.
 - c) Touch-up abraded surfaces with enamel as specified for factory finish coat, except that it shall be Class A (Air-Drying), same as original.
- c. Zinc Coated Optional Finish: All steel except screens, shall be cleaned and:
 - 1) Hot dip galvanized (ASTM A123) and/or Electrodeposited (ASTM B633) or equivalent standards.
 - 2) Zinc coated, phosphate treated and prime painted.
 - 3) Zinc coated, phosphate treated, prime painted and factory finished in color as selected, from manufacturer's standard colors.
 - 4) Use galvanize repair compound where galvanized surfaces need field or shop repair. Apply compound in accordance with manufacturer's printed directions.
7. Glass and Glazing: As specified in Section, GLASS AND GLAZING.
 - a. Windows shall be factory glazed prior to delivery to project site.
 - b. Do not provide weep holes through glazed areas.
8. Accessories:
 - a. Insect Screening:
 - 1) Screen Frame: Formed of electro-galvanized steel having minimum thickness of 0.80 mm (0.032 inch), or of formed or extruded aluminum having a minimum thickness of 1 mm (0.040 inch).
 - a) Screen frames shall be of same material and finish as specified for windows. //
 - b) Screen frames shall be aluminum with natural finish. //
 - 2) Screens: Shall be re-wirable with 18 x 16 mesh cloth of aluminum, or fiberglass. Nominal wire diameter of the cloth shall not be less than 0.25 mm (0.011 inch) for aluminum. Wire cloth shall be held taught with removable spline. Screens shall be the removable type. Design screens to be rewirable and removable from inside building.

204.2.2 FABRICATION:

- A. General: Fabricate steel windows in accordance with approved shop drawings. Form sections in one piece, straight, true and smooth. Prior to fabrication, all hot rolled steel sections shall be cleaned by shot blasting. Provide drips and weep holes in accordance with manufacturer's standard practice.
- B. Frame: Members shall be modified channel shapes. Corners of frame and ventilators shall be mitered or coped then solidly welded. Head and jamb members shall have integral screen-stops. Integrally roll continuous flange at jambs and heads to form a caulking stop between facing and backing masonry. Exposed and contact surfaces shall be finished smooth, flush, with adjacent surfaces.
- C. Sills: Sills shall have stepped rebates to receive lower sash bottom rail, which shall be kept clear of sill wash. Sills shall not be perforated at any point in their full length. Weld strap anchors to underside of sill, or screw to tapped lugs welded thereto.
- D. Sash: Rails shall be tubular. Stiles may be tubular or modified channel shape. Stiles and rails shall be formed in one piece from single strips. Make sash rebates minimum 15 mm (19/32 inch). Make interior horizontal top surfaces of both meeting rails flat and in same plane.

- Meeting rails shall have tight contact with wedge blocks at jambs when sash is closed. Cope, end-lap and weld all corners of sash.
- E. Muntins: Steel tee muntin sections shall be tenoned and welded to perimeter frame. Muntin intersections shall be slotted and cross notched.
 - F. Glazing: Design windows for interior glazing. Provide continuous removable snap-in metal glazing beads to suit specified glazing.
 - G. If windows and interior metal window trim are installed as complete units, mullions may be anchored at head by means of 5 mm (3/16 inch) steel plate clip bolted to mullion and welded to lintel, and supported at sill with 2.3 mm (12 gauge) zinc-coated steel bent clips welded to mullion.
 - H. Closures: Miter or cope closure corners and fit with tightly closed joints. Secure closures to window frames with non-corrosive machine screws or expansion rivets, and to masonry with fasteners specified.
 - I. Reinforcing: Reinforce window frames for attachment of screens, screen hardware or travel-limit lug. Full or limited length reinforcing plates shall be welded to back of frames, and shall be 3 mm (1/8 inch) thick and of sufficient width to securely hold fasteners.
 - J. Welding: Dress all exposed welds and joints, flush and smooth.
 - K. Fasteners for Anchoring: Where type, size or spacing of fasteners for securing windows and accessories to building construction is not shown or specified, use expansion or toggle bolts or screws, recommended by manufacturer for construction material adjacent to window units. Bolts or screws: Minimum 6 mm (1/4 inch) diameter and spaced not over 600 mm (24 inches) on centers.
 - 1. Expansion shield and bolt assemblies shall provide holding power beyond tensile and shearing strength of bolt.
 - 2. Power actuated drive pins may be used for securing anchors to concrete if recommended by manufacturer.

204.2.3 EXTERIOR METAL WINDOW TRIM:

Form window trim of zinc-coated sheet steel. Use 1.2 mm (18 gauge) for heads and jambs, 2.33 mm (12 gauge) for stools and 1.0 mm (20 gauge) for moldings. Make trim of welded assembly with hairline mitered corners, dressed flush and smooth. Trim to be used for plaster key, shall have flanges expanded or perforated and provided with attachments for anchorage. Slightly round exposed edges. Coat back side of trim to masonry. Make provisions for fastening of metal plastering base.

204.2.4 WEATHERSTRIPS:

Install weather strips, as standard with manufacturer, at head, jambs, sill, and meeting rails of sash and of impost. Weather strip shall be applied to both integral weather strip grooves of aluminum weather strip adapter. Secure weather strip adapter to frame surface.

204.3 PART 3 – EXECUTION

204.3.1 INSPECTION:

- A. Window openings shall conform with details, dimensions and tolerances shown on window manufacturer's approved shop drawings.
- B. Conditions which may adversely affect window installation shall be brought to Contractors attention, for repair, prior to commencement of window installation. Do not proceed with window installation until unsatisfactory conditions have been corrected.
- C. Wash down of adjacent masonry shall be completed prior to erection of windows to prevent damage to window finish by cleaning materials.

204.3.2 INSTALLATION

- A. General:
 - 1. Windows specified under this section shall be installed by experienced window manufacturer.
- B. Install windows in strict accordance with approved shop drawings.
 - 1. Set units plumb, level and true to line, without warp or rack of frames.
 - 2. Anchor units securely to surrounding construction with a minimum of three adjustable, asphalt coated or galvanized steel anchors with approved fasteners in accordance with manufacturer's recommendations.
 - 3. Exterior joints between sash, trim and mullions shall be properly sealed watertight with an approved sealant as specified in Section 07920, SEALANTS AND CAULKING, and neatly pointed. Finished work shall have weathertight joints.
- C. Protect window equipment during construction.
- D. Upon complete installation of all windows and accessories, and before acceptance of work, adjust all movable sash and operating mechanism for free and easy operation, and defects of any nature.
- E. Furnish certificate, signed by both contractor and window manufacturer, stating that installation of windows was done by installers approved by manufacturer of windows.

204.3.3 PROTECTION:

Protect windows from damage until final inspection and acceptance.

205. WATER PROOFINGS WORKS

205.1 SBS MEMBRANE

205.1.1 Part 1 – General

1. Section Includes:

Surface preparation, supply, and installation of granule surfaced, styrene-butadiene- styrene (SBS) modified-bitumen 2-ply membrane system with self-adhered, heat welded base sheets and heat welded cap sheets over Non-Nailable Substrate, including concrete tiles for protection.

2. Reference Standards

- a. American National Standards Institute (ANSI)/Single Ply Roofing Industry (SPRI):
 - i. ANSI/SPRI FX-1: Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
- b. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - i. ASCE/SEI 7: Minimum Design Loads for Buildings and Other Structures.
- c. ASTM International:
 - i. C36/C36M: Standard Specification for Gypsum Wallboard (withdrawn).
 - ii. C67: Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - iii. C140: Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - iv. C208: Standard Specification for Cellulosic Fiber Insulating Board.
 - v. C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - vi. C726: Standard Specification for Mineral Wool Roof Insulation Board.
 - vii. C728: Standard Specification for Perlite Thermal Insulation Board.
 - viii. C1177/C1177M: Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - ix. C1289: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - x. D41/D41M: Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 - xi. D312: Standard Specification for Asphalt Used in Roofing.
 - xii. D1668: Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.
 - xiii. D2178: Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
 - xiv. D3617: Standard Practice for Sampling and Analysis of Built-up Roof Systems during Application.
 - xv. D4263: Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - xvi. D4586: Standard Specification for Asphalt Roof Cement, Asbestos-Free.
 - xvii. D4601: Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing.
 - xviii. D4897/D4897M: Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing.
 - xix. E108: Standard Test Methods for Fire Tests of Roof Coverings.
- d. FM Global:

- i. Class Number 4450: Approval Standard for Class 1 Insulated Steel Deck Roofs.
 - ii. Class Number 4470: Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.
 - iii. Approval Guide (online resource).
- e. National Roofing Contractors Association (NRCA)/ Asphalt Roofing Manufacturers Association (ARMA):
- i. Quality Control Guidelines for Application of Polymer Modified Bitumen Roofing (Quality Control Guidelines).

3. Performance requirements

- a) General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- b) Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- c) Roof Assembly must meet the current version of ASHRAE 90.1.

4. Action submittals

- a) Product Data: Roofing-system manufacturer's literature, including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and application instructions
 - i. For membrane and base flashing materials, and roofing cement, asphalt, primer, mastic sealant, and fasteners.
 - ii. Include temperature ranges for storage and application of materials, and special cold weather application requirements or limitations.
 - iii. Include Safety Data Sheets (SDS) for information only; safety restrictions are sole responsibility of Contractor.
 - iv. Laboratory Test Reports: For installation adhesives indicating compliance with requirements for low-emitting materials.
- b) Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Include manufacturer's reviewed and approved details that are project specific. Manufacturer's generic details or replication of Architectural drawings will not be accepted.
 - i. Base flashings and membrane terminations. Draw to scale.
 - ii. Tapered insulation layout including, crickets, saddles, and tapered edge strips, including amount, direction of slopes, and dimensions.
 - iii. Dimensions and locations of all field, perimeter, and corners roof areas.
 - iv. Insulation fastening patterns for field, perimeter, and corners roof areas.
 - v. Membrane fastening (back-nailing) pattern for roof slopes in excess of 1/2 inch per foot.
 - vi. Walkway pad plan and details.
 - vii. Proposed temporary, watertight, tie-off details for each substrate type.
 - viii. Interfacing details with sheet metal components, including but not limited to:
 - a. Counterflashing.
 - b. Stack flashing assemblies.
 - c. Edge and fascia sections.
 - d. Interface with coping cap assemblies.
 - ix. Interfacing details with roofing accessories including but not limited to:

- a. Equipment curbs.
 - b. Roof hatches.
 - c. Expansion joints assemblies.
 - d. Penetrations.
 - e. Crickets, saddles, and tapered edge strips, including slopes.
- c) Installer Certificate and Qualifications:
- a. Signed by roofing-system manufacturer, certifying that Roofing Installer complies with manufacturer's requirements to install specified, warranted, roofing system.

5. WARRANTY

- a) Special No-dollar-limit (NDL) Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
- i. Special warranty includes membrane roofing, base flashings, fasteners, stacks, drains, wall flashings, metal flashings and other components of membrane roofing system.
 - ii. Warranty Period: 10 years from date of Substantial Completion.
- b) Special Installer's Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, and walkway products, for the following warranty period:
- i. Warranty Period: 10 years from date of Substantial Completion.
- c) Maintenance: Along with the issuance of the warranty, a set of instructions shall be included detailing preventative maintenance and noting a list of harmful substances that may damage the roofing membrane.
- i. Conspicuously mount laminated or otherwise protected roof assembly letter and warranty at roof hatch upon completion of the Project.

205.1.2 Part 2 – Product

1. GENERAL

- a) All products and components for the roofing system shall be supplied by the roofing system manufacturer.
- b) Roofing-system manufacturer shall have at least ten years documented experience and FM Global approval for roofing system identical to that specified for Project.
- c) Components other than those manufactured or supplied by the roofing system manufacturer shall be submitted for review, prior to ordering. Any product(s) not specifically authorized in writing for the project by the roofing system manufacturer, shall be considered unacceptable and their performance excluded from the warranty.
- d) Roofing membranes may be installed over or adhered directly to pre-approved insulation, cover board, decking or composites thereof. Contact manufacturer for additional information regarding compatible substrates.
- e) Membranes shall be testes in accordance with ASTM D 5147.
- f) Base Flashing Systems: Subject to compliance with requirements, provide products by one of the following, no substitutions:
- a. Johns Manville (or equivalent):
 - Backer Sheet: DynaLastic 180.
 - Flashing Sheet: DynaClad (aluminum-foil-surfaced), heat-welded
 - b. Siplast (or equivalent):
 - Backer Sheet: Paradiene 20 TG.

- Flashing Sheet: Veral [**Aluminum**] [**Stainless Steel**], heat-welded.
- c. Soprema (or equivalent):
 - Backer Sheet: Elastophene 180 PS.
 - Flashing Sheet: Sopralast [**50 TV ALU**] [**TV Copper**], heat-welded.
- d. Flashing sheet to be coated with granules. Granule color to match color of roofing membrane granules.

2. AUXILIARY ROOFING MEMBRANE MATERIALS

- a) General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
 - i. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - ii. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1) Plastic Foam Adhesives: 50 g/L.
 - 2) Gypsum Board and Panel Adhesives: 50 g/L.
 - 3) Multipurpose Construction Adhesives: 70 g/L.
 - 4) Fiberglass Adhesives: 80 g/L.
 - 5) Contact Adhesive: 80 g/L.
 - 6) Other Adhesives: 250 g/L.
 - 7) Non membrane Roof Sealants: 300 g/L.
 - 8) Sealant Primers for Nonporous Substrates: 250 g/L.
 - 9) Sealant Primers for Porous Substrates: 775 g/L.
- b) Asphalt Primer: ASTM D41.
- c) Roofing Asphalt: ASTM D312, Type IV.
- d) Mastic Sealant: Polyisobutylene, plain or modified bitumen; non hardening, non-migrating, non-skinning, and non-drying.

205.2 BITUMINOUS COAT

205.2.1 Part 1 General

SUMMARY

Section Includes:

- damp-proofing of new structural elements in contact with soil, protecting these structures against water infiltration from the ground.
- damp-proofing of back filled new concrete retaining walls against infiltrated water.
- damp-proofing below slab and over walls of concrete structures retaining aqueous liquids against infiltrated water.
- damp-proofing of cut-off walls in catchment structures.

ACTION SUBMITTALS

- 1) Product Data: For each type of product indicated.
- 2) Shop Drawings: Show locations and extent of waterproofing.

INFORMATIONAL SUBMITTALS

- 1) Product test reports.
- 2) Sample warranties.

Contractor shall submit for approval prior to ordering all the materials, shop drawings, execution equipments and methods.

205.2.2 Part 2 Product

Damp-Proofing materials

Damp-proofing materials are intended to provide a resistance against water and sometimes against humidity and water vapor.

Bituminous Coating

This material is recommended for use on the exterior wall in contact with soil where water infiltration pressure is low (permeable earth foundation) and where the performance level of protection tolerates some damp patches.

Ground water should be checked previously by the Contractor for chemicals which may have a deleterious effect on the structure or internal finishes.

The Contractor must obtain the previous approval of the Engineer on the support as well on the type of material proposed.
(Type B for reinforced concrete design in accordance with B.S. 8110).

The bitumenous coating for damp-proofing should be cold applied emulsion in two coats (of at least 0.750 kg/m² each) and cross applied.

Bitumen primer should be of the same cold bitumen emulsion compound diluted to 50% with water and applied at a minimum rate of 0,400 kg/m². The damp-proof bitumenous coat shall be applied around 24 hours after the primer application.

202.1 CEMENTITIOUS WATERPROOFING

202.1.1 Part 1 General

A. SECTION INCLUDES

1. Surface-applied cementitious waterproofing treatment.
2. Flexible, 2-component brushable sealing slurry for complete and permanent waterproofing of concrete.

1.2 REFERENCES

- B. American Concrete Institute (ACI). 1. ACI 222R-01(R2010) - Protection of Metals in Concrete Against Corrosion.
- C. American Society of the International Association for Testing and Materials (ASTM).
 1. ASTM C109/C109M-16a - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
 2. ASTM C1583/C1583M-13 - Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).

3. ASTM D1411-09 - Standard Test Methods for Water-Soluble Chlorides Present as Admixtures in Graded Aggregate Road Mixes.
- D. British Standard Institution.
 1. BS EN 480-12:1998 - Admixtures for Concrete, Mortar and Grout. Test Methods. Determination of the Alkali Content of Admixtures.
 2. BS EN 12390-8:2009 - Testing Hardened Concrete: Depth of Penetration of Water Under Pressure.
- E. German Institute for Standardization (DIN). 1. DIN 1048 Part 5, Testing Concrete: Testing of Hardened Concrete Water Permeability.
- F. International Concrete Repair Institute (ICRI).
- G. NSF International. 1. NSF/ANSI Standard 61 - Drinking Water System Components, Health Effects.
- H. U.S. Army Corps of Engineers (USACE). 1. CRD C48-92 – Standard Test Method for Water Permeability of Concrete.

1.3 PERFORMANCE REQUIREMENTS

- A. Permeability:
 1. When tested to BS EN 12390-8 or DIN 1048-5 at 0.5 MPa (72.5 psi) for 72 hours, permeability of treated concrete will be reduced by 51% over untreated concrete. Treated samples were cured for 28 days and treatment was mechanically removed from samples prior to testing.
 2. Passes USACE CRD C48 when tested at 1.38 MPa (200 psi) for 14 days. Permeability of treated concrete will be reduced by 90% over untreated concrete.
 3. When tested versus untreated sample to DIN 1048-5 and following 28 day curing period, depth of water penetration shall be reduced by 75%.
- B. Self-Sealing: Autogenous crack sealing of treated concrete for cracks with width of 0.5mm (0.02 inches) or greater when subjected to hydrostatic pressure of 0.44 MPa (65 psi).
- C. Chloride Resistance: When tested to ASTM D1411, the waterproofing treatment shall improve concrete resistance to chlorides below limits require by ACI 222R and demonstrate chloride ion reduction of 84% at 15 mm penetration depth and 83% at 10 mm penetration depth; performance shall be verified by independent testing. Treated samples were cured for 28 days and treatment was mechanically removed from samples prior to testing.
- D. Sulfate Resistance: The waterproofing treatment shall improve concrete resistance to sulfates by reducing permeability without affecting compressive strength; performance shall be verified by independent testing.
- E. Potable Water Containment: Products of this Section shall be certified to NSF/ANSI Standard 61 for use with potable water.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Manufacturer's product data and general recommendations for waterproofing applications.
- B. Independent Test Reports: Provide reports certifying compliance of waterproofing products with specified performance requirements.
- C. Installation Data: Manufacturer's special installation requirements.
- D. Qualification Statements: Written notice from installer confirming project experience.
- E. Warranty Documents: Manufacturer's warranty documentation for specified coverage executed in the Owner's name.
- F. Environmental requirements: Application should not be made when the surface temperature is below 4 degrees C (40 degrees F).

202.1.2 Part 2 Products

1.5 WATERPROOFING MATERIALS

A. cementitious Surface-Applied Waterproofing: dry powder mixed with emulsion.

1. Working Time (-30°C, +80°C) : 30 minutes.
2. Performance Properties:

Temperature resistance: -30 °C to +80 °C

Exposure to rain: after 3 hours

Earth filling: after 3 days

Foot traffic: after 24 hours

Water vapor permeability: Class II

Capillary water absorption: < 0,1 kg/m² h^{0.5}

Compressive strength at 28 days: ≥ 19 N/mm²

Flexure strength at 28 days: ≥ 9 N/mm²

Bond strength on concrete after 28 days: ≥ 1,5 N/mm²

Static crack bridging ability 23 °C: EN 1062-7: Class A2

Dynamic crack bridging ability 23 °C : B1 (1000 cycles, $f = 0,03\text{Hz}$, $W_o = 0,15\text{mm}$, $W_u = 0,10\text{mm}$, crack change 50µm)

Water penetration under positive hydrostatic pressure:
(EN 12390-8, 3 days > 5 bar): No penetration

Water penetration under negative hydrostatic pressure
at 1,5 bar): No penetration

B. Emulsion.

1.6 MIXES

- A. Mix ingredients in clean containers to achieve performance requirements specified.
- B. Mix only quantities that can be applied before mixture begins to set, in accordance with manufacturer's written recommendations.

202.1.3 Part 3 Execution

1.7 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that concrete surfaces are sound and clean, and that form release agents and materials used to cure the concrete are removed prior to applying waterproofing treatment.

- C. Examine surfaces that are to receive waterproofing treatment for formwork tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks.

1.8 PREPARATION

- A. Concrete surfaces must be clean and free of paint, sealers, form release agents, curing compounds, dirt, laitance or any other contaminates.
- B. Prepare the surface by high pressure water blasting (minimum 3,000 psi), scarifying, shot blasting or sand blasting to remove loose concrete and surface contaminates.
- C. Repair leaking cracks or joints in accordance with manufacturer's written instructions and as follows:
 - 1. Chase the length of joints and cracks. Provide rectangular-shaped chase that is 40 mm (1.5 inch) deep x 25 mm (1 inch) wide.
 - 2. Use water stop plug to stop water leakage.
 - 3. Use repair grout to completely fill the chase flush with adjacent surfaces.
- D. Repair form-tie holes, rock pockets, honeycombing, cracks and other concrete defects in accordance with manufacturer's written instructions and as follows:
 - 1. Rout out defective areas to sound concrete. Leave edges square, do not featheredge.
 - 2. Remove loose material and saturate with water.
 - 3. If defect is actively leaking, install water stop plug to a maximum depth of 1/3 of the defect
 - 4. Fill defect with repair grout.

1.9 APPLICATION - WATERPROOFING

- A. Saturate the surface by high pressure water blasting. Remove all standing water so the surface is saturated-surface-dry (SSD) condition.
- B. Apply waterproofing uniformly at a coverage of 1.2 kg/m² (2.2 lb/yd²) to concrete surfaces following manufacturers written instructions.
- C. Curing:
 - 1. Wet cure waterproofing treatment for at least three (3) days and in accordance with manufacturer's written instructions.
 - 2. Cover the waterproofing with tarps or plastic to prevent water loss due to evaporation.
 - 3. Wet curing should begin when waterproofing has hardened enough not to be damaged by the application of curing water, usually 6-24 hours depending on conditions.
 - 4. Do not allow water to pool on the surface during the first 24 hours or until the waterproofing is hard.
 - 5. Keep protective coverings in place during the curing period to retain moisture.
 - 6. Protect from frost, rain and traffic for at least 24 hours. Heavy traffic must be avoided during the curing period.

1.10 CLEANING

Clean spillage and soiling from adjacent surfaces using manufacturer recommended cleaning agents and procedures.

1.11 PROTECTION OF FINISHED WORK

- A. Protect completed waterproofing from damage after application.

B. Backfill:

1. Do not backfill for at least thirty-six (36) hours after application of waterproofing.
 2. If backfill occurs within seven (7) days after application of waterproofing, take precautions to prevent dry fill material from absorbing moisture from finished waterproofing.
- C. Paints and coatings to be applied over waterproofing must be suitable for use on (new) concrete. Always apply according to the paint manufacturer's instructions, including any recommended primers.
- D. Wet cure for a minimum of 3 days, after it has hardened, before water testing treated tanks and reservoirs. For reservoirs that will contain drinking water, cure longer if possible, and then rinse with fresh water several times. Initially, the drinking water may need pH adjustment using citric acid or similar water treatment chemicals.

205.3 THERMAL INSULATION

205.3.1 Part1: GENERAL

SUMMARY

Section Includes:

Foam-plastic board insulation.

Glass-fiber board insulation.

Mineral-wool board insulation.

Glass-fiber blanket insulation.

ACTION SUBMITTALS

Product Data: For each type of product indicated.

LEED Submittals (Projects Authorized for LEED certification only):

Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

INFORMATIONAL SUBMITTALS

Product test reports.

Research/evaluation reports.

205.3.2 PRODUCTS

FOAM-PLASTIC BOARD INSULATION

Extruded-polystyrene board insulation in first paragraph below is also called "XPS insulation."

Extruded-Polystyrene Board Insulation: ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

DiversiFoam Products.

Dow Chemical Company (The).

Owens Corning.

Pactiv Building Products Kingspan Group)

Retain one or more of five subparagraphs below. If retaining more than one, indicate location of each on Drawings or by inserts.

Type IV, 25 psi.

GLASS-FIBER BOARD INSULATION

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

CertainTeed Corporation.

Johns Manville.

Knauf Insulation.

Owens Corning.

Glass-Fiber Board Insulation: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84.

Nominal density of 2.25 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.

MINERAL-WOOL BOARD INSULATION

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- Fibrex Insulations Inc.
- Isolatek International.

- Owens Corning.
- Roxul Inc.
- Thermafiber.

Unfaced, Mineral-Wool Board Insulation: ASTM C 612; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

Retain one or more of three subparagraphs below. If retaining more than one, indicate location of each on Drawings or by inserts.

Nominal density of 6 lb/cu. ft., Type II, thermal resistivity of 4.16 deg F x h x sq. ft./Btu x in. at 75 deg F.

GLASS-FIBER BLANKET INSULATION

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- CertainTeed Corporation.
- Guardian Building Products, Inc.
- Johns Manville.
- Knauf Insulation.
- Owens Corning.

Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

205.3.3 EXECUTION

INSTALLATION, GENERAL

- Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

INSTALLATION OF CAVITY-WALL INSULATION

Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

Glass-Fiber Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

- Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
- Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
- Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
- For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

- Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
- Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

- Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
- Show width of cavity on Drawings.
- Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
- After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
- Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

INSTALLATION OF CURTAIN-WALL INSULATION

Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

- Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
- Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

206. COMMON REQUIREMENTS

All metal sheets shall be 3mm thick minimum. All metal works shall be epoxy painted over a primer. All hardware shall be water resistant.

Buried walls shall receive a bituminous coating for protection.

207. PAINTING

207.1 PART 1 - GENERAL

207.1.1 DESCRIPTION

- A. Section specifies field painting.
- B. Section specifies prime coats which may be applied in shop under other sections.
- C. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.

207.1.2 SUBMITTALS

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
Before work is started, or sample panels are prepared, submit manufacturer's literature, indicating brand names, product type color, gloss level, coating composition, Federal Specification Number or manufacturers name or product number where applicable, and certificates as specified.
- C. Sample Panels:
 - 1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.

207.1.3 DELIVERY, AND STORAGE

- A. Deliver materials to site in manufacturer's sealed container marked to show following:
 - 1. Name of manufacturer
 - 2. Product type
 - 3. Batch number
 - 4. Instructions for use
 - 5. Safety precautions
- B. Maintain space for storage, and handling of painting materials and equipment in a neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- C. Store materials at site at least 24 hours before using, at a temperature between 18 and 30 °K (65 and 85 °F).

207.1.4 MOCK-UP PANEL

- A. Before starting application of water paint mixtures, // cementitious paint // apply paint as specified to an area, not to exceed 9 m² (100 sf), selected by Resident Engineer.
- B. Finish and texture approved by Resident Engineer will be used as a standard of quality for remainder of work.

207.2 PART 2 - PRODUCTS

207.2.1 PAINT PROPERTIES

- A. Use ready-mixed (including colors), except two component polyesters, paints having metallic powders packaged separately and paints requiring specified additives.
- B. Materials finely ground, uniform in consistency and readily dispersed to form a smooth and homogeneous fluid.

- C. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

207.2.2 REGULATORY REQUIREMENTS

- A. Paint materials shall conform to the restrictions of the local Environmental and Toxic Control jurisdiction.
1. Volatile Organic Compounds (VOC): VOC content of paint materials shall not exceed local, state or district requirements.
 2. Lead-Base Paint:
 - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
 - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
 - c. For lead-paint removal, see Section 02090.
 3. Asbestos: Materials shall not contain asbestos.
 4. Chromate, Cadmium, Mercury, Silica: Materials shall not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or silica sand.
 5. Human Carcinogens: Materials shall not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.

207.3 PART 3 – EXECUTION

207.3.1 JOB CONDITIONS

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
 2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each days work.
- B. Atmospheric and Surface Conditions:
1. Do no exterior or interior painting in foggy, damp or rainy weather. When building is completely enclosed, interior work may be painted.
 2. Paint exterior and interior surfaces when ambient temperature is between 10 and 32 degrees C (50 and 90 degrees F), except when otherwise designated in manufacturer's printed instructions. Maintain interior temperatures until paint dries hard.
 3. Do no exterior painting when it is windy and dusty.
 4. Do no painting in direct sunlight or on surfaces which will soon be warmed by the sun.
 5. Apply only on clean, dry and frost free surfaces except as follows:
 - a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces where allowed by manufacturer's printed instructions.
 - b. Dampened with a fine mist of water on hot dry days concrete and masonry surfaces to which water thinned acrylic and cementitious paints are applied to prevent excessive suction and to cool surface.
 6. Varnishing:

- a. Apply in clean areas and in still air.
- b. Before varnishing vacuum and dust area.
- c. Immediately before varnishing wipe down surfaces with a tack rag.

207.3.2 SURFACE PREPARATION

- A. Method of surface preparation is optional, provided results of finish painting produce solid even color and texture specified with no overlays.
- B. General:
 1. Remove prefinished items not to be painted such as lighting fixtures, escutcheon plates, hardware, trim, and similar items for reinstallation after paint is dried.
 2. Remove items for reinstallation and complete painting of such items and adjacent areas when item or adjacent surface is not accessible or finish is different.
 3. See other sections of specifications for specified surface conditions and prime coat.
 4. Clean surfaces for painting with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry.
- C. Ferrous Metals:
 1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter by use of solvents, emulsions, cleaning compounds, or by steam cleaning, as defined in SSPC-SP 1.
 2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 and SSPC-SP 3, except where high temperature aluminum paint is used, prepare surface in accordance with paint manufacturer's instructions.
 3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with metal filler compound. Finish flush with adjacent surfaces.
 - a. This includes flat head countersunk screws used for permanent anchors
 - b. Do not fill screws of item intended for removal such as glazing beads.
 4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
 5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.
- E. Zinc-Coated (Galvanized) Metal, // Zinc, // Aluminum //, // Copper and Copper Alloys // Surfaces Specified Painted:
 1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion, with toluene, xylene or similar solvents in accordance with SSPC-SP 1.
 2. Spot coat abraded and damaged areas of zinc-coating which expose base metal, using zinc rich paint MIL Spec MIL -P-21035, on hot-dip zinc-coated items and spot prime with zinc dust primer, Fed Spec. TT-P-641.
- F. Masonry, Concrete, Cement Board, Cement Plaster and Stucco:
 1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.

2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
3. Remove loose mortar in masonry work.
4. Replace mortar and fill open joints, holes, cracks and depressions with new mortar specified in Section MORTAR AND GROUTS. Do not fill weep holes. Finish to match adjacent surface.
5. Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three days and brush thoroughly free of crystals.
6. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.

207.3.3 PAINT PREPARATION

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two component and two part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.
- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

207.3.4 APPLICATION

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
- B. Unless otherwise specified, apply paint in three coats; prime, body, and finish. When two coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
- D. Allow not less than 48 hours between applications of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by Resident Engineer.
- E. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects.
- F. Apply by brush, roller or spray, except as otherwise specified.
- H. Do not spray paint in existing occupied spaces unless approved by Resident Engineer, except in spaces sealed from existing occupied spaces.
 1. Apply painting materials specifically required by manufacturer to be applied by spraying,
 2. In areas, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in WORK NOT PAINTED, motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- I. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

207.3.5 PRIME PAINTING

- A. After surface preparation prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required, except for exterior exposed steel apply an additional prime coat.
- D. Prime rebates for stop and face glazing of wood, and for face glazing of steel.
- E. Metals except boilers, incinerator stacks, and engine exhaust pipes:
 - 1. Steel and iron: Ferrous metal primer. Use epoxy coating where finish of epoxy coating is specified.
 - 2. Zinc-coated steel and iron: Zinc dust primer.
 - 3. Aluminum scheduled to be painted: Zinc molybdate primer.
 - 4. Terne metal: Ferrous metal primer.
 - 5. Copper and copper alloys scheduled to be painted: Zinc molybdate primer.
 - 6. Machinery not factory finished: Enamel, Alkyd, Gloss Low VOC content.
 - 7. Asphalt coated metal: Aluminum paint.
 - 8. Metal over 94 degrees C. (200 degrees F), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: Heat Resistant Paint, 650 degrees C (1200 degrees F),.
- I. Concrete Masonry Units except glazed or integrally colored and decorative units:
 - 1. Concrete Masonry Unit Filler on interior surfaces.
 - 2. Prime exterior surface as specified for exterior finishes.
- J. Cement Plaster or stucco // Concrete Masonry, Brick Masonry // and Cement board // Interior Surfaces of Ceilings and Walls:
 - 1. Latex emulsion, except use two coats where substrate has aged less than six months for latex emulsion finish coat.
 - 2. Use acrylic emulsion finish coats of cementitious paint or epoxy or water paint as scheduled.
- K. Concrete Floors: Floor Enamel.
- L. Barrier coat to separate epoxy paint from existing oil or alkyd paint:
Two coats latex emulsion or rubber paint.
- M. Rubber paint when rubber paint finish is specified over prime coats to surfaces.

207.3.6 EXTERIOR FINISHES

- A. Steel and Ferrous Metal, // Including Tern //
 - 1. Two coat of exterior oil paint on exposed surfaces, except on surfaces over 94 degrees C (200 degrees F).
 - 2. One coat of heat resistant paint on surfaces over 94 degrees K (200 degrees F) and on surfaces of boiler // incinerator // stacks // engine exhaust pipes.
- B. Machinery without factory finish except for primer: One coat Enamel, Alkyd, Gloss Low VOC content.
 - 1. Use water paint without additions only interior surfaces.
- C. Concrete Masonry Units // Brick // Cement Plaster // Concrete //
 - 1. General:
 - a. Where specified in Section 09050 or shown.
 - b. Mix as specified in manufacturer's printed directions.
 - c. Do not mix more paint at one time than can be used within four hours after mixing. Discard paint that has started to set.
 - d. Dampened warm surfaces above 24 degrees C (75 degrees F) with fine mist of water before application of paint. Do not leave free water on surface.

- e. Cure paint with a fine mist of water as specified in manufacturer's printed instructions.
2. Use one of the following unless specified otherwise.
 - a. Two coats of water paint mixed with additives specified (CEP).
 - 1) Water paint mixed with water and liquid acrylic resin.
 - a) Allow 24 hours minimum drying time between coats.
 - b) Apply paint with stiff fiber brush and thoroughly work into surface with rubbing motion to seal pores, cracks and voids.
 - c) Apply first coat with brush strokes horizontal or vertical, and second coat brush strokes perpendicular to first.
 - d) After the second coat has set so it will not roll or lift, float surface to uniform texture with a sponge float to match finish of mock-up panel.
 - 2) Water paint mixed with water, liquid acrylic resin and sand aggregate grades for application by plasterer's type spray gun.
 - a) Prepare paint powder for spraying by mixing with a liquid consisting of one part of liquid acrylic resin to three parts of water unless specified otherwise in manufacturer's printed instructions.
 - b) Spray first coat evenly distributed.
 - c) Float or brush out first spray coat before starting second spray application to fill holes, pores, and imperfections.
 - d) Spray second coat after first coat has set, and air and water bubbles have broken, double back over surface with an even spray application, or additional applications to provide a uniform texture and to match finish of mock-up panel.
 - b. Two coats of cementitious paint.

207.3.7 INTERIOR FINISHES

- A. Metal Work:
 1. Apply to exposed surfaces.
 2. Omit body and finish coats on surfaces concealed after installation except electrical conduit containing conductors over 600 volts.
 3. Ferrous Metal, Galvanized Metal, and Other Metals Scheduled:
 - a. Apply two coats of Alkyd Semigloss (SG) unless specified otherwise.
 - b. Two coats of // alkyd flat or (AK) // alkyd gloss (G) //.
 - c. One coat of enamel undercoat plus one coat of alkyd semigloss on exposed interior surfaces of alkyd-amine enamel prime finished windows.
 - d. Two coats of rubber paint (RP) on exposed surfaces in // battery rooms // pool area // chlorinator room //.
 - e. Machinery: One coat Enamel, Alkyd Gloss, Low VOC content.
 - f. Asphalt Coated Metal: One coat Aluminum paint (AP).
 - g. Ferrous Metal over 94 degrees K (200 degrees F:), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: One coat Heat Resisting Paint, 650 degrees K (1200 degrees F). (HR).
- B. Masonry and Concrete Walls:
 1. Over filler on CMU surfaces.

2. Two coats of latex emulsion (LE).
3. Two coats of latex flat (AK), low-luster (LL), latex semigloss (SG), or latex gloss (LG).
4. One coat rubber paint. (RP).
5. Two coats water paint (WPC).

207.3.8 PROTECTION CLEAN UP, AND TOUCH-UP

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

208. CHAMBER COVERS AND SURFACE BOXES

Covers and frames shall be manufactured from ductile iron in accordance with BS EN 124:1994, non-rock, locking and solid tops. The wording on covers shall indicate the nature of the network (water supply). Grades of covers shall be Grade A, heavy duty test load 40 tons

Manhole covers shall be of a circular pattern unless otherwise indicated on the Drawings. Frames shall be provided with openings for fixing bolts for solid frame embedment into manhole concrete necks. Covers and frames shall be coated with a bitumen-based compound to BS 3416:1991 with a minimum thickness of 200 microns.

209. ASPHALT WORKS

This Section includes a base course composed of a compacted mixture of a mineral aggregate and asphaltic material. The mixture when designed and tested in accordance with these Specifications shall meet the following requirements:

- Laboratory Density :
 - 1) Minimum 92 percent
 - 2) Optimum 96 percent
 - 3) Maximum 99 percent
- Stability :
 - 1) Shall not be less than 30 percent. The base course shall be constructed on previously completed and approved sub-grade or sub-base, as herein provided.

The design shall comply American Society for Testing and Materials Standards (ASTM)

- 1) ASTM D 698 – Moisture Density Relations of Soil Using 5.5 Pound Rammer and 12 Inch Drop.
- 2) ASTM D 8-02 – Standard Terminology Relating to Materials for Road Pavements.

The contractor shall submit a copy of mix design and aggregate properties for approval.

209.1.1 MATERIALS

The mineral aggregate shall be composed of a coarse aggregate and a fine aggregate. Approval of both material and source must be obtained from the Engineer prior to delivery. Sources of material specified on the Drawings as being available for use will not require prior approval. The mineral aggregate shall contain no more than two percent by weight of organic matter, clays, loam or pebbles coated therewith. Mineral aggregates from each source shall meet the quality tests specified herein.

- 1) Coarse Aggregates: Coarse aggregates shall be that part of the aggregate retained on a No. 10 sieve; shall consist of clean, tough, durable fragments of stone, crushed gravel, iron ore, slag, or combinations thereof; and shall be of uniform quality throughout.
- 2) Fine Aggregate: Fine aggregate shall be that part of the aggregate passing the No. 10 sieve and shall consist of sand or screening or a combination of sand and screening. The plasticity index of that part of the fine aggregate passing the No. 40 sieve shall be no more than 6 when tested. Sand shall be composed of durable stone particles free from injurious foreign matter. Screening shall be material produced during production of the coarse aggregate.
- 3) Asphaltic Material Mixture: Contractor shall notify the Engineer of the sources of asphalt material prior to production of the asphaltic mixture and prior to any change desired during the course of the Project.
- 4) Tack Coat: The asphaltic material for tack coat shall meet the following AASHTO requirements:
 - *Asphalt Binders: AASHTO M 320 (performance-graded) or M 332 [multiple stress creep recovery (MSCR)]*
 - *Asphalt Emulsions: AASHTO M 140 (anionic emulsions), AASHTO M 208 (cationic emulsions),*
 - *AASHTO M 316 (polymer-modified cationic emulsions)*
 - *Asphalt Cutbacks: AASHTO M 81 (rapid-curing), AASHTO M 82 (medium-curing),*
 - *AASHTO M 316 (polymer-modified cationic emulsions)*

210. SHOP DRAWINGS AND MATERIAL TECHNICAL SPECIFICATION, AS-BUILT DRAWINGS

Shop Drawings, design calculation notes and all necessary material technical specification shall be submitted to the Engineer for approval at least 21 days before starting of the work.

As built drawings shall be prepared after completion of the work, and shall also be submitted to the Engineer for approval.

It is the duty of the Contractor to undertake all the Engineer's recommendations, modifications and corrections at his own expense until complete satisfaction of the Engineer.

All the modifications to the design drawings coming out during execution of the works, or after ordering the relating materials should be done by the contractor and approved by the Engineer.
COVID-19 PANDEMIC

203. PIPELINES AND PIPEWORK

203.1 TRENCH EXCAVATION

Excavation for pipelines shall be carried out in accordance with Sub-Section 201.3.2 of the General Specifications. During the pipe laying, jointing, testing of pipes and backfilling, the trench shall be completely dry.

The trench shall be as per trench details included in the contract drawings.

The Contractor shall excavate the trenches without damaging existing pipes, cables and any other structure. In this respect, the Contractor shall excavate the necessary depth or change the route in order to avoid damaging the pipes, cables and culverts that cross the roads.

In case the modification of the pipe depth or route is impossible, the Contractor shall, after the approval of the Engineer, undertake all the necessary works including excavation, fill and concrete works, etc... to modify the culvert in a way to maintain the passing section of the culvert, the cost of these works, after getting the approval of the Engineer should be measured as a concrete works (according to concrete works item).

The Contractor shall clear away within the same day, all excavated material arising from trenches and headings on asphalted roads as the work proceeds, and shall keep these roads free from any accumulations and clear in a good condition, to the satisfaction of the Engineer.

In addition to Sub-Section 201.3.2 of the General Specifications, Earthwork shall not be classified in accordance with the hardness of the excavated material, all excavation should be classified as common excavation and the Contractor shall take the sole responsibility for his assessment of excavated material and conditions. He should also use all suitable materials in the permanent construction required under the contract.

In addition to all the above, the excavated material arising from trenches executed on main roads should be removed from site, transported to environmentally approved disposal areas accepted by the Engineer, all that at the contractor expenses without any extra cost, and the trenches on main roads should be backfilled with imported clean granular material.

203.2 BACKFILLING OF PIPE TRENCHES

Backfilling shall be carried out in accordance with the Ministry of Public Works decree No. 13495 dated 5/11/98 (Refer to Annex 1 of this volume) and in accordance with related general specifications of Volume 3.

In case of ambiguities or discrepancies between the content of the above mentioned decree and the general specifications, the decree shall prevail.

All pipes shall be placed in granular material (fine, coarse) bedding and surround if the pipeline is above water table, and in gravel bedding and surround if the pipeline is below water table.

Backfilling of pipes trenches on main roads should be executed using imported clean granular material and should be compacted by layers of 30cm thick each.

a) Material unsuitable for filling:

Shall mean material other than suitable material and unless accepted by the Engineer shall include:

- Material from swamp, marshes, or bogs and solid containing more than 12% organic matter when tested in accordance with Test 8 of BS 1377, and which occurs below the top soil layer.
- Clay-based materials of liquid limit exceeding 40 and/or plasticity index exceeding 10 as and if directed by the Engineer,

- Boulders.
- Maximum granular diameter > 5 cm.

203.3 PIPELINES AND MATERIALS

As specified in the BOQ, Preferred C-class ductile iron pipes and HDPE pipes shall be used.

Moreover, the materials used shall comply with the requirements of Section 101.9 of the General Specifications. Any unsuitable material not satisfying the specifications shall be rejected by the Engineer, removed from the Site and replaced by the Contractor at his own expense.

203.3.1 SPECIAL REQUIREMENTS

203.3.11. Manufacturer's Certificate

Materials shall be supplied with certificates, in respect of each delivery, stating that products comply with and have been factory tested in accordance with the specified Standards.

203.3.12. Special Tests

Whenever required by the Engineer, the Contractor shall supply and transport to an approved testing laboratory samples of materials selected by the Engineer. The number of samples shall not be less than 0.5% of total supplied, with at least one from each class, diameter and manufacturer. Failure of any sample shall be followed by a second and if necessary, a third test from the same batch. A third test failure will result in all material from that manufacturer being rejected and replaced by material from a different manufacturer, subject to approval by the Engineer, after satisfactory testing. Laboratory test reports in an approved form shall be provided.

203.3.13. Manufacturer's Instructions

The Contractor shall observe the manufacturer's written instructions and recommendation in respect of handling, protection, stacking, storage, laying, fitting, cutting, repair of the products and materials as applicable.

203.3.14. Marking

Unless otherwise specified in the relevant Standard, products shall have legibly cast, stamped or indelibly painted on, the following marks, as appropriate:

- The manufacturer's name, initials and identification mark.
- Nominal diameter.
- Class designation.
- Initials and number of relevant Standard.

- Length of pipe if shorter than the standard length.
- Angle of bends in degrees.
- The date of manufacture.

203.3.15. Samples and storage of materials

Where required by the Engineer, the Contractor shall submit to the Engineer for approval samples of pipes, fittings and materials prior to procurement.

The Contractor shall store pipes, fittings and other materials only at places approved by the Engineer and shall at all times provide adequate supervision and watchmen to prevent theft or damage. Any loss or damage incurred will be the Contractor's responsibility.

Pipes shall not be stacked higher than recommended by the manufacturer. The area on which the pipes are to be stacked shall be free draining, the grass or other vegetation shall be kept cut and suitable timber or cradles shall be provided on which the pipes shall be laid. End stops to all stacks shall be provided.

Fittings and valves shall not be stacked more than one tier high and they shall be supported off the ground by suitable timbers.

Air valves, rubber joint rings, gaskets, bolts and similar fittings and materials shall be kept in approved locked premises and such fittings and materials shall not be distributed to the trench side until immediately prior to laying, fitting, jointing or assembly thereof. All rubber joint rings and gaskets must be stored in a cool damp location and all fittings and materials shall at all times be stored in the shade under cover and protected from the weather to the satisfaction of the Engineer.

203.3.16. Flanges

Unless otherwise specified, flanges shall be faced and drilled to conform to the dimensions specified in BS EN 1092-2:1997. Flanges shall be compatible with the pressure rating of the adjacent pipework but not less than 16 bars. Bolts, nuts, and washers (two washers per bolt) shall be to BS 4504 Clause 5 or ISO 898-2:1999 and ISO 4032:2001. No bolt shall project more than two full threads beyond its nut after tightening. In no circumstances shall be shortening of excessively long bolts but cutting be allowed.

Gaskets shall comply with BS EN1514-4:1997, ISO 4633:2015 or BS 2494 Type W.

Flanges shall be painted with two coats of epoxy resin paint or with the same coating as fittings: an epoxy coating in accordance with EN 14901:2014.

203.3.17. Mechanical Couplings

Unless otherwise specified or shown on the Drawings pipes and fittings shall be supplied with flexible joints.

Mechanical couplings shall be of the Dresser, Viking Johnson type without a center register.

203.3.18. Materials for the assembly of flexible joints

Lubricant shall be of a kind not conducive to the growth of bacteria and shall have no deleterious effects on either the joint rings or pipes. Lubricants for water supply shall not impart to water taste, colour, or any effect known to be injurious to health.

203.3.2 WORKMANSHIP: OPERATIONS

- 1) Manufacturer's recommendations on handling, repairing, laying, jointing, anchoring, testing and other works for pipes and fittings shall be strictly followed.
- 2) The Contractor shall use cranes, hoists or forklifts as directed by the Engineer. The Contractor shall use hooks, spreader beams, ropes, band or wire slings etc. as recommended by the manufacturer for each type of pipe and as approved by the Engineer.
- 3) The Contractor shall stack pipes on a level surface. Pipes shall not rest on sockets or flanges and end pipes in the bottom row shall be securely chocked. Heights of stacks shall be in accordance with the manufacturer's instructions.
- 4) The Contractor shall handle material with care to avoid damage whenever moved by hand, forklifts or hoists.
- 5) The Contractor shall provide safe storage for all material. The interior of pipes, fittings etc. shall be kept free from dirt and foreign matter. The Contractor shall provide shade for materials as required by manufacturers' instructions and recommendations and to the Engineer's approval.
- 6) Pipe Cutting: The Contractor shall use hacksaws, manually operated wheel cutter or pipe cutting machine in accordance with manufacturers' instructions. If, in the opinion of the Engineer, special precautions are required to eliminate airborne particles, the Contractor shall use methods and equipment as directed by the Engineer. The Contractor shall prepare ends according to type of joint used and follow manufacturers' recommendations. The Contractor shall take care not to damage linings. The Contractor shall repair on site minor damage if so permitted by the Engineer.
- 7) The Contractor shall repair damaged coatings, sheathings or linings in accordance with the Specification and the manufacturer's instructions. The Contractor shall use material compatible with that originally used. Repairs shall be approved by the Engineer before incorporating the materials into the works.

203.3.3 SEQUENCE OF CONSTRUCTION

The Contractor shall adhere to the sequence of construction as set out below unless a justified request for modification is approved by the Engineer at least two weeks prior to commencement of work on the affected section of the network:

- 1) Stake out pipe alignments
- 2) Clear and grade the right of way (wherever required)
- 3) Carry out surveys, including trial pits if necessary, along the alignments to verify the location, depth, size and type of existing utilities.
- 4) Prepare and submit for approval composite Shop Drawings for all utilities showing alignment, ground elevation, trench invert elevation, pipe size, class and length, station and size of fittings, valves as applicable manholes, inlets, appurtenances and structures to be demolished and reinstated (curbstone, rails, culverts, etc.). Cross sections showing location and inverts of existing pipes and those proposed shall be prepared. Pipes, structures and other utilities to be removed or relocated shall be indicated on the Shop Drawings.
- 5) Relocate, demolish and reinstate existing services and utilities interfering with pipeline alignments.

- 6) Remove pavement layers, excavate trenches and place bedding as required
- 7) Lay and join pipes, fittings, appurtenances, manholes, etc.
- 8) Place primary backfill material
- 9) Perform hydrostatic testing
- 10) Complete connections to existing services and curb/gutter inlets as required
- 11) Place final backfill
- 12) Restore or reinstate surfaces and structures as required
- 13) Carry out final surface works road surfacing curb stone, backing walls, sidewalk paving, etc.
- 14) Dispose of surplus materials.

203.3.4 DUCTILE IRON PIPES

203.3.41. General

- 1) Ductile iron pipes for raw and potable water pipelines shall be of Preferred C-Class unless otherwise specified pipes in conformance to BS EN 545-2010 and ISO 2531:2009. Pipes shall be to pressure rating suitable for the condition of service as denoted on the drawings and according to the allowable operating pressure of C Class. All ductile iron pipes and fittings to be supplied under this Specification shall be obtained from an approved manufacturer having an ISO9001-2015 TOTAL QUALITY ASSURANCE system based on the latest version of the ISO9001 standard.
- 2) Spigot and socket ended pipe joints shall be used for straight runs and adjacent to elbows or fittings. These joints shall be provided with rubber gaskets, and external thrust blocks at elbows or fittings. Anchored joints shall be the push-in, self anchored type. Concrete thrust blocks are not required for anchored joints. The Contractor shall submit calculations verifying the number of restrained joints required noting that pipe pressure testing will be made when pipes are partially backfilled.
- 3) Prior to the ordering of pipe and fittings materials, the Contractor shall carry out his own calculations of the surge, the maximum allowable pressure and the Test Pressures, using approved parameters to ensure safety of the proposed system under worst working conditions, all to the approval of the Engineer. If the Contractor's approved calculations show that the resulting pipe classes needed are higher than the original Contract Documents, then the Engineer shall instruct the Contractor to adopt them; but if lower classes are needed, then the Contract classes shall prevail.
- 4) Flanges shall be provided in accordance with BS EN 1092-1:2002 and BS EN 1092- 2:1997.
 - Internally: cement lined to BS EN 545:2010 with ordinary Portland or sulphate resisting cement (for potable water) to BS EN 197-1:2011 and ISO 4179:2005.
 - Externally: 200g/m² metallic zinc shall be applied in accordance with BS EN 545:2010 and ISO 8179:2017 And a finishing layer (a bituminous varnish or equivalent anticorrosive paint) shall be uniformly covering the whole surface of the metallic zinc layer, with a minimum thickness not less than 70micron.

5) Factory protection for fittings shall be as follows:

Coated internally and externally by dipping, or other method, using hot applied coal tar based material to BS 4164:2002 or hot applied bitumen to BS 3416:1991, Type 1, grade D, minimum thickness 250 microns or with a hot applied epoxy powder coating, minimum thickness 250 microns, over a shot blasted surface. In accordance with EN545:2010 and EN 14901:2006.

203.3.42. Joints

Joints of Ductile Iron Pipes and Fittings shall be of the Push in automatic standard type and any axial forces shall be taken by thrust and anchor blocks, where necessary and as shown on drawings.

203.3.43. Lubricant paste

The lubricant paste shall be a mixing of Vaseline, non-soluble in accordance with French standard AFNOR T90 M DOC8. The quantities used in the assembly joints shall be as per manufacturer recommendation. The pipes and fittings manufacturer shall supply it.

203.3.44. Connecting pieces

All connecting pieces i.e. flexible coupling, flange adaptors, dismantling joint shall be made of ductile iron and shall be supplied from the same pipes and fittings manufacturer.

203.3.45. Pipes internal protection (including welded flanged pipes)

Pipes shall be internally lined with sulphate resisting blast furnace slag cement applied by a centrifugal process. The cement mortar lining shall be in accordance with the European Standard EN 545-2010 & with the International Standard ISO 4179-2005 with the thickness given in the following table:

| | Thickness of mortar | |
|-------------|----------------------------|-------------------|
| | Nominal mean value (mm) | Tolerance (mm) |
| 80 – 300 | 4 | -1.5 |
| 350 – 600 | 5 | -2 |
| 700 – 1200 | 6 | -2.5 |
| 1400 – 2000 | 9 | -3 |

203.3.46. Pipes external protection (including welded flanged pipes)

Pipes shall be externally coated with:

- A metallic zinc coating in accordance with the European Standard EN545 – 2010 and the International Standard ISO 8179:2017. The quantity of zinc shall not be less than 200 g/m².
- A bituminous varnish or equivalent anticorrosive paint which shall be applied over the zinc coating in accordance with the European Standard EN545-2010 and the International Standard ISO 8179:2017, with a minimum thickness of 150 microns.

203.3.47. Connecting pieces internal and external protection

The connecting pieces (flexible couplings, flange adaptors, dismantling joint) shall be internally and externally protected with a powder epoxy coating having a minimum thickness of 150 microns or with a Rilsan nylon coating having a minimum thickness of 200 microns.

203.4 WARNING TAPES

Warning tapes shall be placed on well compacted backfill at 450mm below the finished level and directly above the center-line of the pipeline.

Warning tapes shall be made of pigmented low density polyethylene and aluminum foil in a bright color or other approved material not less than 250 mm wide and 0.15 mm thick. When laid, the tapes shall provide a continuous band detectable with a metal detector if the pipe itself is not detectable. The tapes shall be continuously and alternatively labeled in Arabic and English.

Where possible, tapes shall also be laid above ducts and concrete protection slabs as directed by the Engineer.

203.5 ALL PIPES

203.5.11. General

- 1) All pipes for raw and potable water pipelines shall be of Preferred C-Class unless otherwise specified pipes in conformance to BS EN 545-2010 and ISO 2531:2009. Pipes shall be to pressure rating suitable for the condition of service as denoted on the drawings and according to the allowable operating pressure of C Class. All pipes and fittings to be supplied under this Specification shall be obtained from an approved manufacturer having an ISO9001-2015 TOTAL QUALITY ASSURANCE system based on the latest version of the ISO9001 standard.
- 2) Spigot and socket ended pipe joints shall be used for straight runs and adjacent to elbows or fittings. These joints shall be provided with rubber gaskets, and external thrust blocks at elbows or fittings. Anchored joints shall be the push-in, self anchored type. Concrete thrust blocks are not required for anchored joints. The Contractor shall submit calculations verifying the number of restrained joints required noting that pipe pressure testing will be made when pipes are partially backfilled.
- 3) Prior to the ordering of pipe and fittings materials, the Contractor shall carry out his own calculations of the surge, the maximum allowable pressure and the Test Pressures, using approved parameters to ensure safety of the proposed system under worst working conditions, all to the approval of the Engineer. If the Contractor's approved calculations show that the resulting pipe classes needed are higher than the original Contract Documents, then the Engineer shall instruct the Contractor to adopt them; but if lower classes are needed, then the Contract classes shall prevail.
- 4) Flanges shall be provided in accordance with BS EN 1092-1:2002 and BS EN 1092- 2:1997.
- 5) Factory protection for pipes shall be as follows:

- Internally: cement lined to BS EN 545:2010 with ordinary Portland or sulphate resisting cement (for potable water) to BS EN 197-1:2011 and ISO 4179:2005.
- Externally: 200g/m² metallic zinc shall be applied in accordance with BS EN 545:2010 and ISO 8179:2017 And a finishing layer (a bituminous varnish or equivalent anticorrosive paint) shall be uniformly covering the whole surface of the metallic zinc layer, with a minimum thickness not less than 70micron.

6) Factory protection for fittings shall be as follows:

Coated internally and externally by dipping, or other method, using hot applied coal tar based material to BS 4164:2002 or hot applied bitumen to BS 3416:1991, Type 1, grade D, minimum thickness 250 microns or with a hot applied epoxy powder coating, minimum thickness 250 microns, over a shot blasted surface. In accordance with EN545:2010 and EN 14901:2006.

203.6 MANHOLES

Manholes shall be constructed as specified in Sub-Sections 202.11.2, 202.14.2 and 202.14.5 of the General Specifications and according to the dimensions specified in the BOQ and the related drawings.

Steel Ladders shall be manufactured in accordance with BS 4211:2005, mild steel, galvanized to BS EN ISO 1461:1999 with 200 grams of zinc per square meter.

All concrete faces in contact with the soil shall receive a waterproofing treatment consisting of two layers of brush-applied bituminous paint, in accordance with Sub-Section 213.2.1 of the General Specifications.

203.7 CHAMBER COVERS AND SURFACE BOXES

Covers and frames shall be manufactured from ductile iron in accordance with BS EN 124:1994, non-rock, locking and solid tops. The wording on covers shall indicate the nature of the network (water supply). Grades of covers shall be Grade A, heavy duty test load 40 tons.

Manhole covers shall be of a circular pattern unless otherwise indicated on the Drawings. Frames shall be provided with openings for fixing bolts for solid frame embedment into manhole concrete necks. Covers and frames shall be coated with a bitumen based compound to BS 3416:1991 with a minimum thickness of 200 microns.

203.8 STEP IRONS FOR VALVE CHAMBERS

Step Irons shall be manufactured in accordance with BS EN 13101: 2002.

203.9 TEMPORARY AND/OR PERMANENT RESTORATION OF PAVED ROADS

In all paved roads, trenches shall be refilled and compacted to the underside of the original road surface.

A sub-base and base layers shall be laid and compacted and shall be carried out in accordance with the Ministry of Public Works decree No. 13495 dated 5/11/98 (Refer to Annex 1 of this volume) and in accordance with related general specifications of Volume 3.

In case of ambiguities or discrepancies between the content of the above mentioned decree and the general specifications, the decree shall prevail.

For main roads subject to a permit from the Ministry of Public Works and Transport, the Contractor, at his own expenses and sole responsibility, should deal to obtain and receive this permit, and the asphalt reinstatement works should be carried out in accordance with the specifications and conditions (if any) of the permit.

As for narrow roads not exceeding 3m width, asphalt reinstatement should be executed to cover the entire width of the road.

203.10 REMARKS

The Contractor shall lay pipes on one side of the streams and on one side of the roads (even if this is not shown of the drawings) and if possible outside the carriageway in order to avoid damaging the roads. The Contractor shall coordinate with the Administration and the Engineer and the relevant Authorities in order to obtain official authorization prior to any construction work.

203.11 HYDRAULIC ACCESSORIES

203.11.1 FLOW METERS / WATER METERS

Unless otherwise stated, all flow meters shall be of the mechanical type.

Where a chlorination system is required, the mechanical flow meter of the pipeline on which the chlorine injection point will be located, shall incorporate a pulsed output unit to enable a chlorine injection proportional to the water flow.

203.11.2 WATER METERS FOR SERVICE CONNECTIONS

203.11.21. Overview

Contractor is requested to supply, transport, and install DN15 class B mechanical type water meters and accessories including installation and connection of boxes to the network.

The water meters are to be compliant with:

- EU Measuring Instruments Directive (MID) – 2004/22/EC
- The water meters should be compliant to the ISO 4064-1:2014|OIML R49 (International Organization for Legal Metrology)
- EN 14154:2005+A2:2011
- Only Water meters manufacturers with a quality assurance system complying with ISO 9001:2008 or ISO 9001:2015 with certification for design, whereas ISO 9001:2015 is required for manufacturing functions.

203.11.22. Water Meter lifespan and testing

The water meters to be installed shall have a minimum operational lifespan (continuous operation) of 10 years or better (at $t_{Bat} < 30^{\circ}C$ based on one emission per 30 sec).

The water meters shall be operational with no impact on accuracy or performance regardless of orientation of the water meter.

The water meters are to undergo metrological verifications and tests in accordance with the Measuring Instruments Directive requirements.

Contractor shall include a typical metrological curve of the meters they would be using.

Contractor to guarantee the dispersion of the meter accuracy curve, with the dispersion of accuracy to average metrological curve not to exceed +/- 5% between Q1 and Q2, and +/- 2% between Q2 and Q4.

The definitions for Q_i being as follow:

- Q1 : Minimum readable flow
- Q2 : Transitional flow
- Q3: Nominal flow
- Q4 : Maximum readable flow

DN15 Class B water meters

The meters shall be of the Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN15 meters that has a Permanent Flow Rate (Q3) of 2.5 m³/hr and an 'R' Ratio (Q3/Q1) of 400 or better. This will guarantee a low Q1. Moreover, meters having a starting flow greater than 2 litres/hour shall not be considered.

DN 20 Class B water meters

The meters shall be Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN20 meters that has a Permanent Flow Rate (Q3) 4 m³/hr, and an 'R' Ratio (Q3/Q1) of 400 or better. This will guarantee a Q1 lower than 10 l/h.

Meters having a starting flow greater than 3 litres/hour shall not be considered.

DN 25 Class B water meters.

The meters shall be Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN 25 meters that has a Permanent flow rate (Q3) of 6.3m³/h and an 'R' ratio (Q3/Q1) of 400 or better. This will guarantee a Q1 of 16 l/h or lower.

Meters having a starting flow greater than 5 liters/hour shall not be considered.

203.11.23. Identification and legible components

Contractor to ensure that all meters have an arrow cast on their body to indicate the direction of the flow. The following markings shall be clearly visible and preferably located on the dial of the water meter:

- Water meter type/model
- Nominal/permanent flow rate Q3
- Metrological class: Class B
- Trade mark and/or name of the manufacturer
- Year of manufacture

- Serial number in numeric format
- Approval marking and No. of approval certificate

Contractor to ensure that markings are easily legible and permanent. The markings are not to be affected by normal storage, weather, handling or use. If print markings are used, the color of the print markings is to differ from the color of the water meter.

The totalizer shall be designed in such a way that if the totalizer protective glass is broken for a reason or another the totalizer cannot be removed from its place.

- The totalizer shall be of straight reading type
- The totalizer shall register in cubic meter units
- The totalizer shall consist of a row of minimum five on-line consecutive digits to read at least 99,999 m³
- Another three digits or pointers shall register flows in liters and be of a different color.
- The totalizer or any part of it shall be capable of being repaired
- The totalizer should be of open type
- The totalizer must be suitable for test on an electronic test bench
- The protection class of the totalizer should be IP 68

203.11.24. Meter construction and composition

All meter materials that are to be in direct contact with water need to be suitable for contact with potable water and shall withstand 2 ppm of chlorine residual and be resistant to corrosion.

The materials, which come in contact with the potable water, shall not create a toxic hazard, shall not support microbiological growth, and shall not give rise to unpleasant taste or discoloration in the water supply.

The acceptable water meter body material is either brass (low lead EnviroBrass suitable for potable water), bronze, stainless steel or composite material such as fiber reinforced polymers or copolymers and shall be NSF 61 certified.

The meter upper and lower cases and any other exposed parts must be made of brass or bronze alloy. However, the spindle and bearings inside the hydraulic chamber shall be made of polished stainless steel with tungsten carbide tip and sapphire or similar material ensuring a longlife operational period.

The internal pressure cup must overlap the meter body. The lower case of the meter shall be painted with thermal painting internally and externally. The painting materials should be safe for human health.

Water meter moving components and working surfaces must be composed of durable materials that are resistant to wear, tear, and abrasion scenarios.

In the case of mechanical meters, pistons shall be designed to reduce the risk of blockage by particulate matter that was not stopped by the strainer.

The meter ends are to be threaded to ¾ inch BSP male thread which shall conform to BS21 for the threaded end. The connecting end threads shall be robust in construction. The threaded ends shall be protected with plastic covers. The plastic cover for the inlet will be removed when connecting the water meter to the network, whereas the plastic cover for the outlet will be kept until the subscriber decides to connect.

203.11.3 Water resilience

Meters should be able to operate normally in waters with different parameters with no impact on performance or accuracy. The following water parameter ranges can be considered:

| | |
|---------------------------------------|--------------------------|
| pH | 6 – 8 |
| Total Alkalinity as CaCO ₃ | Between 200 and 300 mg/l |
| Total hardness as CaCO ₃ | Between 200 and 250 mg/l |
| Chlorides as Cl | Between 15 and 25 mg/l |
| Total Disolved Solids (TDS) | Between 200 and 400 mg/l |
| Sulphates (SO ₄) | Between 30 and 40 mg/l |
| Free Chlorine Cl ₂ | Between 0.3 and 0.9 mg/l |

203.11.4 Humidity and immersion

Meters have to withstand total and continuous immersion in waters up to 1 meter of depth with no impact to operation or readability.

The hermetical seals of the dry dial meters in particular are to prevent water from entering. Water meters are to remain compliant with the maximum permissible errors (MPEs) following conclusion of test. Any indication of moisture or intrusion of water under these conditions shall be considered a non-compliance of specifications rendering meters ineligible for use.

203.11.5 Anti-tampering

Contractor is to ensure that water meters are supplied and transported to worksite in adequate sealing that prevents meter tampering to take place. Contractor is to ensure that the installation of the meters and associated accessories is to be done in a way to prevent tampering without causing any damage to the meters.

Contractor is to provide a detailed explanation of the anti-tampering capabilities of the water meters being installed. The protective cover of the dial is to be made of transparent glass to eliminate the risk of deliberate damage or tampering.

203.11.6 Pressure

Water meter used by contractor are to withstand a minimum continuous working pressure of 16 bars and shall conform to the testing in accordance with ISO 4064. Meters shall be tested for continuous operation at a minimum of 1.5 working pressure and is to remain compliant with the maximum permissible errors following the pressure test. The meters must also be able to withstand any adverse effect related to water hammers.

The meter shall be capable to operate in an ambient temperature of up to 40°.

203.11.7 Head loss

Head losses inside the meter and strainer/filter are not to exceed 0.15 bars of pressure at Q3 and 0.6 bar of pressure at Q4.

203.11.8 Literature and samples

The contractor is required to submit the following list of documents:

- Technical specifications of items being offered
- Quality assurance documentation
- Detailed drawings and construction materials
- Water meter typical metrological curve
- Description of water meter anti-tampering specifications
- EU entity sanitary conformity certification

203.12 WATER METER ACCESSORIES

A typical arrangement for water meters installation consists of a Quarter turn valve followed by an air valve before distributing into the different house pipes. All house pipes shall be equipped with two ball valves and a subscriber meter.

The pipe arrangement shall force air trapped in the service pipe to exit from the air valve. Therefore the air valve must be located at a high point that provides at least 5 cm head room above the air valve. Supply pipes may need to be re-arranged to allow for the installation of all fittings and valves required for the installation of subscriber meters in a given location. All pipes above ground until the new water meters shall be executed with galvanized iron pipes.

Where water meters are installed above 700m, contractor must proceed to insulation for protection against frost. Thermal insulating materials should be of the closed cell type complying with BS 5422 and be installed in accordance with BS 5970.

The Contractor shall provide and install all pipes, fittings, bends, reducers and materials required for the installation of the new pipe arrangement.

203.12.1 Strainers and non-return valves

Contractor shall ensure that water meter bodies are fitted with a tubular strainer made of stainless steel in addition to a non-return valve for Multi-jet type meters. The strainer shall have at least at least 18 holes/cm² and is to be fitted at the inlet and both the strainer and non-return valve are to be fitted in such a way that they can be removed but cannot fall of the meter inlet or outlet.

203.12.2 Union joints and washers

Contractor is required to supply transport and install union joints and washers. The joints are to be used for the installation of the water meters. The union joints shall be of brass, stainless steel or composite material (for plastic bodies) and shall be supplied in separate packaging than the meters.

The nut of the union joint shall have two 1 mm diameter holes drilled on its side diagonally and opposite to each other. This will allow a 0.8 mm seal wire to pass through it while the meter is being installed.

203.12.3 Air valves

The contractor shall install one air valve before every individual water meter. The air valve is to be installed on the upper part of the pipe arrangement prior to the entry of the water meter. The pipe arrangement shall be designed in such a way to force any trapped air to exit from the air valve. The air valve shall therefore be located at a high point that provides a minimum of 5 cm of headroom above the air valve.

203.12.4 Quarter turn valves

The contractor is required to supply, transport, and install one quarter turn valve before the water meter. The quarter turn valve must allow locking/plumbing.

203.12.5 Meter protection boxes

The contractor is required to supply transport and install meter protection boxes. The meter boxes are installed in order to prevent and mitigate the risk of vandalism and tampering and therefore should be solid and are to be secured with locks in order to avoid unwanted access to water meters. A sample of water meter boxes is to be provided to the Supervising engineer for approval.

203.12.51. Cabinet material and dimensions

The meter protection boxes are to be made of steel; the box shall be of off-white color and the profile of the boxes' door should be at least 1 cm curved (90 degrees), to prevent the entrance of heavy waste or rain water.

The contractor is required to ensure that the box is tested for:

- High temperature resistivity
- Electrical insulation (paint)
- Dust and weather
- Impact resistance

The box should be designed in such a way to allow for easy mounting on walls and surfaces: it should have a minimum of 4 wall mounting holes at the back, each one to be located in one of the corners.

There should be at least three sizes of water meter protection boxes:

- Box able to fit 1 water meter (15, 20, or 25 mm)
- Box able to fit 2 water meters (15, 20, or 25 mm)
- Box able to fit 3 water meters (15, 20, or 25 mm)

In these two latter cases, a collector linked to the downstream end of the service line shall distribute water to each house connection. For pricing purposes, this collector shall be considered an integral part of the water meter boxes it is supplying. The dimensions of the boxes will vary based on the water meter dimensions, and should allow for a minimum of 5 cm space in between water meters themselves and in between the water meter and the walls of the box.

The contractor shall ensure that the water meter cabinets have built-in 20 mm incoming/outgoing water pipes opening. The number of outgoing openings will vary on the number of water meters the cabinet holds.

Boxes must be insulated with rigid polyurethane foam or equivalent, box openings to be sealed with water proof glands and injected with polyurethane materials.

Boxes must be equipped with built-in locks that can be locked with a triangular Allen key.

These locks shall be identical for a given number of boxes. For each group of similar locks, shall be provided a corresponding set of 5 identical keys.

203.13 INSTALLATION OF WATER METERS

The contractor is to follow the instructions of the manufacturer when installing the new water meters and related accessories. In particular, for mechanical domestic meters, the orientation of installation has to be horizontal because any tilting will affect the accuracy. The contractor needs to ensure that the water meters are installed in such a way as to allow easy legibility of water meter reading.

When installing a new water meter in place of an already existing domestic connection, the contractor is required to dismantle the existing water meter/gauge and hand them over to the water establishment. The contractor is to ensure that the subscriber's access to water is not interrupted for more than 6 hours when dismantling old water meters/gauges and installing new water meters and water meter cabinets. The contractor is required to modify the supply pipe after installing the water meters in order to fit the available space conditions.

The contractor is to strive to carry out works carefully in order to avoid sand or dirt entering water meters and water meter boxes. For aesthetic reasons, pipes shall either be installed horizontally or vertically. Inclined pipes will not be accepted.

203.14 VALVES & PENSTOCKS

203.14.1 General Requirements for Valves

203.14.11. General

Small valves of ND less than or equal to 40 mm shall be provided with self locking handles or handwheels to prevent accidental operation.

Emergency isolation valves shall be gate, ball or plug valves.

Drain and vent valves shall be provided with a plug or blind on the discharge side.

Flangeless valves shall not be used as the first block valves against storage tank.

Unless otherwise specified, valves shall be epoxy coated internally and externally. The coating shall have a minimum thickness of 150 µm.

Threaded ends shall not be used for valve sizes larger than 50 mm ND.

All handwheels, headstock, foot brackets, guide bracket and thrust tubes shall be of cast iron.

Fixing nuts and bolts supplied by the manufacturer shall be as specified in the general requirements for fasteners.

Valves shall be sized such that the velocity through the valve when fully open does not exceed 2.50 metres per second at the rated throughput. They shall have flanges to not less than BS.4504 NP.16 and shall be capable of withstanding the same test pressures as the pipeline on which they operate. All nuts and studs subject to vibration shall be fitted with spring washer or locking tabs.

203.14.12. **Types and Operating Conditions**

Valves shall be designed to meet the operational and environmental conditions specified for the types indicated in the specific valve schedule.

The closure rates of all valves shall be designed to prevent the effects of surge. Where necessary, valves with a varying closure rate shall be used.

Valve flanges or couplings shall be as specified in the valve schedule and match those specified for the pipework installation.

Working and tests pressures shall equal respectively 16 and 20 bars.

203.14.13. **Identification**

Each valve shall be identified by a unique reference as approved which shall identify the medium/plant controlled and be numbered in a logical sequence.

The reference shall be either engraved on a 3mm thick laminated white/black/white traffolyte disc or stamped on a 1.0mm (19g) thick brass disc. The discs shall be at least 35mm dia. with reference letters and numerals not less than 4mm and 8mm high respectively.

The discs shall be mounted on the hub of the handwheel or where this is impractical, they shall be attached to the valve stem by means of suitable brass 'S' hooks and/or jack chain through a hole at the top of the disc.

203.14.14. **Access**

All valves, spindles and handwheels shall be positioned to give good access for operational personnel. It shall be possible either to remove and replace or to recondition seats, gates or gland packings which shall be accessible without removal of the valve from the pipework or, in the case of power operated valves, without removal of the actuator from the valve.

Extension spindles shall be supplied wherever necessary to achieve the specified operating requirements.

203.14.15. **Hand Operation**

All handwheels shall be arranged to turn in a clockwise direction to close the valve or penstock, the direction of rotation for opening and closing being indicated on the handwheels.

The handwheels shall be coated with black plastic and incorporate facilities for padlocking in either the open or closed position.

Bituminous paints shall not be applied to any valve handwheel.

The operating gear of all valves and penstocks shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified service value and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 55kgf.

Power operated valves shall include equipment for manual operation by means of a handwheel or other suitable device which shall be interlocked with, and fixed to, the power unit.

Headstocks and valves of 125mm nominal bore and above shall be fitted with mechanical position indicators to show the amount which the valve is open or closed in relation to its full travel, i.e. 0.25, 0.50, 0.75, 1 etc.

203.14.2 Valve Materials

Valve bodies and other components shall be of corrosion resistant materials, compatible with the medium and of robust industrial design.

For water applications and where specified, valve bodies, discs and wedges shall be of cast iron, with facing rings, seating rings, wedge nut and other trim of corrosion resistant bronze or gun metal.

The valve stem, thrust washers, screws, nuts and other components exposed to the water shall be of a corrosion resistant grade of bronze or stainless steel.

For water works applications, wedge gate, metal seated valve materials shall be in accordance with BS 5163 Table 6A, fitted with a stuffing box and gland seal on the stem. Oil or grease shall not be used on any bearing or seal that may be in contact with the water being controlled.

The type and size of valve to be used to any particular location shall be as indicated on the contract drawings. Valve materials shall comply with the following minimum requirements.

| ENVIRONMENT | BODY | TRIM** | REMARKS |
|-----------------------|--|--------------------------------------|--|
| Air | Carbon Steel or Bronze | 410 SS Bronze | Blower discharge valves can be supplied to blower manufacturer standard. |
| Cl ₂ Gas | Carbon Steel | 410 SS | |
| Cl ₂ Water | PVC | PVC | |
| Diesel Oil | Carbon Steel | 410 SS | |
| Sewage | Ductile Iron Cast Iron PVC | Bronze* Bronze* PVC | Zinc free. |
| Potable Water | Bronze PVC Ductile Iron Cast Iron | Bronze* PVC Bronze* Bronze* | Less than 1000 mg/l total dissolved solids. Zinc free. |

* Alternate acceptable materials for stem is aluminum bronze, or nickel aluminum bronze

** Trim material includes stem, body and closure seating surface, seat rings, bushings, springs, or any small parts in contact with service fluid.

203.14.3 Butterfly Valves

Butterfly valves shall have a resilient disc seating and be designed for a positive leak-proof shut off at a minimum pressure of 16 bar. Non-wafer types are preferred.

Butterfly valves shall conform to BS 5155

The disc shall be in grey or ductile cast iron unless otherwise specified with a resilient seating ring in moulded rubber, or other material to the approval of the Engineer.

For valves of 350 mm ND and above, a suitably lubricated axial thrust bearing shall be fitted.

A stuffing box and gland shall be fitted on the operation shaft extension to seal the pressure side of the valve. The design shall be such as to facilitate packing replacement without removal of the valve from the pipeline.

A valve position indicator, to show the position of the disc, shall be provided on the valve operating gear.

Suitable stops shall be incorporated to prevent movement beyond the disc "fully open" and "fully closed" positions.

Valves for flow regulation shall be of all metal construction.

203.14.4 Air Valves

Air valves shall be of two types:

- a) Single (small) orifice valves (SOV), for the discharge of air during the normal operation of the pipeline.
- b) Double orifice valves (DOV), consisting of a large orifice and a small orifice. These shall permit the bulk discharge of air from the main during filling and air inflow when emptying in addition to the discharge of small quantities of air during normal operating conditions.

Air valves shall be supplied with an independent isolating butterfly valve (DOV) or cock (SOV) which permits the complete removal of the air valve from the main, without affecting the flow of water in the main.

The sizing of the air valve and isolating assembly shall be such that the pressure drop at design flow capacity does not exceed 0.5 bar.

Each air valve assembly shall be suitable for connection to a flange on the pipeline.

At the connection between the air valve and its isolating valve a BSP tapping shall be made suitable for fitting of a pressure gauge. All tappings shall be sealed by a brass plug and copper compression ring gasket.

Air valves shall operate automatically and be constructed so that the operating mechanism will not jam in either the open or closed positions.

203.14.5 Pressure / flow control valves (reducing/regulating)

Control valves shall function efficiently of line pressure or flow without human intervention. They shall be hydraulically or electrically operated depending on the availability of a power source. The basic valve shall be heavy duty globe type to BS 5152 & 5160. It shall have no packing glands or stuffing boxes and shall be maintained with ease without removal from the pipeline.

The valve shall be coated internally and externally with epoxy 150 µm minimum thickness. The material of the valve and its elements shall be selected to suit the fluid in the line and the environmental factors such as abrasion, corrosion, pressure and temperature.

203.15 TEMPORARY AND/OR PERMANENT RESTORATION OF PAVED ROADS

The Contractor shall make all types of reinstatement immediately after the completion of the backfilling, including sub-base and base layers. In asphalted roads, reinstatement shall be done according to the decree No. 13495 dated 5/11/98 and in accordance with related general specifications of Volume 3. Asphalt wearing course shall be executed immediately after the backfilling, sub-base and base layers. This asphalt work will be considered as temporary. The contractor shall repair all future damages using the same procedure as above. When no damage occurs anymore to the reinstated trenches, asphalt work will be considered permanent and completed after presenting a clearance from the concerned authority to the supervising Engineer and getting the approval of the latter.

In case of ambiguities or discrepancies between the content of the above-mentioned decree and the general specifications, the decree shall prevail.

For concrete areas, the Contractor shall restore them to their original conditions, such reinstatement shall be done in full accordance with section 202 of the General Specifications.

203.16 REMARKS

The Contractor shall lay pipes on one side of the streams and on one side of the roads (even if this is not shown on the drawings) and if possible, outside the carriageway in order to avoid damaging the roads. The Contractor shall coordinate with the Administration, the Engineer and the relevant Authorities in order to obtain an official authorization prior to any construction work.

203.17 SURGE SUPPRESSION EQUIPMENT

The surge suppression equipment shall include surge vessels(s) for the pumping line, air compressor unit, valves, fittings and compressor control panel, complete with cabling and wiring. The above panel shall incorporate the power and control gear of the compressor and level indication and protection of the surge suppression system.

The control and monitoring of the surge suppression equipment shall be achieved by the compressor's control panel PLC. This PLC shall be linked to the main PLC in the control room (if available).

It shall also include all accessories required for the complete installation such as pipes, bends, gaskets, bolts, nuts, supports, flanges, unions, couplings, adaptors, etc....

Note: It is the responsibility of the Contractor to gather all necessary information and submit a detailed calculation sheet for design justification, based on the pumping line profile and characteristics, and decide on the type of surge suppression equipment to be used.

203.1 SHOP DRAWINGS AND MATERIAL TECHNICAL SPECIFICATION, AS-BUILT DRAWINGS

Shop Drawings, design calculation notes and all necessary material technical specification shall be submitted to the Engineer for approval at least 21 days before starting of the work.

As built drawings shall be prepared after completion of the work, and shall be also submitted to the Engineer for approval.

It is the duty of the Contractor to undertake all the Engineer's recommendations, modifications and corrections at his own expense until complete satisfaction of the Engineer.

All the modifications to the design drawings coming out during execution of the works, or after ordering the relating materials (especially for pumping stations building dimensions) should be done by the Contractor and approved by the Engineer.

204. COVID-19 PANDEMIC

204.1 GENERAL NOTES

204.1.1 Workers and staff

All engineers and staff shall go to their private homes and all workers shall go to their small houses next to the project location at the end of the day after works are done.

The offices shall not contain any dormitories nor lunch break rooms. There should be a strict policy based on the COVID-19 measures restraining and minimizing gatherings.

204.1.2 Covid-19

In this reporting period, Lebanon is reporting an increasing number of cases (more than 2000-3000 cases daily).

In this period, the measures on site should be stricter. All workers and staff should be prevented to enter the sites if they do not wear masks.

204.1.3 Safety measures and traffic

PPEs shall always be worn.

Organizing the site and the traffic shall be done using caution tapes, cones, and guidance signboards.

204.2 COVID-19 PANDEMIC PRECAUTIONS:

At the end of 2019 a novel coronavirus was identified as the cause of a cluster of pneumonia cases in Wuhan, China. It rapidly spread, resulting in an epidemic throughout China, followed

by an increasing number of cases in the countries throughout the world, resulting in a pandemic that was called COVID-19 which is designated as a severe acute respiratory syndrome.

Till this date, this virus has medications or vaccines, but all vaccines have not arrived to Lebanon yet. The virus symptoms range from mild (fever, dry cough, tiredness...) to severe (shortness of breath, chest pain, loss of speech or movement ...) and could lead the patient to ICU (intensive care unit) or even to end his life (up to 10% death rate depending on patient age, diseases and the country's health care status and lifespan).

The procedures, advised by WHO (world health organization), to face this virus are to minimize the spread of the virus until a vaccine is produced. Meanwhile, as long as the number of cases is within the country's healthcare capacity, patients can have the needed help to be healed.

But in case the numbers increase dramatically, the healthcare system will collapse and the death rates will increase.

Lebanon, as all of the world, began to identify cases in February 2020. But, as time progresses, the cases began to increase dramatically.

In order to decrease the speed of the virus, the ministry of health in Lebanon has put a plan to manage the pandemic. This plan takes into account the procedures of the World Health Organization.

As for this project, as in Lebanon and all of the world, those procedures and precautions plans should be respected in order to prevent the virus spread and damage among the community and among the project staff and workers, especially that it may delay the works and the project and it may result in loss in lives.

The procedures taken consists mainly of the following:

204.2.1 Social distancing

This point is the main key to stop coronavirus. If the person is distant from others, there will be no source to transmit the infection.

So, the staff and workers should avoid being in crowds and try to always maintain distance (more than 1 meter at least) between them.

204.2.2 Good Hygiene

Good hygiene is one of the precautions that should be taken into consideration concerning COVID-19 virus. This includes washing hands regularly, avoid touching nose and eyes, and using alcohol-based liquids to clean hands.

204.2.3 Protective equipment (masks, gloves, helmets ...)

Masks and gloves are important to prevent the virus spread. So, they should be used among all staff and workers.

Even with coronavirus prevention importance, safety should not be forgotten and should be taken into consideration by wearing helmets.

204.2.4 Health and awareness monitoring

There are many signs and symptoms of the virus that can give an alarm of an infection (coughing, pain, temperature...).

Thus, anyone who shows any symptom must be reported to the local authorities to take proper actions.

In addition to monitoring, there should be regular campaigns to increase awareness among all workers and staff in order to remind them about the big danger and the importance of all precautions that need to be taken.

Note that the contractor should provide a H&S plan including requirement and precautions for COVID-19.

P.S.: Recommendations and precautions from COVID-19 should always be updated upon new requirements of WHO and local MOH requirements.

PART 3
MECHANICAL WORKS

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300. TLEIL BOOSTER PUMPING STATION

- Reference: Hydraulic Schematic drawing N° 667W-02M01
 Mechanical drawing for PS N° 667W-02M02

300.1 PUMPING SYSTEM

300.1.1 Electric Motor

| Minimum Power Factor at 75% to 100% Output | Efficiency at 75% to 100% Output | No. of Starts/Hour | Quantity | Remarks |
|--|----------------------------------|--------------------|----------|----------------|
| ≥ 0.85 | ≥ 86 % | ≥ 10 | 2 | Surface motors |

300.1.2 Pump

Type: - Surface Motopumpset (Qty: 2)

| Flow (l/s) | Head (m) | N.P.S.H. (m) | Efficiency at Duty Point | Quantity | Remarks |
|------------|----------|--------------|--------------------------|----------|---------------|
| 6 | 45 | ≤ 3 | ≥ 70% | 2 | Surface pumps |

- Motopumpsets shall undergo witness test in factory. At least one supervising engineer should witness the testing of the pumps in factory. All expenses shall be on the behalf of the contractor executing the works.

Supply and installation of all the necessary miscellaneous mechanical accessories required for the assembly of the complete motopumpset system such as joints, couplings, adaptors, supports, bolts and nuts, etc...

300.2 PIPING AND ACCESSORIES

- All pipes, valves, and hydraulic accessories shall bear NSF 61 approval.
- All pipes, valves, and hydraulic accessories shall have flanged and or mechanical joints.
- All piping of suction and discharge headers, and motopumpsets inlet and outlet sections shall be internally and externally coated with epoxy (300 microns).
- All valves shall be coated internally and externally with epoxy (150 microns).
- The installation of piping and valves is deemed to include all the necessary miscellaneous hydraulic accessories required for the assembly of the complete

system such as flanges, gaskets, coupling, adaptors, tees, bends, pipe supports, nuts and bolts, etc...

300.2.1 Scope of Works

The hydraulic system of booster station is composed of the following:

1. One (1) off Motopumpset suction header 80 mm diameter.
2. Two (2) off Motopumpset inlet sections 80 mm diameter.
3. Two (2) off surface Motopumpsets.
4. Two (2) off Motopumpset outlet sections 80 mm diameter.
5. One (1) off 80 mm diameter Motopumpset discharge header.
6. One (1) off 80 mm diameter Motopumpset discharge drain.
7. Level, pressure, flow and temperature measurements as specified in “Instrumentation, Control Equipment and accessories” section.

300.2.2 Piping

| Piping | Type | Material | DN (mm) | PN (bars) |
|---------------------------------------|------------------|----------|---------|-----------|
| Surface Motopumpsets suction Header | ERW/ Seamless | Steel | 80 | 16 |
| Surface Motopumpsets inlet sections | ERW/ Seamless | Steel | 80 | 16 |
| Surface Motopumpsets outlet sections | ERW/ Seamless | Steel | 80 | 16 |
| Surface Motopumpsets discharge Header | ERW/ Seamless | Steel | 80 | 16 |
| Surface Motopumpsets discharge drain | ERW/ Seamless | Steel | 80 | 16 |

300.2.3 Valves

| Valves | Type | Material | DN (mm) | PN (bars) | Qty (No) |
|--|---------------|-----------------|---------|-----------|----------|
| Booster discharge air release valve | 3 functions | Cast Iron | 50 | 16 | 2 |
| Surface Motopumpsets inlet sections isolation | Butterfly | Cast iron | 80 | 16 | 2 |
| Surface Motopumpsets outlet sections isolation | Gate | Cast iron | 80 | 16 | 2 |
| Surface Motopumpsets outlet sections check valve | Anti-Slam | Cast iron | 80 | 16 | 2 |
| Surface Motopumpsets Discharge header isolation | Gate | Cast steel | 80 | 16 | 1 |
| Surface Motopumpsets Discharge header drain | Gate | Cast steel | 80 | 16 | 1 |
| Surface Motopumpsets outlet Sampling | Ball | Cast Iron | 13 | 16 | 2 |
| Ground Tank suction header | Gate | Cast Iron | 80 | 16 | 1 |
| Ground Tank suction | Tube Strainer | Stainless Steel | 80 | 10 | 1 |
| Surface pumps suction Header | Y strainer | Stainless Steel | 80 | 16 | 1 |
| Ground Tank suction | Foot valve | Cast Iron | 80 | 10 | 1 |

300.3 FIRE FIGHTING

300.3.1 Portable Fire Extinguishers

| Location | “G” Type | “P” Type |
|--------------|----------|----------|
| Pumping room | 1x 10 kg | 1x 10 kg |

PART 4
ELECTRICAL WORKS

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400. TLEIL BOOSTER PUMPING STATION

- Reference: Electrical schematic drawing No: 667W-02E01
- Water Tower Lighting plan view drawing No: 667W-02E02
- Water Tower Lighting Side view drawing No: 667W-02E03
- Pumping station lighting drawing No: 667W-02E04
- Pumping station electrical system drawing No: 667W-02E05
- Pumping station Earthing & lightning drawing No: 667W-02E06

400.1 SUBSCRIPTION TO EDL

The Contractor shall coordinate with EDL after gathering all necessary information in order to make sure that an EDL subscription for the pumping station is installed as follows:

- Voltage: 400 V.
- Rated Power: 3 x 30 A.

400.2 MOTOR PUMPSET SWITCHGEAR

Distribution board: A primary distribution board shall be provided at each installation. The board shall have, as applicable, feeds to:

1. Each motor starter/control panel.
2. Instrumentation and control equipment.
3. Building services electrical distribution board.
4. Other as particularly specified.

The primary distribution panel shall be located in the control room. It may be either wall mounted or free standing as appropriate to its rating power factor meter and size. The board shall incorporate door mounted ammeters, voltmeter with a phase-phase and phase-neutral selector switch, frequency meter and power factor meter.

Where the EDL transformer is not in a building or where the incoming EDL supply to the site is at 380 V, an earth fault relay shall be incorporated in the main distribution board to trip out the incoming supply under earth fault conditions.

400.2.1 General Circuit Breakers (G.C.B.)

400.2.1.1 *Type “A” circuit breakers*

With an Electronic Trip Unit for protection as follows:

Long time protection against overload with adjustable threshold:

$I_r = 0,4$ to $1 \cdot I_n$ and adjustable time delay.

Short time protection against short-circuits with adjustable threshold:

$I_m = 2$ to $10 I_n$ and adjustable time delay: 0.05 s to 0,30 s.

Instantaneous protection against short circuit with adjustable threshold:

$$I = 1,5 \text{ to } 11 I_n$$

Earth fault protection with adjustable residual current threshold:

0.2 to $1xI_r$ and time delay threshold: 0,2 s to 0,40 s.

- A minimum of 4 Auxiliary changeover switches that indicate pole position and a minimum of one auxiliary switch for tripping.
- A shunt trip release for remote tripping.
- A motor mechanism for remote control closing with the following main characteristics and auxiliaries:

a) Remote spring charging after an opening by a shunt trip release.

b) Toggle extension for manual spring charging.

- Terminal shields and Phase barriers.
- A counter that indicates normal Open/Close or tripping of the circuit breaker shall be installed for maintenance operation.
- One calibration test kit shall be supplied with connecting cables used to check the operation of the trip units of all circuit breakers.
- Visual indication of Open, Close and Trip conditions shall be provided. Circuit breakers shall be pad lockable in the “OFF” position.

N.B. All circuit breakers shall normally operate at no-load.

- G.C.B. shall be a moulded case circuit breaker of type “A”
- G.C.B. shall be installed upstream the Automatic-Transfer Switch, one for network supply and another for emergency supply.

| No. of Poles | Rating (A) at 380 V | Qty (No) |
|--------------|---------------------|----------|
| 4 | 32 | 1 |
| 4 | 32 | 1 |

400.2.2 Circuit Breakers for MOTOR PUMPSETS (C.B.P.)

400.2.2.1 Type “B” circuit breakers:

- All characteristics of type “A” circuit breakers.
- Each circuit breaker shall be mounted on a withdrawable chassis with the following functions:

a) Operations on disconnected position: the power circuits are disconnected, the circuit breaker is simply “withdrawn” and may still be operated and controlled (on, off, push-to trip etc...)

b) A safety trip shall be installed on the circuit breaker that causes automatic tripping if the circuit breaker is ON before engaging or withdrawing it.

c) Auxiliary switches shall be supplied for remote position indication (connected and disconnected positions).

Multiple breakers shall have a common trip bar and trip elements on each pole to ensure that any abnormal condition on any one pole will cause all poles to open simultaneously.

Visual indication of open, close and trip conditions shall be provided. Circuit breakers shall be pad lockable in the “OFF” or “Withdrawable” positions.

- C.B.P. shall be a moulded case circuit breaker of type “B”
- C.B.P. shall be installed upstream the starters that control the motopumpsets.

| No. of Poles | Rating (A) at 380 V | Qty (No) |
|--------------|---------------------|----------|
| 3 | 15 | 2 |

400.2.3 Auxiliaries Switchgear

- Shall include all outgoing feeders and corresponding protection for the auxiliaries of the site.
- The circuit breakers shall be supplied and installed to supply all auxiliary equipment of the site.
- The circuit breaker shall be a moulded case circuit breaker of type “B” as described in the specifications.

| No. of Poles | Rating (A) at 380 V | Qty (No) |
|--------------|---------------------|----------|
| 3 | 20 | 1 |

400.2.4 Starter

| Type | Rating (KW) at 380 V | Contactors Mechanical Life (Cycles) | Contactors Switching Frequency (Cycles/Hour) | Qty (No) |
|------------|----------------------|-------------------------------------|--|----------|
| Star Delta | ≥ 7 | ≥ 10 million | ≥ 2400 | 2 |

Variable Frequency Drive control panel should have the following features:

- Open loop.
- Proportional differential pressure.
- Constant differential pressure
- Constant level.
- Constant flow rate.
- Constant temperature.
- Constant "Other Value".
- Duty/Standby Function to alternate between two pumps (each pump operated on separate Drive).
- Dry running protection.
- 2 analog inputs, 1 analog output, 4 digital inputs, 2 signal relay.
- Modbus communication
- Availability of Output Filters from same brand "IF needed".
- Enclosure 200 x 80 x 40 cm.
- Filter

Values needed from V.F.D:

- Frequency reference
- Output Frequency
- Motor Speed
- Motor Current
- Motor Torque
- Motor Power
- Motor Voltage
- DC link Voltage
- Unit Temperature
- Motor Temperature
- Analogue Input 1
- Analogue Input 2
- Digital Input status
- Digital Output status (Run, Fault, Trip)
- Analogue output (if applicable)
- Multimonitor Items: Display three selectable monitoring items.

400.2.5 Automatic Transfer Switch (A.T.S.) (Main/Standby Supply Changeover)

- A.T.S complete with mechanical inter-lock shall be installed for the pumping station.

- This Automatic Transfer Switch shall be supplied with auxiliary contacts for monitoring and control.

| No. of Poles | Rating (A) at 380 V | Qty (No) |
|--------------|---------------------|----------|
| 4 | 32 | 1 |

400.3 UNINTERRUPTIBLE POWER SUPPLY (U.P.S)

Set of two online U.P.S. systems each, of adequate power output operating in redundancy shall be installed to supply the control, protection, measuring, signalling, valve actuators, circuits of the pump station and suction reservoir.

- The UPS efficiency is at least 91%, without degradation of output regulation as specified.
- The UPS battery system comprises user replaceable, hot swappable, battery modules.
- The battery jars housed within each removable battery module are of the Valve Regulated Lead Acid (VRLA) type.
- The UPS incorporates the Intelligent Battery Management system to continuously monitor the health of each removable battery module as well as external battery modules installed in extended run battery cabinets. This system shall notify the user if a failed or weak battery module is found.
- The UPS shall have a dry contact for battery failure and UPS operation mode.

Operation: One source is on duty, the other is on standby. Should the first source be out of service, the automatic changeover to the second source occurs within the cycle at zero voltage.

400.4 GROUNDING SYSTEM - LIGHTNING & SURGE PROTECTIONS

400.4.1.1 Earthing/Grounding System

A system of earthing and bonding shall be provided to minimize danger to life and equipment arising from:

- Faults between energised conductors and non-current carrying metal works
- Atmospheric discharges
- Accumulation of static charges

To provide protection against the above, a protective earth network shall be established consisting of an earthing grid of buried conductors and earth rods to which will be connected:

- Structural steelworks
- Protective earth conductors

- Cable armouring
- Vessels
- Electrical equipment panels, motors, switchboards, MCC's; and
- Supply neutral

All main items of electrical system shall have a minimum of two direct connections to this protective earth network.

Each connection being of sufficient size to carry the prospective fault current and shall be as stated on drawing.

The physical position of earth connections per equipment is diagonally opposite.

All structural steel works is to be bonded together and connected to the earth system, with copper conductors as per provided drawings.

Crane tracks shall be earthed at both ends to the earth system with copper conductors, as per provided drawing.

For smaller items of the electrical system, the minimum size of earth continuity conductors shall be one step bigger than the half of the main cable cross section. Nonetheless, earth cable should be of same size of phase conductor for cables of $csa \leq 16mm^2$.

Earth rods and buried earth conductors shall be of low resistance and highly resistant to corrosion.

Reinforced concrete electrode test and inspection chambers are to be provided.

Earthing electrodes are to be interconnected with each other and an earth grid is to be established to which all electrical plant and metalwork shall not exceed.

The combined resistance of the earth electrodes shall not exceed two ohms.

The short time rating of the installation shall be at least equal to the prospective short circuit current and maximum possible duration.

The Contractor shall ensure that dangerous touch voltages cannot arise.

Transformer neutrals shall be connected to the earthing system.

Holes drilled for earth rods where applicable shall be injected with bentonite to ensure good contact with the surrounding area.

Demonstration identifying the final ohmic value of the earth system will be required by the site Employer's Representative.

400.4.1.2 Lightning system - General

The lightning protection system shall be installed to protect the plant against damage caused by lightning strokes. A distinction is made between external and internal lightning protection.

External lightning protection comprises all devices provided and existing outside, at and in the protected installation for the purpose of intercepting and diverting the lightning stroke current to the earthing system.

Internal lightning protection comprises the measures taken to counteract the effects of the lightning stroke current and its electrical and magnetic fields on assemblies and electrical apparatus included in the structures of the installation.

The earthing facilities necessary for lightning protection must conform to DIN VDE 0141, with particular attention paid to the requirements for lightning protection in outdoor switching stations (e.g. back flashover).

The design of lightning protection systems shall be according to IEC 62305-3

Reinforced concrete electrode test and inspection chambers are to be provided for each earth electrode.

Each earth pit shall comprise copper clad steel rod earth rods of minimum 25 mm diameter and minimum 4.5 m long.

The minimum depth to the top of each earth rod assembly shall be 6 meters.

Earth pits shall not be located near areas where people may walk and shall not be less than 4 meters from the building foundations.

The measured value of resistance to earth shall not exceed 2 Ω .

Buried earthing conductors shall be by means of a copper conductor not less than 50 mm² in cross-sectional area.

400.4.1.3 Air Terminal Lightning Protection System

The lightning protection system at the Treatment Plant will comprise of the following:

- Air Terminals being the EF type or equivalent mounted regulation height above ground level utilising galvanised pipe in tapered sections and supported on a steel baseplate with a concrete base.
- This terminal shall generate a current of free primary electrons coming from the Air Natural Gradient, the potential of which rises in proportion with the approach of lightning and its change.
- It shall not use any radio-element, nor shall it be electrically supplied by batteries or solar cells, nor shall it include capacitors, diodes or electric resistance.
- It shall not be designed to prevent the corona development; therefore, it shall not be of spherical shape.

- It shall be made of highly dielectric materials so that, as soon as lightning strikes its tip, it enters into a sealed hole down to earth.

400.4.1.4 Lightning Protection Down Conductor (EF)

The down conductor will be a special coaxial cable which can convey lightning currents while eliminating side-flashing risks and cutting waves which propagate dangerous over voltages to electronic equipment.

It shall be manufactured of two concentric copper conductors (2x35 mm²) which are strongly insulated from each other and from the structure.

Approximate Diameter shall be 32 mm with a 1,5 kg/m weight.

With installation it shall not be subject to bends of less than 365 mm in radius.

400.4.1.5 Earth Terminal (EF)

The earthing shall not exceed 2 Ω of static impedance.

The earthing shall be achieved by buried copper strips or copper clad steel rods or a combination of both.

The bonding to the earthing of structures to be protected is acceptable but the resistance shall be measured before making this bonding.

400.4.2 Overvoltage protection

Electrical and electronic equipment shall be protected against surges or transients generated

by switching operations, electrostatic discharges and induction, etc... by the use of graded

lightning and overvoltage arresters.

Other grounding systems such as that for building, plumbing, power supplies, information

processing etc... shall be taken into consideration upon designing the complete protection

system.

Compatible overvoltage devices for 'line-side' protection that includes basic, medium level

and detailed protection, shall be installed and shall be of the same brand.

These overvoltage devices shall be installed according to the manufacturer's recommendations and shall have the following characteristics:

- Modular design
- Visual fault indication
- Remote signalling module
- Replacement of active module (varistor) without interrupting the power supply
- Negligible leakage current
- High discharge capacity
- No follow current when the surge voltage has died down
- Short response time

Telecommunication systems, data interfaces, electronic networks, etc... shall be protected with adequate overvoltage protection devices.

400.5 PROTECTION OF MOTOPUMPSETS

The automatic shut off of the MOTOR PUMPSET shall occur in case of the following:

- Minimum water level in suction reservoir for MOTOR PUMPSETS fed from reservoirs.
- High flow at the discharge of the MOTOR PUMPSET (with delay).
- Insufficient flow at the discharge of the MOTOR PUMPSET (with delay).
- High pressure at the discharge of the MOTOR PUMPSET (with delay).
- Low pressure at the discharge of the MOTOR PUMPSET (with delay).
- Unauthorized starting when main circuit-breakers are open.
- Thermal fault
- Long start if autotransformer starter is used.

400.6 ALARMS & SIGNALLING

A visual indication and sound alarm shall be foreseen, in the electrical room with the switchgear, for the following faults (where applicable):

- Tripping of medium voltage circuit-breaker.
- Voltage fault.
- Minimum level in the suction and discharge reservoirs.
- Maximum level in the suction and discharge reservoirs.
- High pressure at the suction of motopumpsets.
- Low pressure at the suction of motopumpsets.
- Minimum water level in boreholes.
- Minimum water level in barrels.
- High pressure at the discharge of motopumpsets.
- Low pressure at the discharge of motopumpsets.
- Excessive flow at the discharge of motopumpsets.
- Insufficient flow at the discharge of motopumpsets.
- Emergency stop.
- Overheating of cooling air.
- Fire alarm.

These defects shall be signalled on a luminous panel, constituted of labels of translucent material specific for each fault, and comprising two associated push buttons: lamp test and reset (acknowledge).

A visual signalling (independent) of the state of each set shall be provided: RUN, STOP.

400.7 ELECTRICAL INSTALLATION FOR BUILDINGS

The electrical installation for buildings shall the following items which shall be applied to all rooms of the building, including electrical panel's room, wellhead chamber, along with external lighting system of the pumping station.

Contractor shall submit detailed shop drawings for the electrical installation of the buildings along with all necessary technical data sheets for the equipment to be installed.

All equipment installed in the Chlorine Room and Cylinder Room should be rated for the location they are installed in. No steel conduit to be used due to corrosion. Lighting fixtures and power outlets to be rated for use in a corrosive atmosphere.

400.7.1 Electrical Panel Boards

Including signalling lamps, measuring instruments, selectors, bus bars, glands, cables, wiring, connections, to incoming and outgoing feeders, installations, connection, labelling, accessories, identification, etc...

Main distribution board to be installed near the entrance to the building

i) A cable shall supply the power to this panel from the pumping station main panel

All distribution boards shall be metallic or polyester construction, they shall be monocellular, rectangular and have a plane front face, designed for built in or surface mounting as specified.

They shall have a lockable door and a key.

They shall have class of protection IP55 and be finished with textured paint RAL 7032 or RAL 7035.

These boards shall comprise:

Distribution boards shall be supplied with all wiring, bus-bars, equipment such as circuit breakers, ammeters, voltmeter selector switch etc..., accessories, cables, junction boxes, and installation material ready for installation directly on arrival at site.

The boards shall be designed to facilitate inspection, maintenance and repair and all articles having the same characteristics and dimensions shall be entirely interchangeable.

Distribution boards must not show any deformation or welding effect. They shall be rigid enough to support the equipment without deformation both during normal operation and under short circuit condition. They shall be fitted with reinforcement especially against the effect of short-circuits.

All bus-bars, equipment and connections shall withstand the nominal rated current continuously without heating beyond admissible values.

The design of distribution boards shall take into consideration every change of rating of the equipment to suit the climatic conditions specific to the site. All live terminals and parts shall be adequately insulated from the frame of the panel board. Metallic boards frame shall be grounded.

Bus-bars shall be so protected as to exclude the possibility of contact with them or any live part when closing or releasing circuit breakers.

Boards comprising several cells shall be protected with an earthing bar covering the entire length of the board.

Frames and the metallic enclosures of equipment shall be connected to the earthing bar by means of approved accessories.

Each single-phase distribution board shall have one bus-bar and one neutral bar. The section of the bars shall be sufficient to allow the passage of the nominal current without leading to excessive heating; the rating shall be equivalent to at least the total nominal current of incoming circuit breakers in the board.

Bus-bars shall be made of electrolytic copper. The Contractor may offer variants made of another material, but in this case, he shall submit for the Engineer's approval all the details concerning the accessories required for the connection of cables and equipment to bus-bars.

The frames of metallic distribution boards shall be treated against corrosion. They shall be painted internally and externally with one coat of primer and two grey finishing coats.

All circuits fed from the panel board shall be labelled.

Distribution boards shall have at each feeder, a chart or diagram describing, according to the distribution scheme, the circuits connected to this feeder. The boards shall be of fixed, non-removable type. Circuit breakers shall be of miniature type.

Connections to all equipment shall be easily reached and made from the front without having to dismantle the board.

Ammeters shall be fitted at each incoming feeder.

400.7.2 Circuit Breakers

All circuit breakers shall meet the following conditions:

- They shall be designed to function under the electrical current supplied to the station.
- Each phase pole shall be fitted with an instantaneous action thermo-magnetic type over current trip. The trip shall act on a common tripping bar and provoke the simultaneous tripping of all poles.
- Circuit breakers shall be of automatic trip type.

- Each pole shall be fitted with an arc extinguishing mechanism.
- Circuit breakers shall be compensated for ambient temperature. All thermal relays shall be compensated in order to function correctly in the ambient temperature of the site.
- Circuit breakers shall be fitted

Three-phase circuit breakers shall also meet the following conditions:

- Incoming circuit breakers from the main panel board, connected directly to the transformer station shall be four poles. All other circuit breakers shall be three poles.
- All the poles of three-phase circuit breakers should trip simultaneously with one control mechanism.

Circuit breakers installed in the general panel board may be of miniature type.

Circuit breakers installed in secondary panel boards may be moulded case miniature type.

Rupturing Capacity

- All circuit breakers shall have sufficient rupturing capacity to switch off the highest short-circuit currents.
- Circuit breakers shall have a rating approved by the engineer.

The minimum rupturing capacities shall be as tabulated hereunder and consistent with the D.T.U.

| Rating (A) | Voltage (V) | Rupturing Capacity (A) |
|------------|-------------|------------------------|
| 32 | 240-380 | 6000 |
| 70 | 240-380 | 6000 |
| 100 | 380 | 14000 |
| 125 | 380 | 14000 |
| 150 | 380 | 22000 |
| 500 | 380 | 30000 |

400.7.3 Electrical Cables

Including conduits, cable trays, connections, supports, installation, accessories, identification, etc...

The cables to be installed include the following:

- Main distribution board power supply cables.

- Connection cables between the main and secondary distribution boards.
- Power supply cables to metering.
- Connection cables between meters and secondary boards.
- Cables used for the power supply of low power motors.

Multicore cables shall be protected with an external sheath made of thermoplastic material of NYA type consistent with the most recent VDE standards or of an equivalent type consistent with other recognised standards.

All cables shall be of 1000 volts rating.

Cores shall be made of pure electrolytic copper; resistivity = 0.01724 Ohm/mm²/m at a temperature of 20⁰C. They shall be multi stranded for sections exceeding 6mm²

The insulation of the cores shall be colour coded as specified.

400.7.4 Conduits

Including clamps, flexible, fittings, connections, installation, accessories, etc...

Where electrical wires and cables, including very low voltage wiring, are installed in plastic (PVC) conduit, rigid type, and the conduit shall be consistent with the DTU and its addenda (class of protection IP55)

The connection of conduits shall be carried out by means of accessories of the same type, using the materials specified in the catalogues of the conduit manufacturer (class of protection IP55)

Adequate flexible accessories shall be used for electric lines crossing expansion joints or fixed to different structure units.

Generally, all accessories used with electrical networks shall be of the same type and shall have the same characteristics.

Conduits shall be so installed that the junction, sub circuit, and wiring draw boxes are always accessible for maintenance and repair.

The connection of conduits or of conduits and other accessories shall be carried out according to the instructions of the conduit manufacturer.

Surface mounted conduits shall be fixed by means of galvanised steel brackets, sufficiently close to each other to ensure a solid fixing. Screws and nuts shall also be galvanised.

After laying the conduits, they shall be fixed in cement mortar.

The Contractor shall make grooves in the walls for built in conduits; in all cases he shall fix the conduits in such a way as not to damage the finish of the structure.

The use of wooden pegs for sealing is strictly forbidden.

No more than two 90° bends shall be permitted throughout the run of a conduit between two junction boxes. Should more than two bends be required, the Contractor shall install additional junction boxes in order to facilitate the laying and removal of wires.

In the event of the electrical conduits crossing other pipes, electrical conduits shall be so installed as to keep a free space between conduits and pipes.

A minimum clearance of 200mm shall be maintained between electrical conduits and heating or steam pipes. If this 200mm clearance cannot be achieved electrical conduits shall be externally insulated.

Conduits embedded in walls shall be vertical or horizontal. Installation of diagonal conduits inside walls is not permitted.

Surface mounted conduits shall run parallel or perpendicular to walls.

Note: All low voltage cables shall be installed in separate conduits.

The internal diameters of various sizes of conduit are tabulated hereunder together with the number and section of conductors that may be installed therein. The numbers stated in the table represent in millimetres the minimum internal diameters. The Contractor shall supply conduits having a diameter equal to at least that specified.

| Section of Conductors (mm ²) | Number of Conductors in Conduit | | | |
|--|---------------------------------|----|----|----|
| | 3 | 4 | 5 | 6 |
| 2.5 | 16 | 16 | 16 | 16 |
| 4 | 16 | 16 | 16 | 16 |
| 6 | 16 | 16 | 16 | 23 |
| 10 | 21 | 21 | 21 | 29 |
| 16 | 21 | 29 | 36 | 36 |
| 25 | 36 | 36 | 36 | 48 |
| 35 | 36 | 48 | 48 | 48 |

No more than 6 conductors may be installed in one conduit unless the seventh is an earthing conductor.

400.7.5 Junction and Distribution Boxes

Including glands, installation, connections, labelling, accessories, covers, etc...

Boxes used for connections and sub circuits, shall be PVC material, as well as those installed at each feeder, shall be supplied with appropriate covers (class of protection IP55)

They shall have knockouts for conduit connections.

Switch and socket boxes shall be provided for the switches and sockets to be installed, in conformity with the recommendations of the supplier of these items.

Surface mounted boxes shall be watertight to IP55, of moulded construction with inlets fitted with glands.

Junction and Distribution Boxes shall be rated IP 65 for outdoor locations and rated for the area that they will be installed in.

Power supply circuits of low power equipment such as fans and air convectors shall be linked to junction boxes with fixed connections for the corresponding equipment.

Junction boxes shall be either single-phase or three-phase.

400.7.6 Switches

Including boxes, covers, installation, accessories, cables, conduits, wiring, connections to panel boards, etc...

Lighting circuit switches shall be single two, or three way rated for 16 Amp, 220V. They shall be silent toggle switches.

The switch and cover plate shall be fixed to the box with stainless steel or chromium-plated screws. Hook fixings are forbidden.

Flush switches shall have their covers made of an insulating material (class of protection IP55)

Switches shall be flush or surface mounted according to the type of installation.

Surface mounted switches shall have the same mechanism as flush switches, but shall be installed inside dust proof boxes, having inlets fitted with glands (class of protection IP55)

Switches shall be installed on phase wires and in no case on neutral wires.

Switches shall, in general, be installed 1100 mm above the finished level of the floor, except in particular cases where their installation shall be submitted for the Engineer's approval.

Switches intended for the same duty in different locations shall be installed at the same heights. Switches shall always be installed in the most suitable places for their operation.

400.7.7 Power Outlet Sockets and Plugs

Including plugs, boxes, covers, installation, cables, conduits, wiring, connections to panel boards, labelling, accessories, etc...

400.7.7.1 General

The exact locations of power-outlet sockets shall be determined according to the construction details of the building. These locations shall be submitted for the Engineer's approval.

Power outlet sockets shall be flush or surface mounted according to the type of the installation.

Flush mounted socket outlets shall be installed in their boxes with screws.
All single-phase power-outlet sockets and plugs shall have ground contacts or terminals to be connected to the grounding system.

Three-phase power-outlet sockets shall be installed at heights which suit the equipment they supply with power.

Power-outlet sockets intended for the same duty in different locations shall be installed at the same heights.

Three-phase power outlet sockets shall be supplied with corresponding plugs.

400.7.7.2 *Single Phase Power-Outlets (1-Ph P.O.)*

Each single-phase power-outlet sockets and plug shall have 2 terminals and one ground contact. They shall be rated for 20Amp - 220V.

Fixing the switch and cover plate to the box shall be done with stainless steel or chromium plated screws. Hook fixings are forbidden.

Switches used with built-in installations shall be of flush type and fitted with square or rectangular covers made of an insulating material.

Surface mounted switches shall be installed inside waterproof boxes (class of protection IP55). These boxes shall have inlets fitted with glands and shall be provided with knockouts.

It shall not be possible to insert telephone plus into power outlet sockets.

400.7.7.3 *Three-phase Power-Outlet Sockets (3-Ph P.O.)*

Three-phase socket-power and sockets plugs shall be rated for 32 Amp, 380V and shall have ground terminals.

Surface mounted power-outlet sockets shall be installed inside water-proof boxes (class of protection IP55) or better. These boxes shall have inlets fitted with glands and shall be provided with knockouts.

It shall not be possible to insert telephone plugs into sockets.

400.7.8 *Lighting Fixtures*

The installation of the lighting system shall be consistent with the technical specifications generally, and particular attention shall be given to those related to humid and corrosive situations.

Lighting installations shall be complete and shall include all necessary accessories, whether the accessories are described hereunder with the description of the lighting installation or not.

The body of the lighting fixture, its base, or support shall entirely cover the corresponding box.

External devices shall be mounted with non-ferrous accessories.

The frame of lighting devices inserted in a false-ceiling shall not allow light to infiltrate

between the frame and the false-ceiling.

Lighting devices fixed directly to a centre box shall be solidly held by a peg and a cramping block.

Lamps shall be supplied and placed in all the lighting fixtures as specified.

Prior to the final commissioning of electrical installations, lamps used throughout the works shall be replaced by new ones.

Lamps shall be LED type designed to work at 220V (or 24V) voltage, they shall have a lifetime of a minimum 50,000 hours, L80.

400.7.9 Emergency Lighting System

Emergency lighting shall be provided to maintain sufficient illumination in accordance with BS 5266 for escape routes within the building during mains supply failures.

Luminaires shall comprise at least a single 8 W LED type suitable for the environment installed in.

The diffuser shall be of unbreakable opal polycarbonate material, secured by an oil and water proof sealing gasket to result in a luminaire rated to IP65.

Luminaires shall be self-contained and shall incorporate a maintenance free, nickel cadmium battery, capable of preserving the light output for a period of at least 3 hours without mains supply, together with an automatic recharging circuit to restore the charge within 24 hours of total discharge. Each luminaire shall incorporate an indicator to show that the charger circuit is healthy and have a removable gear tray and fused terminal blocks for ease of maintenance and installation.

Unless otherwise specified, luminaires shall be either of the following forms:

- a) maintained form, normally lit from the mains and automatically switched from mains to battery during mains failure;
- b) non-maintained form, energised automatically from the battery supply only when the mains fails and the associated local lighting circuit is switched on;
- c) sustained form, having two lamps, one of which is mains fed only, the other operating from the battery supply during mains failure

400.7.10 Testing and Commissioning

Including measuring of resistances of the grounding and the lightning protection systems, luminaires, power, continuity and insulation meggering of cables installation, etc...

N.B.:

- All conduits used for domestic electrical installation shall be imbedded in walls or in floor.
- All outlet sockets and switches shall be flush mounted.

400.8 LOCAL ELECTRICAL INSTRUMENTATION

| Local Electrical Instrumentation | Quantity (set) |
|---|----------------|
| Set of three digital Ammeters with current transformers | 4 |
| Set of digital voltmeters with selector switches | 1 |
| Digital hour meters | 2 |
| Digital frequency meters | 1 |
| Digital power factor measurement (Response time \leq 1 s) | 1 |
| Signalling lamps (Set of three) | 6 |

- Current, voltage, power factor and frequency measurements shall also be transmitted, via the relevant Programmable Logical Controller (PLC) and the main PLCs, to the supervisor program for calculation, remote display or any other application.

PART 5
INSTRUMENTATION AND CONTROL

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500. TLEIL BOOSTER PUMPING STATION

- | | |
|--------------------------------|----------------|
| – Reference: Control schematic | No: 667W-02I01 |
| Electrical schematic | No: 667W-02E01 |
| Hydraulic schematic | No: 667W-02M01 |

The Contractor shall supply and install the following systems for the measurement of the operation parameters of the pumping installation, their local display and remote transmission.

500.1 PUMPING SYSTEM

The control system shall be designed and implemented on the following basis:

- All general circuit breakers (GCB), the corresponding ATS system, the circuit breaker for auxiliaries, the relevant signalling and electric parameters (voltage, current, frequency, power factor) shall be connected and/or controlled by one PLC unit adequately sized (PATS).
- For each moto-pump set system, the circuit breaker (CBP), the starter, the suction and discharge motorized valves, where applicable, the discharge pressure, the discharge flow, the motor temperature measuring instruments, the relevant signalling and electric parameters (voltage, current, frequency, power factor) shall be all connected and/or controlled by one PLC unit adequately sized (PSC).
- One main P.L.C. unit (MPLC), shall be installed and connected to all PLC units through a communication bus, and shall be responsible for the automation and control of the pumping station/system according to the relevant parameters and variables.
- For each group of surface moto-pump sets, and unless otherwise specified, the moto-pump sets shall be operated cyclically and the maximum number of pumps simultaneously running is the total number of pumps less one pump.
- Where the pumping station consists of only one moto-pump set system (borehole or surface), then this system and the electric ATS shall be controlled by the main PLC (MPLC) of the station.
- The Contractor shall supply two portable programming unit for the above PLC unit(s).
- The proposed equipment and add-in options shall offer and support cable redundancy on the network components.
- Cable route markers shall be installed at bends and along the cable length.
- Where the Contractor does not have a pipeline to install, he shall provide for the execution of all necessary civil works, trenches, etc...
- In addition to the control and indication equipment (measurements display, alarms, push buttons, etc...) installed in the control room of the pumping station, this latter shall be designed to house a HMI panel representing the complete water system.

500.2 INSTRUMENTATION

The Contractor shall supply and install the following systems for the measurement of the operation parameters of the pumping installation, their local display and remote transmission.

500.2.1 Level Measurements

| Location | Type | Qty (No) |
|--------------------|----------------|----------|
| Reservoir (L1, L2) | Piezoresistive | 2 |
| Fuel tank (L3) | Piezoresistive | 1 |

The water level shall be monitored by a system providing the necessary duty set points, each being adjustable over the full range of control required.

To achieve performance stability under all environmental conditions and variations, all necessary signal compensation devices shall be included.

The monitoring system shall be damped to prevent spurious switching due to transient wave motion but shall respond sufficiently to allow adequate time for plant reaction to stabilize in order to prevent hunting.

The system shall include a duplicate back-up monitoring device or have built-in self-monitoring circuitry with alarm facilities.

Any high-level settings which may be provided as part of a level control system may be linked with the independent high level alarm sensors specified.

500.2.2 Pressure Measurements

| Location | Type | Qty (No) |
|-------------------------------------|----------------|----------|
| Booster Motopumpset outlet | Manometer | 2 |
| Booster Motopumpset outlet (P1, P2) | Piezoresistive | 2 |

500.2.2.1 *Pressure Transducers*

Pressure monitoring shall be by a transducer suitable for the medium and pressure/level range specified herein.

Each transducer shall be ranged to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. They shall be of rugged and waterproof design, employing a pressure sensitive element within a stainless steel enclosure having an isolation diaphragm, suitable for either free wire suspension in the medium or fitted with a BSP thread for external connection to the relevant pipe tapping.

Suspended sensors shall be mounted in accordance with the manufacturer's instructions within a UPVC or HDPE 'stilling tube' of sufficient nominal bore to enable easy withdrawal of the sensor.

Sensors shall be enclosed to IP 68, offer a long life and shall be supplied complete with a suitable signal cable to reach the approved point of termination transmitter-converter without intermediate joints.

The position of the equipment shall be such that withdrawal and installation can be achieved easily.

Cable entry shall be by integral sealed assembly or by 20mm conduit entry into a sealed watertight terminal enclosure with provision for transducer venting.

A transmitter shall be provided either integral with the transducer or separately mounted as specified, suitable for operation from the mains or battery supply or UPS specified (not greater than 24V) and converting the signals received from the transducer to a 4 - 20 mA signal proportional to the range specified which shall be used as follows:

- (i) To drive an indicator/recorder to give a continuous readout;
- (ii) To operate separate on/off pre-set adjustable points.

The transmitter shall have provision for range and zero adjustment.

For use in hazardous areas as specified, the units shall be certified intrinsically safe Ex (I).

500.2.3 Flow Measurements

| Location | Type | DN (mm) | PN (bars) | Qty (No) |
|---|-----------------|---------|-----------|----------|
| Booster motopumpset suction header (F) | Electromagnetic | 80 | 16 | 1 |
| Booster motopumpset suction header (FS) | Flow switch | 13 | 16 | 1 |

500.2.3.1 *Electro-magnetic Flow Meters*

The flowmeters shall be of electro-magnetic inductive type having a DC pulsed field with automatic zero error averaging and low power consumption. They shall have no moving or protruding parts nor cause any restriction in the flow path and be capable of setting adjustments without the need to stop the flow.

Each metering system shall comply with the latest international standard and comprise a flow sensor mounted in the pipework line and a transmitter which degree of protection is IP67, either integrally mounted or remotely located preferably within the main control panel.

The system accuracy shall be a maximum at normal operating flow with an error not more than 0.2% of the reading. When operating in the lower 30% of the meter range, the accuracy shall be within $\pm 0.5\%$.

500.2.3.2 flow switch

This flow control device shall have the following characteristics:

- Body in Stainless Steel 316L
- IP65 class of protection according to DIN
- 1/2” and NPT pipe fitting
- 85°C maximum ambient temperature
- 120°C maximum fluid temperature
- Stainless Steel paddle sensing element
- 8A, 250Vac microswitch with switching contacts
- Galvanized steel base plate with ABS cover
- Mounting in all directions

The device shall be supplied with “T” connection to fit the required pipe size.

500.2.4 Temperature Measurements

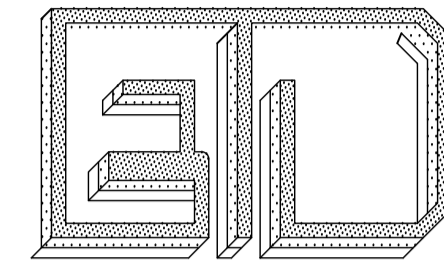
| Location | Type | Qty (No) |
|------------------------------------|------|-----------------|
| Booster Motopumpset electric motor | PTC | 2 (3 per motor) |

500.3 CONTROL SYSTEM

- The main PLC shall have a provision for the connection to the PLC in the reservoir.
- PLC1 shall be installed in the electrical panel in the control room and PLC2 shall be installed in a weatherproof enclosure of appropriate sizing to be installed near the reservoir.
- The control system of the well pumping station shall use a radio link for the communication between the main PLC (MPLC) of the pumping station and the PLC of the reservoir.
- The Contractor shall supply and install an HMI (Human Machine Interface) panel showing the entire pumping system.
- The contractor shall provide the sequence of operation of the PLC in addition to its programming and configuration to be checked and approved by the engineer.
- The PLC unit receives data from the well level sensor, tank level sensor, flow meter, pressure sensor, and temperature probe convey signals to the pump’s control panel, causing the pump to start running as long as the transmitted data fall between the preset tolerances, otherwise it orders the pump to stop.
- For dry run protection of the system, a piezoresistive level sensor is installed deep in the well, to prevent the pump from running in case of low water level in the well.
- The system should operate on both automatic and manual modes.

500.4 PLC CONTROLLER

- The main PLC shall have a provision for the connection to the water tower.
- The control system of booster pumping station shall use a cable link for the communication between the main PLC (MPLC) of the booster pumping station and the water tower.
- The Contractor shall supply and install telemetry cables from the booster pumping station to the location of water tower.
- The Contractor shall supply and install a mimic panel showing the entire pumping system.



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REPUBLIC OF LEBANON

MINISTRY OF ENERGY AND WATER

SOLIDARITES INTERNATIONAL

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES
(TLEIL RESERVOIRS' SITE)

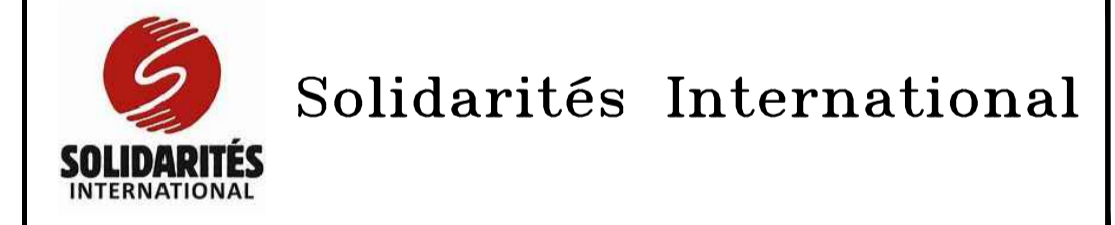
DRAWINGS

MARCH 2023

| SHEET No. | DRAWING TITLE | DRAWING No. |
|-----------|---|--------------|
| 0 | LIST OF DRAWINGS | 667W-L0D01 |
| | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL | |
| | • FORMWORK | |
| 01 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - GENERAL LAYOUT | 667W-02STR01 |
| 02 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - RAFT FOUNDATION PLAN VIEW | 667W-02STR02 |
| 03 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - GROUND TANK UPPER SLAB PLAN VIEW | 667W-02STR03 |
| 04 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - ROOF PLAN VIEW | 667W-02STR04 |
| 05 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - ELEVATED WATER TOWER AND SECTION | 667W-02STR05 |
| 06 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - TYPICAL SECTION ON INTERNAL STEEL STAIR | 667W-02STR06 |
| 07 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - TYPICAL SECTION ON INTERNAL STEEL STAIR | 667W-02STR07 |
| 08 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - SECTION AND ELEVATION AND PLAN VIEWS | 667W-02STR08 |
| 09 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - STEEL LOUVERS STEEL DOORS | 667W-02STR09 |
| 10 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - DETAILS | 667W-02STR10 |
| 11 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - DETAILS | 667W-02STR11 |
| 12 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- FORMWORK - PUMPS CHAMBER SECTION AND ELEVATION AND PLAN VIEWS | 667W-02STR12 |
| | • STRUCTURAL | |
| 13 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - MAT REINFORCEMENT PLAN VIEWS | 667W-02STR13 |
| 14 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - GROUND TANK UPPER SLAB REINFORCEMENT | 667W-02STR14 |
| 15 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - ELEVATED WATER TOWER SECTION AND ELEVATION AND PLAN VIEWS | 667W-02STR15 |
| 16 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - ELEVATED WATER TOWER SECTION AND ELEVATION AND PLAN VIEWS | 667W-02STR16 |
| 17 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - CORE REINFORCEMENT SECTION AND ELEVATION AND PLAN VIEWS | 667W-02STR17 |
| 18 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - SECTION AND DETAILS REINFORCEMENT | 667W-02STR18 |
| 19 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - ROOF PLAN VIEW REINFORCEMENT | 667W-02STR19 |
| 20 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - BAR BENDING SCHEDULE | 667W-02STR20 |
| 21 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - BAR BENDING SCHEDULE | 667W-02STR21 |
| 22 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - REINFORCEMENT | 667W-02STR22 |
| 23 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - FENCE FORMWORK | 667W-02STR23 |
| 24 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - FENCE SECTIONS AND ELEVATION FORMWORK | 667W-02STR24 |
| 25 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - FENCE REINFORCEMENT | 667W-02STR25 |
| 26 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL- REINFORCEMENT - TYPICAL VALVE CHAMBER DETAILS | 667W-02STR26 |
| | • ELECTRO - MECHANICAL | |
| 27 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - PIPING LAYOUT (1 OF 4) | 667W-TR01 |
| 28 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - PIPING LAYOUT (2 OF 4) | 667W-TR02 |
| 29 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - PIPING LAYOUT (3 OF 4) | 667W-TR03 |
| 30 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - PIPING LAYOUT (4 OF 4) | 667W-TR04 |
| 31 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - HYDRAULIC SCHEMATIC | 667W-02M01 |
| 32 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - MECHANICAL LAYOUT | 667W-02M02 |
| 33 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - ELECTRICAL SCHEMATIC | 667W-02E01 |
| 34 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - CONTROL SCHEMATIC | 667W-02E02 |
| 35 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - LIGHTING SCHEMATIC FOR THE WATER TOWER CORE PLAN VIEW | 667W-02E03 |
| 36 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - LIGHTING SCHEMATIC FOR THE WATER TOWER CORE SIDE VIEW | 667W-02E04 |
| 37 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - LIGHTING SCHEMATIC FOR THE MECHANICAL ROOM | 667W-02E05 |
| 38 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - ELECTRICAL SCHEMATIC FOR THE MECHANICAL ROOM | 667W-02E06 |
| 39 | PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER - TLEIL - EARTHING AND LIGHTNING PROTECTION SYSTEM | 667W-02E07 |

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



ED BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
 JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
 P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

| | |
|--|------------------|
| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | LIST OF DRAWINGS |
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| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
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| 667W | E.L. | R.C. | Z.S. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | -- | 00 | 637W-L0D00 |

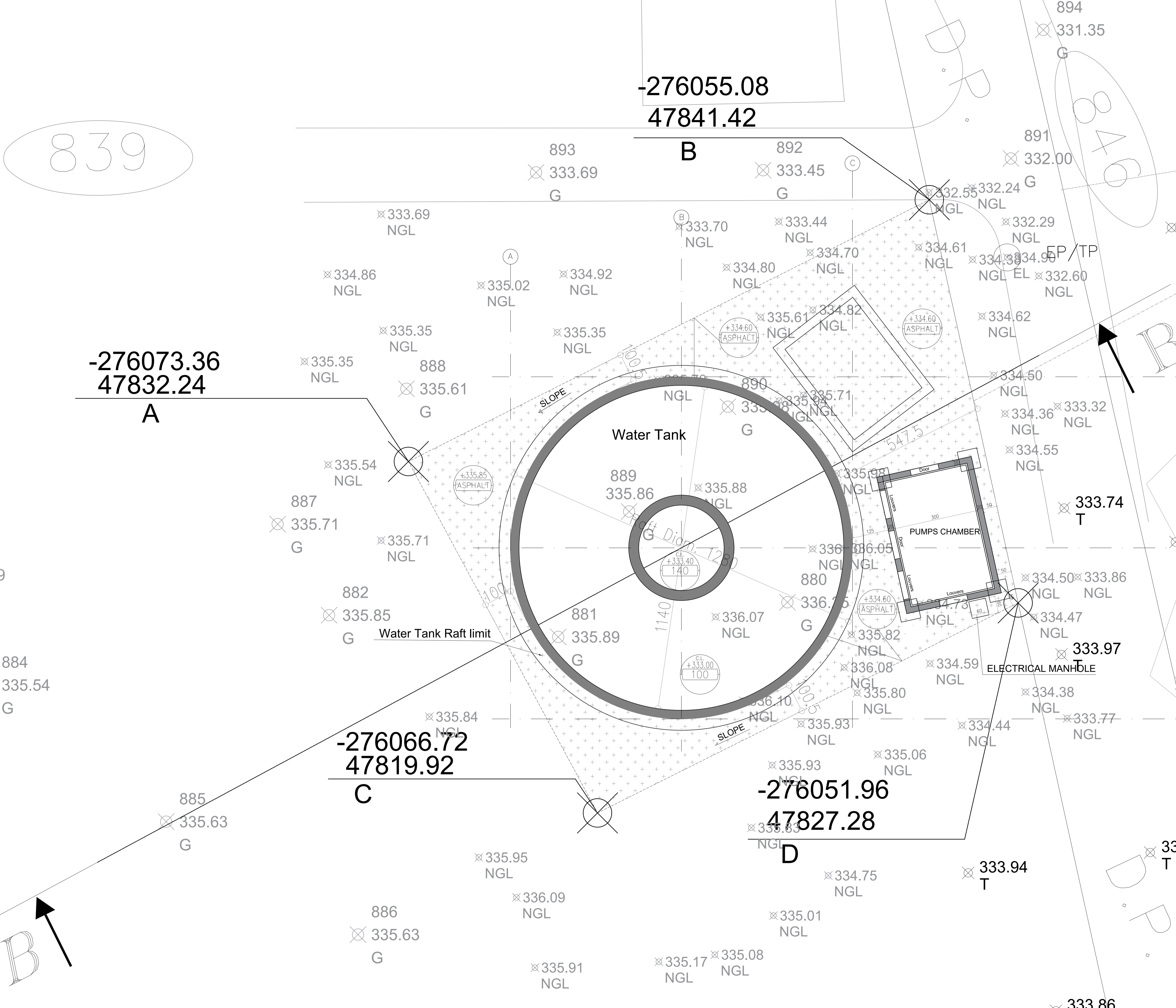
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NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, a= 150mm : 37N/mm²
- ON A CYLINDER ø=150mm, h=300mm : 30N/mm²

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: F_y=420 N/mm²
MILD STEEL BARS: SYMBOL ø YIELD STRESS: F_y=215 N/mm²
MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60ø
(ø = BAR NOMINAL DIAMETER)
PINS ø8 SHALL BE USED ON EACH LAP.

BENDING:
ø>12mm MECHANICAL
ø<12mm MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF ø6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEO/TECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
• SOIL BEARING CAPACITY = 5 bar (SLS).
• FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
• ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
• SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
• ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

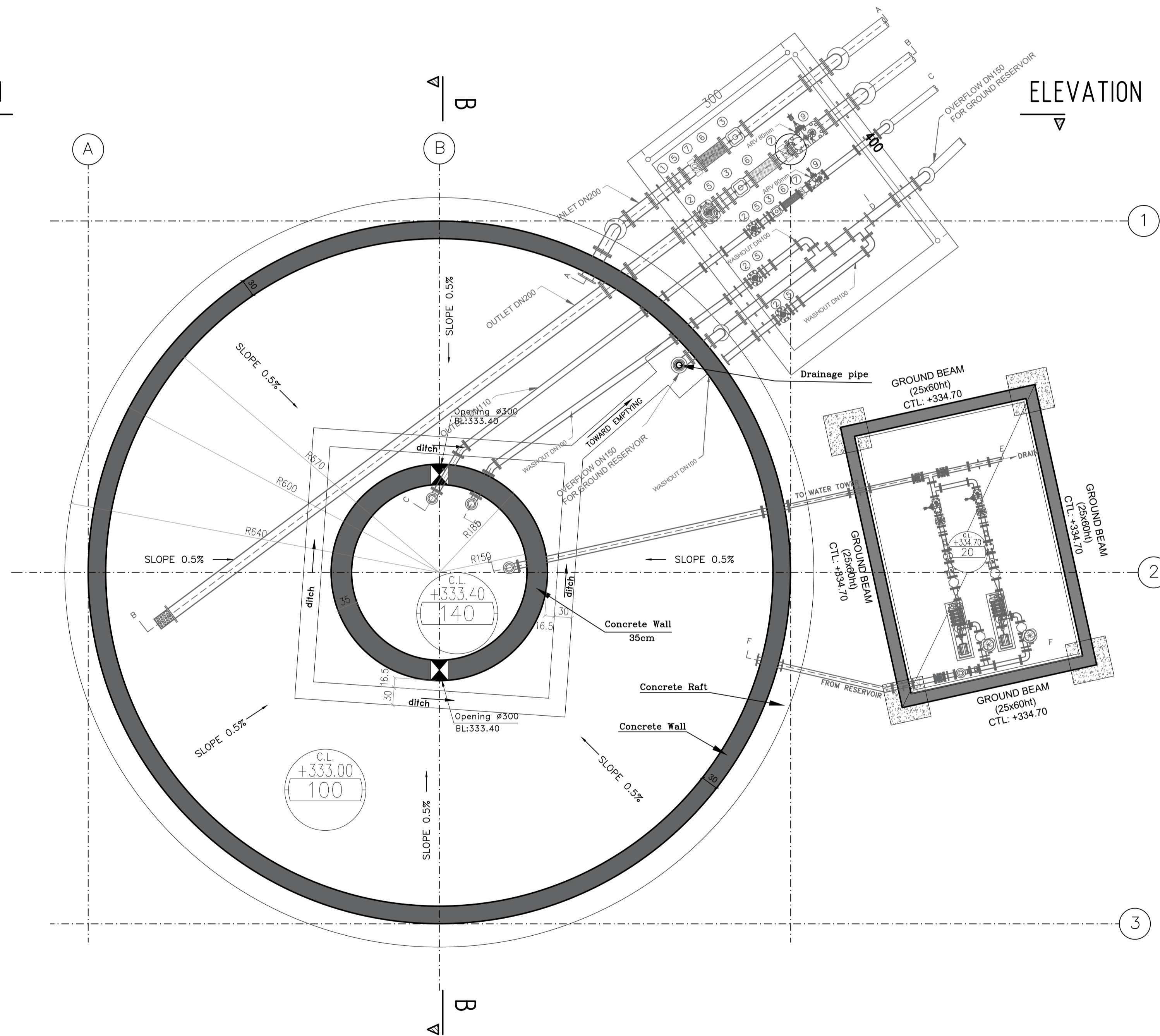
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK- GENERAL LAYOUT |
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| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | NOT SCALED | 01 | 667W-02STR01 |

ELEVATION

ELEVATION



RAFT FONDATION – PLAN VIEW
SCALE: 1/50

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m3 FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m3 FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, a= 150mm : 37N/mm2
 - ON A CYLINDER φ=150mm, h=300mm : 30N/mm2

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: $F_y=420$ N/mm².
- MILD STEEL BARS: SYMBOL φ YIELD STRESS: $F_y=215$ N/mm².
- MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
- WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$
- (φ = BAR NOMINAL DIAMETER)
- PINS #8 SHALL BE USED ON EACH LAP.

BENDING:

- φ>12mm MECHANICAL
- φ<12mm MANUAL (POSSIBLY)
- STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
- THE USE OF #6mm BARS AS TIE-RODS IS NOT ALLOWED.
- HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION (Performed by SAFWAN ABDUL KADER CHAHAL)

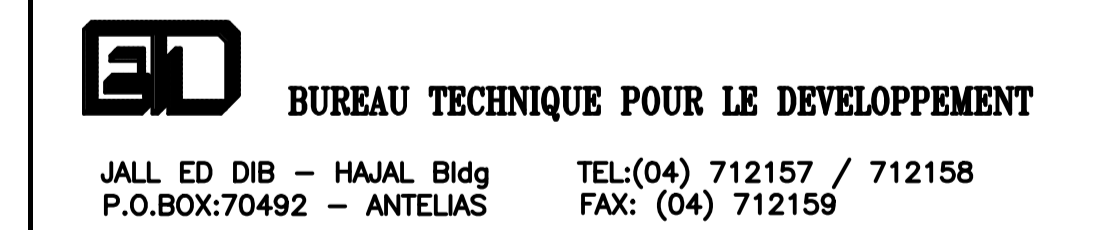
- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

- * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

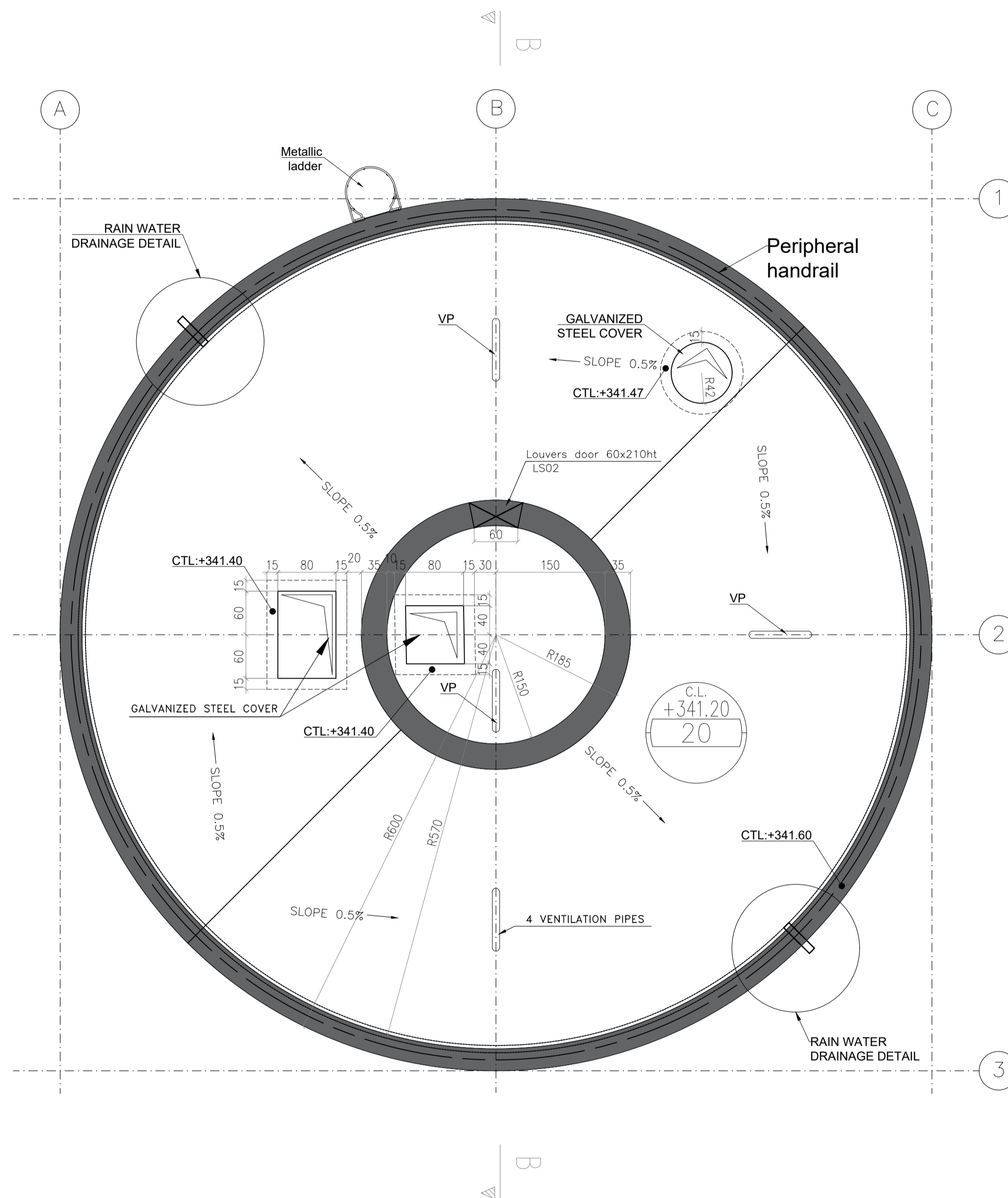
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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | FORMWORK-RAFT FONDATION PLAN VIEW |
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| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | 1/50 | 02 | 667W-02STR02 |

ELEVATION

ELEVATION



GROUND TANK UPPER SLAB – PLAN VIEW
SCALE: 1/50

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, $\sigma = 150\text{mm}$: 37N/mm²
 - ON A CYLINDER $\phi = 150\text{mm}$, $h = 300\text{mm}$: 30N/mm²

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: $F_y = 420 \text{ N/mm}^2$
- MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y = 215 \text{ N/mm}^2$
- MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$ (ϕ = BAR NOMINAL DIAMETER)
- PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:

- $\phi > 12\text{mm}$ MECHANICAL
- $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
- STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
- HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- SOIL BEARING CAPACITY = 5 bar (SLS).
- FOUNDATION AT 1.50m BENEATH EGL.

REMARKS:

- ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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REPUBLIC OF LEBANON

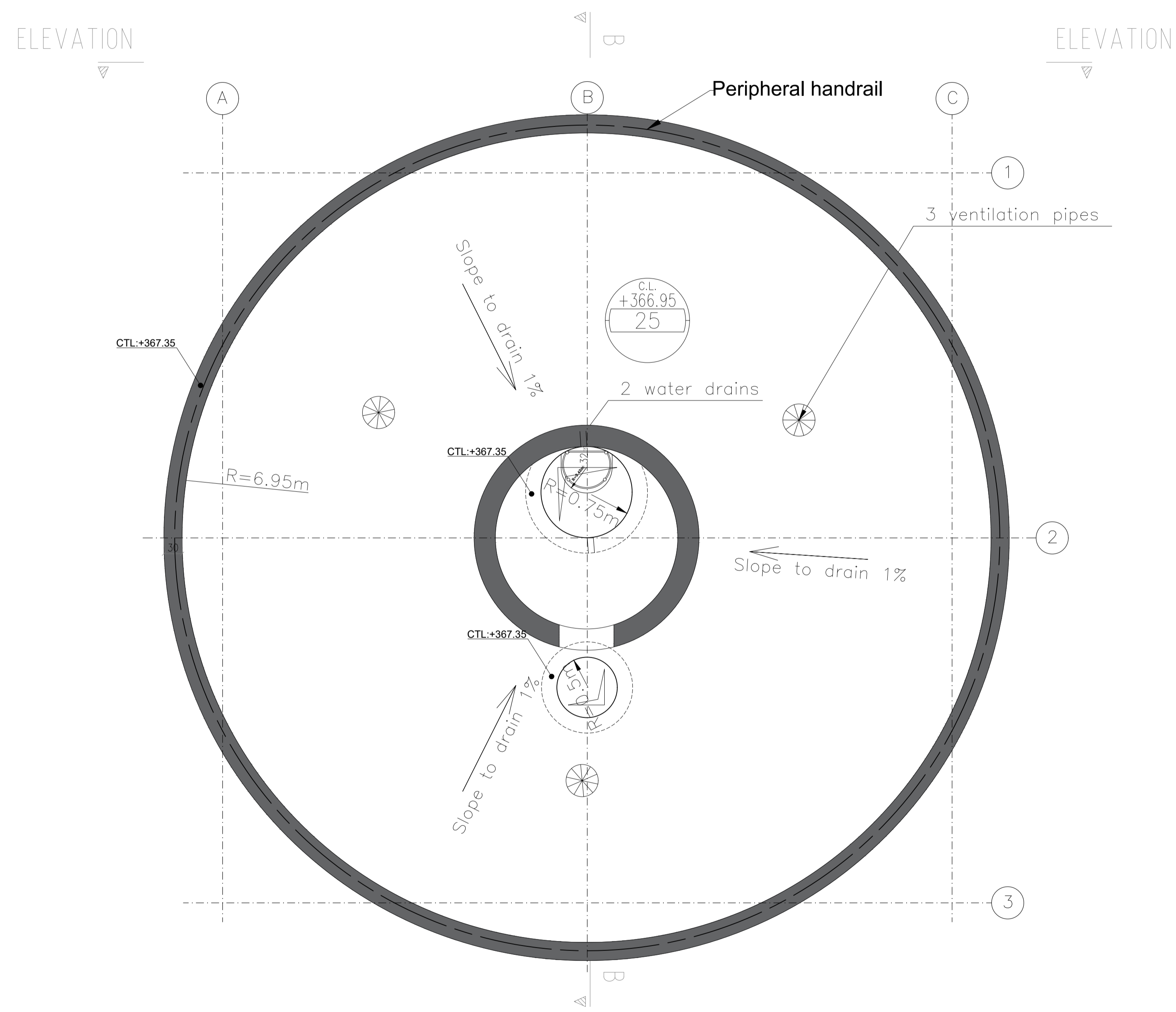


PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK- GROUND TANK UPPER SLAB PLAN VIEW |
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| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | 1/50 | 03 | 667W-02STR03 |



ELEVATOR TANK - ROOF PLAN VIEW
SCALE: 1/50

NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, $\phi=150\text{mm}$: 37N/mm²
- ON A CYLINDER $\phi=150\text{mm}$, h=300mm : 30N/mm²

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: $F_y=420\text{ N/mm}^2$
MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y=215\text{ N/mm}^2$
MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$
(ϕ = BAR NOMINAL DIAMETER)
PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:
 $\phi > 12\text{mm}$ MECHANICAL
 $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1.50m BENEATH EGL.

REMARKS:
* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
* SCALING FROM THESE DRAWINGS IS NOT ALLOWED
* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drawn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



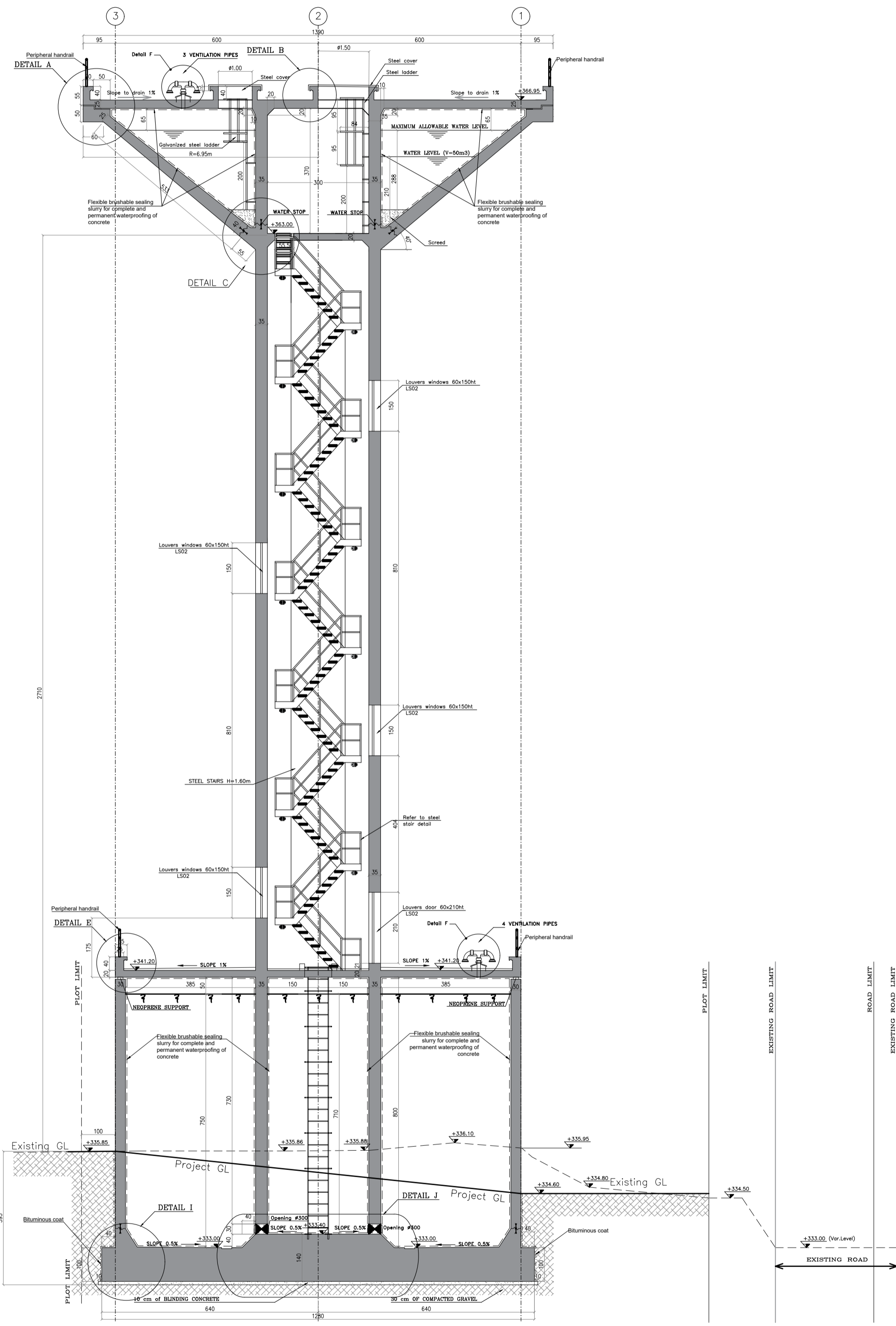
BD BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

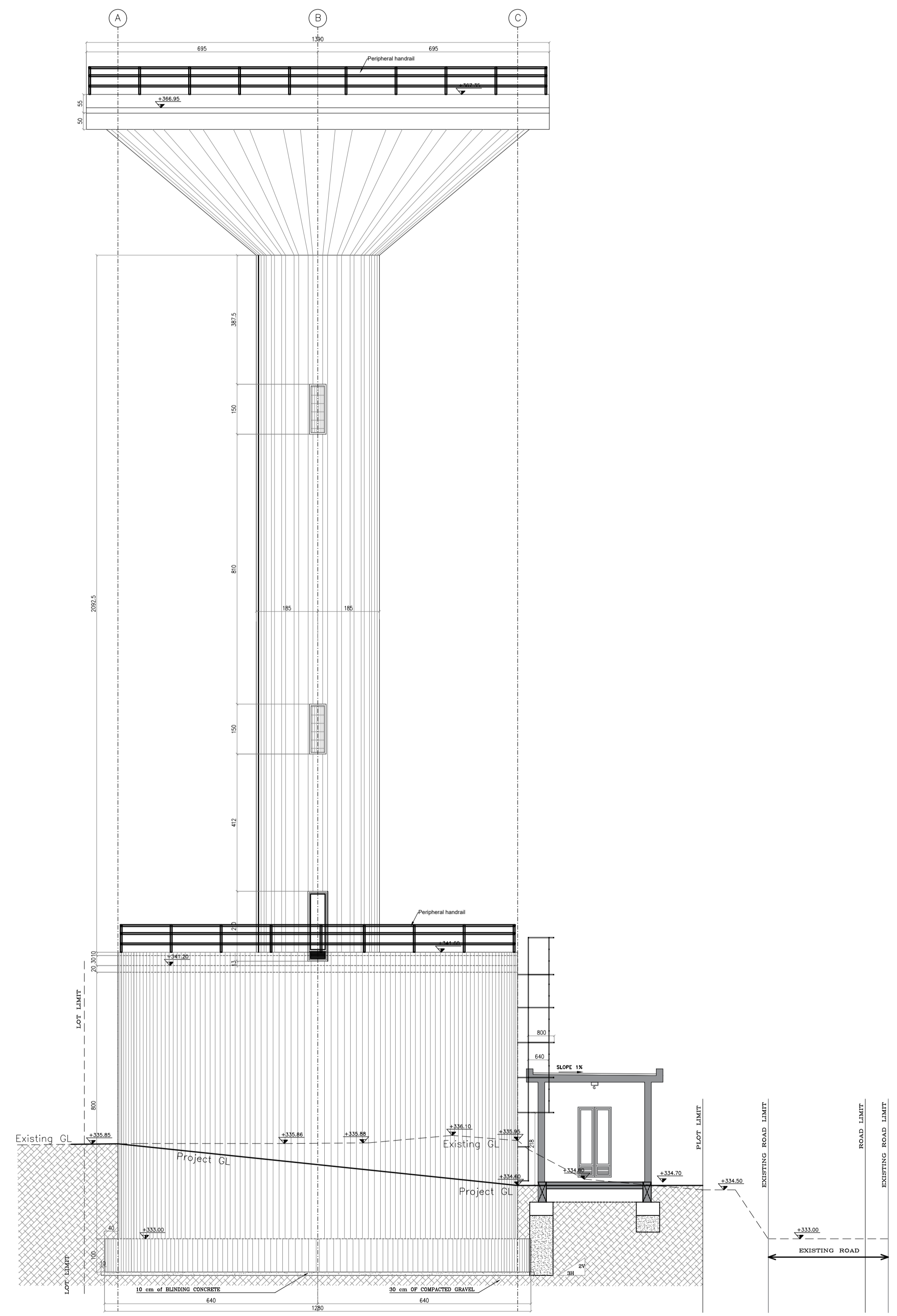
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK- ROOF PLAN VIEW |
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| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | 1/50 | 04 | 667W-02STR04 |



SECTION B-B
SCALE: 1/100



WATER TOWER ELEVATION
SCALE: 1/100

NOTES

- REINFORCED CONCRETE:
- NORMAL PORTLAND CEMENT
- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
 Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
 Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.
- SULFATE RESISTING CEMENT.
- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.
- STRESSES:
- SEVERE CONTROL.
- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, $\phi = 150\text{mm}$: 37N/mm²
 - ON A CYLINDER $\phi=150\text{mm}$, $h=300\text{mm}$: 30N/mm²
- CONCRETE COVER:
- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
- 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.
- REINFORCEMENT:
- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
 YIELD STRESS: $F_y=420$ N/mm².
- MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y=215$ N/mm².
 MAXIMUM POURING HEIGHT : 1500mm
- OVERLAPPING:
- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 6\phi$
 (ϕ = BAR NOMINAL DIAMETER)
 PINS $\phi 8$ SHALL BE USED ON EACH LAP.
- BENDING:
- $\phi > 12\text{mm}$ MECHANICAL
 - $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
 - STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.
- FORMWORK:
- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED. HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS. ALL CORNERS SHALL BE CHAMFERED. ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.
- WATERPROOFING:
- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL.
- GEOTECHNICAL INVESTIGATION (Performed by SAFWAN ABDUL KADER CHAHAL)
- SOIL BEARING CAPACITY = 5 bar (SLS).
 - FOUNDATION AT 1.50m BENEATH EGL.
- REMARKS:
- ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
 - SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
 - ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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REPUBLIC OF LEBANON



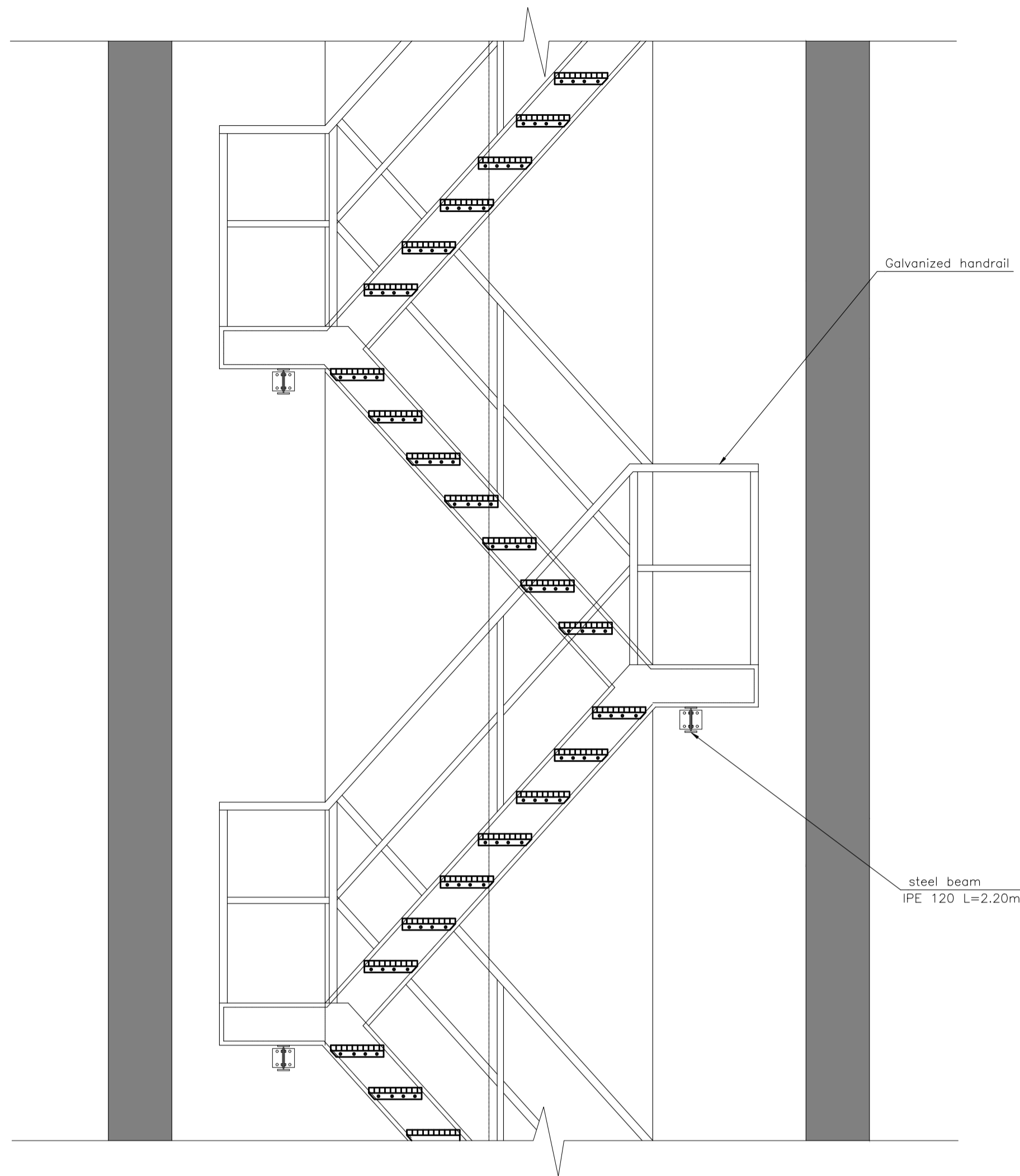
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 P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHM WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

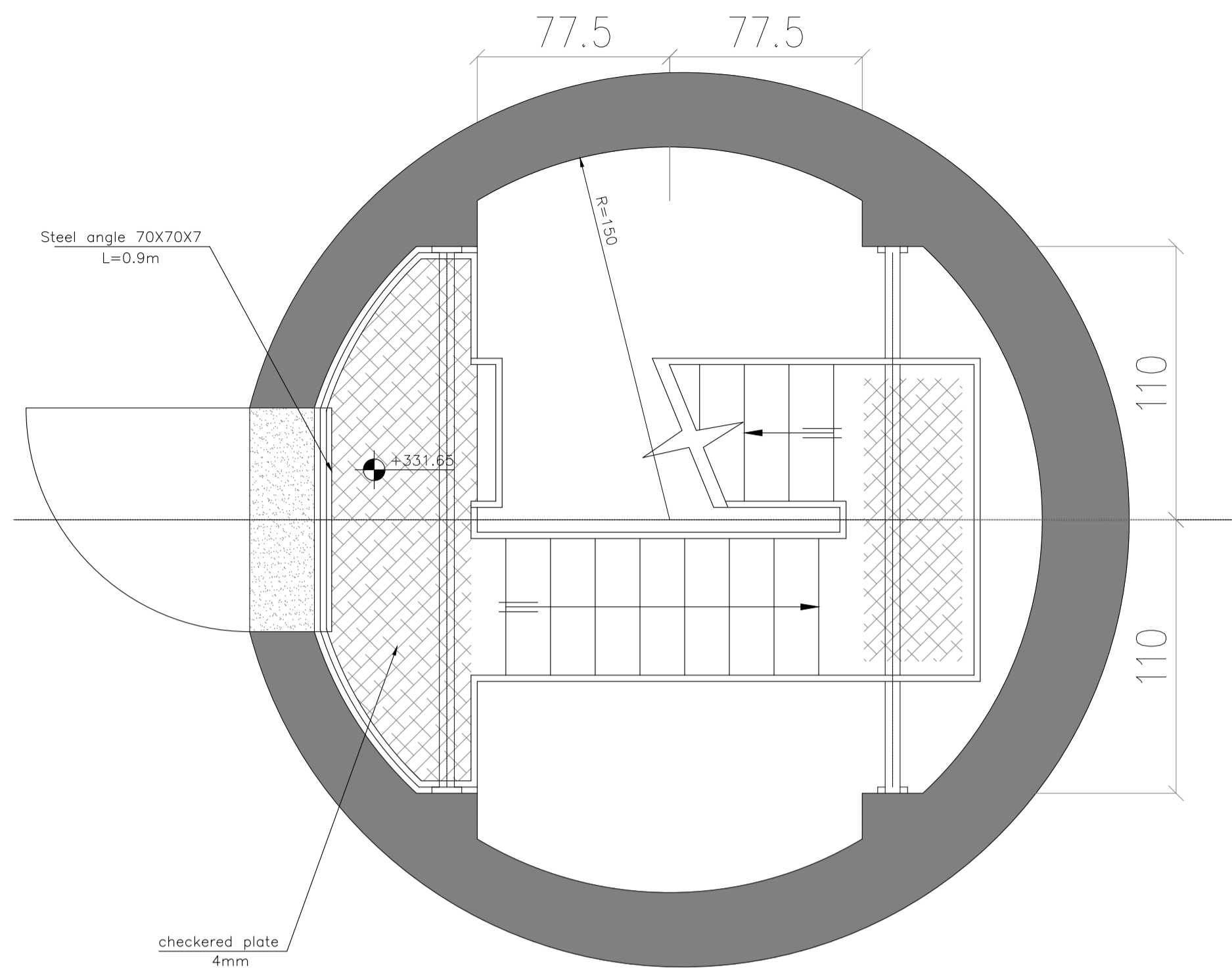
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK - ELEVATED WATER TOWER AND SECTION |
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| 667W | J.Y. | R.S. | T.G. |

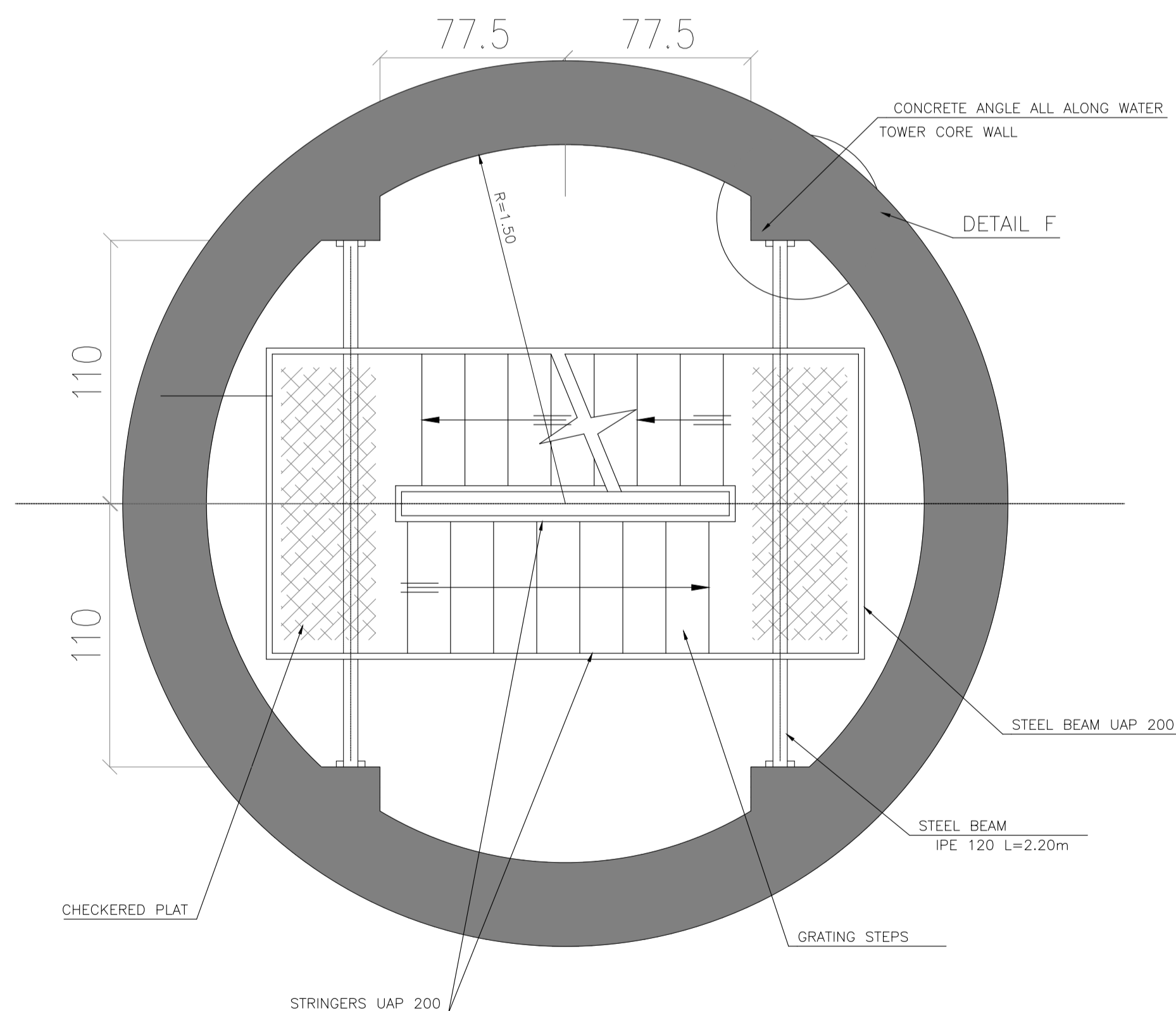
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| MARCH 2023 | 1/100 | 05 | 667W-02STR05 |



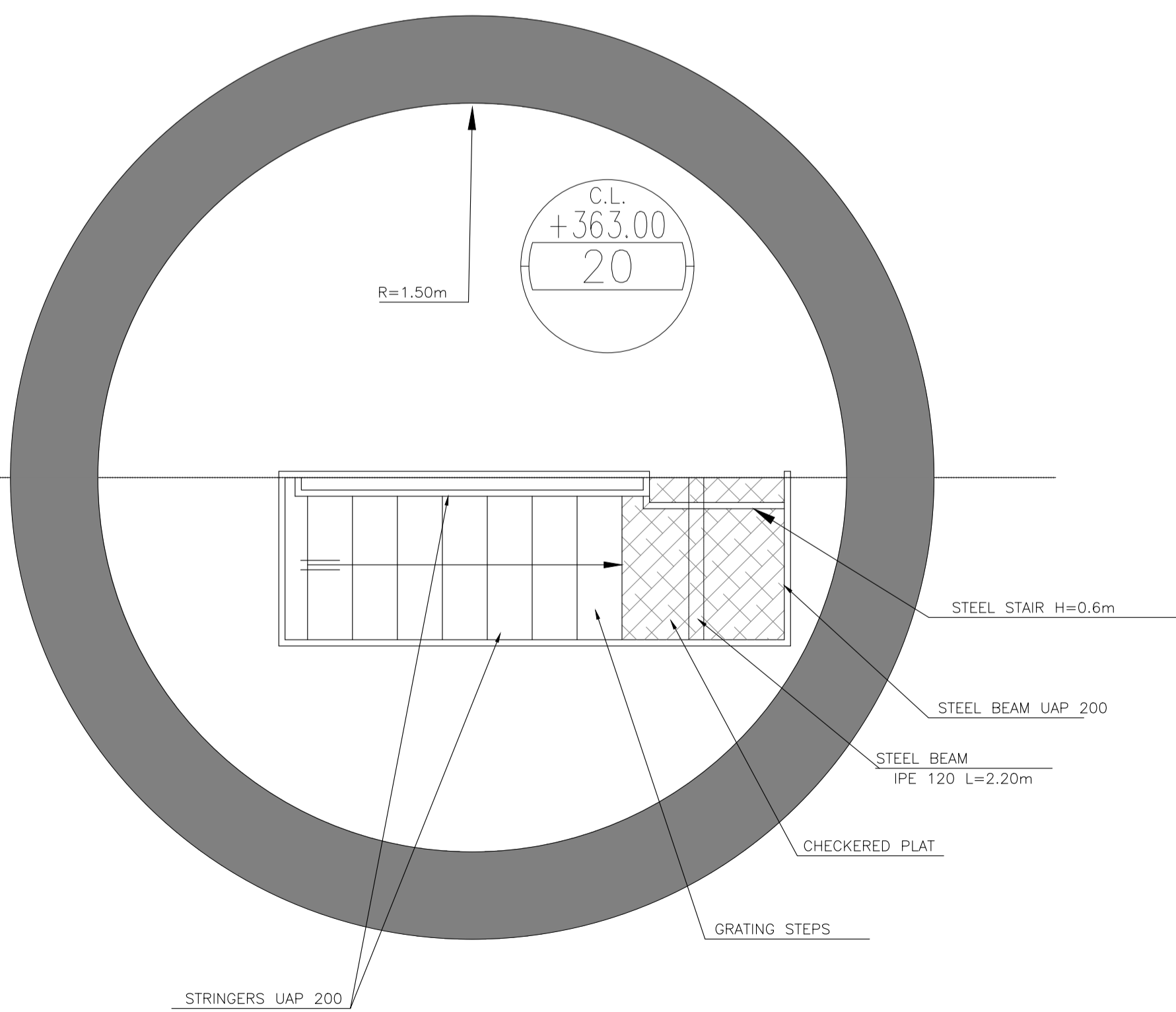
TYPICAL SECTION ON INTERNAL STEEL STAIR
SCALE: 1/20



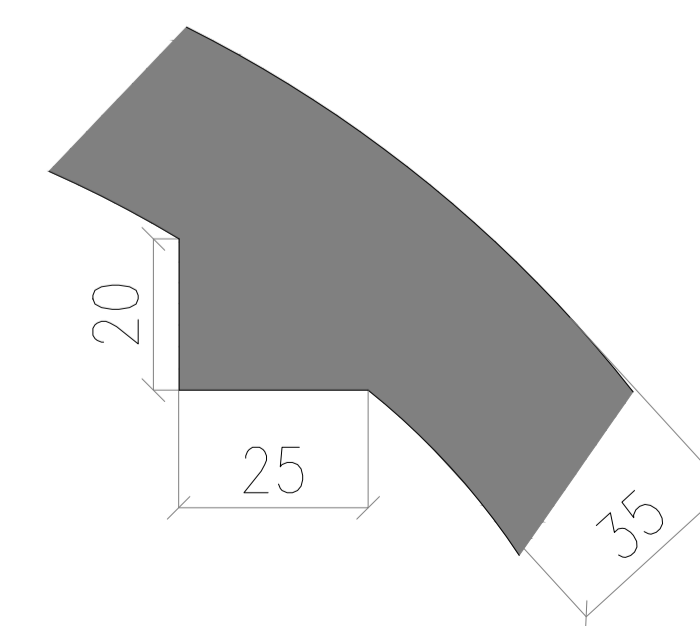
TYPICAL SECTION ON CENTRAL STEEL STAIR
SCALE: 1/20



TYPICAL SECTION ON INTERNAL STEEL STAIR
SCALE: 1/20



LOWER SLAB OF WATER TANK PLAN VIEW
SCALE: 1/20



DETAIL F
SCALE: 1/20

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, a= 150mm :37N/mm²
 - ON A CYLINDER φ=150mm, h=300mm :30N/mm²

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T

YIELD STRESS: F_y=420 N/mm²

MILD STEEL BARS: SYMBOL φ YIELD STRESS: F_y=215 N/mm²

MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ (φ = BAR NOMINAL DIAMETER)
- PINS φ8 SHALL BE USED ON EACH LAP.

BENDING:

φ>12mm MECHANICAL

φ<12mm MANUAL (POSSIBLY)

STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.
- Holes made by tie-rods shall be filled with a non shrink grout by means of special injection methods.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- SOIL BEARING CAPACITY = 5 bar (SLS).
- FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

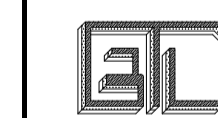
- ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

FORMWORK - TYPICAL SECTION ON INTERNAL STEEL STAIR

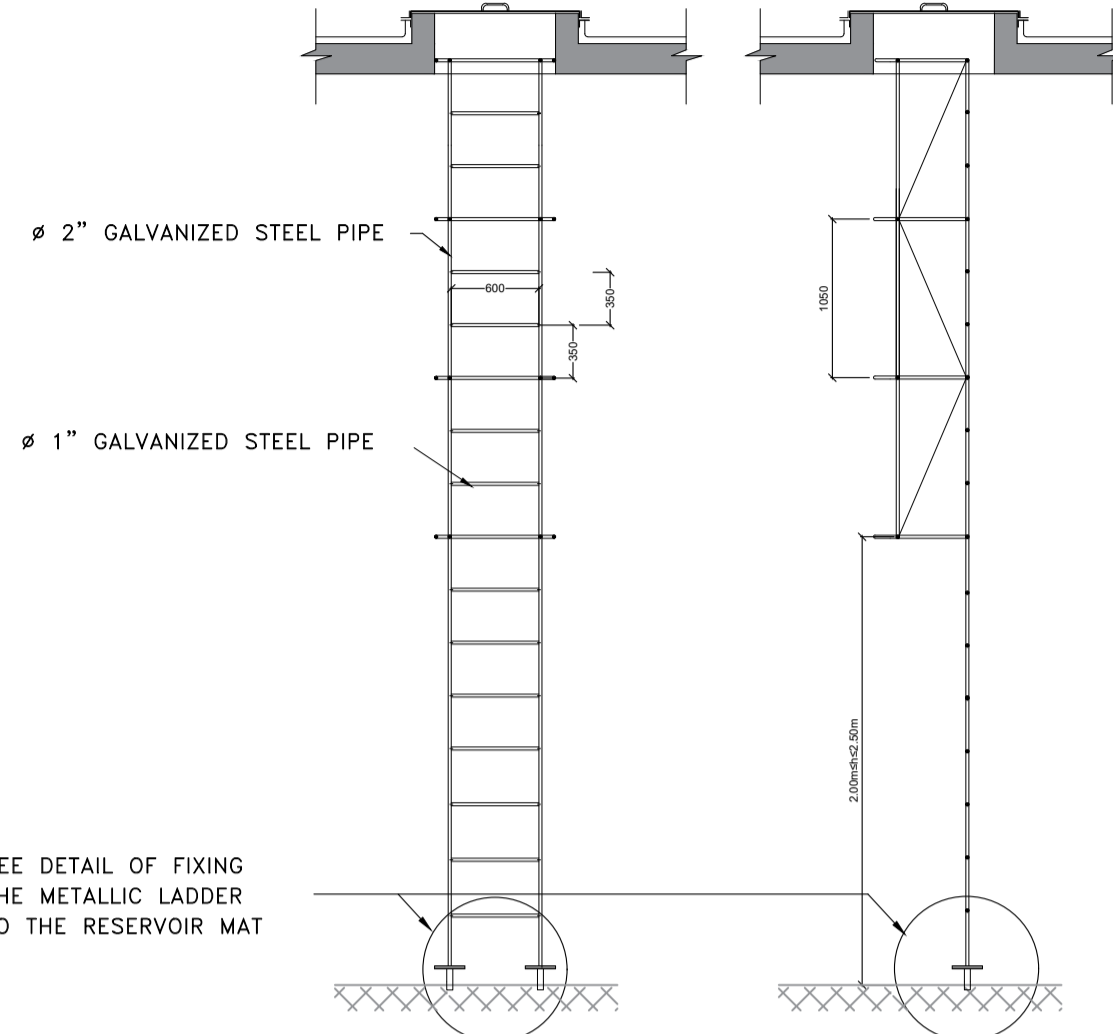
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| MARCH 2023 | 1/20 | 06 | 667W-02STR06 |

INTERNAL METALLIC LADDER DETAIL

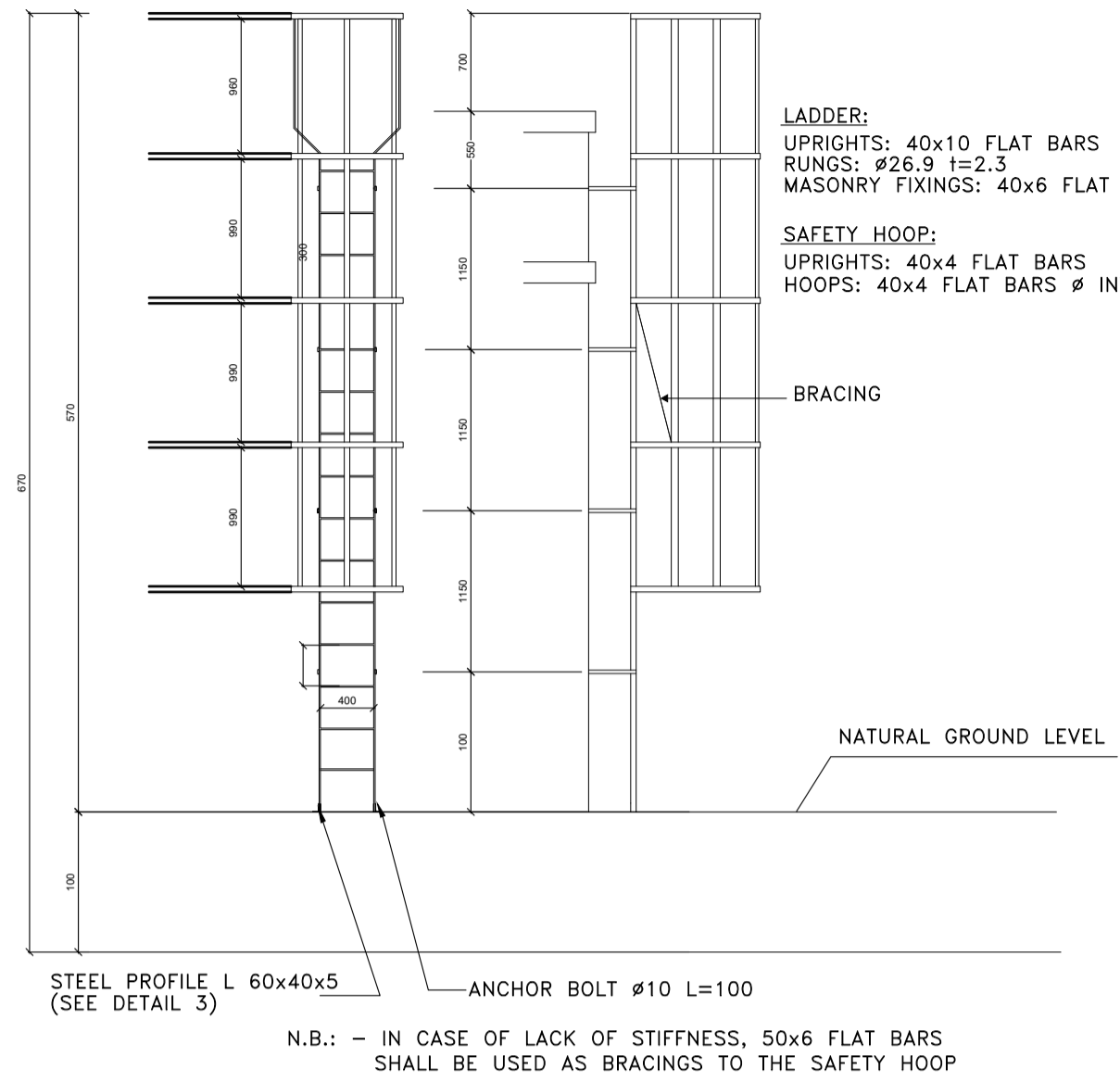
FRONT VIEW
Scale 1:50

SIDE VIEW
Scale 1:50

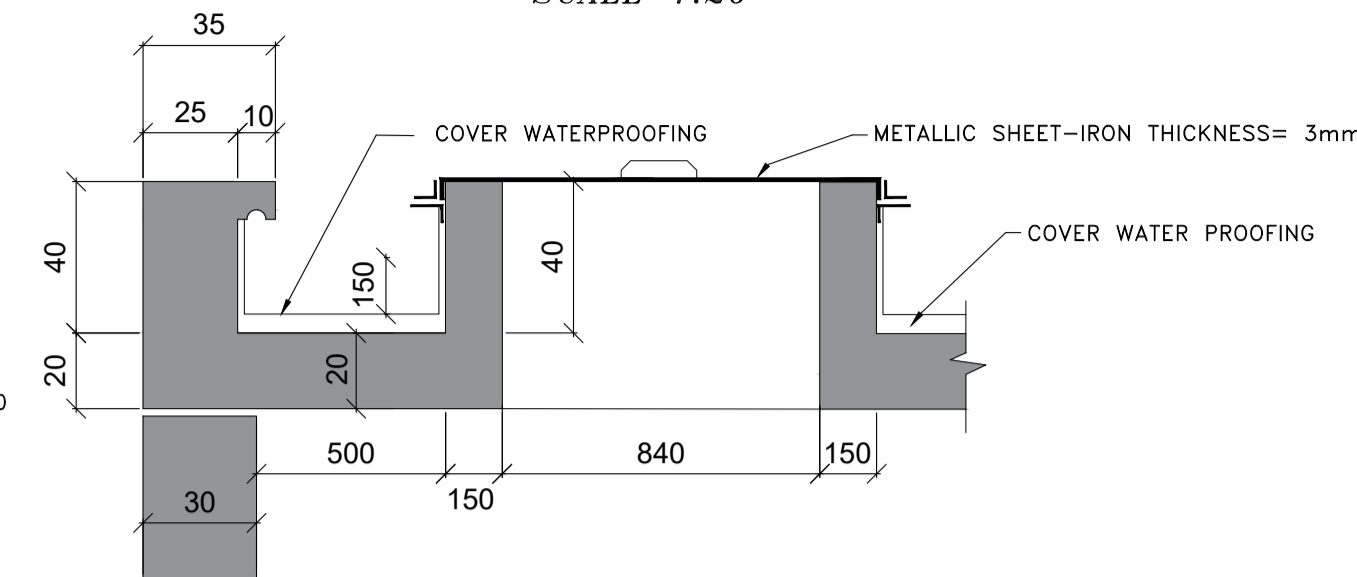


EXTERNAL METALLIC LADDER DETAIL

Scale 1:50

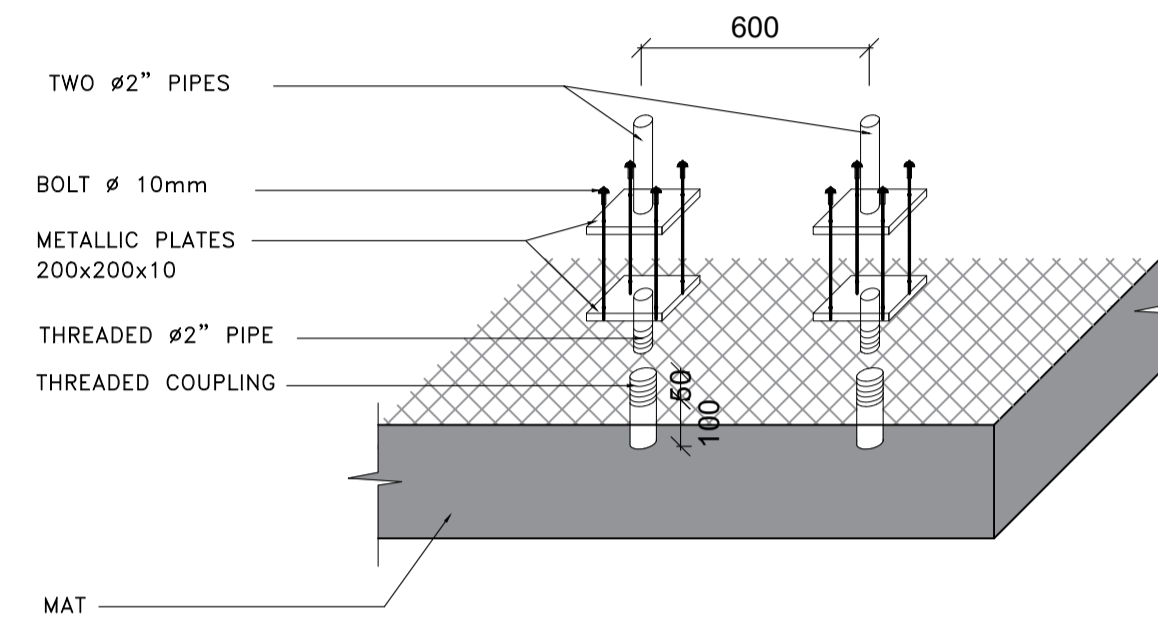


PARAPET-SLAB-TRAP DOOR SECTION
SCALE 1:20



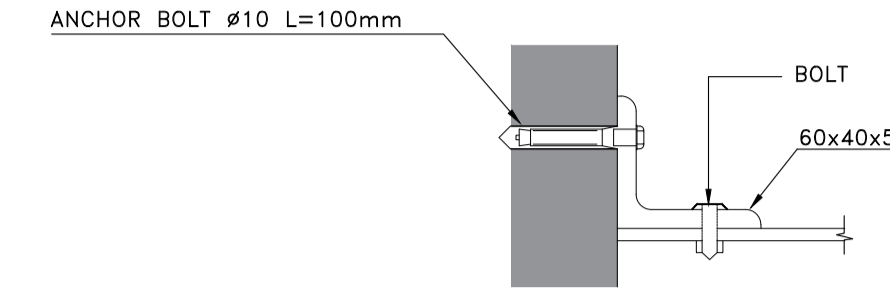
FIXING OF INTERNAL METALLIC LADDER DETAIL

Scale 1:20



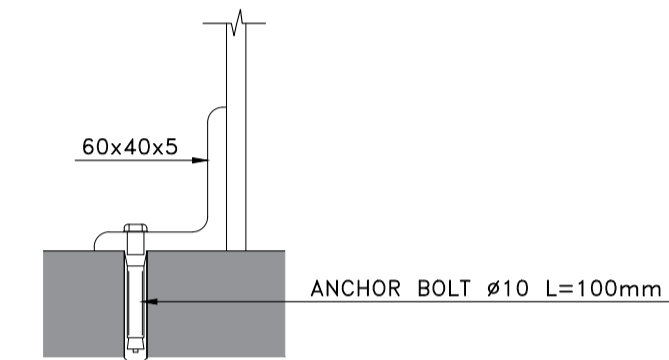
DETAIL 4: FIXING OF EXTERNAL LADDER TO RESERVOIR WALLS

Scale 1:5



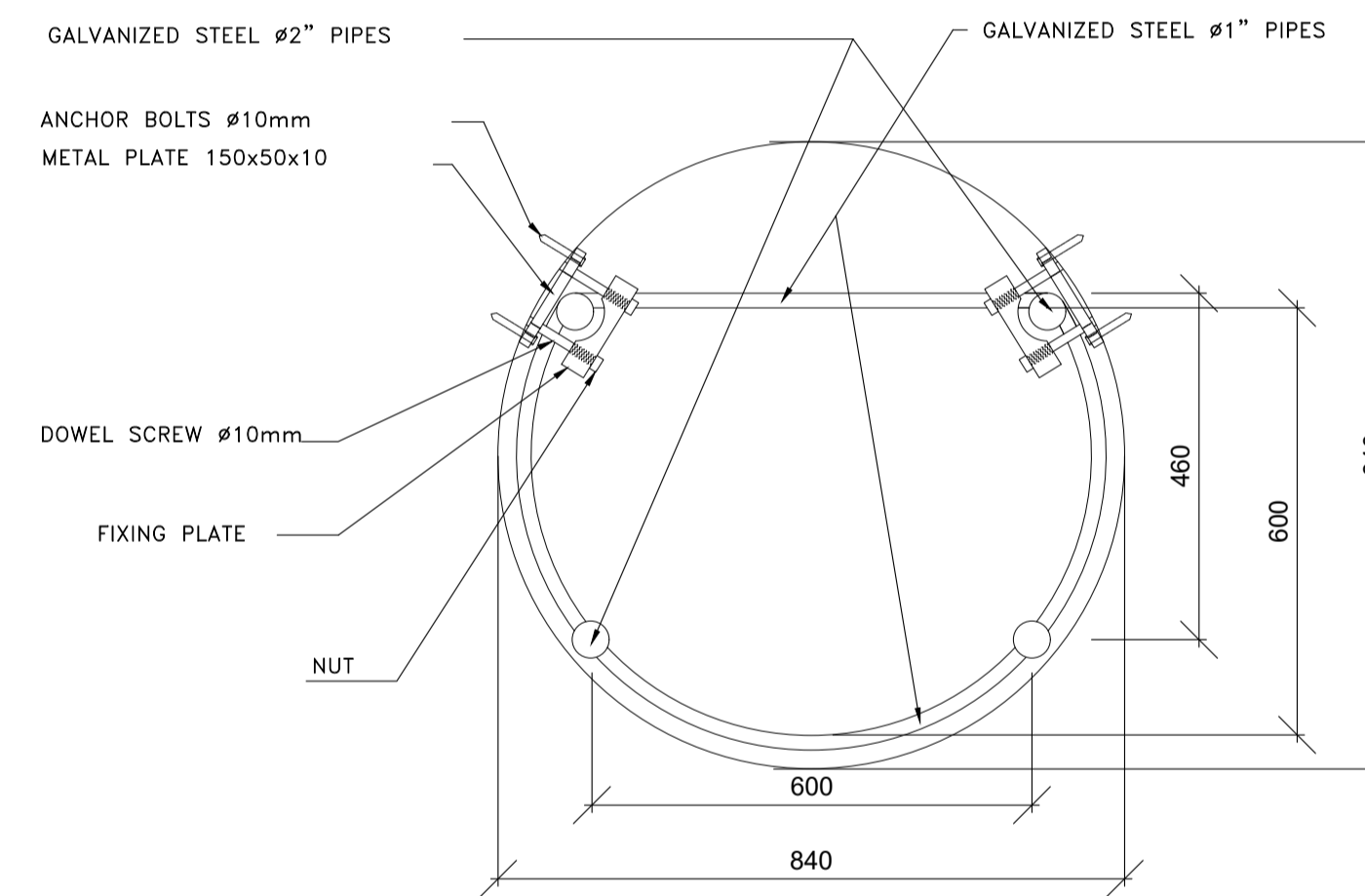
DETAIL 3: FIXING OF EXTERNAL LADDER TO CONCRETE

Scale 1:5



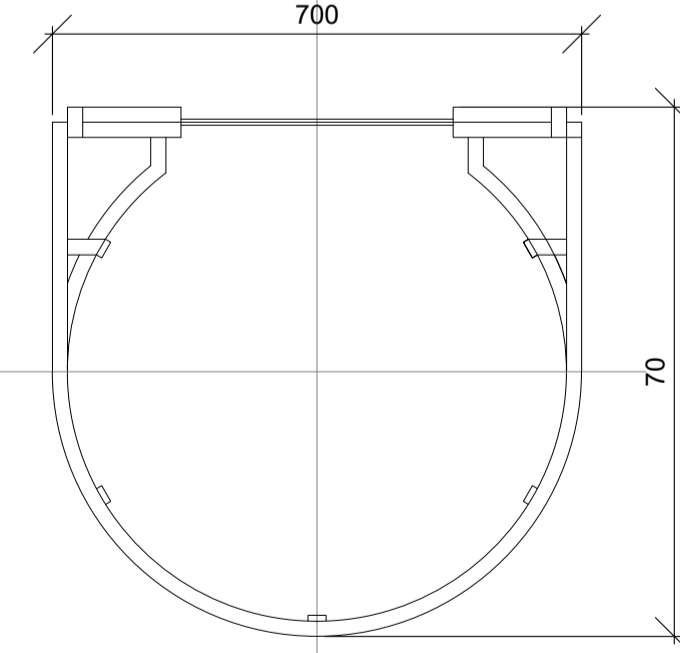
DETAIL OF INTERNAL LADDER AND UPPER FIXING
PLAN VIEW

Scale 1:10



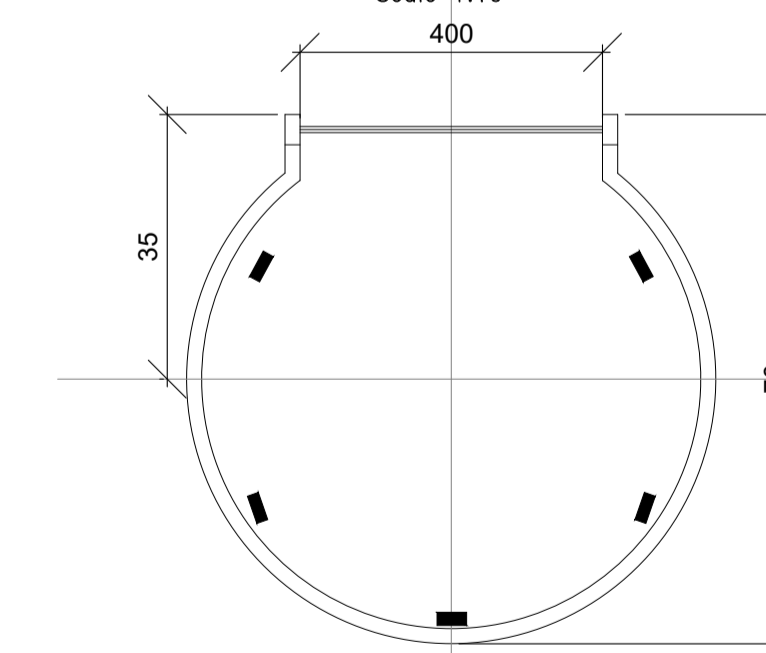
VIEW 1-1

Scale 1:10



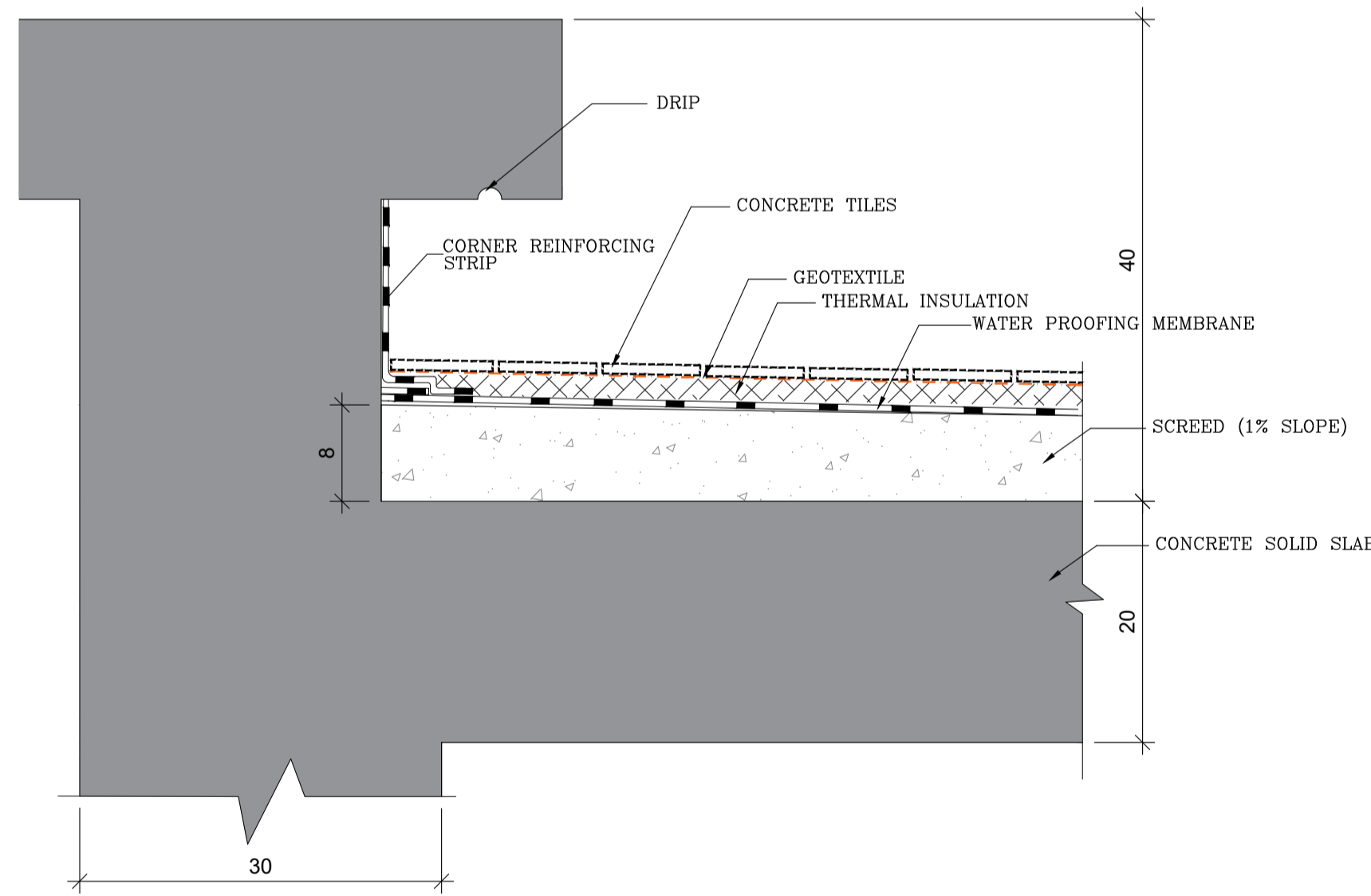
VIEW 2-2

Scale 1:10

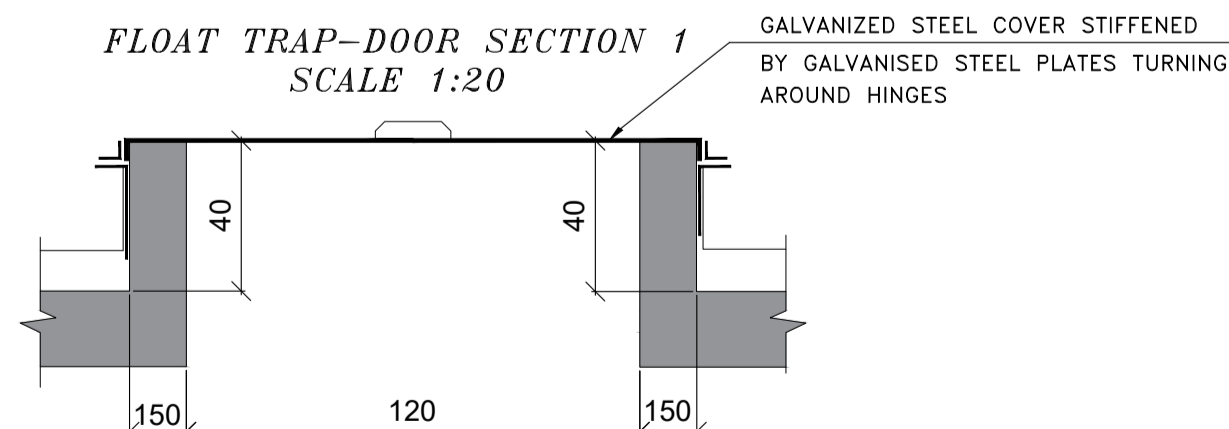


WATERPROOFING DETAIL

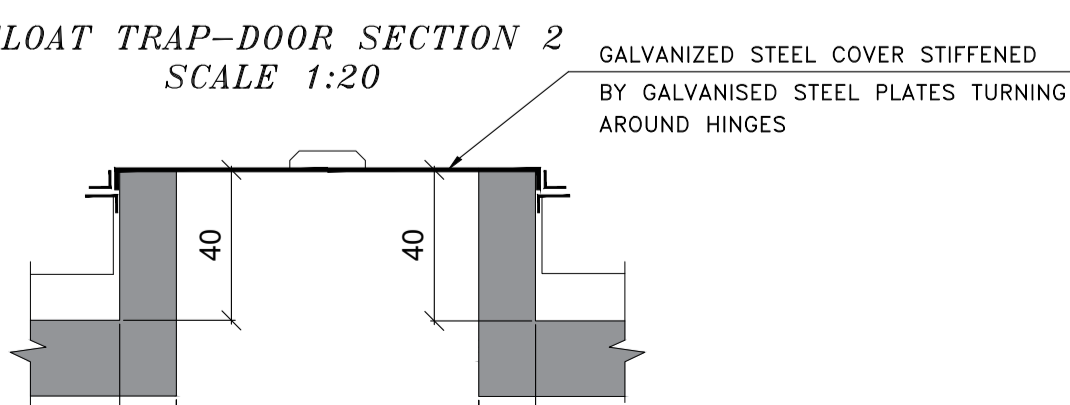
SCALE 1:5



FLOAT TRAP-DOOR SECTION 1
SCALE 1:20



FLOAT TRAP-DOOR SECTION 2
SCALE 1:20



NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m3 FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m3 FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, a= 150mm :37N/mm2
- ON A CYLINDER ø=150mm, h=300mm :30N/mm2

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: Fy=420 N/mm2.
MILD STEEL BARS: SYMBOL Ø YIELD STRESS: Fy=215 N/mm2.
MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60ø
(ø = BAR NOMINAL DIAMETER)
PINS ø8 SHALL BE USED ON EACH LAP.

BENDING:
ø>12mm MECHANICAL
ø<12mm MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF ø6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.
WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
* SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
|--|---|
| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | FORMWORK - SECTION AND ELEVATION AND PLAN VIEWS |
|--|---|

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|------------|-------|-----------|--------------|
| MARCH 2023 | -- | 08 | 667W-02STR08 |

| STEEL DOORS | | STEEL LOUVERS | |
|-------------|---------------|---------------|-------------|
| DS02 | ENTRANCE DOOR | LS02 | WATER TOWER |
| WATER TOWER | 1 | WATER TOWER | 4 |
| | | | |
| TOTAL | 1 | TOTAL | 4 |

| STEEL LOUVERS | |
|---------------|---------------|
| LS01 | PUMPS CHAMBER |
| PUMPS CHAMBER | 3 |
| | |
| TOTAL | 3 |

| STEEL DOORS | |
|---------------|---------------|
| DS01 | PUMPS CHAMBER |
| PUMPS CHAMBER | 1 |
| | |
| TOTAL | 2 |

| STEEL DOORS | |
|---------------|---------------|
| DS01 | PUMPS CHAMBER |
| PUMPS CHAMBER | 1 |
| | |
| TOTAL | 2 |

NOTES

REINFORCED CONCRETE:
 NORMAL PORTLAND CEMENT
 Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
 Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
 Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
 Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
 SEVERE CONTROL.
 CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, a= 150mm :37N/mm²
 - ON A CYLINDER φ=150mm, h=300mm :30N/mm²

CONCRETE COVER:
 THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
 DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
 YIELD STRESS: Fy=420 N/mm².
 MILD STEEL BARS: SYMBOL Ø YIELD STRESS: Fy=215 N/mm².
 MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:
 LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ
 (φ = BAR NOMINAL DIAMETER)
 PINS Ø8 SHALL BE USED ON EACH LAP.

BENDING:
 φ>12mm MECHANICAL
 φ<12mm MANUAL (POSSIBLY)
 STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
 ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED. HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
 ALL CORNERS SHALL BE CHAMFERED.
 ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

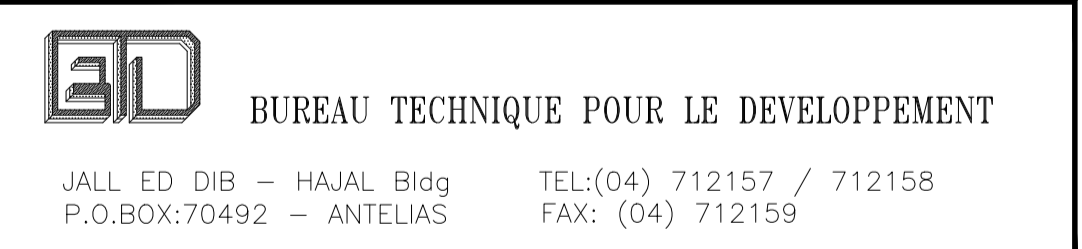
WATERPROOFING:
 BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
 * SOIL BEARING CAPACITY = 5 bar (SLS).
 * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
 * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
 * SCALING FROM THESE DRAWINGS IS NOT ALLOWED
 * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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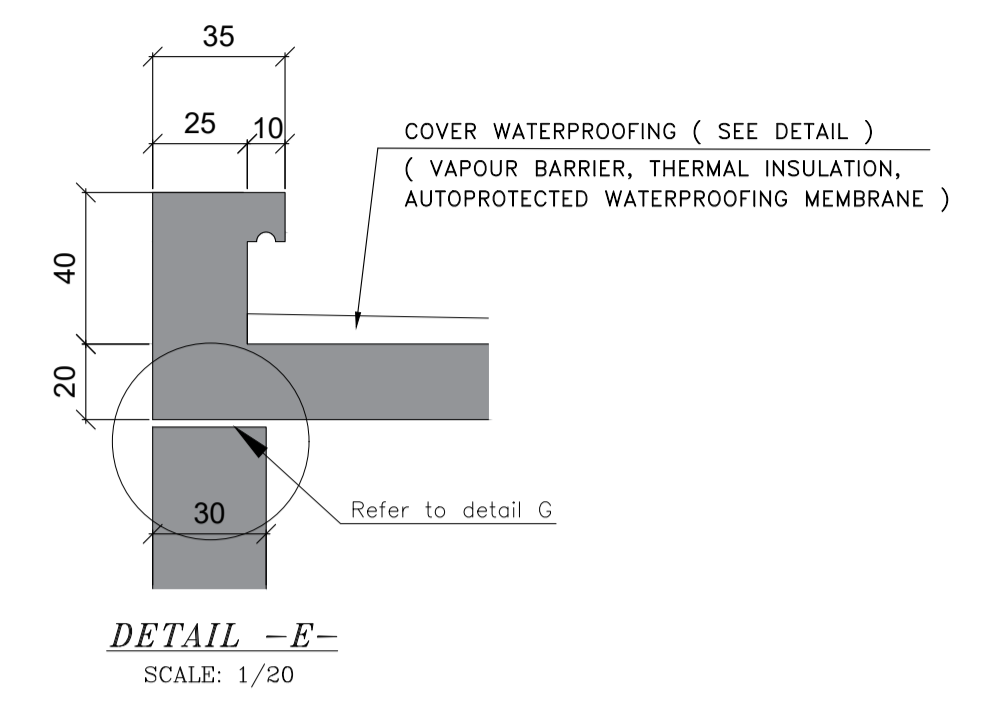
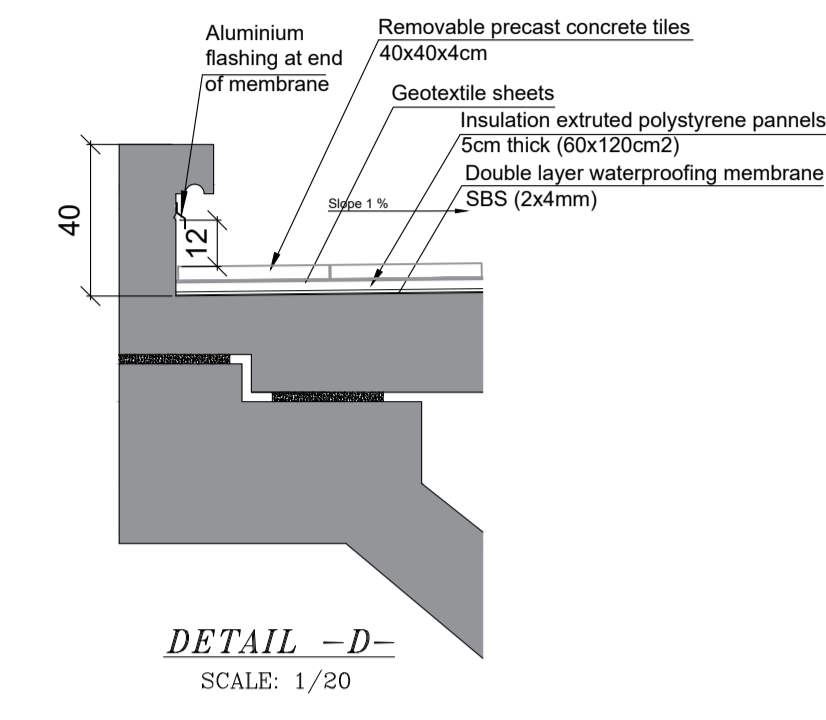
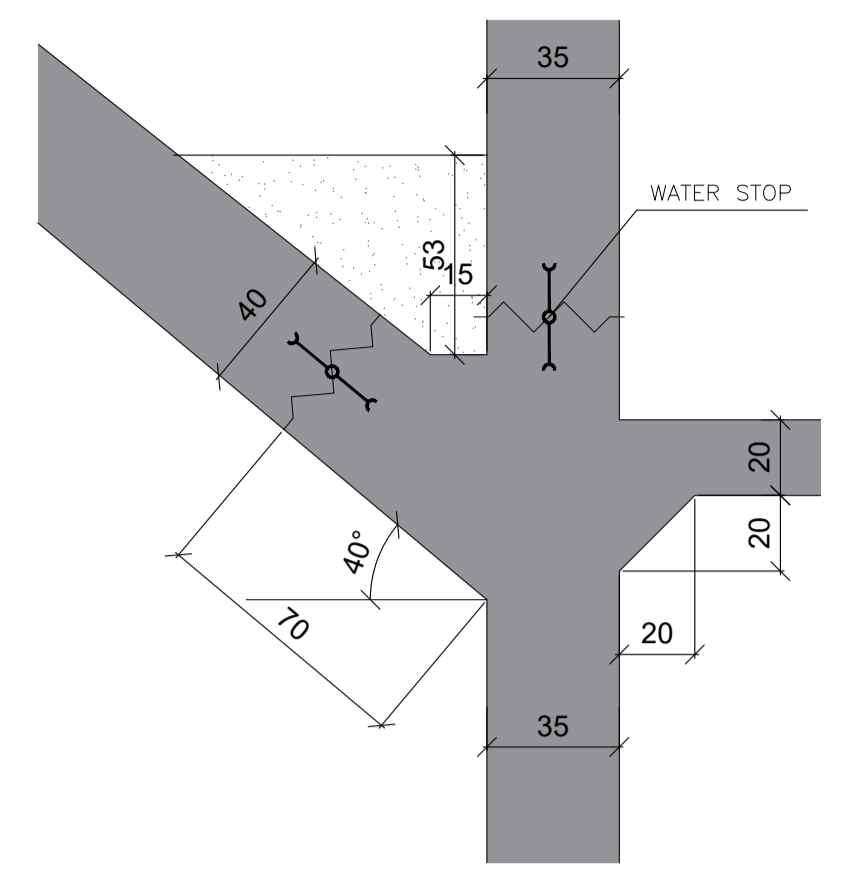
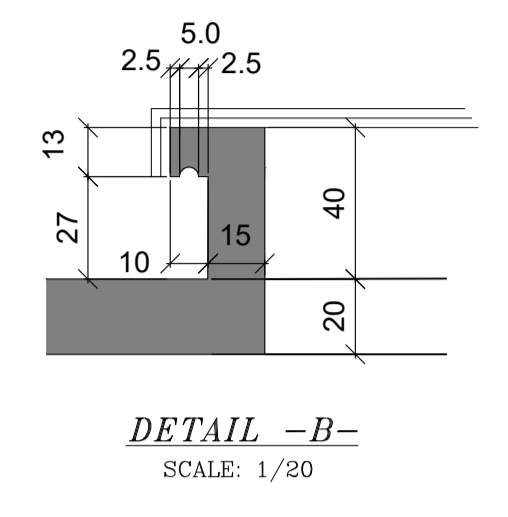
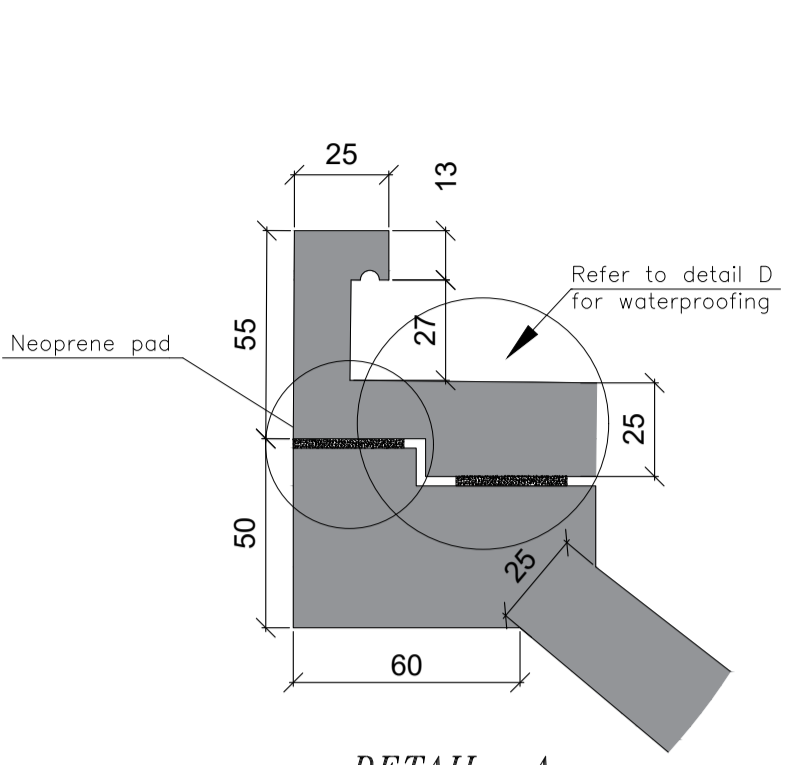


PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

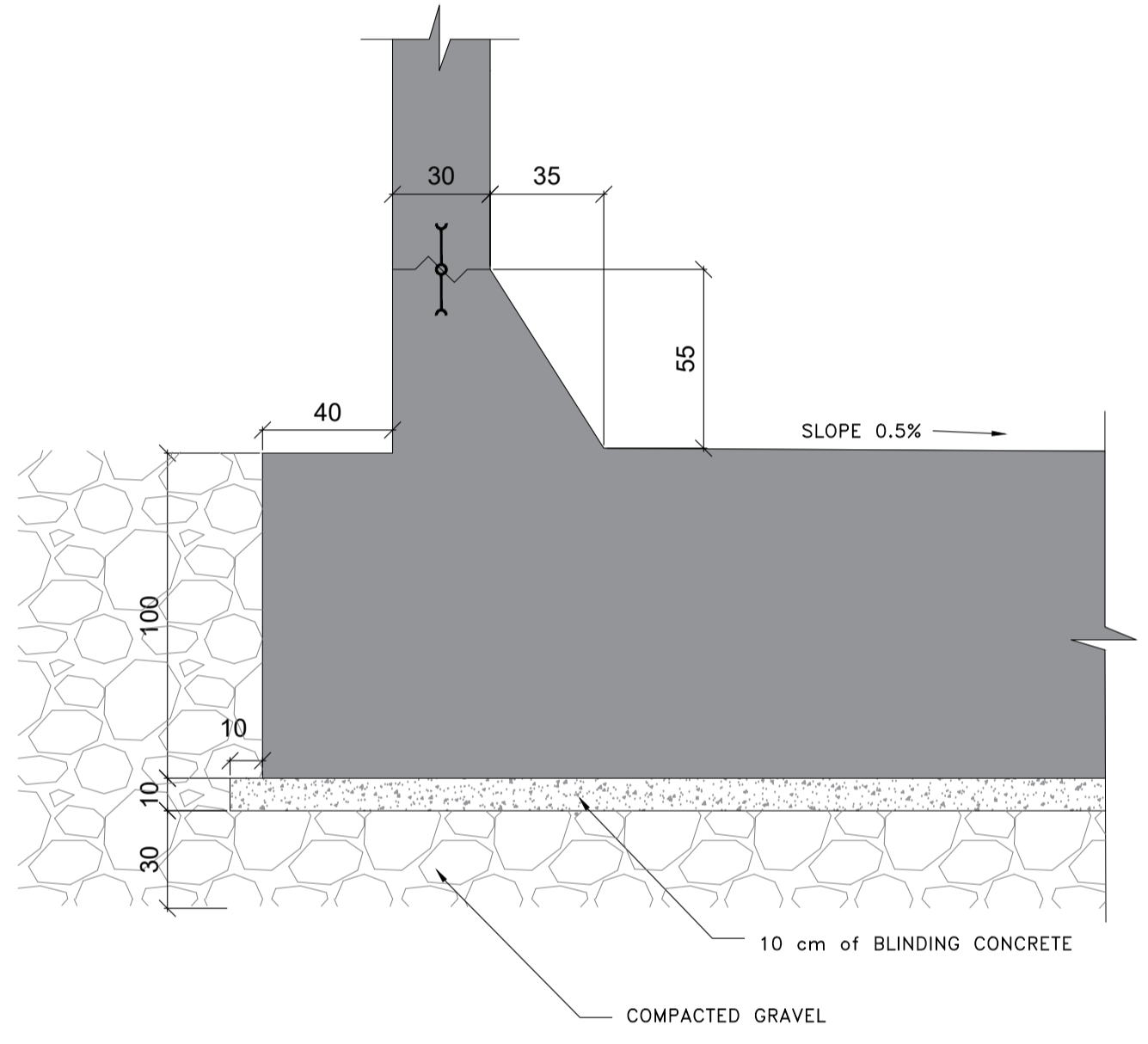
| | |
|--|--------------------------------------|
| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK – STEEL LOUVERS STEEL DOORS |
|--|--------------------------------------|

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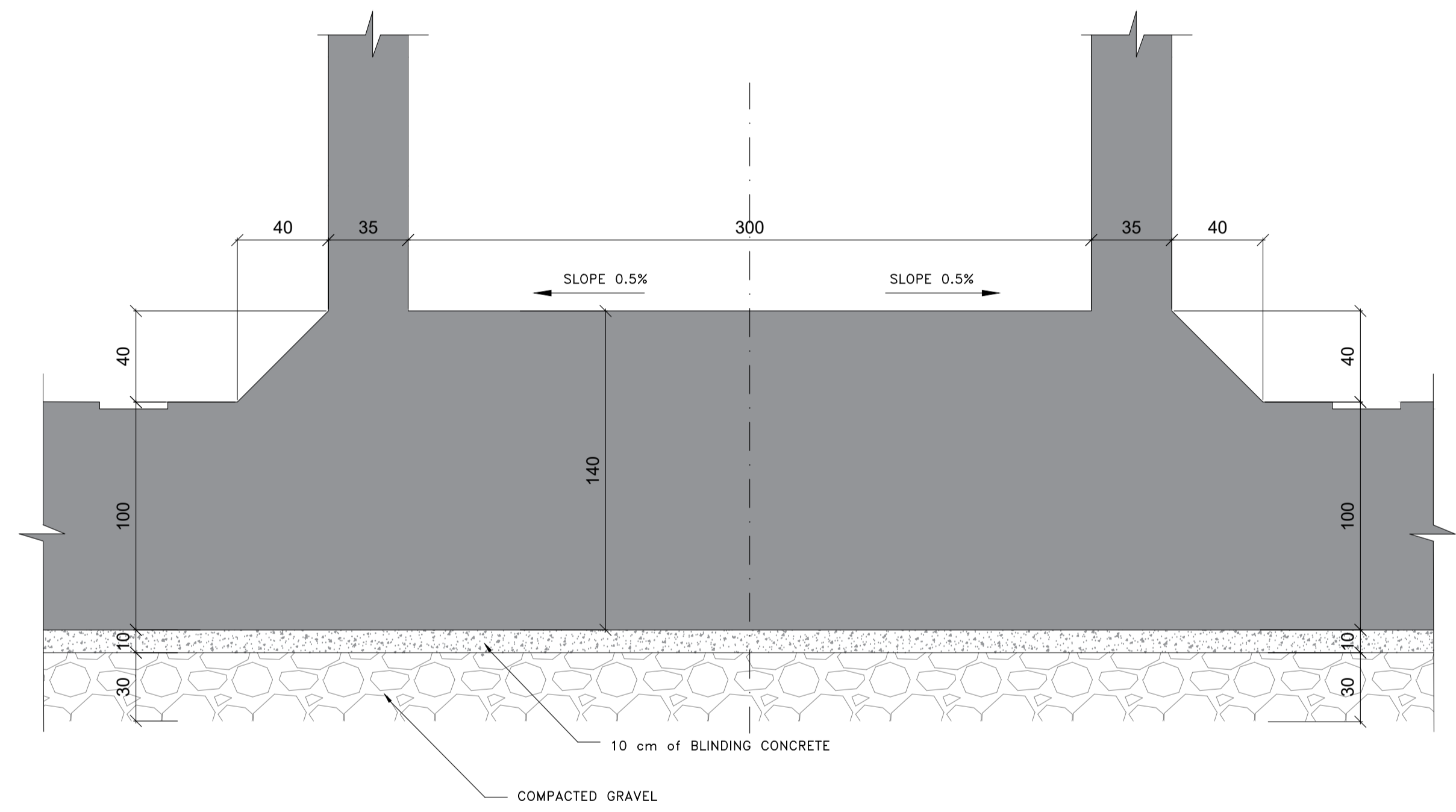
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| MARCH 2023 | -- | 09 | 667W-02STR09 |



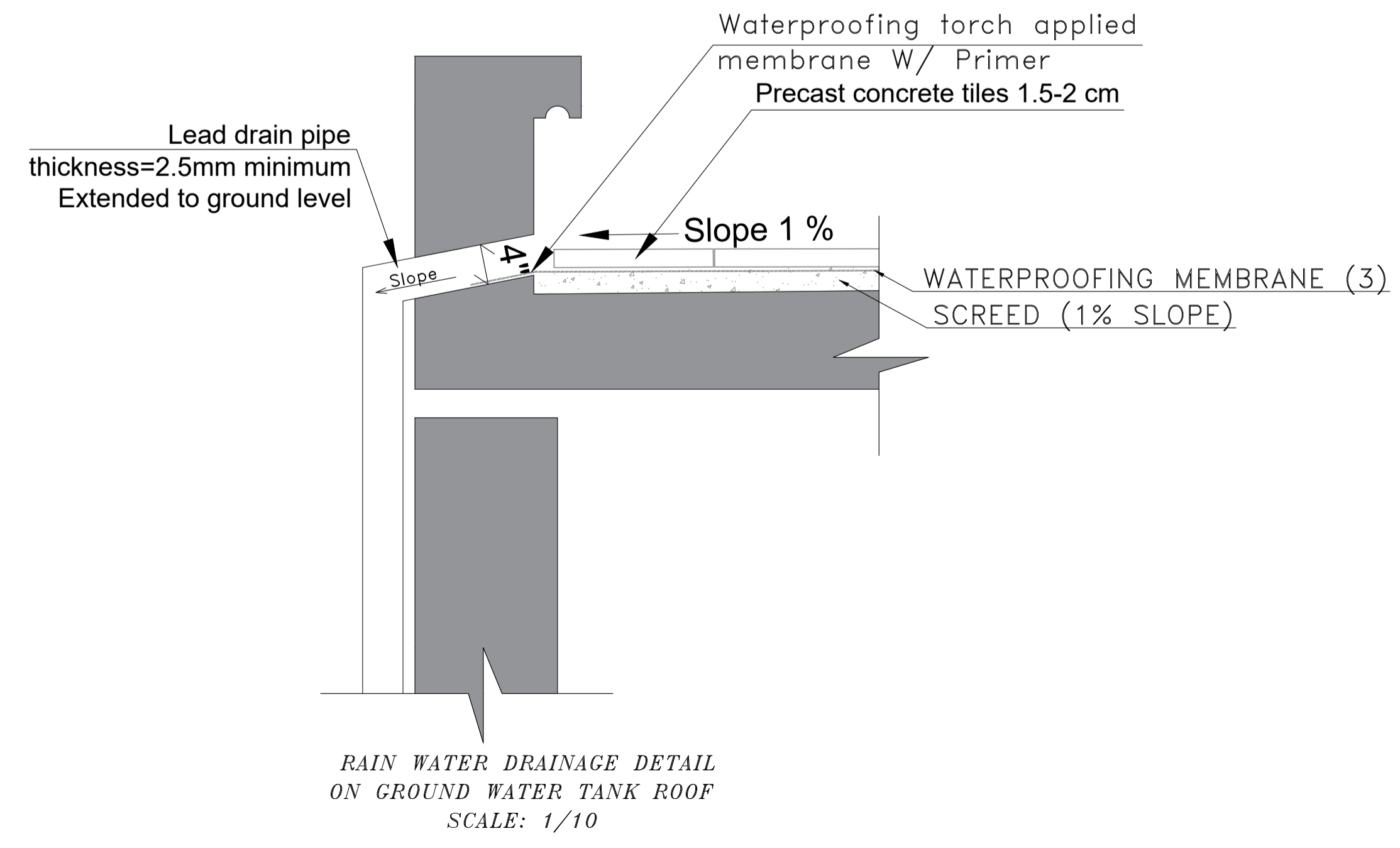
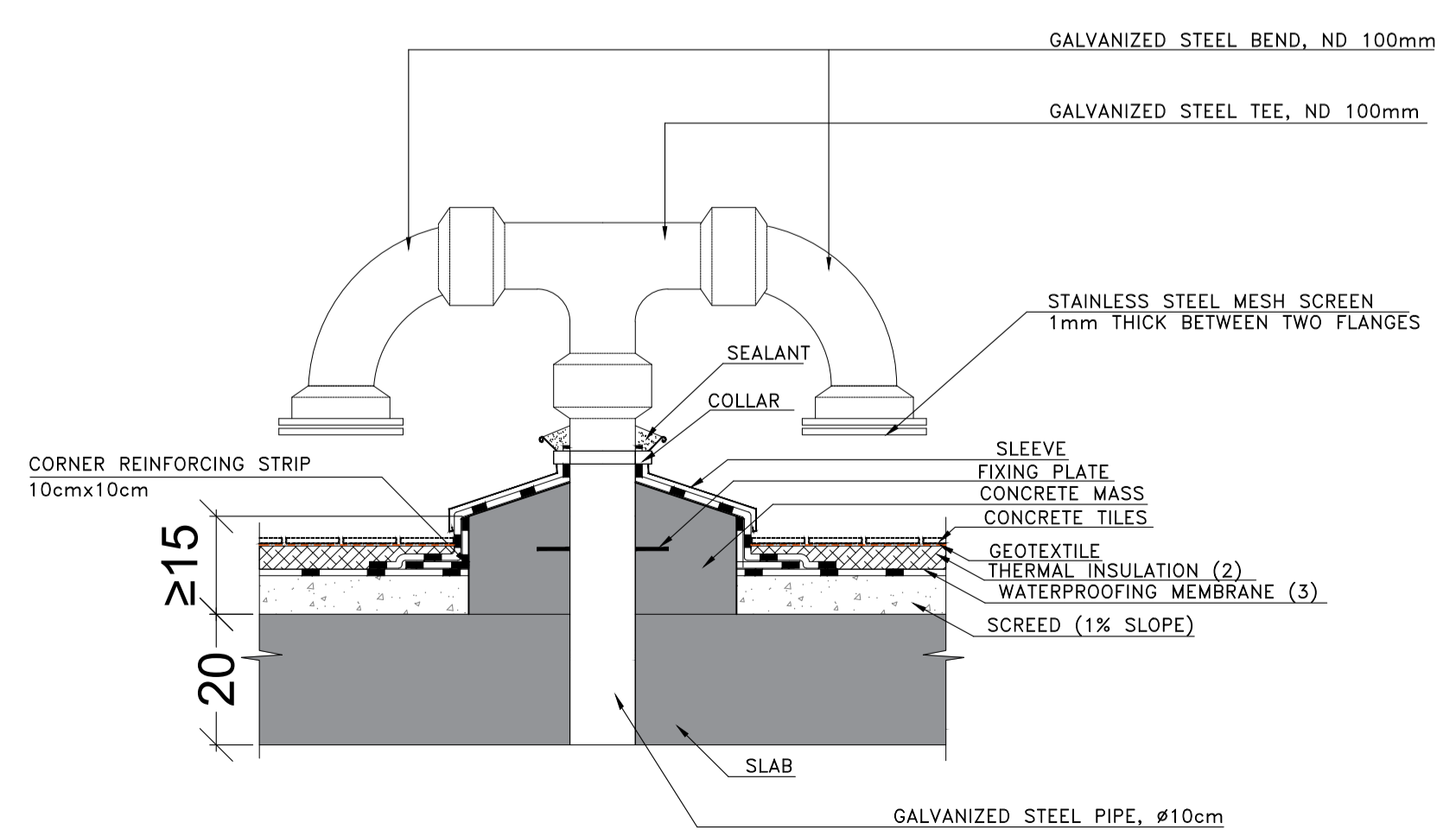
DETAIL I
MAT-EXTERIOR WALL SECTION
SCALE 1:20



DETAIL J
MAT-INTERIOR WALL SECTION
SCALE 1:20



DETAIL F - VENTILATION PIPE
Scale 1:10



NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.

Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.

Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:

- ON A CUBE, a= 150mm : 37N/mm²
- ON A CYLINDER Ø=150mm, h=300mm : 30N/mm²

CONCRETE COVER:

THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:

- 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
- 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
- 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T

YIELD STRESS: F_y=420 N/mm².

MILD STEEL BARS: SYMBOL Ø

YIELD STRESS: F_y=215 N/mm².

MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:

LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60Ø

(Ø = BAR NOMINAL DIAMETER)

PINS Ø8 SHALL BE USED ON EACH LAP.

BENDING:

- Ø>12mm MECHANICAL
- Ø<12mm MANUAL (POSSIBLY)

STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF Ø6mm BARS AS TIE-RODS IS NOT ALLOWED. HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.

ALL CORNERS SHALL BE CHAMFERED.

ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

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PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

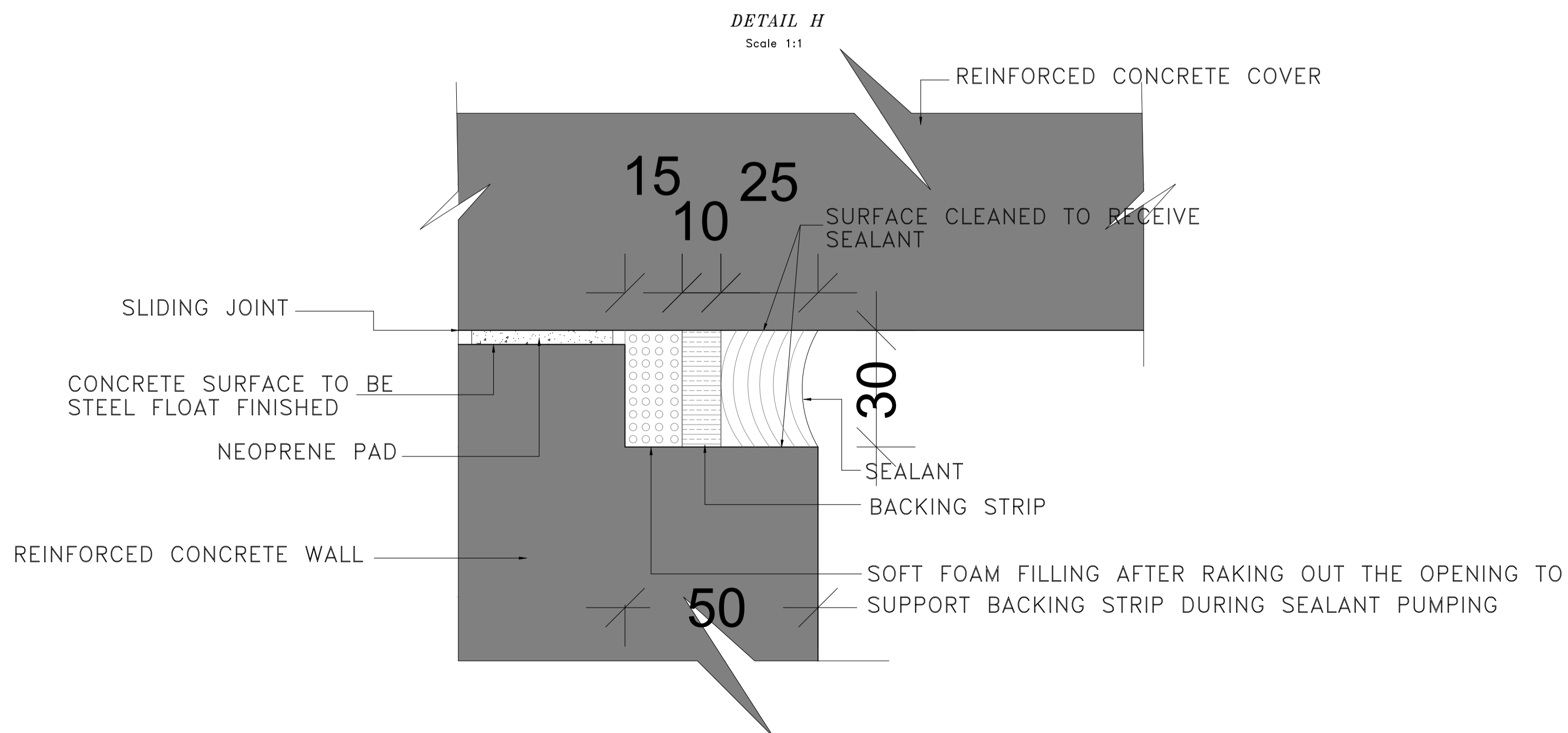
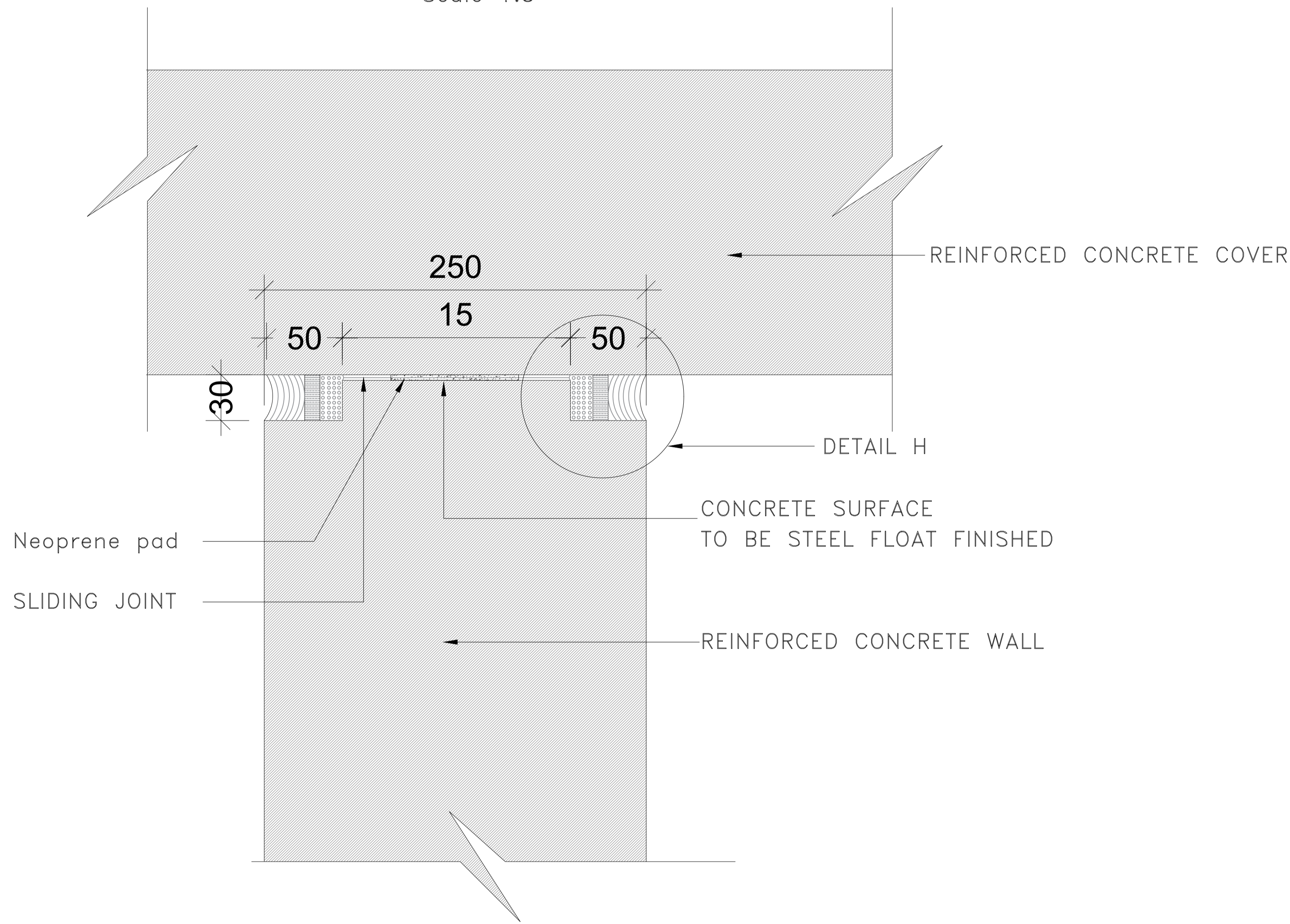
FORMWORK - DETAILS

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|------|-------------|----------|------------|
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|------------|-------|-----------|--------------|
| MARCH 2023 | 1/100 | 10 | 667W-02STR10 |

DETAIL G SLIDING JOINT

Scale 1:5



NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.

Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS

OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.

Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:

- ON A CUBE, a= 150mm : 37N/mm²

- ON A CYLINDER φ=150mm, h=300mm : 30N/mm²

CONCRETE COVER:

THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:

30MM: CONCRETE SURFACES ABOVE GROUND LEVEL

50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER

75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T

YIELD STRESS: F_y=420 N/mm².

MILD STEEL BARS: SYMBOL φ YIELD STRESS: F_y=215 N/mm².

MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ

(φ = BAR NOMINAL DIAMETER)

PINS φ8 SHALL BE USED ON EACH LAP.

BENDING:

φ>12mm MECHANICAL

φ<12mm MANUAL (POSSIBLY)

STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.

THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.

Holes made by tie-rods shall be filled with a non shrink grout by means of special injection methods.

ALL CORNERS SHALL BE CHAMFERED.

ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

* SOIL BEARING CAPACITY = 5 bar (SLS).

* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED

* SCALING FROM THESE DRAWINGS IS NOT ALLOWED.

* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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REPUBLIC OF LEBANON



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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
|--|--------------------|
| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | FORMWORK - DETAILS |
|--|--------------------|

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| MARCH 2023 | 1/100 | 11 | 667W-02STR11 |

ELEVATION 2

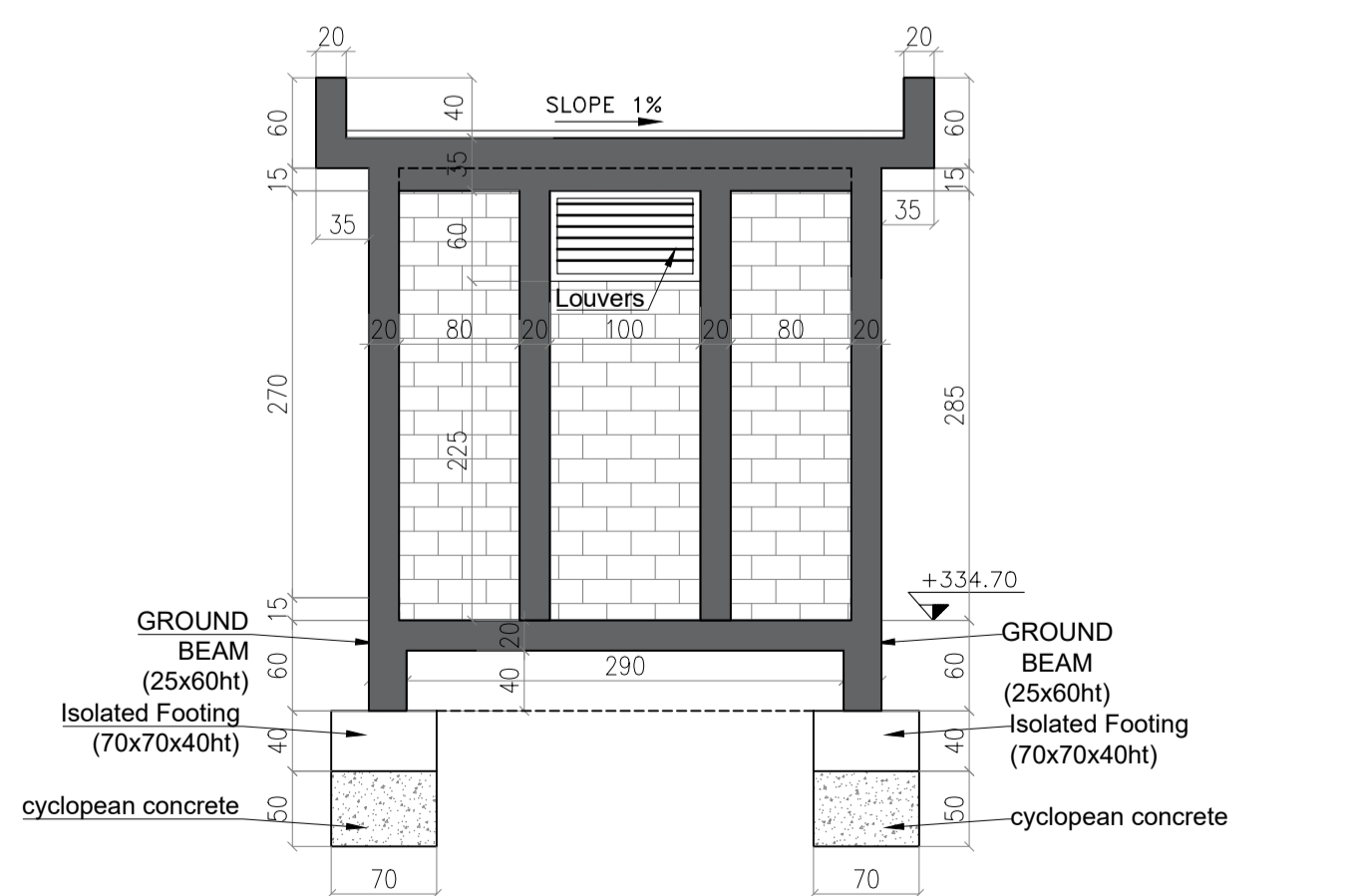
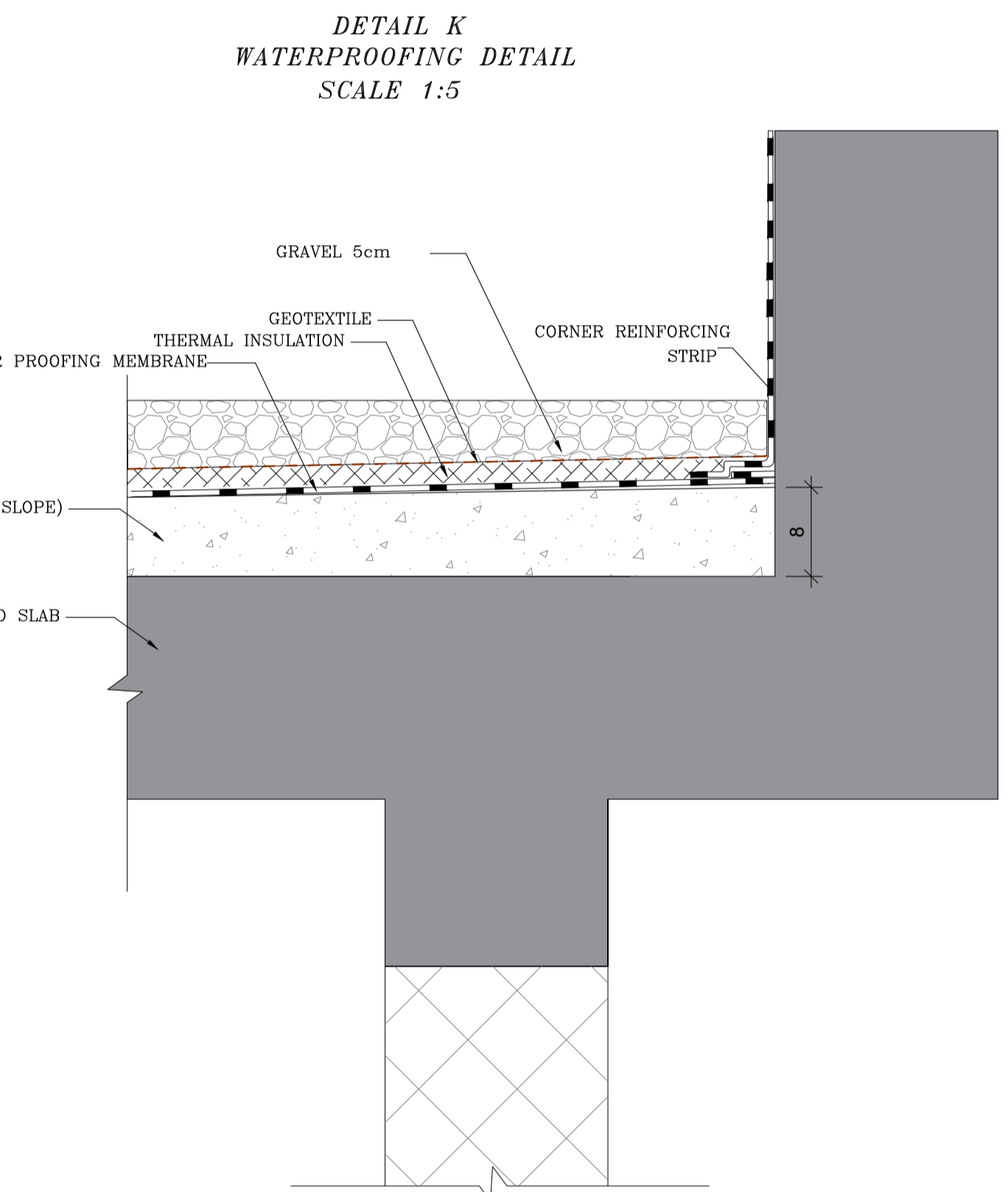
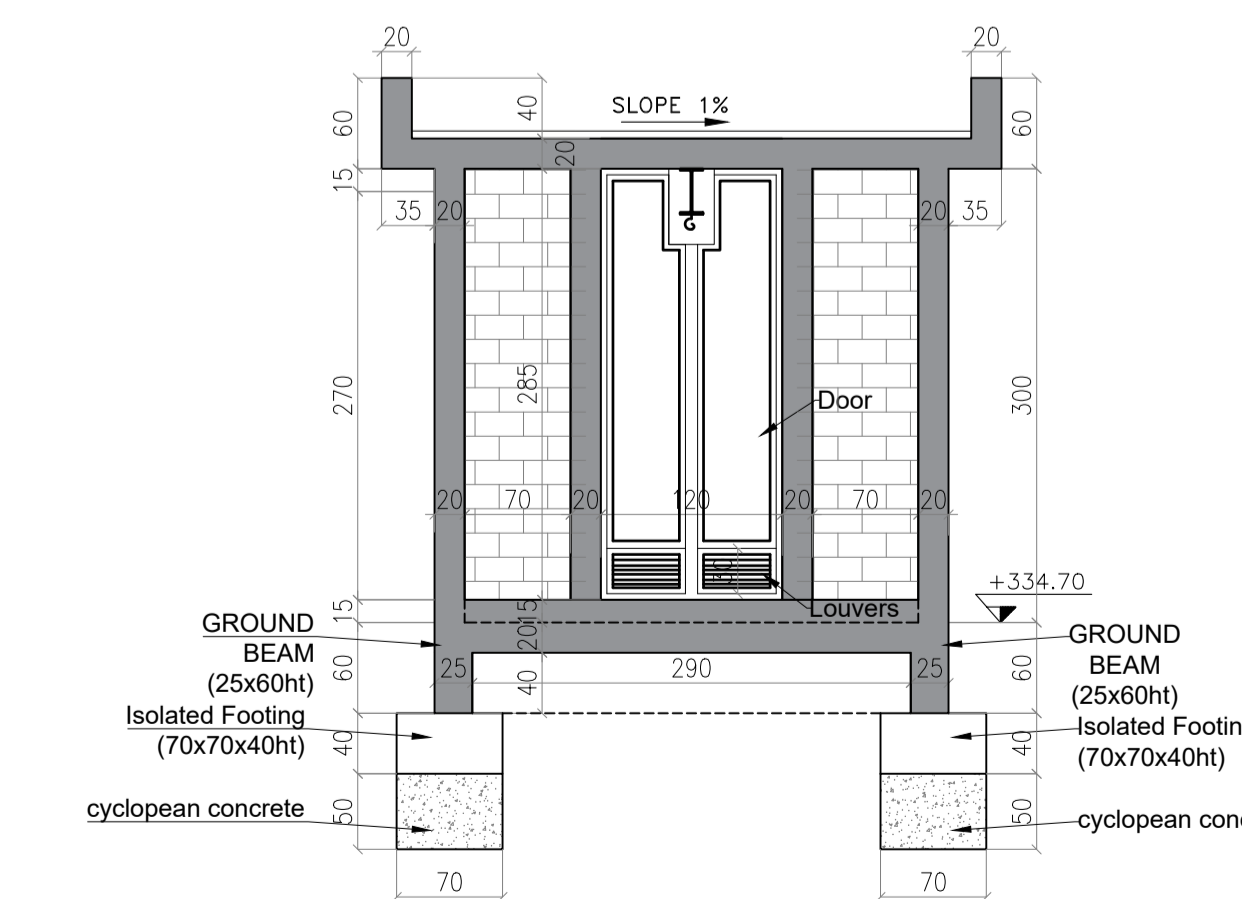
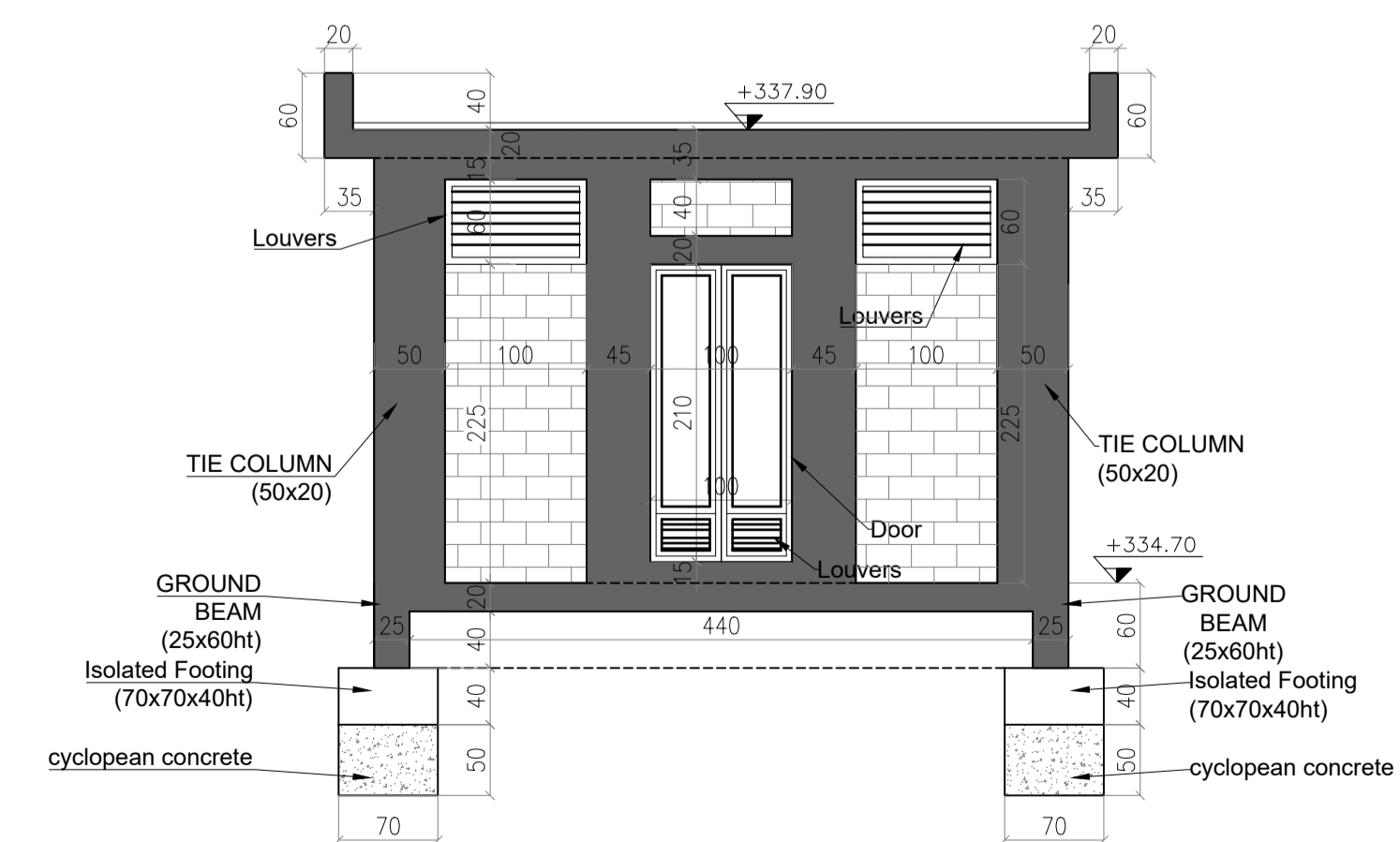
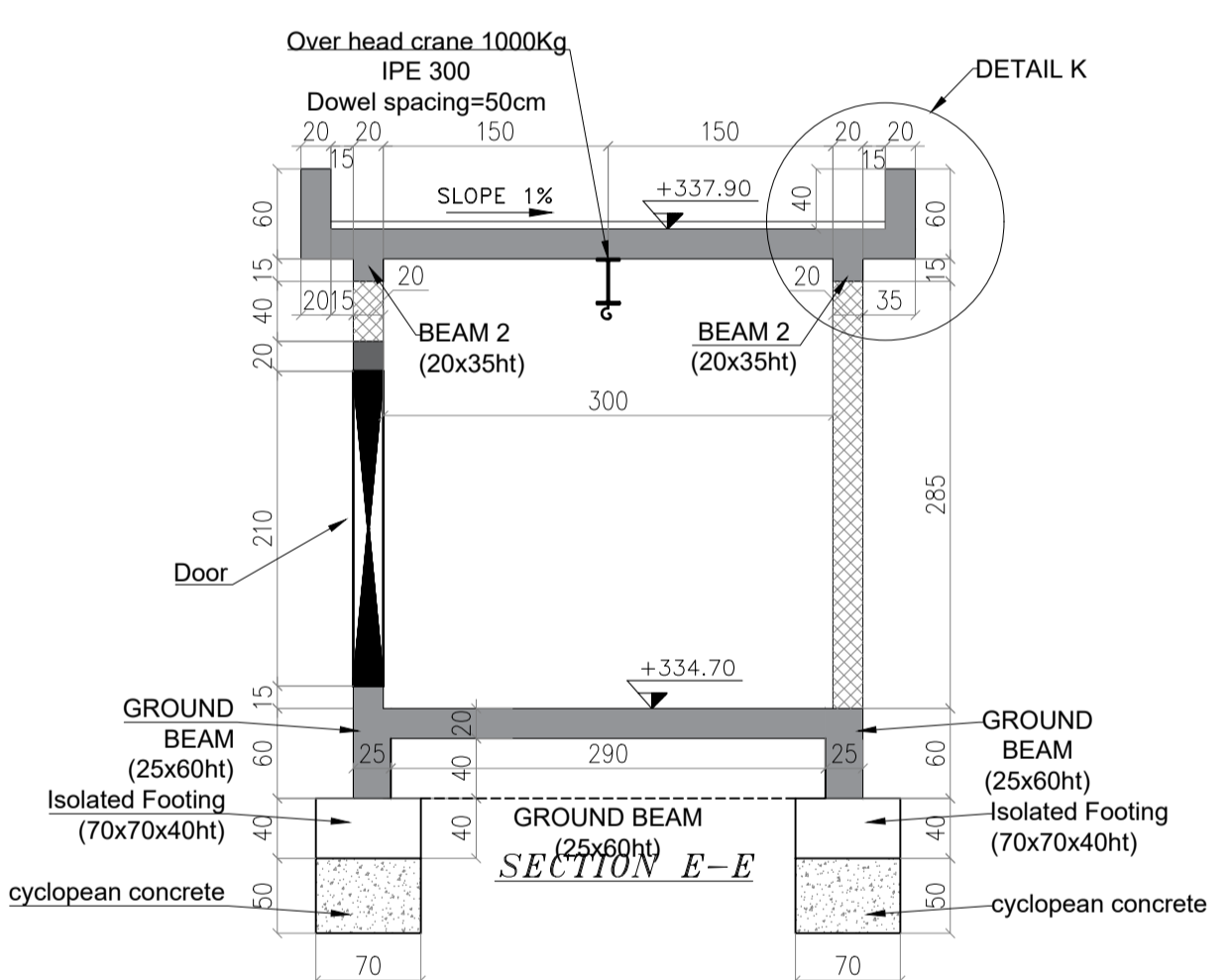
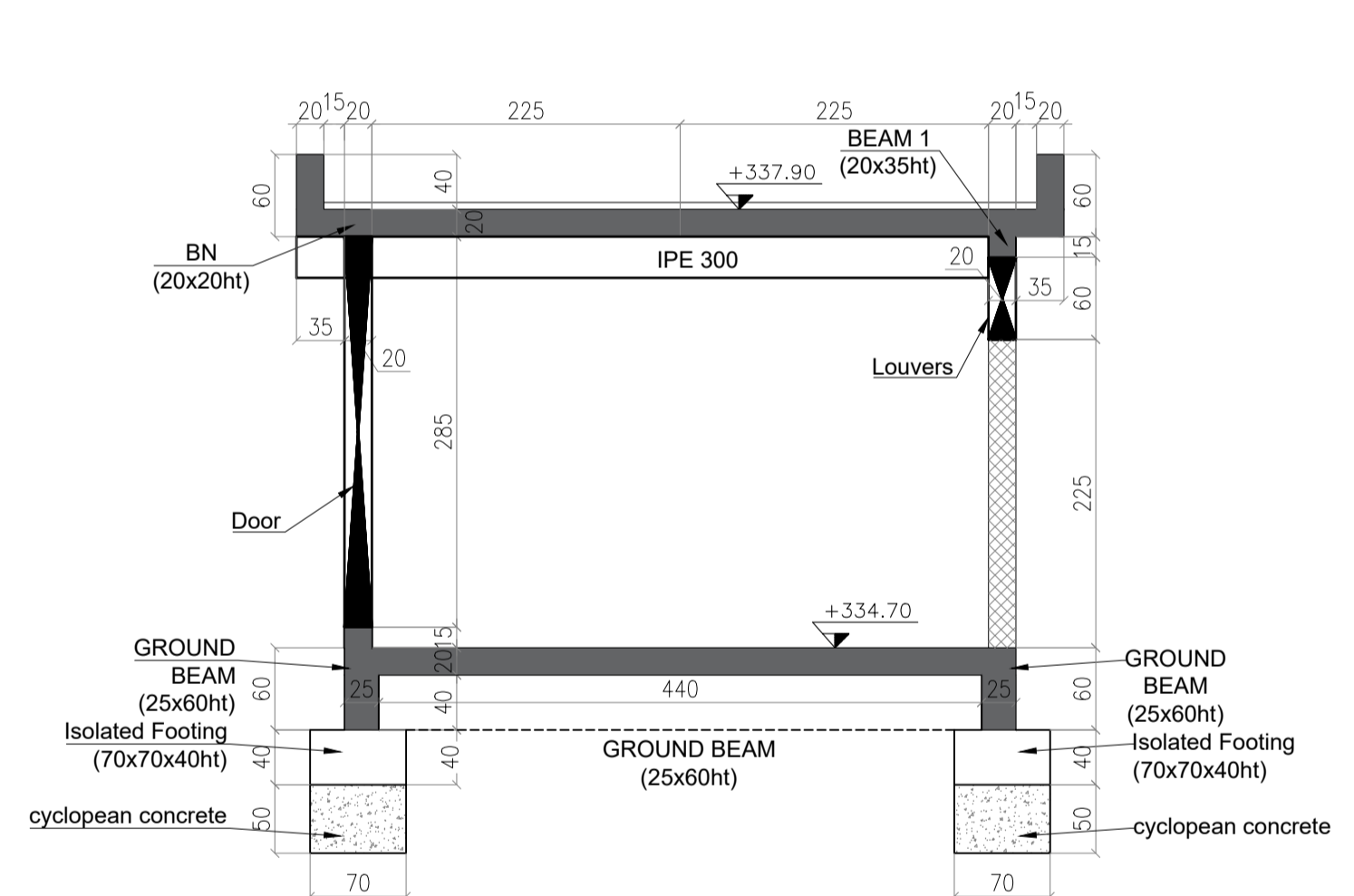
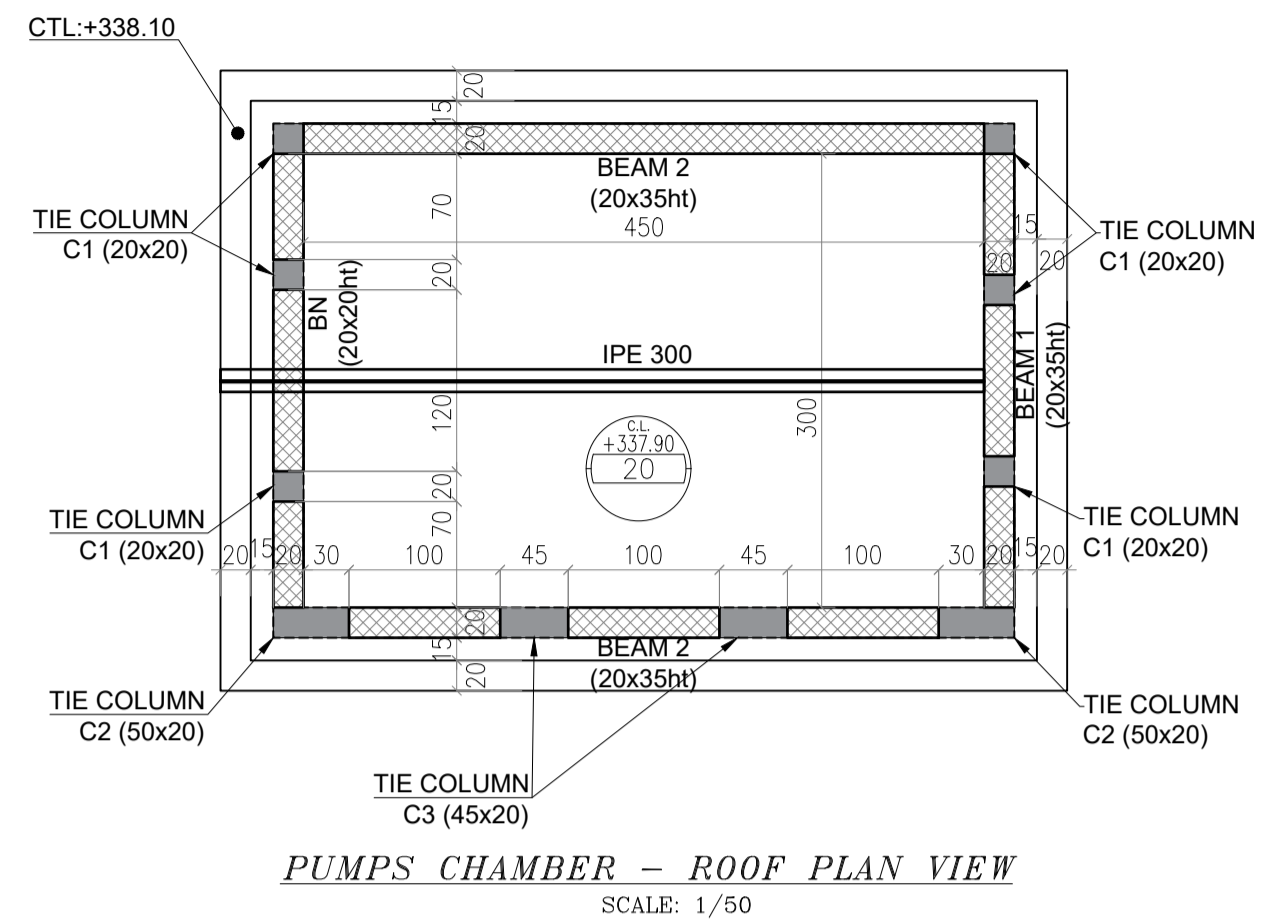
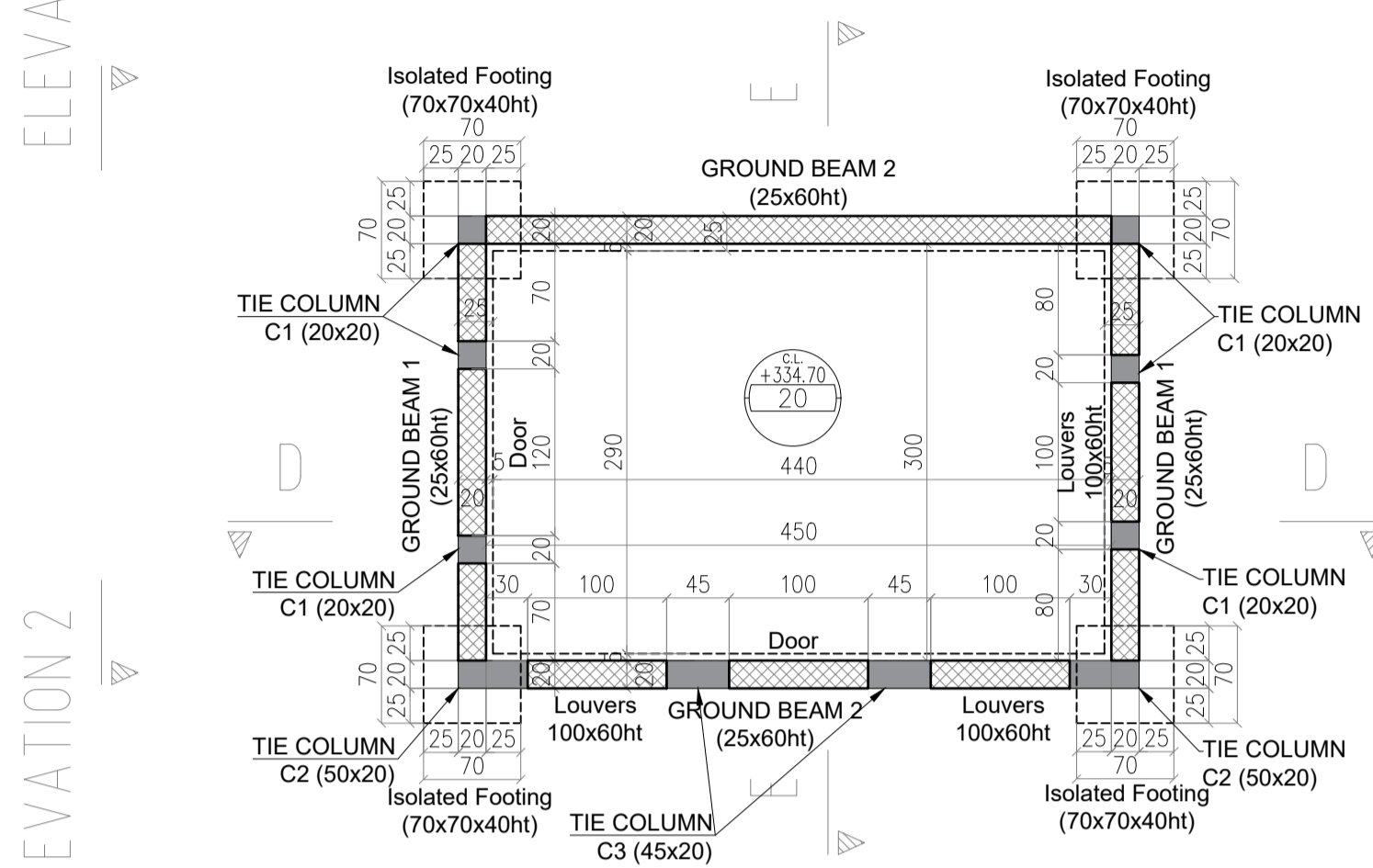
ELEVATION 2

ELEVATION 1

ELEVATION 1

ELEVATION 3

ELEVATION 3



NOTES

NORMAL PORTLAND CEMENT

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, a=150mm : 37N/mm²
- ON A CYLINDER φ=150mm, h=300mm : 30N/mm²

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: F_y=420 N/mm²
MILD STEEL BARS: SYMBOL φ YIELD STRESS: F_y=215 N/mm²
MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x6φ
(φ = BAR NOMINAL DIAMETER)
PINS φ8 SHALL BE USED ON EACH LAP.

BENDING:
φ>12mm MECHANICAL
φ<12mm MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION (Performed by SAFWAN ABDUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
* SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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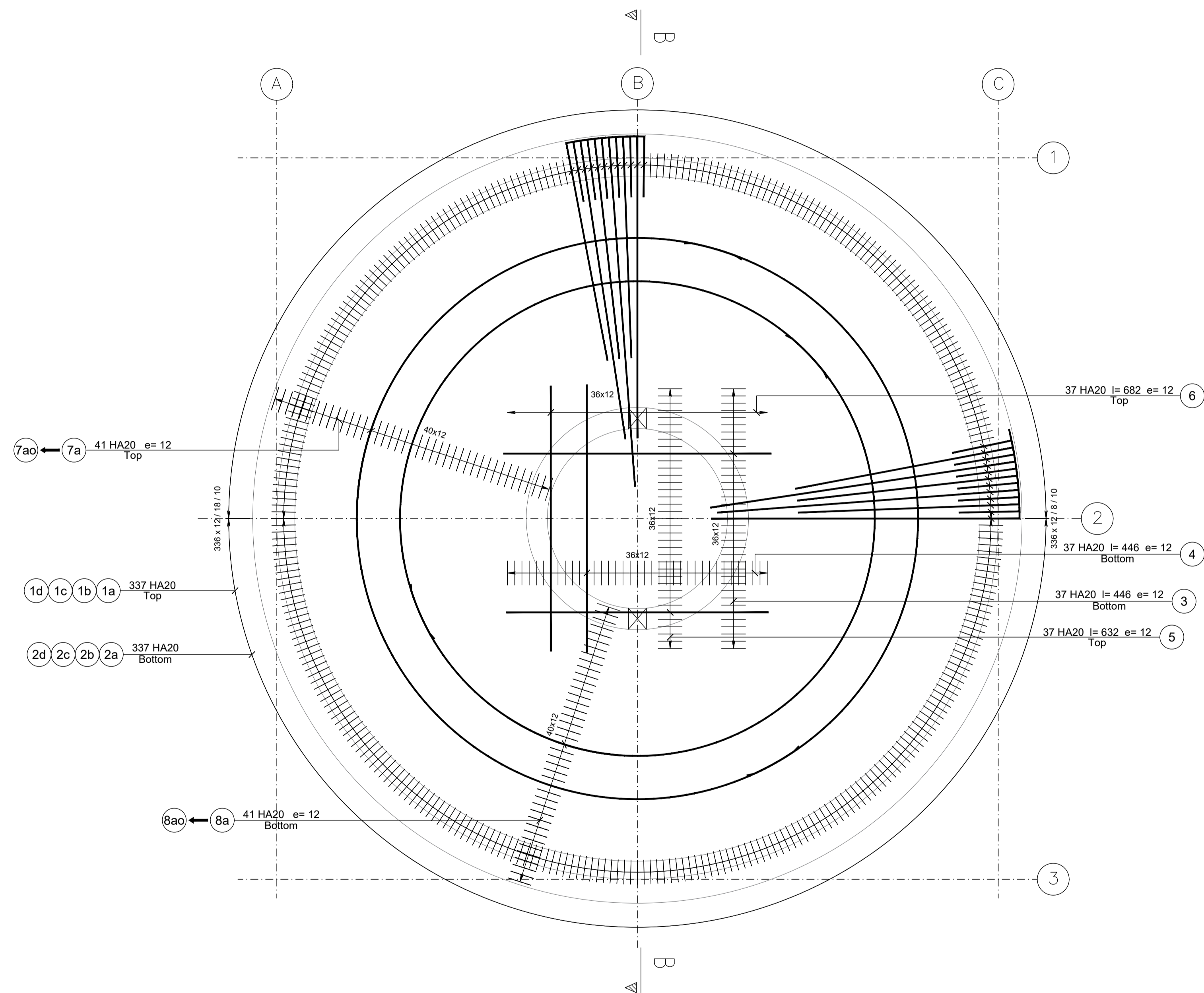
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

FORMWORK - PUMPS CHAMBER SECTION AND ELEVATION AND PLAN VIEWS

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
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| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | 1/50 | 12 | 667W-02STR12 |



MAT REINFORCEMENT
SCALE: 1/50

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, $\alpha = 150\text{mm}$: 37N/mm²
 - ON A CYLINDER $\phi = 150\text{mm}$, $h = 300\text{mm}$: 30N/mm²

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: $F_y = 420 \text{ N/mm}^2$.
- MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y = 215 \text{ N/mm}^2$.
- MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
- WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$
- (ϕ = BAR NOMINAL DIAMETER)
- PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:

- $\phi > 12\text{mm}$ MECHANICAL
- $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
- STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
- THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
- HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION (Performed by SAFWAN ABDUL KADER CHAHAL)

- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

- * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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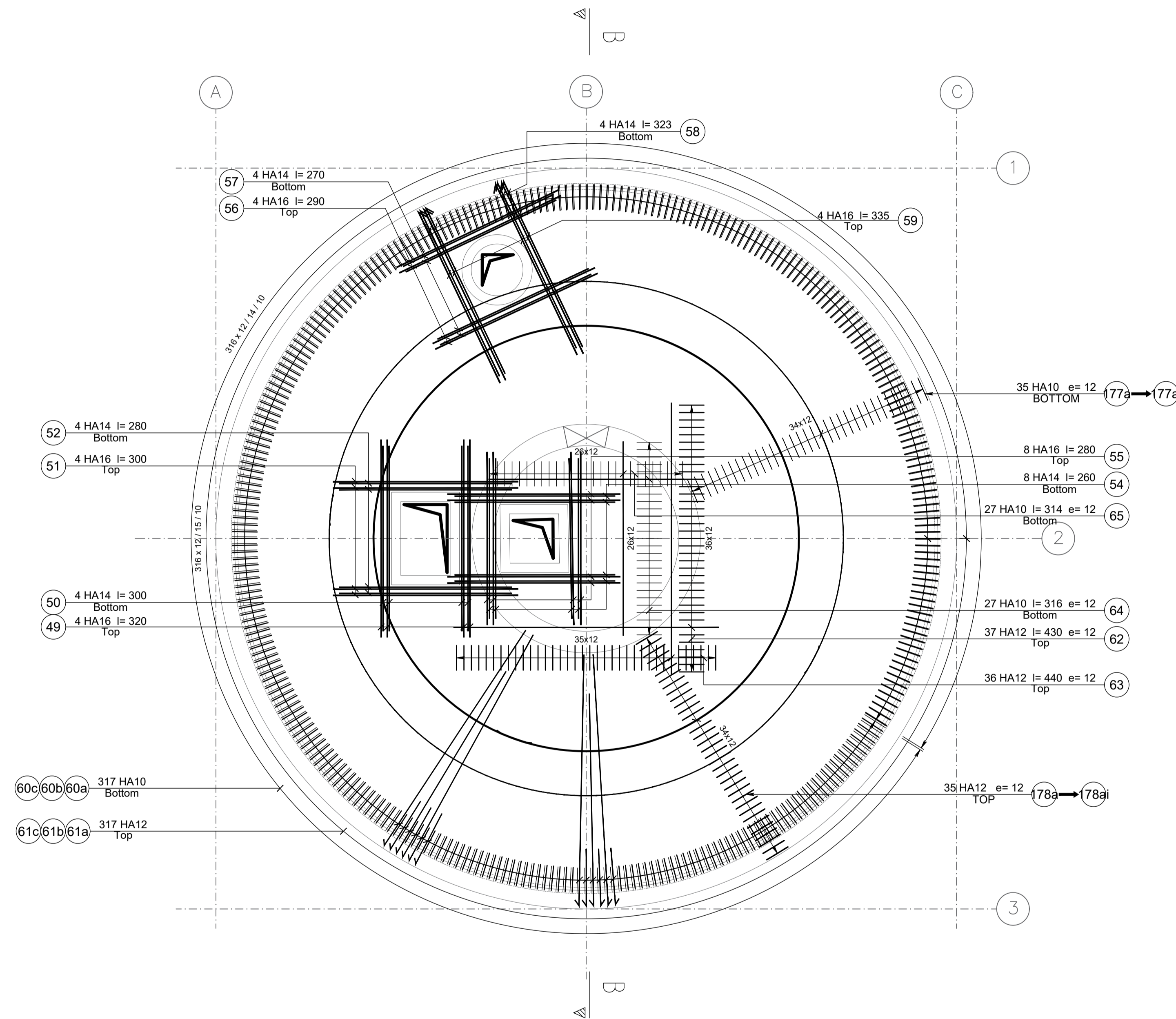
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

REINFORCEMENT - MAT REINFORCEMENT PLAN VIEWS

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| 667W | J.Y. | R.S. | T.G. |

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| MARCH 2023 | 1/100 | 13 | 667W-02STR13 |



GROUND TANK UPPER SLAB REINFORCEMENT

SCALE: 1/50

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m3 FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m3 FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, $a=150\text{mm}$: 37N/mm²
 - ON A CYLINDER $\phi=150\text{mm}$, $h=300\text{mm}$: 30N/mm²

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: $F_y=420\text{ N/mm}^2$.
- MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y=215\text{ N/mm}^2$.
- MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
- WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$
- (ϕ = BAR NOMINAL DIAMETER)
- PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:

- $\phi > 12\text{mm}$ MECHANICAL
- $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
- STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
- THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
- HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

- * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

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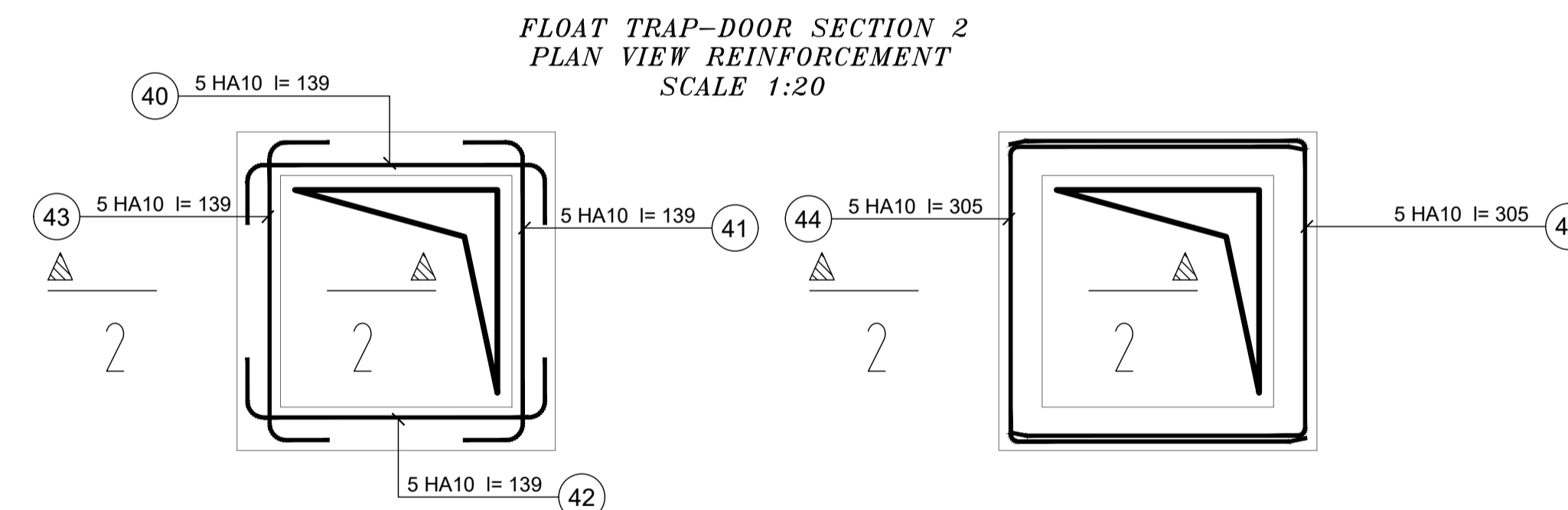
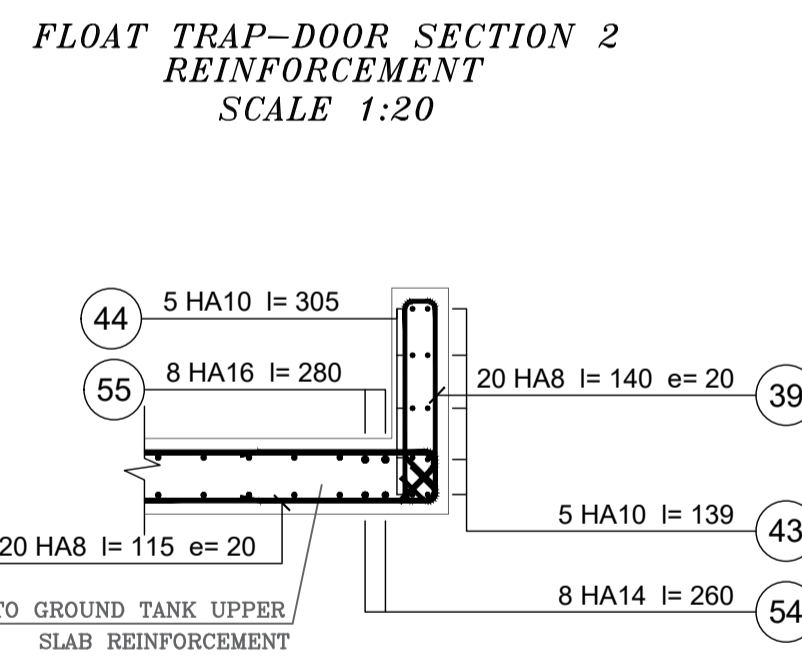
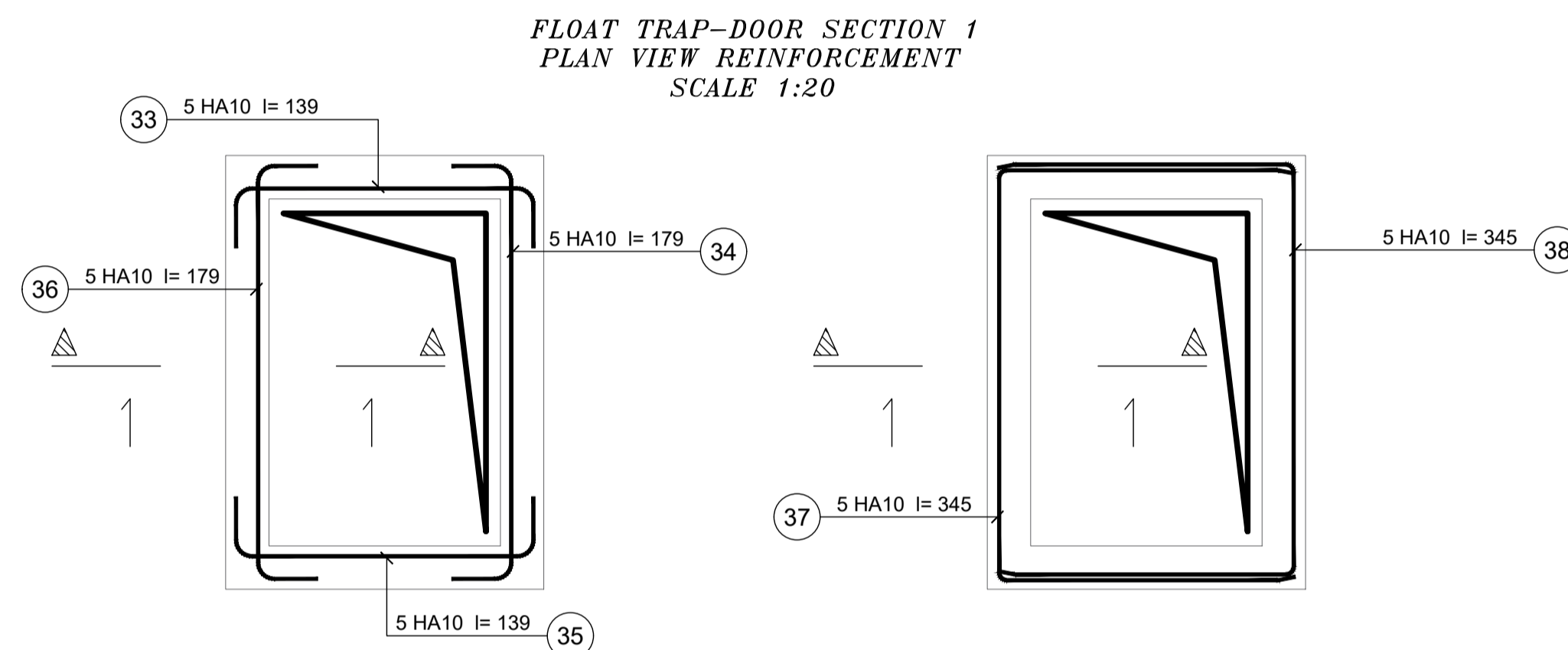
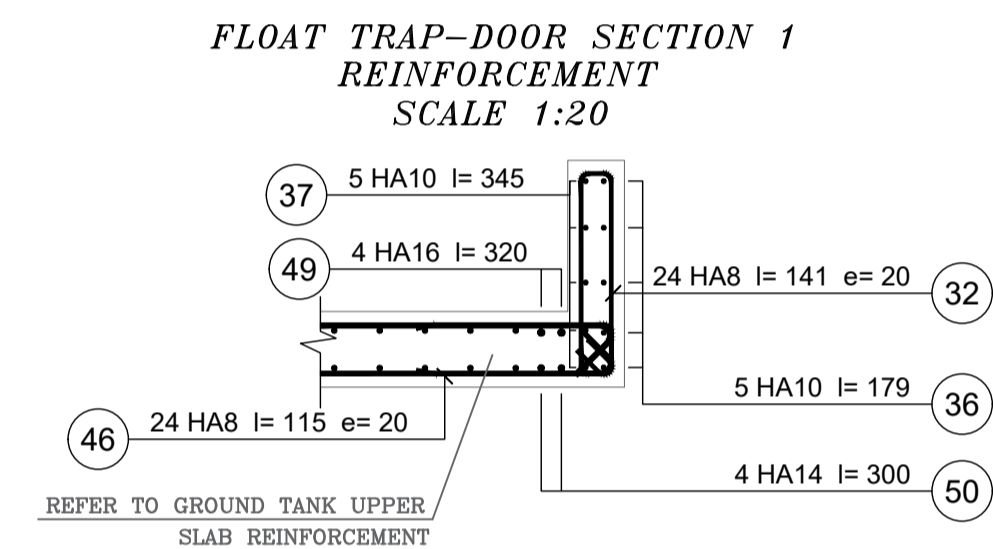
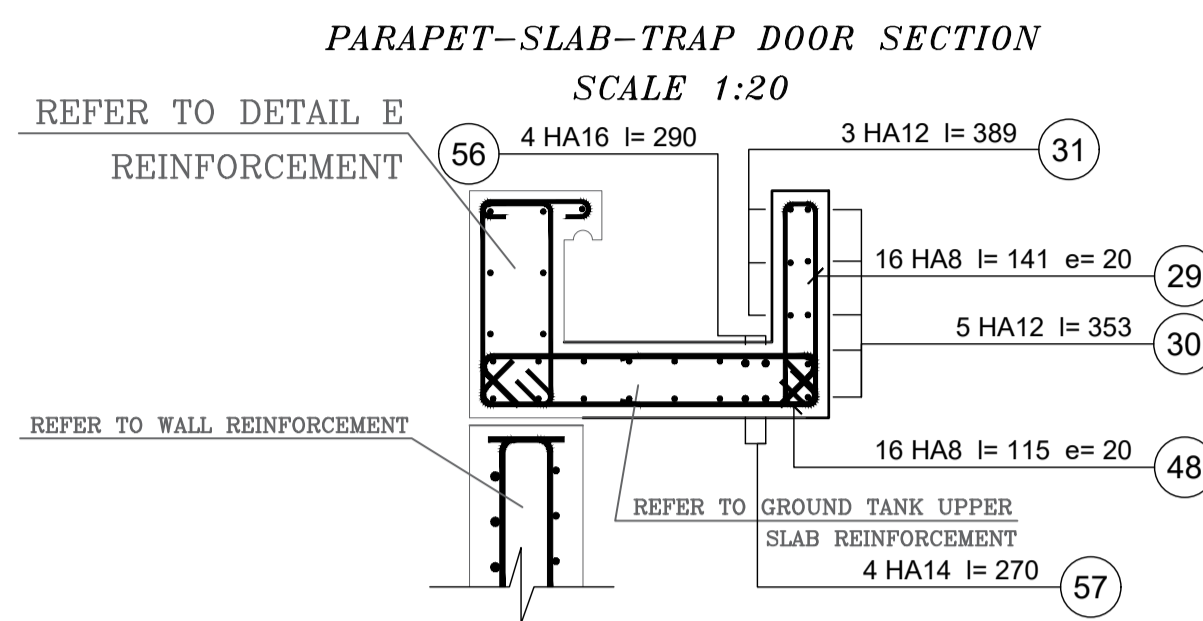
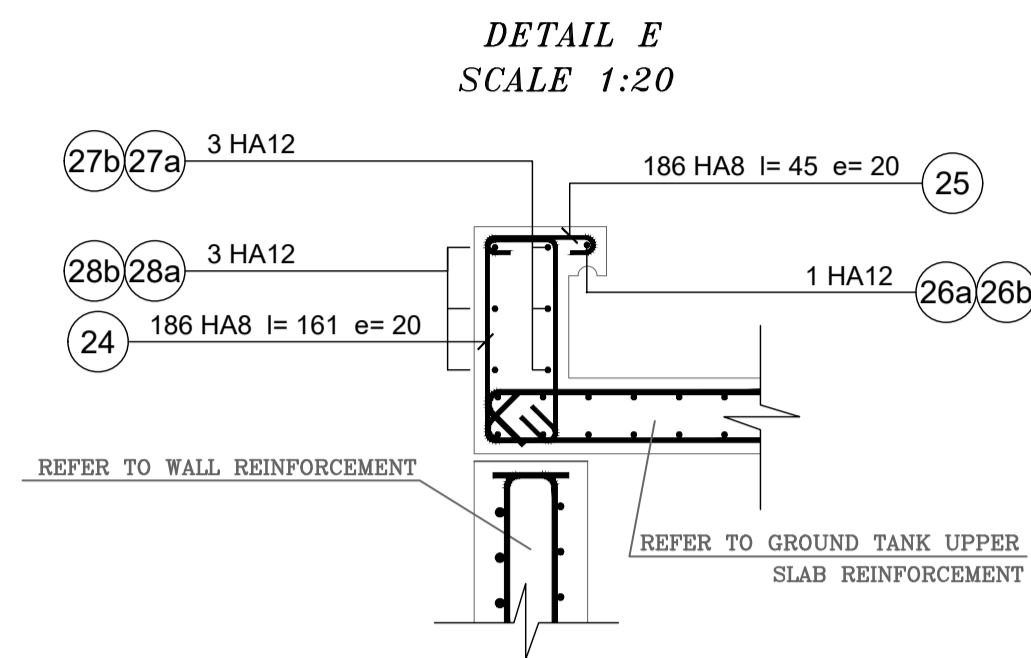


PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | REINFORCEMENT – GROUND TANK UPPER SLAB REINFORCEMENT |
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| MARCH 2023 | 1/100 | 14 | 667W-02STR14 |



NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, a=150mm : 37N/mm²
- ON A CYLINDER φ=150mm, h=300mm : 30N/mm²

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: F_y=420 N/mm²
MILD STEEL BARS: SYMBOL φ YIELD STRESS: F_y=215 N/mm²
MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ
(φ = BAR NOMINAL DIAMETER)
PINS φ8 SHALL BE USED ON EACH LAP.

BENDING:
φ>12mm MECHANICAL
φ<12mm MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER
REINFORCEMENT - ELEVATED WATER TOWER SECTION AND PLAN VIEWS

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
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| MARCH 2023 | 1/100 | 16 | 667W-02STR16 |

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
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SULFATE RESISTING CEMENT.

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STRESSES:

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REINFORCEMENT:

- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: $F_y=420\text{ N/mm}^2$.
- MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y=215\text{ N/mm}^2$.
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BENDING:

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FORMWORK:

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WATERPROOFING:

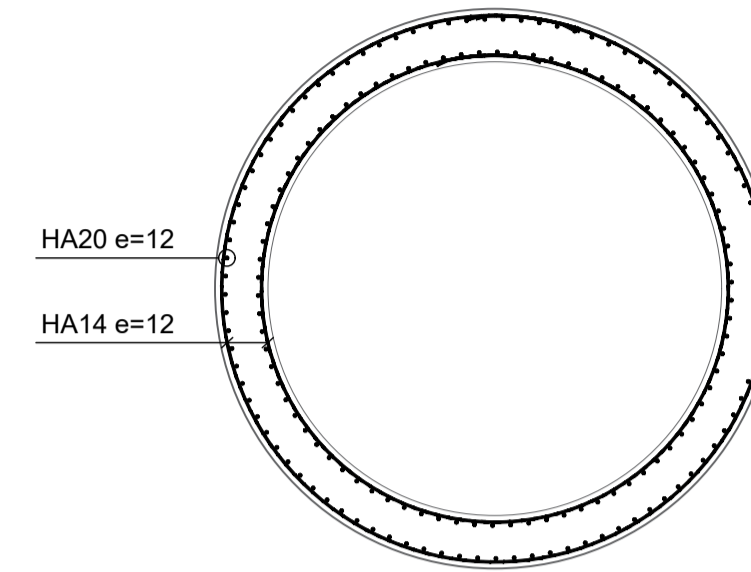
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GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

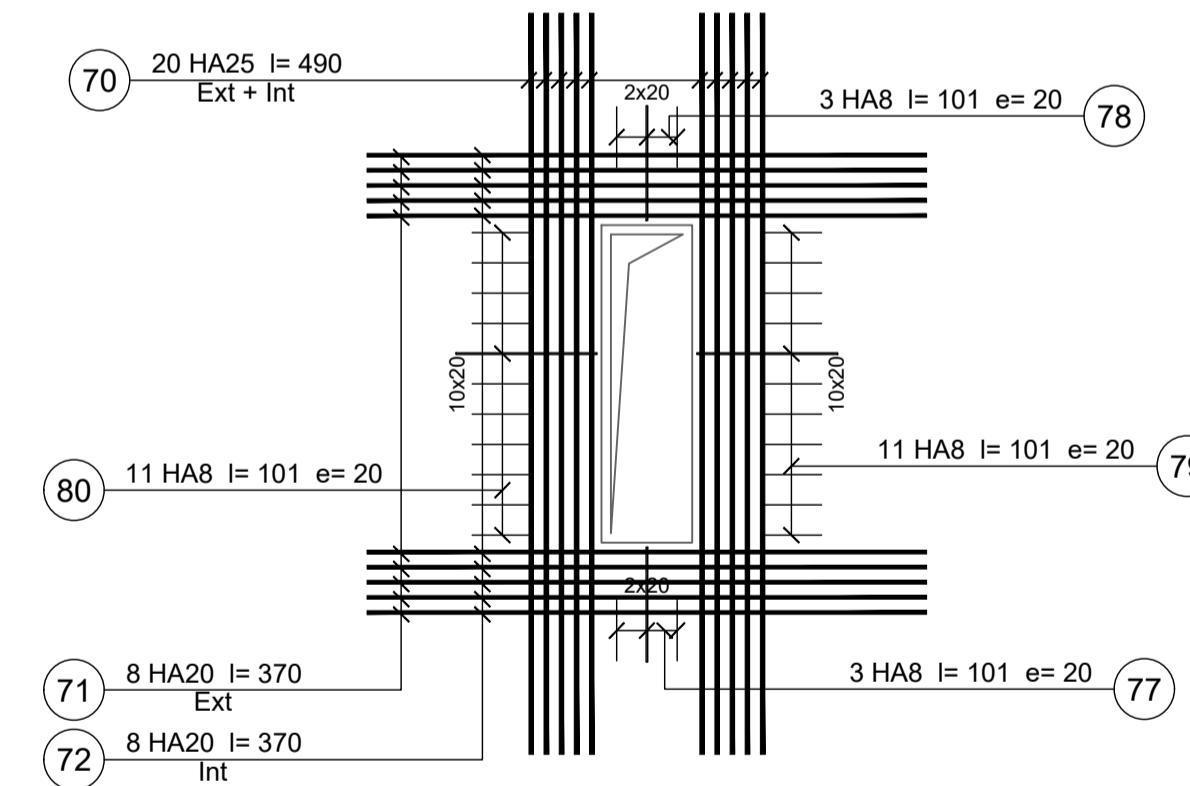
- * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.



CORE REINFORCEMENT TYPE 2
FROM +341.20 TO +363.00
WITH 120 CM OVERLAP
FOR VERTICAL BARS
SCALE: 1/50

DOOR DETAIL - REINFORCEMENT

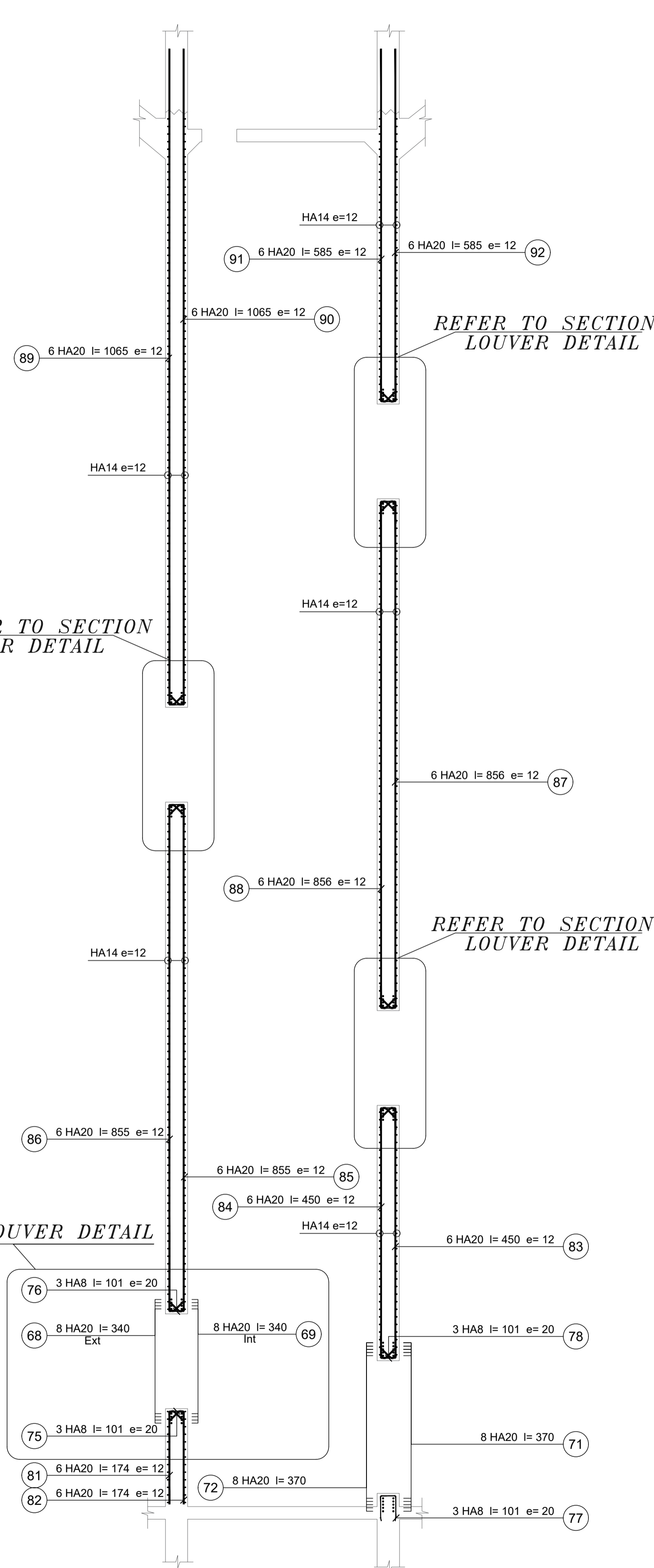
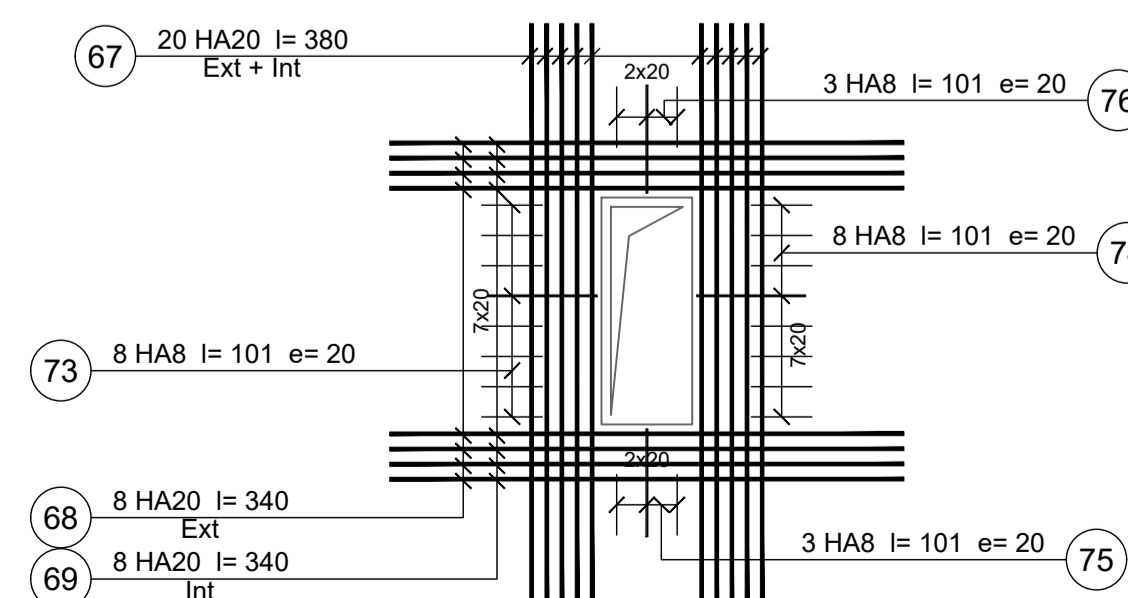
SCALE: 1/50



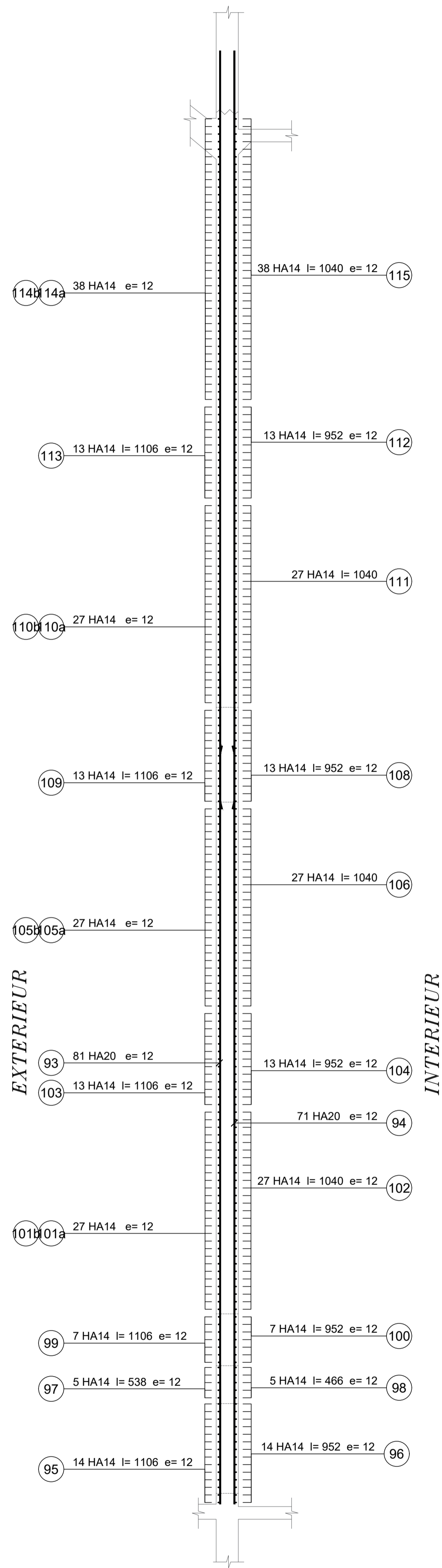
LOUVER DETAIL - REINFORCEMENT

Nbr.: 4

SCALE: 1/50



CORE REINFORCEMENT - ELEVATION
FROM +341.20 TO +363.00
VERTICAL REINFORCEMENT
SCALE: 1/50



CORE REINFORCEMENT - ELEVATION
FROM +341.20 TO +363.00
HORIZONTAL REINFORCEMENT
SCALE: 1/50

REFER TO SECTION LOUVER DETAIL

REFER TO SECTION LOUVER DETAIL

REFER TO SECTION LOUVER DETAIL

EXTERIEUR

INTERIEUR

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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| | | | | | |

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Solidarités International

BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

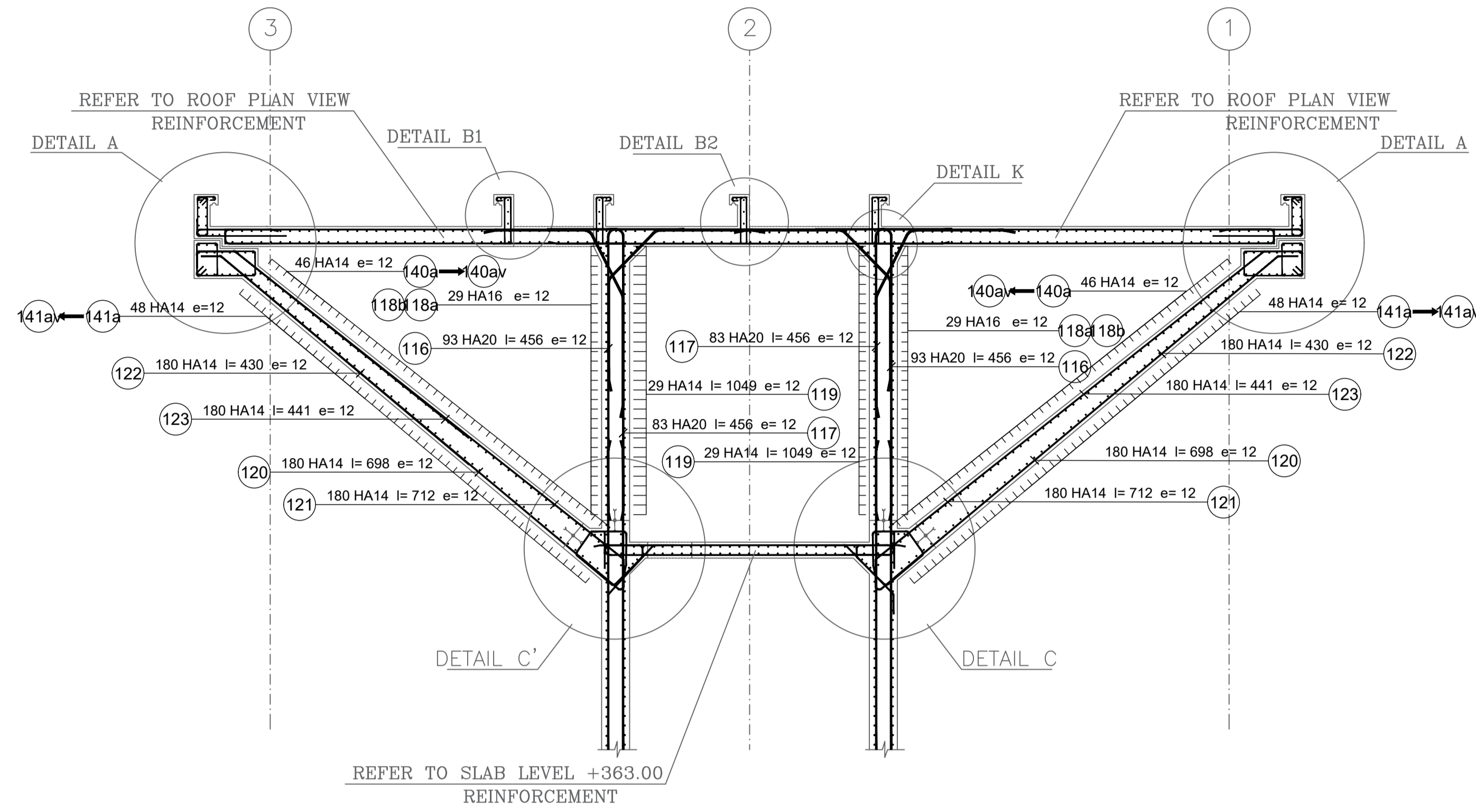
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHM WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

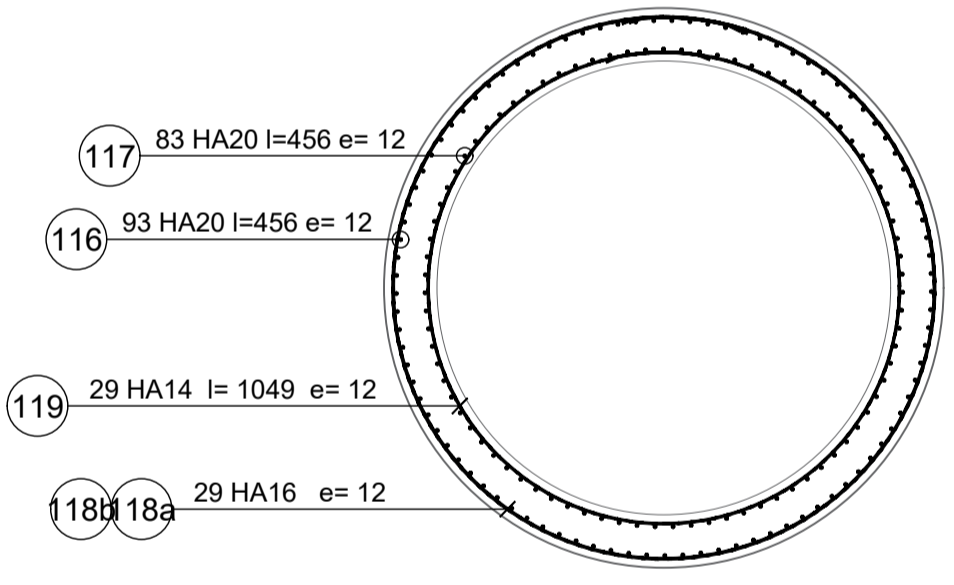
REINFORCEMENT - CORE REINFORCEMENT SECTION AND ELEVATION AND PLAN VIEWS

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | J.Y. | R.S. | T.G. |

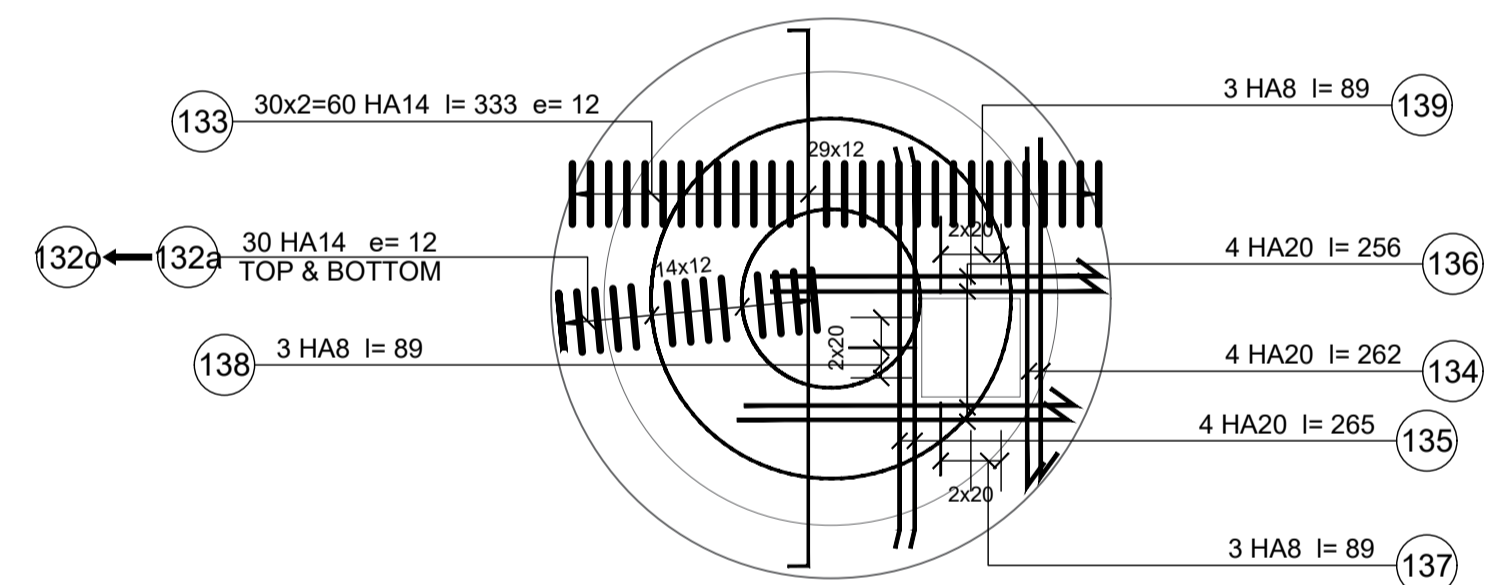
| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|--------------|
| MARCH 2023 | 1/100 | 17 | 667W-02STR17 |



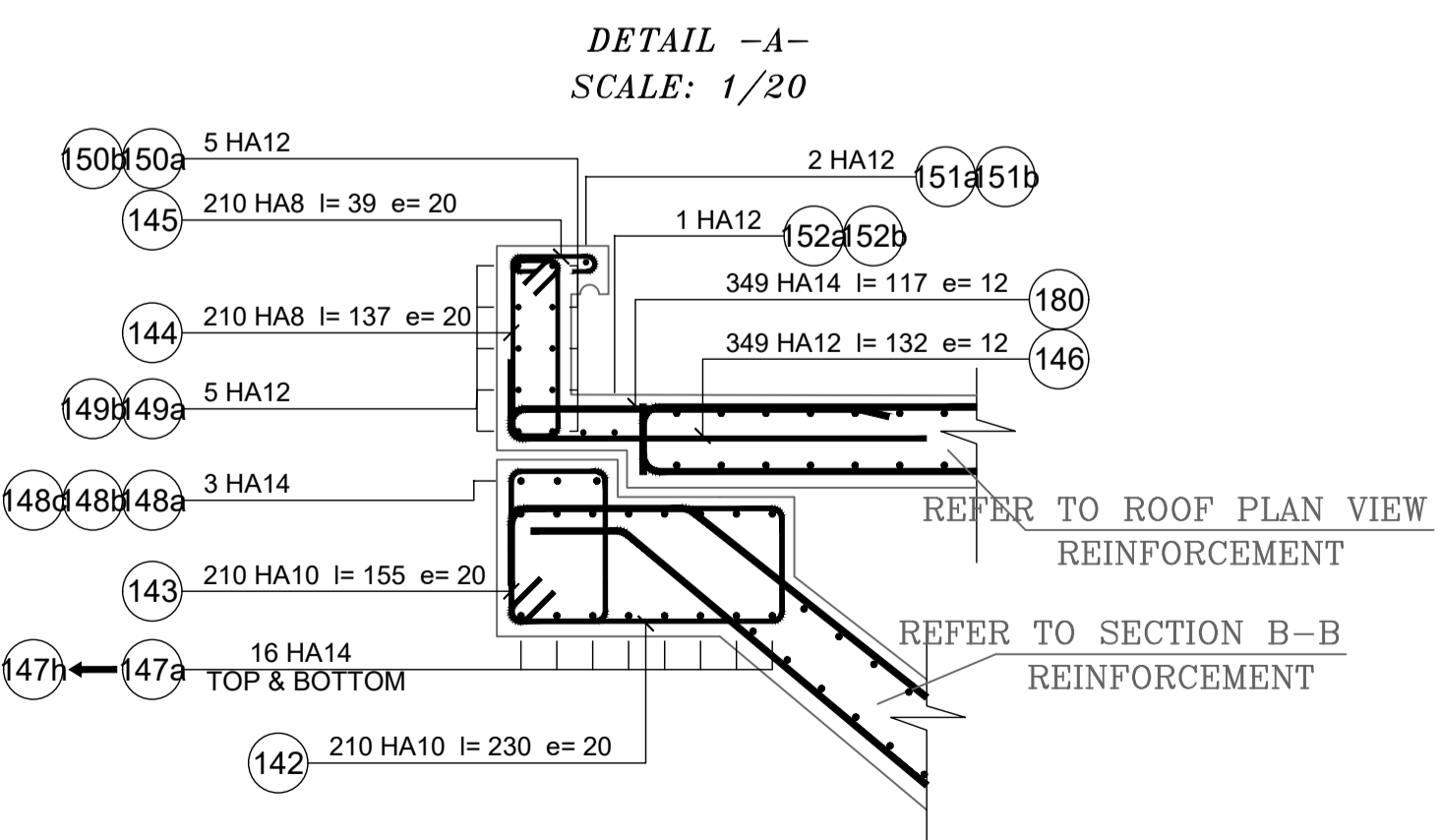
SECTION B-B REINFORCEMENT
SCALE: 1/50



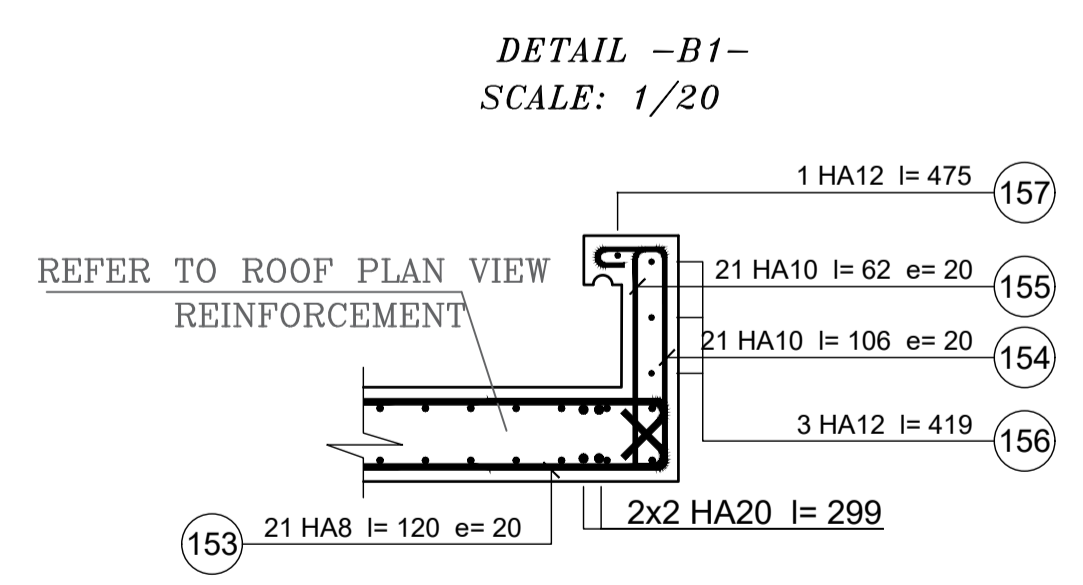
CORE REINFORCEMENT TYPE 3
FROM +363.00 TO +366.95
WITH 120 CM OVERLAP
FOR VERTICAL BARS
SCALE: 1/50



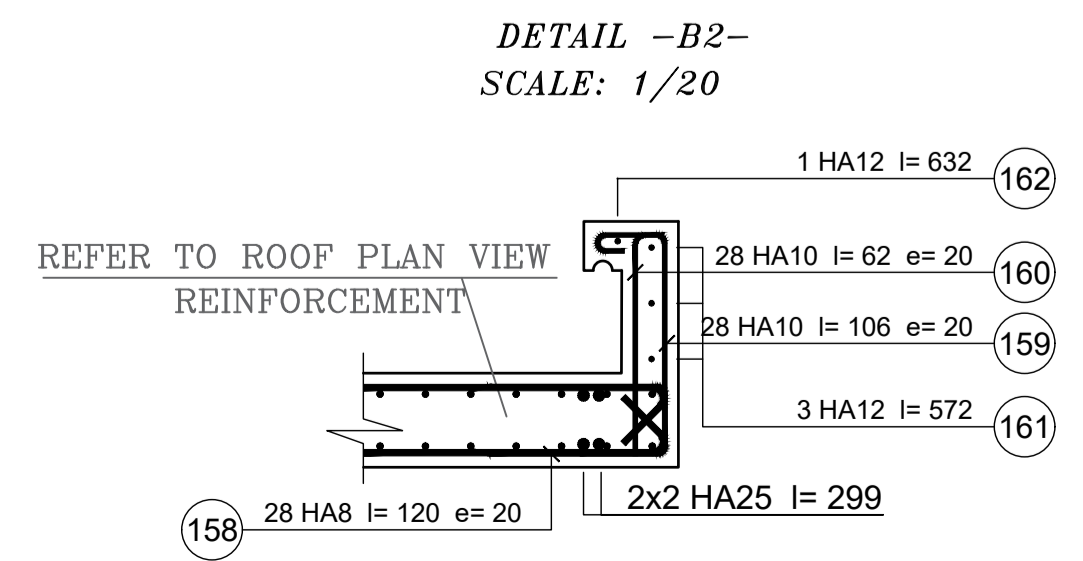
SLAB LEVEL +363.00 - REINFORCEMENT
SCALE: 1/50



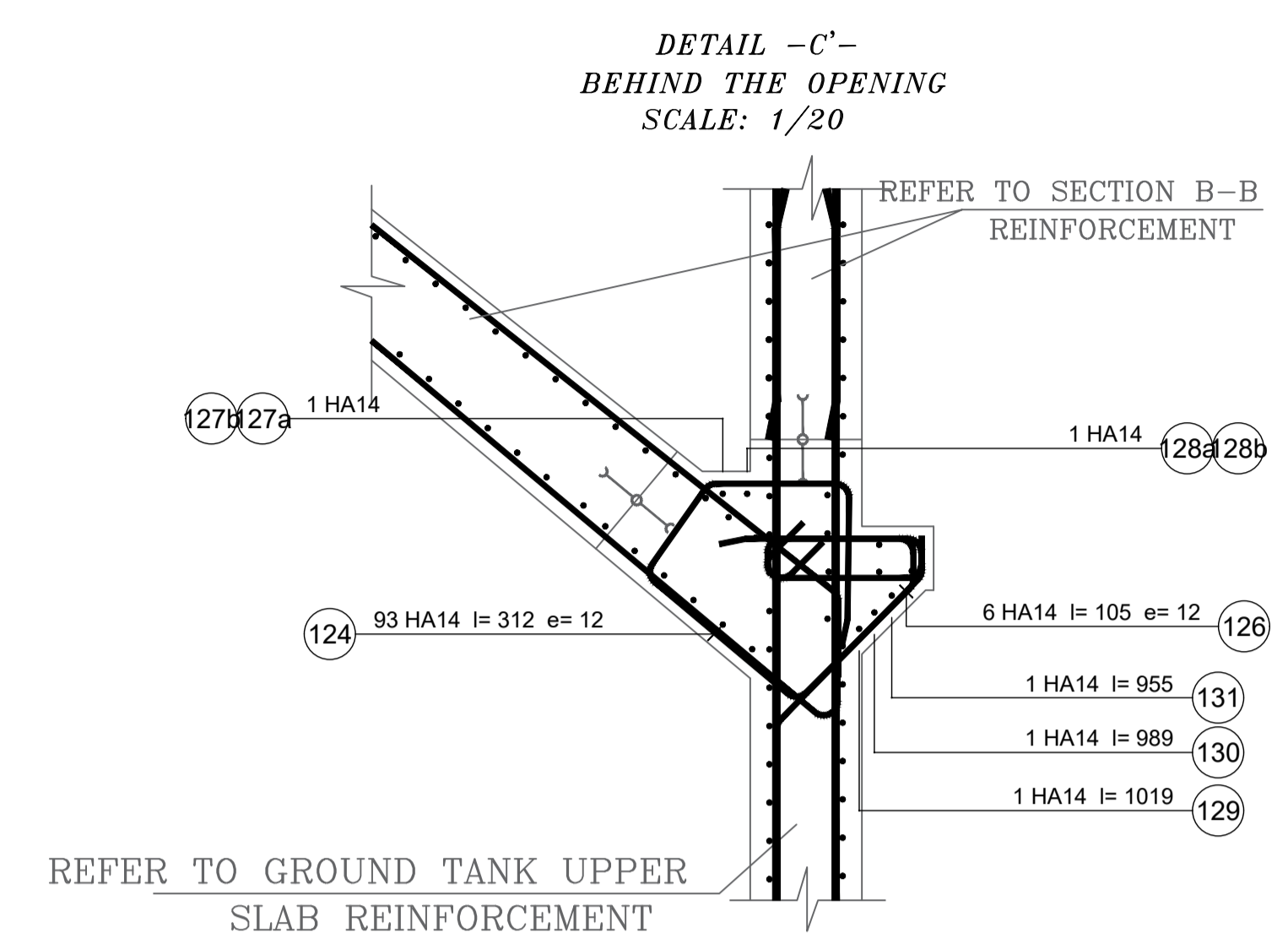
DETAIL -A-
SCALE: 1/20



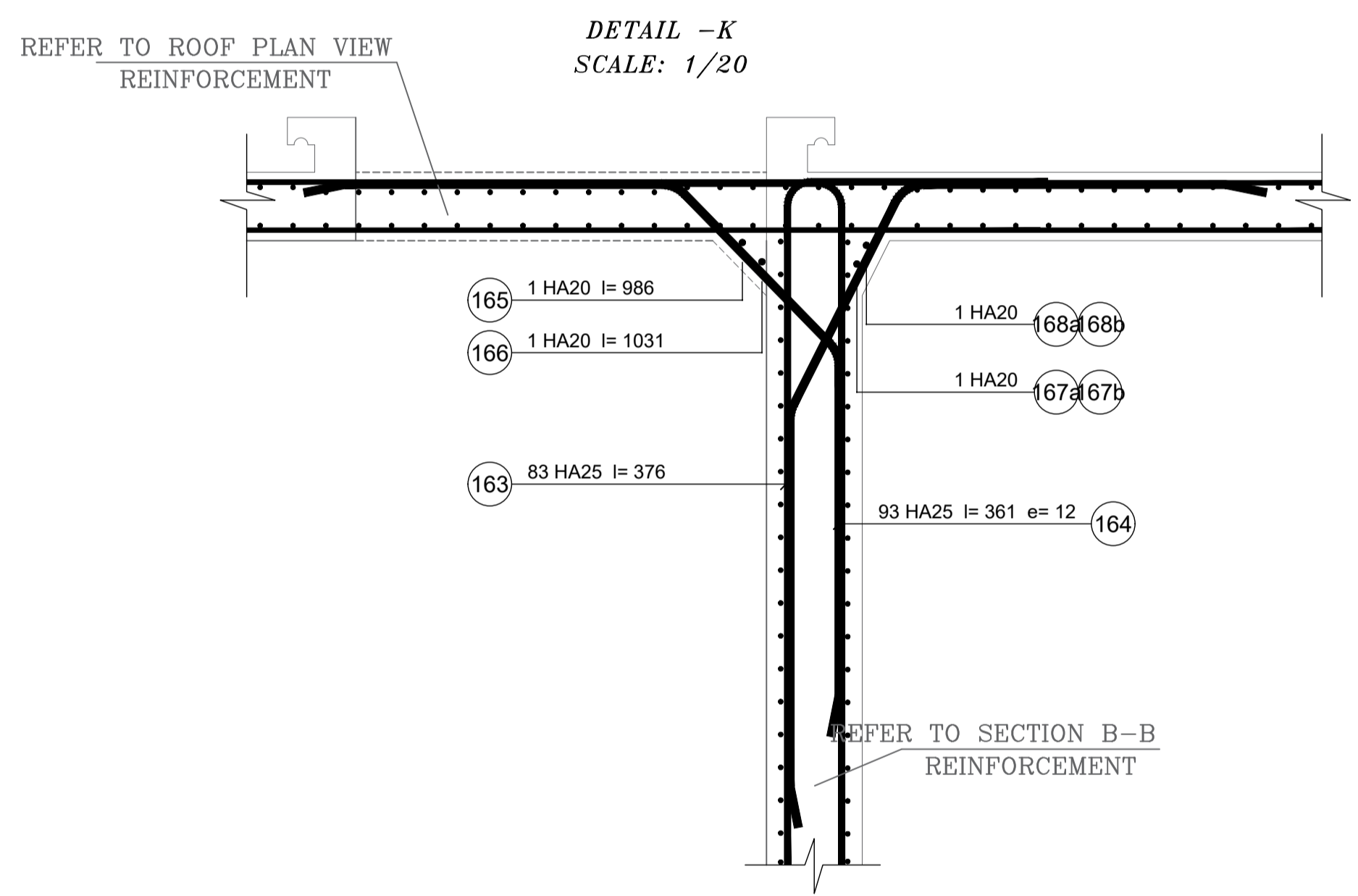
DETAIL -B1-
SCALE: 1/20



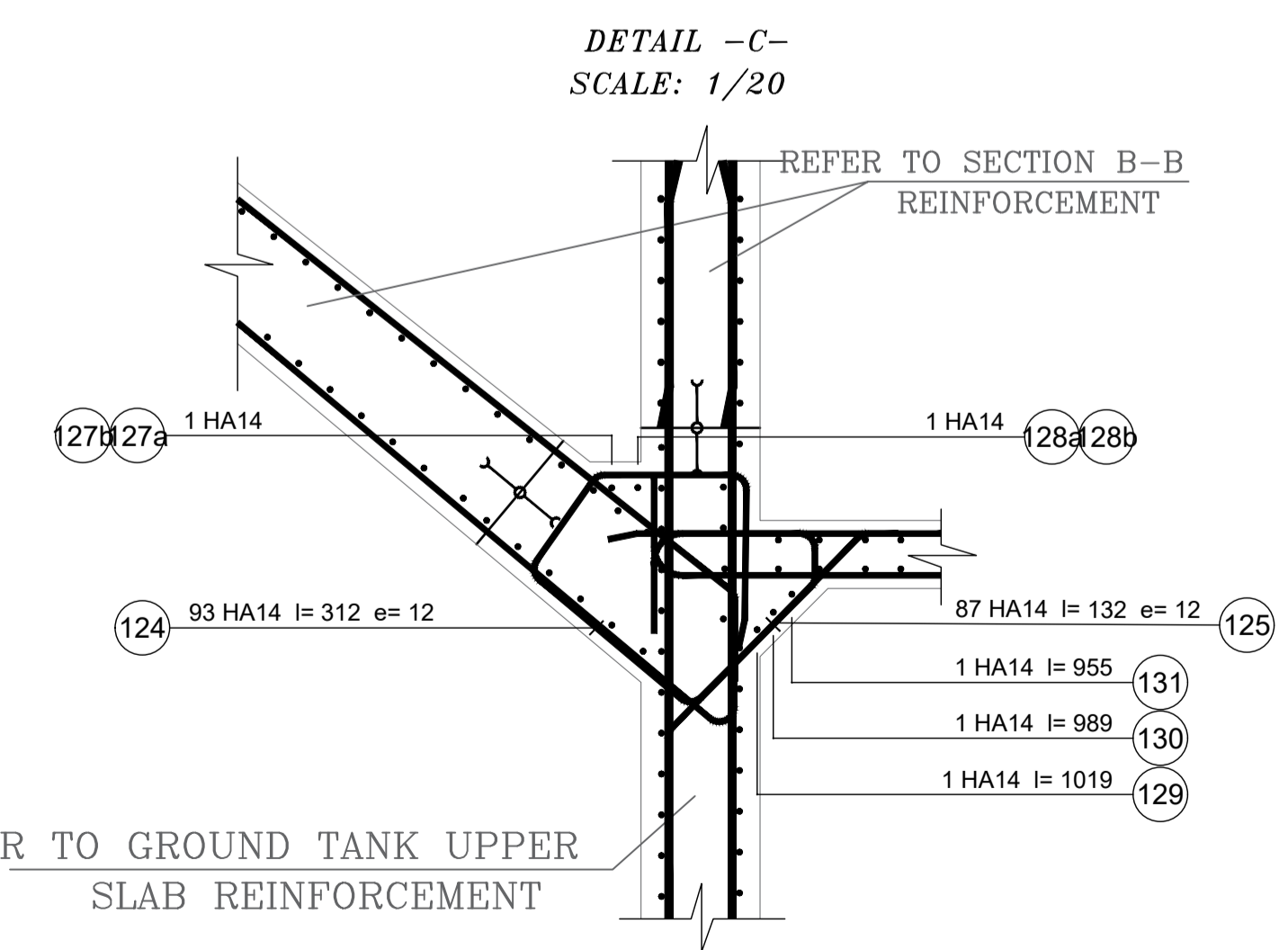
DETAIL -B2-
SCALE: 1/20



**DETAIL -C'-
BEHIND THE OPENING**
SCALE: 1/20



DETAIL -K
SCALE: 1/20



DETAIL -C-
SCALE: 1/20

NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, $\phi = 150\text{mm}$: 37N/mm²
- ON A CYLINDER $\phi = 150\text{mm}$, h=300mm : 30N/mm²

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: $F_y = 420 \text{ N/mm}^2$
MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y = 215 \text{ N/mm}^2$
MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 60\phi$
(ϕ = BAR NOMINAL DIAMETER)
PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:
 $\phi > 12\text{mm}$ MECHANICAL
 $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION (Performed by SAFWAN ABUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
* SCALING FROM THESE DRAWINGS IS NOT ALLOWED
* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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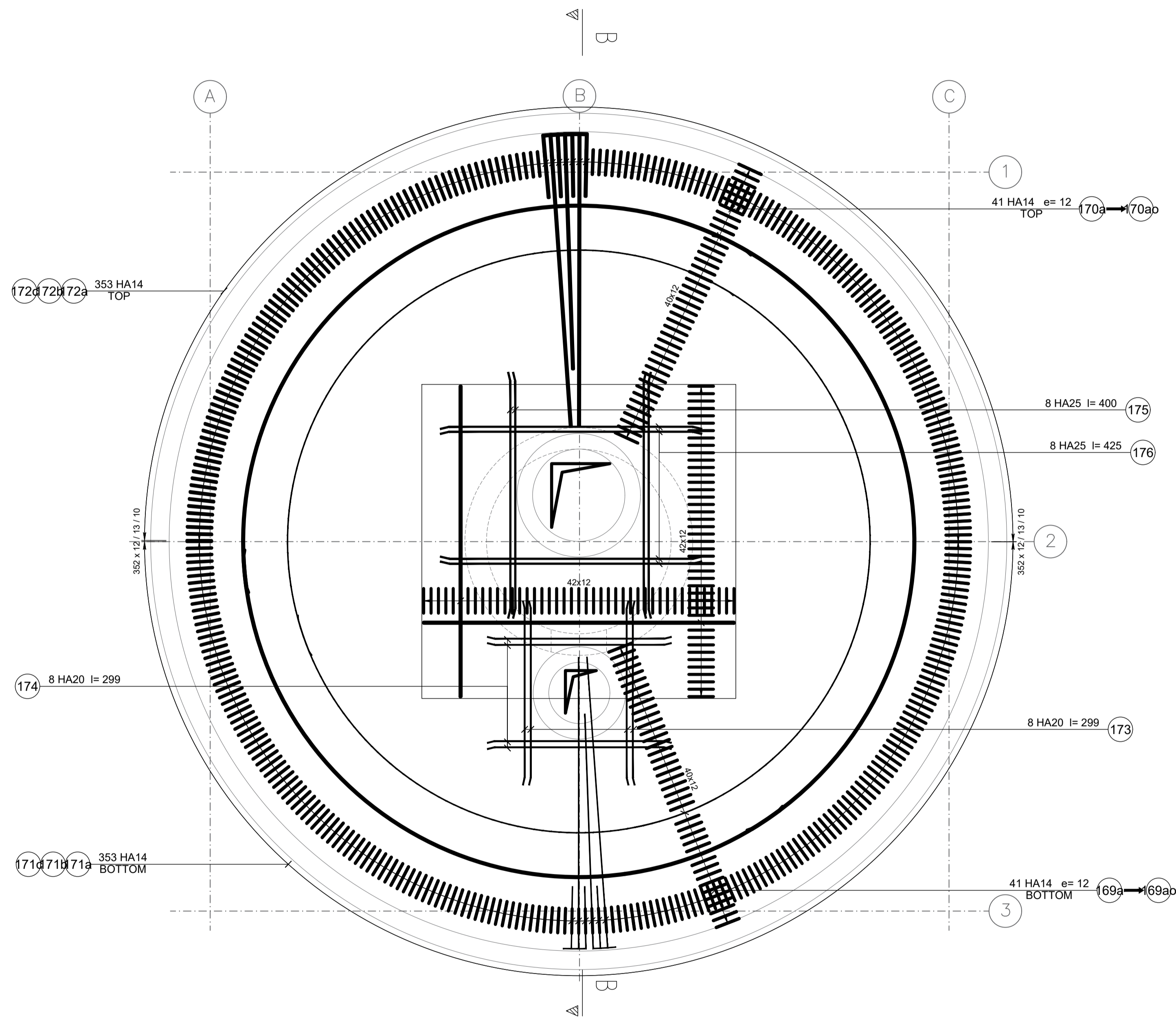
BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
|--|---|
| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | REINFORCEMENT - SECTION AND DETAILS REINFORCEMENT |
|--|---|

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|--------------|-----------|--------------|
| MARCH 2023 | 1/50 1/20 | 18 | 667W-02STR18 |



ROOF PLAN VIEW - REINFORCEMENT
SCALE: 1/50

NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
- Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, a= 150mm :37N/mm²
 - ON A CYLINDER ø=150mm, h=300mm :30N/mm²

CONCRETE COVER:

- THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 - 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 - 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 - 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T

YIELD STRESS: Fy=420 N/mm².

MILD STEEL BARS: SYMBOL ø YIELD STRESS: Fy=215 N/mm².

MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:

- LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
- WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60ø
- (ø = BAR NOMINAL DIAMETER)
- PINS ø8 SHALL BE USED ON EACH LAP.

BENDING:

- ø>12mm MECHANICAL
- ø<12mm MANUAL (POSSIBLY)
- STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

- ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
- THE USE OF ø6mm BARS AS TIE-RODS IS NOT ALLOWED.
- HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
- ALL CORNERS SHALL BE CHAMFERED.
- ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

- BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

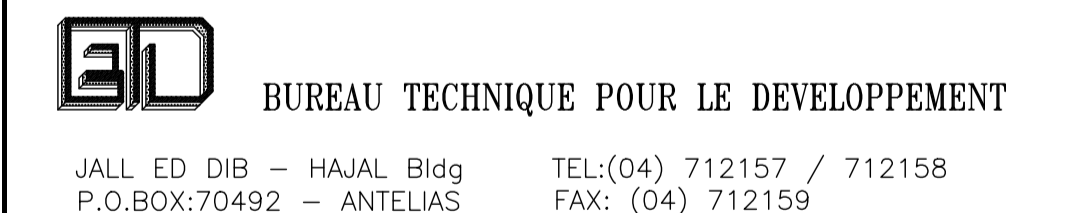
- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

- * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
- * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
- * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
|--|--|
| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | REINFORCEMENT - ROOF PLAN VIEW REINFORCEMENT |
|--|--|

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
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| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|--------------|
| MARCH 2023 | 1/50 | 19 | 667W-02STR19 |

| Rebars General nomenclature | | | | | | | | | |
|-----------------------------|------|-----|----------|-------|-------------|-------|--------------|--------|--------------|
| N° | Type | φ | quantity | Space | Unit Length | sTpe | Total Length | Weight | Total Weight |
| 1a | HA20 | 43 | 1 | 43 | 651 | | 29993 | | |
| 1b | HA20 | 42 | 1 | 42 | 571 | | 23982 | | |
| 1c | HA20 | 84 | 1 | 84 | 437 | | 36708 | | |
| 1d | HA20 | 168 | 1 | 168 | 170 | | 28560 | | |
| 2a | HA20 | 43 | 1 | 43 | 582 | | 25026 | | |
| 2b | HA20 | 42 | 1 | 42 | 571 | | 23982 | | |
| 2c | HA20 | 84 | 1 | 84 | 437 | | 36708 | | |
| 2d | HA20 | 168 | 1 | 168 | 170 | | 28560 | | |
| 3 | HA20 | 37 | 1 | 37 | 12 | 4.66 | 16502 | | |
| 4 | HA20 | 37 | 1 | 37 | 12 | 4.46 | 16502 | | |
| 5 | HA20 | 38 | 1 | 38 | 12 | 4.66 | 24016 | | |
| 6 | HA20 | 37 | 1 | 37 | 12 | 6.82 | 25234 | | |
| 7a | HA20 | 4 | 1 | 4 | 12 | 1122* | 4488 | | |
| 7b | HA20 | 4 | 1 | 4 | 12 | 1103* | 4412 | | |
| 7c | HA20 | 4 | 1 | 4 | 12 | 1084* | 4336 | | |
| 7d | HA20 | 4 | 1 | 4 | 12 | 1066* | 4264 | | |
| 7e | HA20 | 4 | 1 | 4 | 12 | 1047* | 4188 | | |
| 7f | HA20 | 4 | 1 | 4 | 12 | 1028* | 4112 | | |
| 7g | HA20 | 4 | 1 | 4 | 12 | 1009* | 4036 | | |
| 7h | HA20 | 4 | 1 | 4 | 12 | 990* | 3960 | | |
| 7i | HA20 | 4 | 1 | 4 | 12 | 971* | 3884 | | |
| 7j | HA20 | 4 | 1 | 4 | 12 | 953* | 3812 | | |
| 7k | HA20 | 4 | 1 | 4 | 12 | 934* | 3736 | | |
| 7l | HA20 | 3 | 1 | 3 | 12 | 1186* | 3558 | | |
| 7m | HA20 | 3 | 1 | 3 | 12 | 1161* | 3483 | | |
| 7n | HA20 | 3 | 1 | 3 | 12 | 1136* | 3408 | | |
| 7o | HA20 | 3 | 1 | 3 | 12 | 1111* | 3333 | | |
| 7p | HA20 | 3 | 1 | 3 | 12 | 1086* | 3258 | | |
| 7q | HA20 | 3 | 1 | 3 | 12 | 1061* | 3183 | | |
| 7r | HA20 | 3 | 1 | 3 | 12 | 1036* | 3108 | | |
| 7s | HA20 | 3 | 1 | 3 | 12 | 1011* | 3033 | | |
| 7t | HA20 | 3 | 1 | 3 | 12 | 985* | 2958 | | |
| 7u | HA20 | 3 | 1 | 3 | 12 | 960* | 2880 | | |
| 7v | HA20 | 3 | 1 | 3 | 12 | 935* | 2805 | | |
| 7w | HA20 | 3 | 1 | 3 | 12 | 910* | 2730 | | |
| 7x | HA20 | 3 | 1 | 3 | 12 | 885* | 2655 | | |
| 7y | HA20 | 3 | 1 | 3 | 12 | 860* | 2580 | | |
| 7z | HA20 | 3 | 1 | 3 | 12 | 835* | 2505 | | |
| 7aa | HA20 | 2 | 1 | 2 | 12 | 1164* | 2328 | | |
| 7ab | HA20 | 2 | 1 | 2 | 12 | 1126* | 2252 | | |
| 7ac | HA20 | 2 | 1 | 2 | 12 | 1089* | 2178 | | |
| 7ad | HA20 | 2 | 1 | 2 | 12 | 1051* | 2102 | | |
| 7ae | HA20 | 2 | 1 | 2 | 12 | 1013* | 2026 | | |
| 7af | HA20 | 2 | 1 | 2 | 12 | 976* | 1952 | | |
| 7ag | HA20 | 2 | 1 | 2 | 12 | 938* | 1876 | | |
| 7ah | HA20 | 2 | 1 | 2 | 12 | 900* | 1800 | | |
| 7ai | HA20 | 2 | 1 | 2 | 12 | 863* | 1726 | | |
| 7aj | HA20 | 2 | 1 | 2 | 12 | 825* | 1650 | | |
| 7ak | HA20 | 2 | 1 | 2 | 12 | 787* | 1574 | | |
| 7al | HA20 | 2 | 1 | 2 | 12 | 749* | 1498 | | |
| 7am | HA20 | 2 | 1 | 2 | 12 | 712* | 1424 | | |
| 7an | HA20 | 2 | 1 | 2 | 12 | 674* | 1348 | | |
| 7ao | HA20 | 1 | 1 | 1 | 12 | 1173 | 1173 | | |
| 7a | HA20 | 4 | 1 | 4 | 12 | 1122* | 4488 | | |
| 7b | HA20 | 4 | 1 | 4 | 12 | 1103* | 4412 | | |
| 7c | HA20 | 4 | 1 | 4 | 12 | 1084* | 4336 | | |
| 7d | HA20 | 4 | 1 | 4 | 12 | 1066* | 4264 | | |
| 7e | HA20 | 4 | 1 | 4 | 12 | 1047* | 4188 | | |
| 7f | HA20 | 4 | 1 | 4 | 12 | 1028* | 4112 | | |
| 7g | HA20 | 4 | 1 | 4 | 12 | 1009* | 4036 | | |
| 7h | HA20 | 4 | 1 | 4 | 12 | 990* | 3960 | | |
| 7i | HA20 | 4 | 1 | 4 | 12 | 971* | 3884 | | |
| 7j | HA20 | 4 | 1 | 4 | 12 | 953* | 3812 | | |
| 7k | HA20 | 4 | 1 | 4 | 12 | 934* | 3736 | | |
| 7l | HA20 | 3 | 1 | 3 | 12 | 1186* | 3558 | | |
| 7m | HA20 | 3 | 1 | 3 | 12 | 1161* | 3483 | | |
| 7n | HA20 | 3 | 1 | 3 | 12 | 1136* | 3408 | | |
| 7o | HA20 | 3 | 1 | 3 | 12 | 1111* | 3333 | | |
| 7p | HA20 | 3 | 1 | 3 | 12 | 1086* | 3258 | | |
| 7q | HA20 | 3 | 1 | 3 | 12 | 1061* | 3183 | | |
| 7r | HA20 | 3 | 1 | 3 | 12 | 1036* | 3108 | | |
| 7s | HA20 | 3 | 1 | 3 | 12 | 1011* | 3033 | | |
| 7t | HA20 | 3 | 1 | 3 | 12 | 985* | 2958 | | |
| 7u | HA20 | 3 | 1 | 3 | 12 | 960* | 2880 | | |
| 7v | HA20 | 3 | 1 | 3 | 12 | 935* | 2805 | | |
| 7w | HA20 | 3 | 1 | 3 | 12 | 910* | 2730 | | |
| 7x | HA20 | 3 | 1 | 3 | 12 | 885* | 2655 | | |
| 7y | HA20 | 3 | 1 | 3 | 12 | 860* | 2580 | | |
| 7z | HA20 | 3 | 1 | 3 | 12 | 835* | 2505 | | |
| 7aa | HA20 | 2 | 1 | 2 | 12 | 1164* | 2328 | | |
| 7ab | HA20 | 2 | 1 | 2 | 12 | 1126* | 2252 | | |
| 7ac | HA20 | 2 | 1 | 2 | 12 | 1089* | 2178 | | |

| Rebars General nomenclature | | | | | | | | | |
|-----------------------------|------|-----|----------|-------|-------------|-------|--------------|--------|--------------|
| N° | Type | φ | quantity | Space | Unit Length | sTpe | Total Length | Weight | Total Weight |
| 8ad | HA20 | 2 | 1 | 2 | 12 | 1051* | 2102 | | |
| 8ae | HA20 | 2 | 1 | 2 | 12 | 1013* | 2026 | | |
| 8af | HA20 | 2 | 1 | 2 | 12 | 976* | 1952 | | |
| 8ag | HA20 | 2 | 1 | 2 | 12 | 938* | 1876 | | |
| 8ah | HA20 | 2 | 1 | 2 | 12 | 900* | 1800 | | |
| 8ai | HA20 | 2 | 1 | 2 | 12 | 863* | 1726 | | |
| 8aj | HA20 | 2 | 1 | 2 | 12 | 825* | 1650 | | |
| 8ak | HA20 | 2 | 1 | 2 | 12 | 787* | 1574 | | |
| 8al | HA20 | 2 | 1 | 2 | 12 | 749* | 1498 | | |
| 8am | HA20 | 2 | 1 | 2 | 12 | 712* | 1424 | | |
| 8an | HA20 | 2 | 1 | 2 | 12 | 674* | 1348 | | |
| 8ao | HA20 | 1 | 1 | 1 | 12 | 1173 | 1173 | | |
| 9 | HA12 | 310 | 1 | 310 | 12 | 363 | 112530 | | |
| 10 | HA12 | 303 | 1 | 303 | 12 | 363 | 109989 | | |
| 11 | HA12 | 310 | 1 | 310 | 12 | 386 | 119660 | | |
| 12a | HA14 | 4 | 1 | 4 | 4 | 974* | 3896 | | |
| 12b | HA14 | 4 | 1 | 4 | 4 | 968* | 3872 | | |
| 12c | HA14 | 4 | 1 | 4 | 4 | 962* | 3848 | | |
| 12d | HA14 | 4 | 1 | 4 | 4 | 957* | 3828 | | |
| 12e | HA14 | 4 | 1 | 4 | 4 | 951* | 3804 | | |
| 13 | HA20 | 83 | 1 | 83 | 12 | 362 | 30046 | | |
| 14 | HA20 | 93 | 1 | 93 | 12 | 270 | 25110 | | |
| 15 | HA20 | 83 | 1 | 83 | 12 | 270 | 22410 | | |
| 16 | HA12 | 310 | 1 | 310 | 12 | 755 | 234050 | | |
| 17 | HA12 | 303 | 1 | 303 | 12 | 754 | 228462 | | |
| 18 | HA20 | 93 | 1 | 93 | 12 | 880 | 81840 | | |
| 19 | HA20 | 83 | 1 | 83 | 12 | 880 | 73040 | | |
| 20a | HA20 | 201 | 1 | 201 | 12 | 1200 | 241200 | | |
| 20b | HA20 | 67 | 1 | 67 | 12 | 539 | 36113 | | |
| 21a | HA14 | 201 | 1 | 201 | 12 | 1200 | 241200 | | |
| 21b | HA14 | 67 | 1 | 67 | 12 | 306 | 20502 | | |
| 22 | HA14 | 64 | 1 | 64 | 12 | 1196 | 76544 | | |
| 23 | HA14 | 64 | 1 | 64 | 12 | 1049 | 67136 | | |
| 24 | HA8 | 186 | 1 | 186 | 20 | 161 | 29946 | | |
| 25 | HA8 | 186 | 1 | 186 | 20 | 45 | 8370 | | |
| 26a | HA12 | 3 | 1 | 3 | 1200 | | 3600 | | |
| 26b | HA12 | 1 | 1 | 1 | 1 | 222 | 222 | | |
| 27a | HA12 | 9 | 1 | 9 | 1200 | | 10800 | | |
| 27b | HA12 | 3 | 1 | 3 | 287 | | 861 | | |
| 28a | HA12 | 9 | 1 | 9 | 1200 | | 10800 | | |
| 28b | HA12 | 3 | 1 | 3 | 376 | | 1128 | | |
| 29 | HA8 | 16 | 1 | 16 | 20 | 141 | 2256 | | |
| 30 | HA12 | 5 | 1 | 5 | 353 | | 1765 | | |
| 31 | HA12 | 3 | 1 | 3 | 389 | | 1167 | | |
| 32 | HA8 | 24 | 1 | 24 | 20 | 141 | 3384 | | |
| 33 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 34 | HA10 | 5 | 1 | 5 | 179 | | 895 | | |
| 35 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 36 | HA10 | 5 | 1 | 5 | 179 | | 895 | | |
| 37 | HA10 | 5 | 1 | 5 | 345 | | 1725 | | |
| 38 | HA10 | 5 | 1 | 5 | 345 | | 1725 | | |
| 39 | HA8 | 20 | 1 | 20 | 140 | | 2800 | | |
| 40 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 41 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 42 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 43 | HA10 | 5 | 1 | 5 | 139 | | 695 | | |
| 44 | HA10 | 5 | 1 | 5 | 305 | | 1525 | | |
| 45 | HA10 | 5 | 1 | 5 | 305 | | 1525 | | |
| 46 | HA8 | 24 | 1 | 24 | 20 | 115 | 2760 | | |
| 47 | HA8 | 20 | 1 | 20 | 20 | 115 | 2300 | | |
| 48 | HA8 | 16 | 1 | 16 | 20 | 115 | 1840 | | |
| 49 | HA16 | 4 | 1 | 4 | 320 | | 1280 | | |
| 50 | HA14 | 4 | 1 | 4 | 300 | | 1200 | | |
| 51 | HA16 | 4 | 1 | 4 | 300 | | 1200 | | |
| 52 | HA14 | 4 | 1 | 4 | 280 | | 1120 | | |
| 54 | HA14 | 8 | 1 | 8 | 260 | | 2080 | | |
| 55 | HA16 | 8 | 1 | 8 | 280 | | 2240 | | |
| 56 | HA16 | 4 | 1 | 4 | 290 | | 1160 | | |
| 57 | HA14 | 4 | 1 | 4 | 270 | | 1080 | | |
| 58 | HA14 | 4 | 1 | 4 | 323 | | 1292 | | |
| 59 | HA16 | 4 | 1 | 4 | 335 | | 1340 | | |
| 60a | HA10 | 80 | 1 | 80 | 436 | | 34880 | | |
| 60b | HA10 | 79 | 1 | 79 | 362 | | 28598 | | |
| 60c | HA10 | 158 | 1 | 158 | 111 | | 17538 | | |
| 61a | HA12 | 80 | 1 | 80 | 428 | | 34240 | | |
| 61b | HA12 | 79 | 1 | 79 | 365 | | 28835 | | |
| 61c | HA12 | 158 | 1 | 158 | 113 | | 17854 | | |
| 62 | HA12 | 37 | 1 | 37 | 12 | 430 | 15910 | | |
| 63 | HA12 | 36 | 1 | 36 | 12 | 440 | 15840 | | |
| 64 | HA10 | 27 | 1 | 27 | 12 | 316 | 8532 | | |
| 65 | HA10 | 27 | 1 | 27 | 12 | 314 | 8478 | | |
| 67 | HA20 | 20 | 4 | 80 | 380 | | 30400 | | |

| Rebars General nomenclature | | | | | | | | | |
|-----------------------------|------|----|----------|-------|-------------|------|--------------|--------|--------------|
| N° | Type | φ | quantity | Space | Unit Length | sTpe | Total Length | Weight | Total Weight |
| 68 | HA20 | 8 | 4 | 32 | 340 | | 10880 | | |
| 69 | HA20 | 8 | 4 | 32 | 340 | | 10880 | | |
| 70 | HA25 | 20 | 1 | 20 | 490 | | 9800 | | |
| 71 | HA20 | 8 | 1 | 8 | 370 | | 2960 | | |
| 72 | HA20 | 8 | 1 | 8 | 370 | | 2960 | | |
| 73 | HA8 | 4 | 32 | | | | | | |

| Rebars General nomenclature | | | | | | | | | | |
|-----------------------------|------|-----|----------|---------|-------|-------|-------------|-------|--------------|---|
| N° | Type | Ø | Quantity | | | Space | Unit Length | sType | Total Length | m |
| | | | in each | of them | TOTAL | | | | | |
| 177b | HA10 | 4 | 1 | 4 | 12 | 981* | | 110 | 3924 | |
| 177c | HA10 | 4 | 1 | 4 | 12 | 962* | | 110 | 3848 | |
| 177d | HA10 | 4 | 1 | 4 | 12 | 943* | | 110 | 3772 | |
| 177e | HA10 | 4 | 1 | 4 | 12 | 924* | | 110 | 3696 | |
| 177f | HA10 | 3 | 1 | 3 | 12 | 1191* | | 110 | 3573 | |
| 177g | HA10 | 3 | 1 | 3 | 12 | 1165* | | 110 | 3495 | |
| 177h | HA10 | 3 | 1 | 3 | 12 | 1140* | | 110 | 3420 | |
| 177i | HA10 | 3 | 1 | 3 | 12 | 1115* | | 110 | 3345 | |
| 177j | HA10 | 3 | 1 | 3 | 12 | 1090* | | 110 | 3270 | |
| 177k | HA10 | 3 | 1 | 3 | 12 | 1065* | | 110 | 3195 | |
| 177l | HA10 | 3 | 1 | 3 | 12 | 1040* | | 110 | 3120 | |
| 177m | HA10 | 3 | 1 | 3 | 12 | 1015* | | 110 | 3045 | |
| 177n | HA10 | 3 | 1 | 3 | 12 | 989* | | 110 | 2967 | |
| 177o | HA10 | 3 | 1 | 3 | 12 | 964* | | 110 | 2892 | |
| 177p | HA10 | 3 | 1 | 3 | 12 | 939* | | 110 | 2817 | |
| 177q | HA10 | 3 | 1 | 3 | 12 | 914* | | 110 | 2742 | |
| 177r | HA10 | 3 | 1 | 3 | 12 | 889* | | 110 | 2667 | |
| 177s | HA10 | 3 | 1 | 3 | 12 | 864* | | 110 | 2592 | |
| 177t | HA10 | 3 | 1 | 3 | 12 | 839* | | 110 | 2517 | |
| 177u | HA10 | 2 | 1 | 2 | 12 | 1195* | | 110 | 2390 | |
| 177v | HA10 | 2 | 1 | 2 | 12 | 1158* | | 110 | 2316 | |
| 177w | HA10 | 2 | 1 | 2 | 12 | 1120* | | 110 | 2240 | |
| 177x | HA10 | 2 | 1 | 2 | 12 | 1082* | | 110 | 2164 | |
| 177y | HA10 | 2 | 1 | 2 | 12 | 1044* | | 110 | 2088 | |
| 177z | HA10 | 2 | 1 | 2 | 12 | 1007* | | 110 | 2014 | |
| 177aa | HA10 | 2 | 1 | 2 | 12 | 969* | | 110 | 1938 | |
| 177ab | HA10 | 2 | 1 | 2 | 12 | 931* | | 110 | 1862 | |
| 177ac | HA10 | 2 | 1 | 2 | 12 | 894* | | 110 | 1788 | |
| 177ad | HA10 | 2 | 1 | 2 | 12 | 856* | | 110 | 1712 | |
| 177ae | HA10 | 2 | 1 | 2 | 12 | 818* | | 110 | 1636 | |
| 177af | HA10 | 2 | 1 | 2 | 12 | 781* | | 110 | 1562 | |
| 177ag | HA10 | 2 | 1 | 2 | 12 | 743* | | 110 | 1486 | |
| 177ah | HA10 | 2 | 1 | 2 | 12 | 705* | | 110 | 1410 | |
| 177ai | HA10 | 2 | 1 | 2 | 12 | 667* | | 110 | 1334 | |
| 178a | HA12 | 4 | 1 | 4 | 12 | 1012* | | 110 | 4048 | |
| 178b | HA12 | 4 | 1 | 4 | 12 | 993* | | 110 | 3972 | |
| 178c | HA12 | 4 | 1 | 4 | 12 | 974* | | 110 | 3896 | |
| 178d | HA12 | 4 | 1 | 4 | 12 | 956* | | 110 | 3824 | |
| 178e | HA12 | 4 | 1 | 4 | 12 | 937* | | 110 | 3748 | |
| 178f | HA12 | 4 | 1 | 4 | 12 | 918* | | 110 | 3672 | |
| 178g | HA12 | 3 | 1 | 3 | 12 | 1179* | | 110 | 3537 | |
| 178h | HA12 | 3 | 1 | 3 | 12 | 1154* | | 110 | 3462 | |
| 178i | HA12 | 3 | 1 | 3 | 12 | 1128* | | 110 | 3384 | |
| 178j | HA12 | 3 | 1 | 3 | 12 | 1103* | | 110 | 3309 | |
| 178k | HA12 | 3 | 1 | 3 | 12 | 1078* | | 110 | 3234 | |
| 178l | HA12 | 3 | 1 | 3 | 12 | 1053* | | 110 | 3159 | |
| 178m | HA12 | 3 | 1 | 3 | 12 | 1028* | | 110 | 3084 | |
| 178n | HA12 | 3 | 1 | 3 | 12 | 1003* | | 110 | 3009 | |
| 178o | HA12 | 3 | 1 | 3 | 12 | 978* | | 110 | 2934 | |
| 178p | HA12 | 3 | 1 | 3 | 12 | 953* | | 110 | 2859 | |
| 178q | HA12 | 3 | 1 | 3 | 12 | 927* | | 110 | 2781 | |
| 178r | HA12 | 3 | 1 | 3 | 12 | 902* | | 110 | 2706 | |
| 178s | HA12 | 3 | 1 | 3 | 12 | 877* | | 110 | 2631 | |
| 178t | HA12 | 3 | 1 | 3 | 12 | 852* | | 110 | 2556 | |
| 178u | HA12 | 3 | 1 | 3 | 12 | 827* | | 110 | 2481 | |
| 178v | HA12 | 2 | 1 | 2 | 12 | 1173* | | 110 | 2346 | |
| 178w | HA12 | 2 | 1 | 2 | 12 | 1135* | | 110 | 2270 | |
| 178x | HA12 | 2 | 1 | 2 | 12 | 1097* | | 110 | 2194 | |
| 178y | HA12 | 2 | 1 | 2 | 12 | 1059* | | 110 | 2118 | |
| 178z | HA12 | 2 | 1 | 2 | 12 | 1022* | | 110 | 2044 | |
| 178aa | HA12 | 2 | 1 | 2 | 12 | 984* | | 110 | 1968 | |
| 178ab | HA12 | 2 | 1 | 2 | 12 | 946* | | 110 | 1892 | |
| 178ac | HA12 | 2 | 1 | 2 | 12 | 909* | | 110 | 1818 | |
| 178ad | HA12 | 2 | 1 | 2 | 12 | 871* | | 110 | 1742 | |
| 178ae | HA12 | 2 | 1 | 2 | 12 | 833* | | 110 | 1666 | |
| 178af | HA12 | 2 | 1 | 2 | 12 | 796* | | 110 | 1592 | |
| 178ag | HA12 | 2 | 1 | 2 | 12 | 758* | | 110 | 1516 | |
| 178ah | HA12 | 2 | 1 | 2 | 12 | 720* | | 110 | 1440 | |
| 178ai | HA12 | 2 | 1 | 2 | 12 | 682* | | 110 | 1364 | |
| 179a | HA16 | 9 | 1 | 9 | | 1200 | | | 10800 | |
| 179b | HA16 | 3 | 1 | 3 | | 668 | | | 2004 | |
| 180 | HA14 | 349 | 1 | 349 | 12 | 117 | | 110 | 40833 | |

* : Average length Average Diam. : 15.6mm

| REBARS SUMMARY | | | | | | | | | | | | |
|-------------------------|-------|--------|--------|---------|---------|-----------------------|---------|--------|-------|-------|-----|-------------|
| DIAMETRE | HA6 | HA8 | HA10 | HA12 | HA14 | HA16 | HA20 | HA25 | HA32 | HA40 | HA- | Aver.Ø (mm) |
| MASSE (kg/ml) | 0.222 | 0.395 | 0.617 | 0.888 | 1.208 | 1.578 | 2.466 | 3.854 | 6.313 | 9.864 | - | 15.67 |
| LONG (m) | - | 1090.1 | 2924.1 | 11508.7 | 22158.5 | 577.8 | 16223.6 | 811.8 | - | - | - | TOTAL (kg) |
| MASSE (kg) | - | 430.6 | 1804.1 | 10219.7 | 26767.5 | 911.8 | 40007.4 | 3128.7 | - | - | - | 83269.9 |
| Average Diam. : 15.6 mm | | | | | | Posed mass : 83270 kg | | | | | | |

NOTES

REINFORCED CONCRETE:
 NORMAL PORTLAND CEMENT
 Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL CONCRETE ELEMENTS.
 Grade C30 : CEMENT RATIO 400 Kg/m3 FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
 Grade C20 : CEMENT RATIO 250 Kg/m3 FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
 Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
 SEVERE CONTROL.
 CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
 - ON A CUBE, $\alpha = 150\text{mm}$: 37N/mm2
 - ON A CYLINDER $\phi = 150\text{mm}$, $h = 300\text{mm}$: 30N/mm2

CONCRETE COVER:
 THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
 DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
 YIELD STRESS: $F_y = 420 \text{ N/mm}^2$
 MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y = 215 \text{ N/mm}^2$.
 MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:
 LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2x\phi$
 (ϕ = BAR NOMINAL DIAMETER)
 PINS $\phi 8$ SHALL BE USED ON EACH LAP.

BENDING:
 $\phi > 12\text{mm}$ MECHANICAL
 $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
 STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
 ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE. THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED. HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
 ALL CORNERS SHALL BE CHAMFERED.
 ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.
 WATERPROOFING:
 BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL.

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
 * SOIL BEARING CAPACITY = 5 bar (SLS).
 * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
 * ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
 * SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
 * ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drawn | Chk'd | Appr'd |
|------|------|------|-------|-------|--------|
| | | | | | |

REPUBLIC OF LEBANON



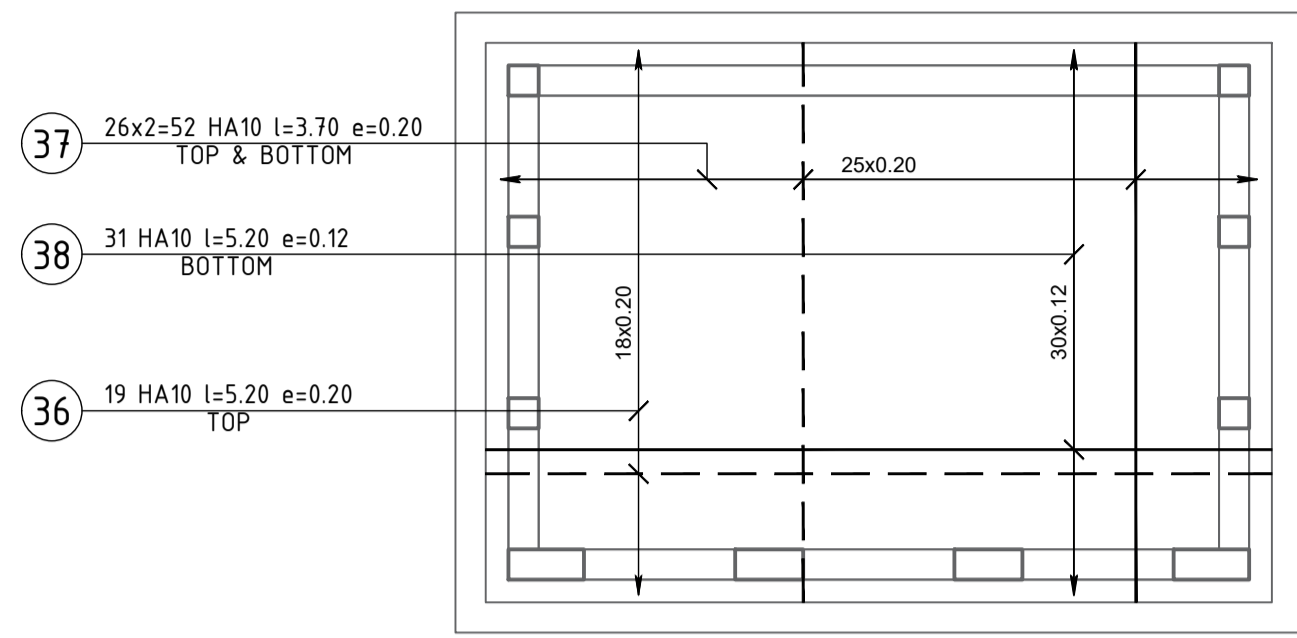
BD BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
 JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
 P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

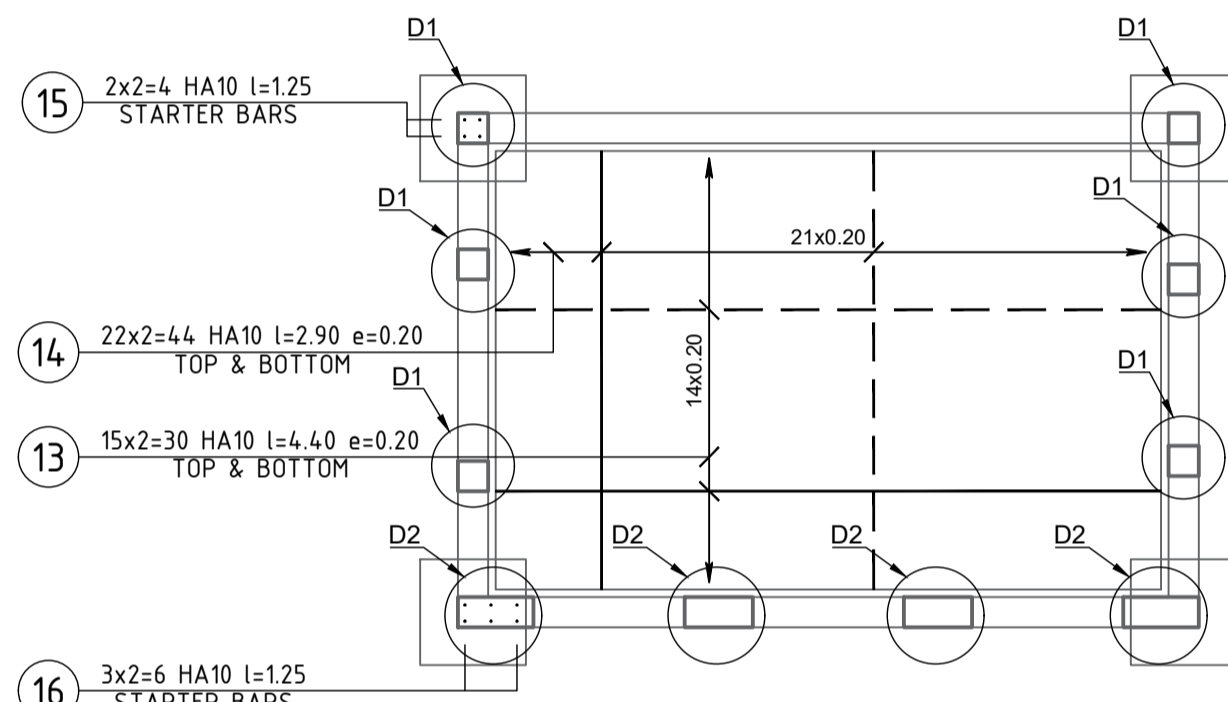
| | |
|--|--------------------------------------|
| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | REINFORCEMENT - BAR BENDING SCHEDULE |
|--|--------------------------------------|

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|--------------|
| MARCH 2023 | 1/50 | 21 | 667W-02STR21 |

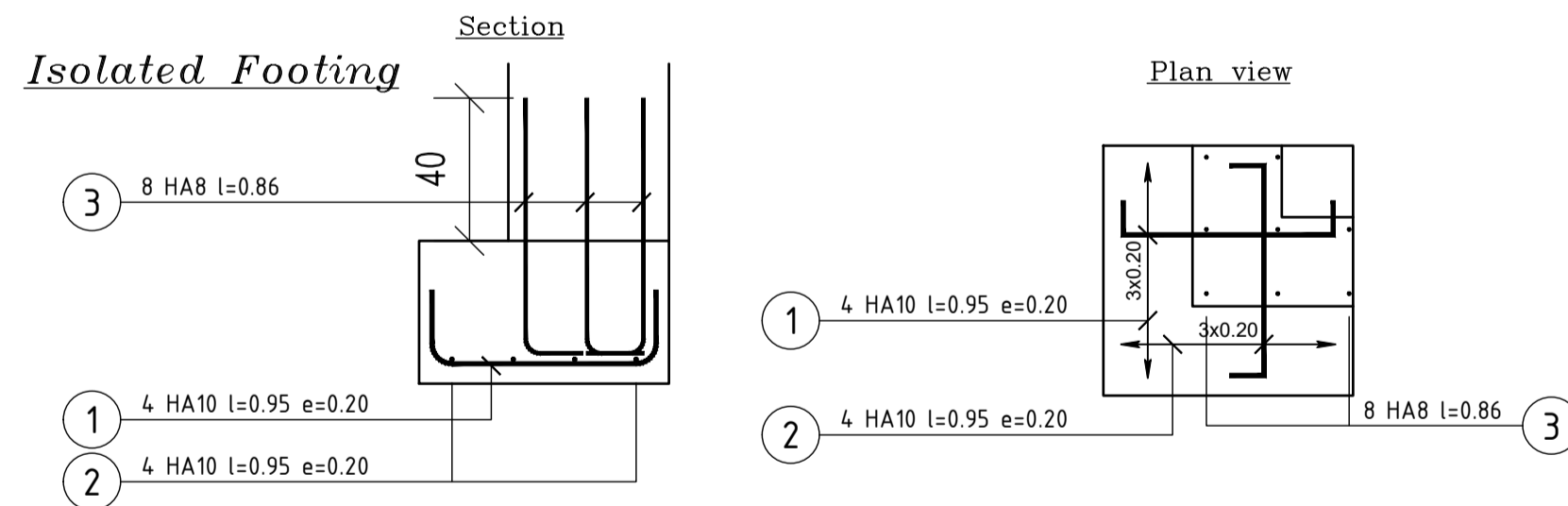


PUMPS CHAMBER - ROOF PLAN VIEW REINFORCEMENT
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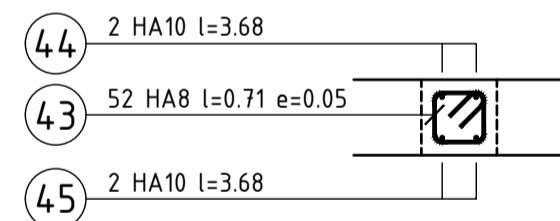


PUMPS CHAMBER - FONDATION REINFORCEMENT
SCALE: 1/50

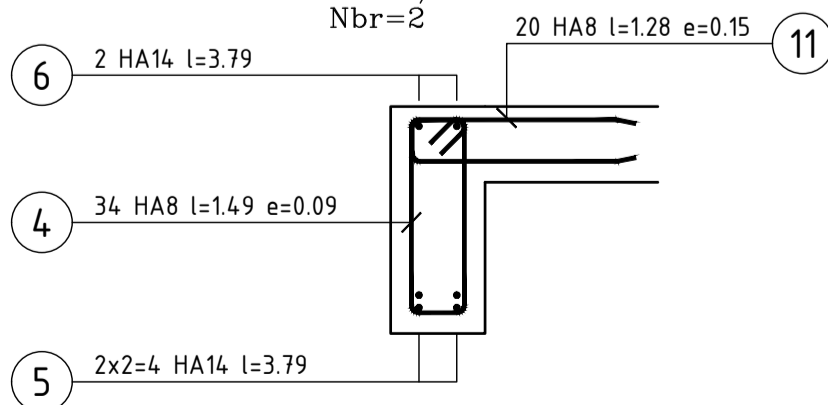
Isolated Footing
(70x70x40ht)
SCALE: 1/20
Nbr=4



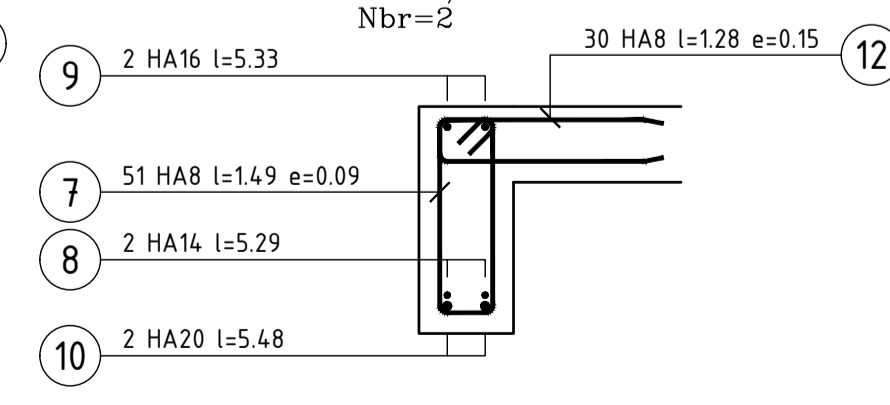
BN
(20x20ht)
SCALE: 1/20
Nbr=1



GROUND BEAM 1
(25x60ht)
SCALE: 1/20
Nbr=2

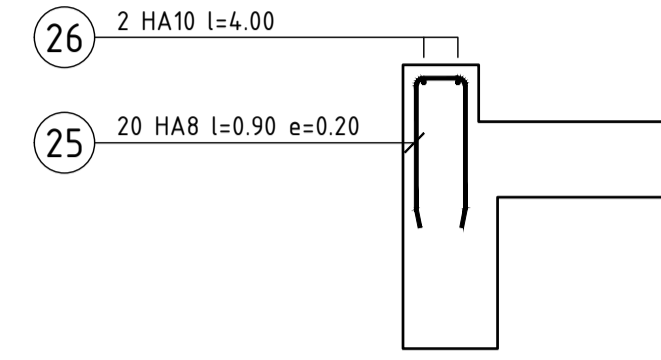


GROUND BEAM 2
(25x60ht)
SCALE: 1/20
Nbr=2

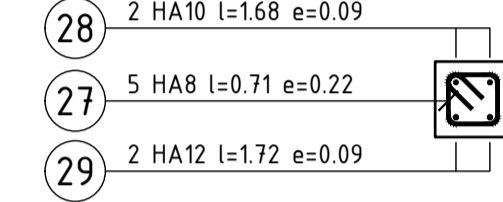


| REBARS SUMMARY | | | | | | | | | | | | |
|------------------------|-------|-------|----------------------|-------|-------|-------|-------|-------|-------|-------|-----|-------------|
| DIAMETRE | HA6 | HA8 | HA10 | HA12 | HA14 | HA16 | HA20 | HA25 | HA32 | HA40 | HA- | Aver-φ (mm) |
| MASSE (kg/ml) | 0.222 | 0.395 | 0.617 | 0.888 | 1.208 | 1.578 | 2.466 | 3.854 | 6.313 | 9.864 | - | 9.54 |
| LONG. (m) | - | 114.4 | 1078.2 | 69.5 | 66.6 | 21.3 | 21.9 | - | - | - | - | TOTAL (kg) |
| MASSE (kg) | - | 452 | 665.2 | 61.7 | 80.5 | 33.6 | 54.1 | - | - | - | - | 1347.2 |
| Average Diam. : 9.5 mm | | | Posed mass : 1347 kg | | | | | | | | | |

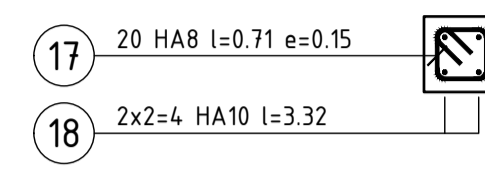
HEIGHT 20x15
SCALE: 1/20



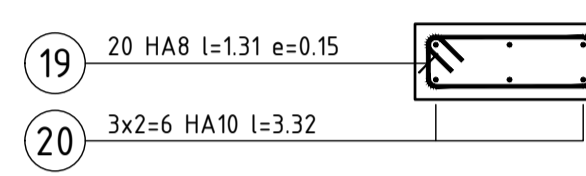
Lintel reinforcement
(20x20)
SCALE: 1/20
Nbr=2



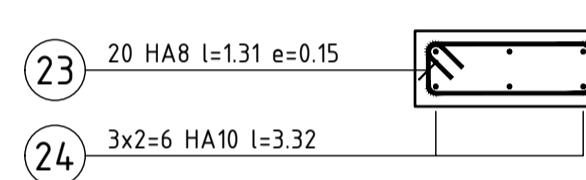
TIE COLUMN C1
(20x20)
SCALE: 1/20
Nbr=6



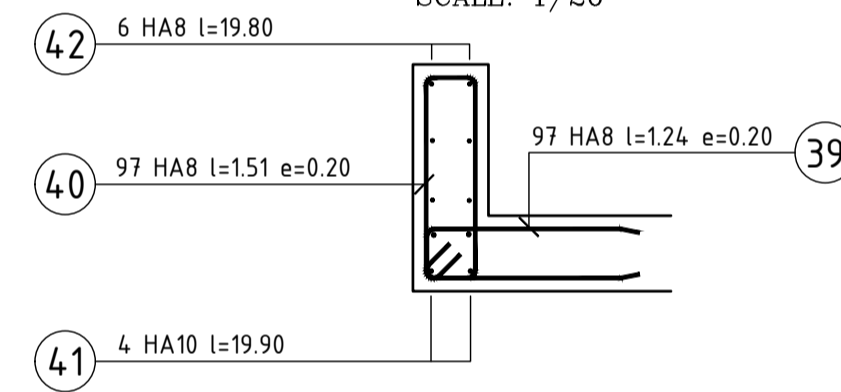
TIE COLUMN C2
(50x20)
SCALE: 1/20
Nbr=2



TIE COLUMN C3
(45x20)
SCALE: 1/20
Nbr=2



PARAPET
SCALE: 1/20



| Rebars General nomenclature | | | | | | | | | | | | |
|-----------------------------|------|----|----------|---------|-------|-------------|-------|--------------------------|--------------|--------|---|----|
| N° | Type | φ | quantity | | Space | Unit Length | sTpe | Marginal | Total Length | mm | m | kg |
| | | | in each | of Memb | | | | | | | | |
| 1 | HA | 10 | 4 | 4 | 16 | 0.20 | 0.95 | | 10 | 15.20 | | |
| 2 | HA | 10 | 4 | 4 | 16 | 0.20 | 0.95 | | 10 | 15.20 | | |
| 3 | HA | 8 | 8 | 4 | 32 | | 0.86 | | 7 | 27.52 | | |
| 4 | HA | 8 | 34 | 2 | 68 | 0.09 | 1.49 | | 3 | 101.32 | | |
| 5 | HA | 14 | 4 | 2 | 8 | 0.10 | 3.79 | | 15 | 30.32 | | |
| 6 | HA | 14 | 2 | 2 | 4 | 0.10 | 3.79 | | 15 | 15.16 | | |
| 7 | HA | 8 | 51 | 2 | 102 | 0.09 | 1.49 | | 3 | 151.98 | | |
| 8 | HA | 14 | 2 | 2 | 4 | 0.10 | 5.29 | | 15 | 21.16 | | |
| 9 | HA | 16 | 2 | 2 | 4 | 0.10 | 5.33 | | 15 | 21.32 | | |
| 10 | HA | 20 | 2 | 2 | 4 | 0.10 | 5.48 | | 20 | 21.92 | | |
| 11 | HA | 8 | 20 | 2 | 40 | 0.15 | 1.28 | | 3 | 51.20 | | |
| 12 | HA | 8 | 30 | 2 | 60 | 0.15 | 1.28 | | 3 | 76.80 | | |
| 13 | HA | 10 | 30 | 1 | 30 | 0.20 | 4.40 | | | 132.00 | | |
| 14 | HA | 10 | 44 | 1 | 44 | 0.20 | 2.90 | | | 127.60 | | |
| 15 | HA | 10 | 4 | 6 | 24 | 0.11 | 1.25 | | 10 | 30.00 | | |
| 16 | HA | 10 | 6 | 4 | 24 | 0.17 | 1.25 | | 10 | 30.00 | | |
| 17 | HA | 8 | 20 | 6 | 120 | 0.15 | 0.71 | | 3 | 85.20 | | |
| 18 | HA | 10 | 4 | 6 | 24 | 0.09 | 3.32 | | 10 | 79.68 | | |
| 19 | HA | 8 | 20 | 2 | 40 | 0.15 | 1.31 | | 3 | 52.40 | | |
| 20 | HA | 10 | 6 | 2 | 12 | 0.19 | 3.32 | | 10 | 39.84 | | |
| 23 | HA | 8 | 20 | 2 | 40 | 0.15 | 1.31 | | 3 | 52.40 | | |
| 24 | HA | 10 | 6 | 2 | 12 | 0.19 | 3.32 | | 10 | 39.84 | | |
| 25 | HA | 8 | 20 | 1 | 20 | 0.20 | 0.90 | | 3 | 18.00 | | |
| 26 | HA | 10 | 2 | 1 | 2 | 0.09 | 4.00 | | | 8.00 | | |
| 27 | HA | 8 | 5 | 2 | 10 | 0.22 | 0.71 | | 3 | 7.10 | | |
| 28 | HA | 10 | 2 | 2 | 4 | 0.09 | 1.68 | | 10 | 6.72 | | |
| 29 | HA | 12 | 2 | 2 | 4 | 0.09 | 1.72 | | 10 | 6.88 | | |
| 30 | HA | 8 | 21 | 1 | 21 | 0.15 | 1.01 | | 3.0 | 21.21 | | |
| 31 | HA | 10 | 2 | 1 | 2 | 0.09 | 3.68 | | 10.0 | 7.36 | | |
| 32 | HA | 10 | 2 | 1 | 2 | 0.09 | 3.68 | | 10.0 | 7.36 | | |
| 33 | HA | 8 | 38 | 2 | 76 | 0.12 | 1.01 | | 3 | 76.76 | | |
| 34 | HA | 12 | 2 | 2 | 4 | 0.09 | 5.22 | | 10 | 20.88 | | |
| 35 | HA | 12 | 4 | 2 | 8 | 0.09 | 5.22 | | 10 | 41.76 | | |
| 36 | HA | 10 | 19 | 1 | 19 | 0.20 | 5.20 | | | 98.80 | | |
| 37 | HA | 10 | 52 | 1 | 52 | 0.20 | 3.70 | | | 192.40 | | |
| 38 | HA | 10 | 31 | 1 | 31 | 0.12 | 5.20 | | | 161.20 | | |
| 39 | HA | 8 | 97 | 1 | 97 | 0.20 | 1.24 | | 3 | 120.28 | | |
| 40 | HA | 8 | 97 | 1 | 97 | 0.20 | 1.51 | | 3 | 146.47 | | |
| 41 | HA | 10 | 4 | 1 | 4 | | 19.90 | 1x 12.00 + 7.90 Rec=0.50 | | 79.60 | | |
| 42 | HA | 8 | 6 | 1 | 6 | | 19.80 | 1x 12.00 + 7.80 Rec=0.50 | | 118.80 | | |
| 43 | HA | 8 | 52 | 1 | 52 | 0.05 | 0.71 | | 3.0 | 36.92 | | |
| 44 | HA | 10 | 2 | 1 | 2 | 0.09 | 3.68 | | 10 | 7.36 | | |
| 45 | HA | 10 | 2 | 1 | 2 | 0.09 | 3.68 | | 10 | 7.36 | | |

* : Average length Diamètre moyen : 9.5

NOTES

REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m3 FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m3 FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.
Grade C30 : CEMENT RATIO 350 Kg/m3 FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, φ= 150mm : 37N/mm2
- ON A CYLINDER φ=150mm, h=300mm : 30N/mm2

CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: Fy=420 N/mm2.
MILD STEEL BARS: SYMBOL φ YIELD STRESS: Fy=215 N/mm2.
MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ
(φ = BAR NOMINAL DIAMETER)
PINS φ8 SHALL BE USED ON EACH LAP.

BENDING:
φ>12mm MECHANICAL
φ<12mm MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
ALL CORNERS SHALL BE CHAMFERED.
ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.
WATERPROOFING:
BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
* FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:
* ALL THE DIMENSIONS ARE IN cm UNLESS OTHERWISE SPECIFIED
* SCALING FROM THESE DRAWINGS IS NOT ALLOWED.
* ALL LEVELS MUST BE VERIFIED BY A TOPOGRAPHER AT THE CONTRACTOR'S EXPENSES.

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON

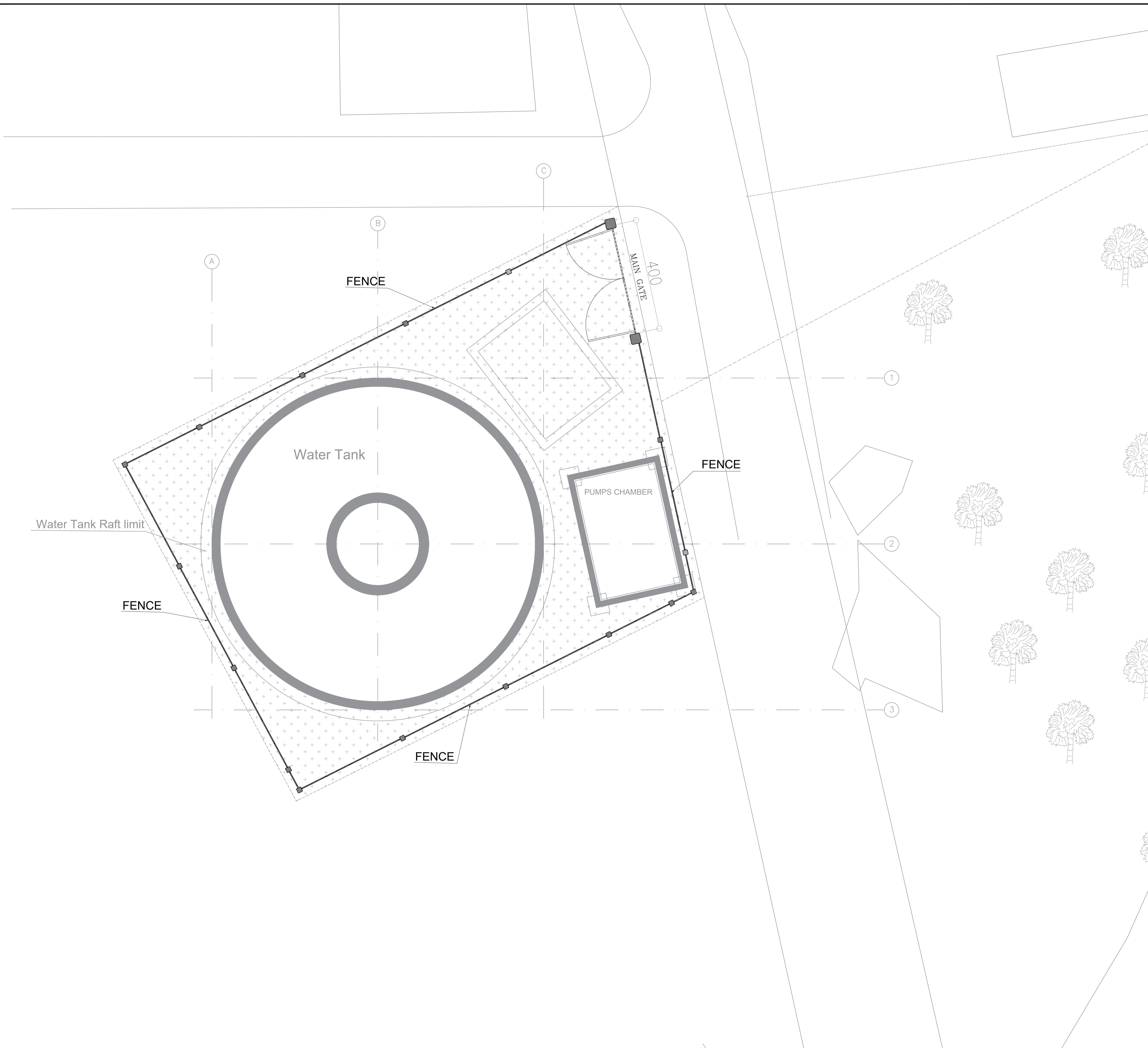


PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHM WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER REINFORCEMENT

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|--------------|-----------|--------------|
| MARCH 2023 | 1/50 1/20 | 22 | 667W-02STR22 |



NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
 Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
 Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.

SULFATE RESISTING CEMENT.

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.

STRESSES:

SEVERE CONTROL.

CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:

- ON A CUBE, a= 150mm : 37N/mm²
- ON A CYLINDER ø=150mm, h=300mm : 30N/mm²

CONCRETE COVER:

THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:

- 30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
- 50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
- 75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
 YIELD STRESS: F_y=420 N/mm².

MILD STEEL BARS: SYMBOL ø YIELD STRESS: F_y=215 N/mm².
 MAXIMUM POURING HEIGHT :1500mm

OVERLAPPING:

LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
 WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x6ø
 (ø = BAR NOMINAL DIAMETER)
 PINS ø8 SHALL BE USED ON EACH LAP.

BENDING:

- ø>12mm MECHANICAL
- ø<12mm MANUAL (POSSIBLY)

STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
 THE USE OF ø6mm BARS AS TIE-RODS IS NOT ALLOWED.
 HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
 ALL CORNERS SHALL BE CHAMFERED.
 ALL EXTERIOR AND INTERIOR MASONRY SURFACES SHALL BE PLASTERED.

WATERPROOFING:

BITUMINOUS COATING SHALL BE APPLIED TO ALL CONCRETE SURFACES IN CONTACT WITH SOIL

GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)

- * SOIL BEARING CAPACITY = 5 bar (SLS).
- * FOUNDATION AT 1,50m BENEATH EGL.

REMARKS:

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REPUBLIC OF LEBANON

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 BUREAU TECHNIQUE POUR LE DEVELOPPEMENT

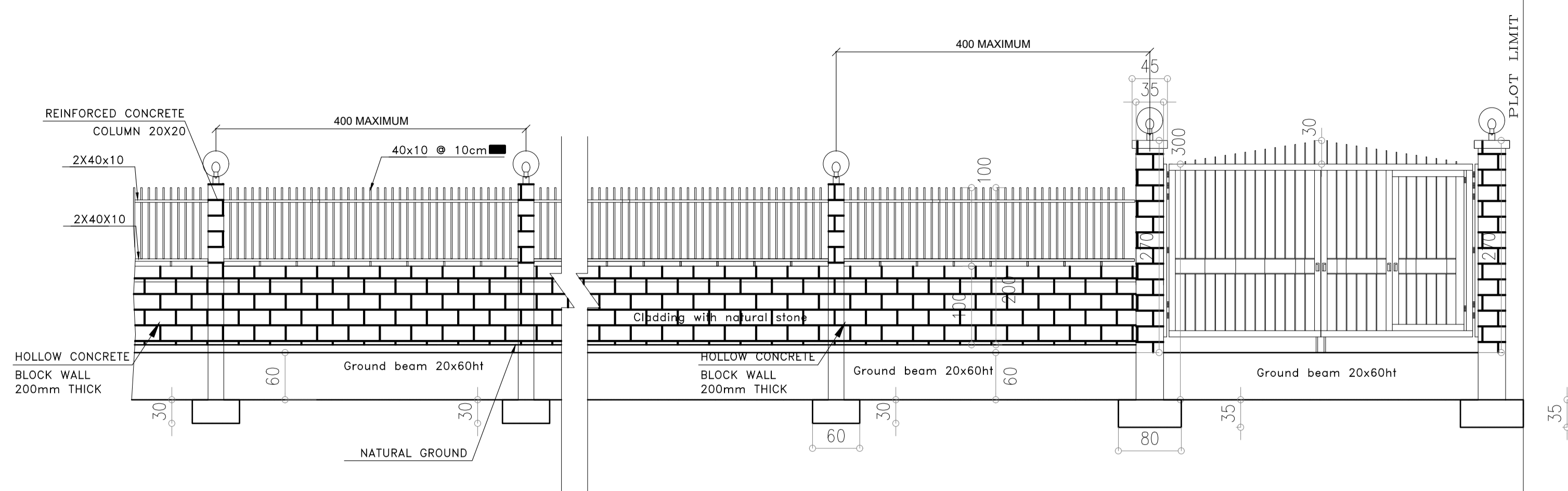
JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
 P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

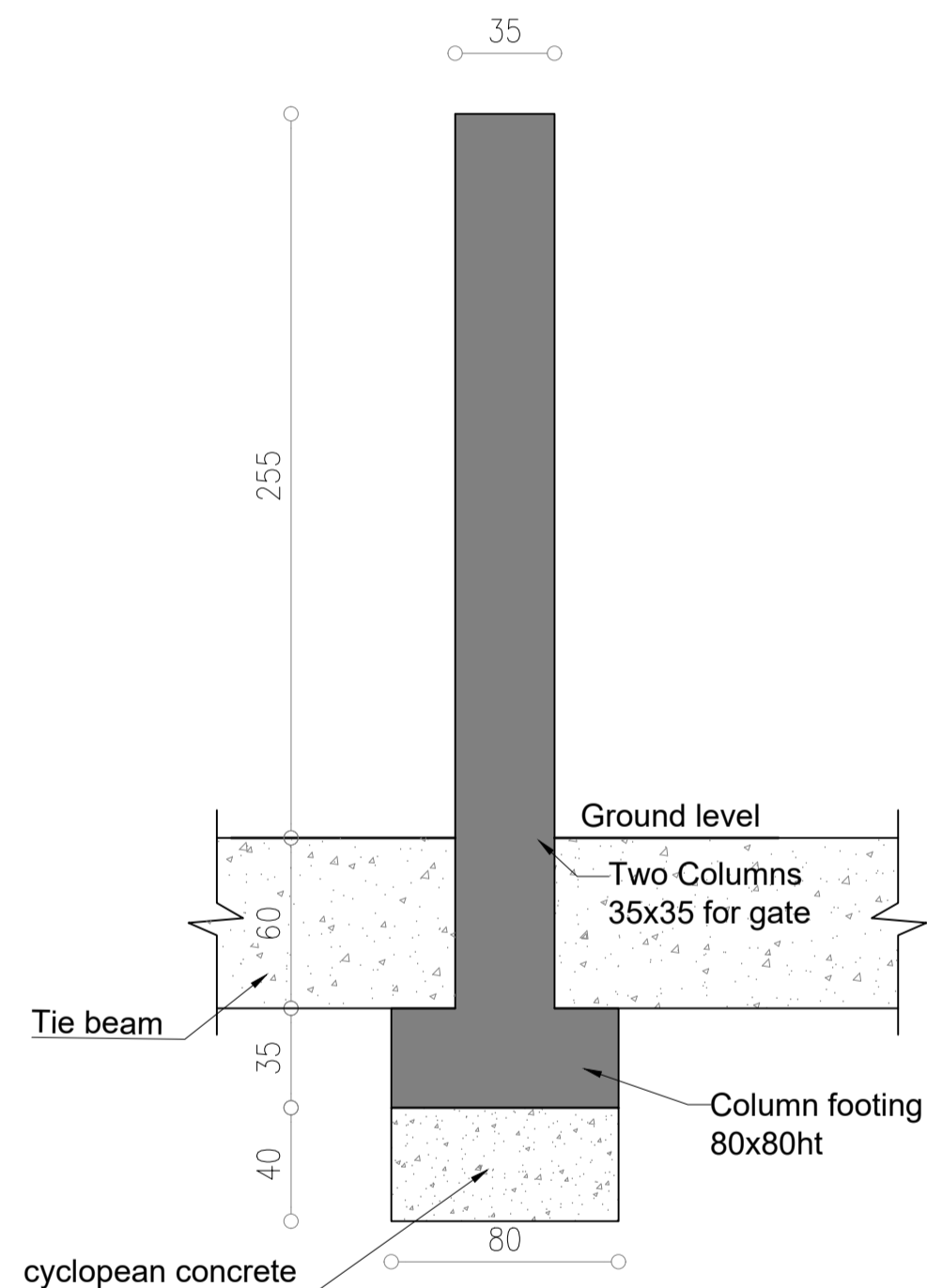
| | |
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | REINFORCEMENT - FENCE FORMWORK |
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| 667W | J.Y. | R.S. | T.G. |

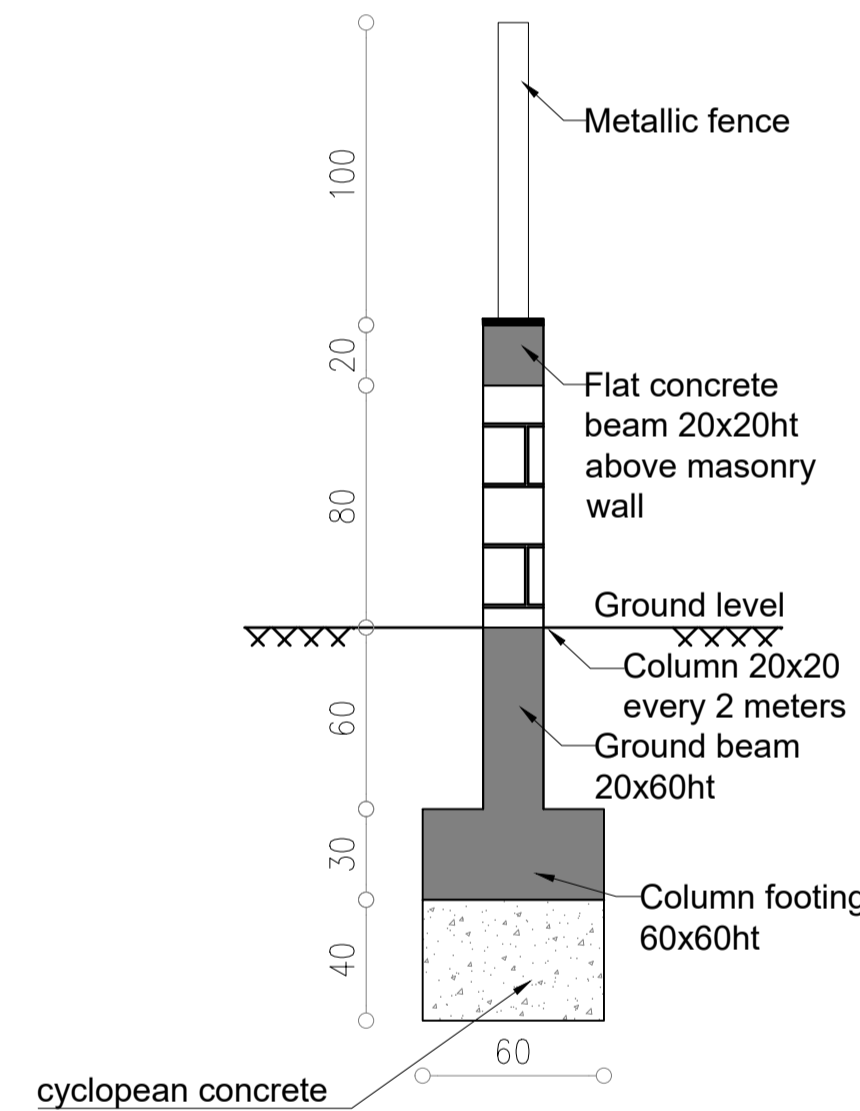
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| MARCH 2023 | NOT SCALED | 23 | 667W-02STR23 |



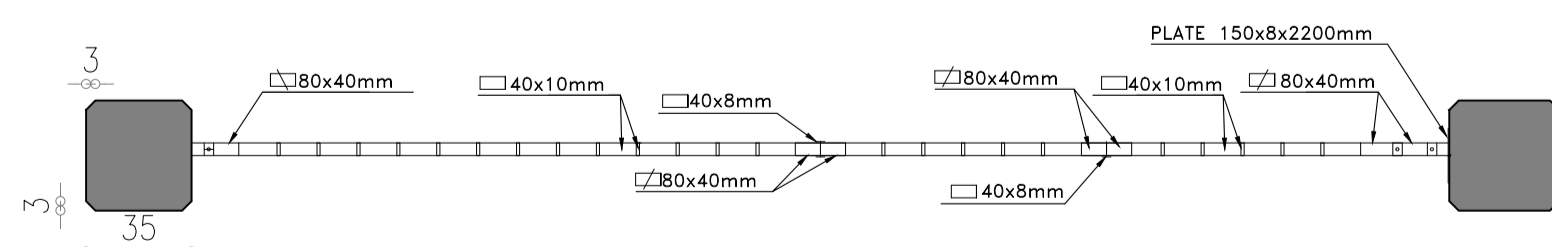
ELEVATION ON 4m ACCESS GATE
SCALE 1:50



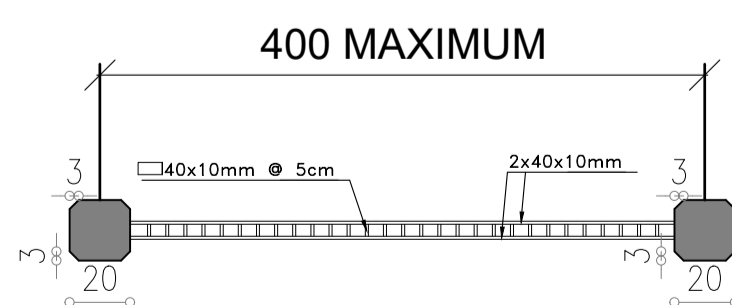
GATE COLUMN SECTION
SCALE 1:25



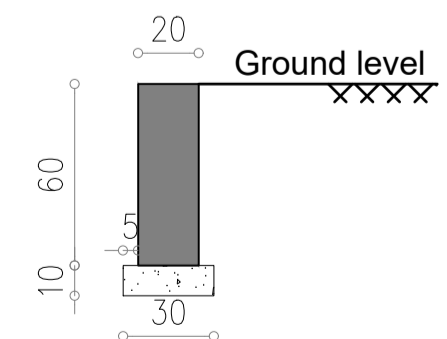
WALL SECTION
SCALE 1:25



MAIN GATE
SCALE 1:25



FENCE
SCALE 1:25



TIE BEAM
SCALE 1:25

NOTES

- REINFORCED CONCRETE:
NORMAL PORTLAND CEMENT
- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
Grade C20 : CEMENT RATIO 250 Kg/m³ FOR LEAN CONCRETE.
- SULFATE RESISTING CEMENT:
Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL FOUNDATIONS AND CONCRETE ELEMENTS IN CONTACT WITH SOIL.
- STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
- ON A CUBE, $\sigma = 150\text{mm}$: 37N/mm²
- ON A CYLINDER $\phi=150\text{mm}$, $h=300\text{mm}$: 30N/mm²
- CONCRETE COVER:
THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:
30MM: CONCRETE SURFACES ABOVE GROUND LEVEL
50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.
- REINFORCEMENT:
DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
YIELD STRESS: $F_y=420\text{ N/mm}^2$
MILD STEEL BARS: SYMBOL ϕ YIELD STRESS: $F_y=215\text{ N/mm}^2$
MAXIMUM POURING HEIGHT : 1500mm
- OVERLAPPING:
LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER.
WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN $2 \times 6\phi$
(ϕ = BAR NOMINAL DIAMETER)
PINS $\phi 8$ SHALL BE USED ON EACH LAP.
- BENDING:
 $\phi > 12\text{mm}$ MECHANICAL
 $\phi < 12\text{mm}$ MANUAL (POSSIBLY)
STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.
- FORMWORK:
ALL EXECUTED CONCRETE SHALL BE FAIR FACED CONCRETE.
THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
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- GEOTECHNICAL INVESTIGATION(Performed by SAFWAN ABDUL KADER CHAHAL)
* SOIL BEARING CAPACITY = 5 bar (SLS).
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| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON

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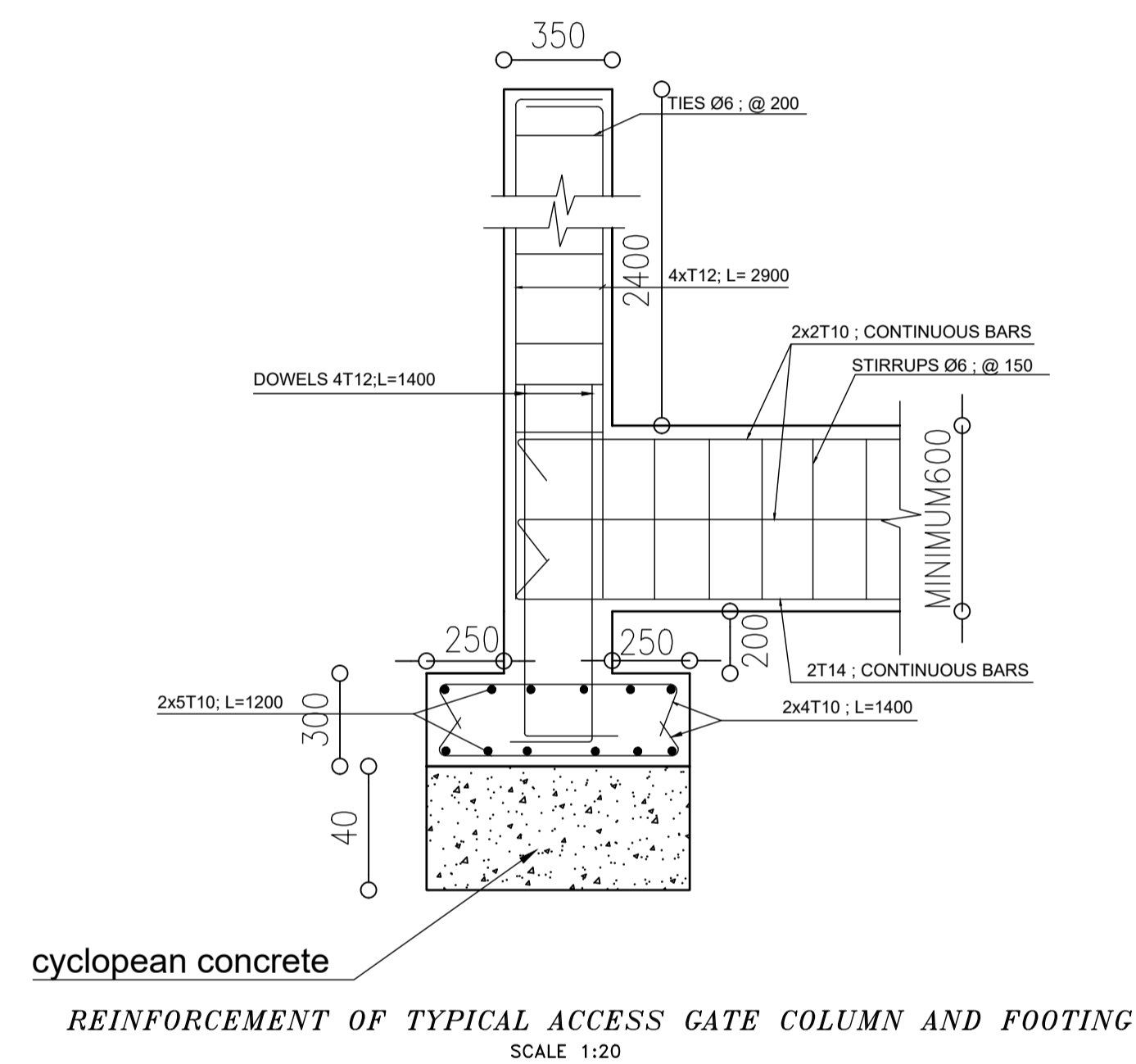
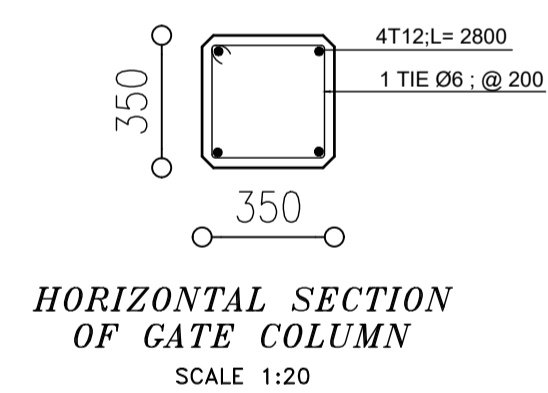
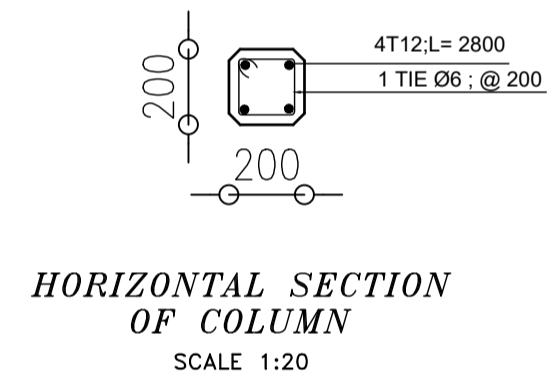
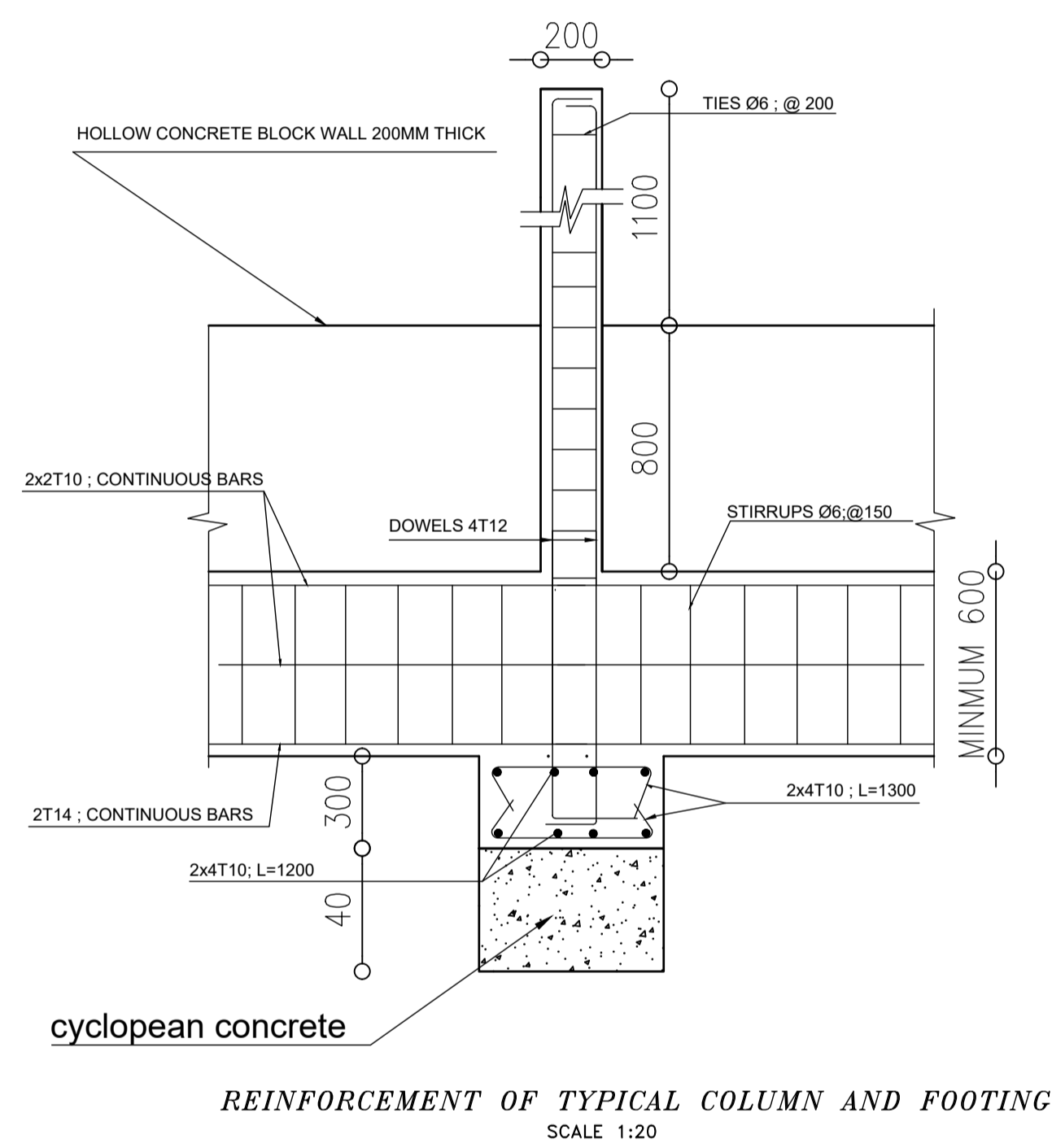
BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

| | |
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | REINFORCEMENT - FENCE SECTIONS AND ELEVATION FORMWORK |
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| 667W | J.Y. | R.S. | T.G. |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | 1/50 - 1/25 | 24 | 667W-02STR24 |



NOTES

REINFORCED CONCRETE:

NORMAL PORTLAND CEMENT

Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
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CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:

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- ON A CYLINDER φ=150mm, h=300mm : 30N/mm²

CONCRETE COVER:

THE CONCRETE COVER FOR ALL STEEL BARS SHALL NOT BE LESS THAN:

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50MM: CONCRETE SURFACES IN CONTACT WITH SOIL AND WATER
75MM: CONCRETE SURFACES IN DIRECT CONTACT WITH SOIL WITHOUT BLINDING CONCRETE.

REINFORCEMENT:

DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T

YIELD STRESS: F_y=420 N/mm²

MILD STEEL BARS: SYMBOL φ YIELD STRESS: F_y=215 N/mm²

MAXIMUM POURING HEIGHT : 1500mm

OVERLAPPING:

LAPS SHALL NOT BE LESS THAN SIXTY TIMES THE BAR DIAMETER. WHERE SPLICE BARS ARE USED, THEIR LENGTH SHALL NOT BE LESS THAN 2x60φ

(φ = BAR NOMINAL DIAMETER)

PINS Ø8 SHALL BE USED ON EACH LAP.

BENDING:

φ>12mm MECHANICAL

φ<12mm MANUAL (POSSIBLY)

STRAIGHTENING OF BENDED BARS IS NOT ALLOWED.

FORMWORK:

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| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



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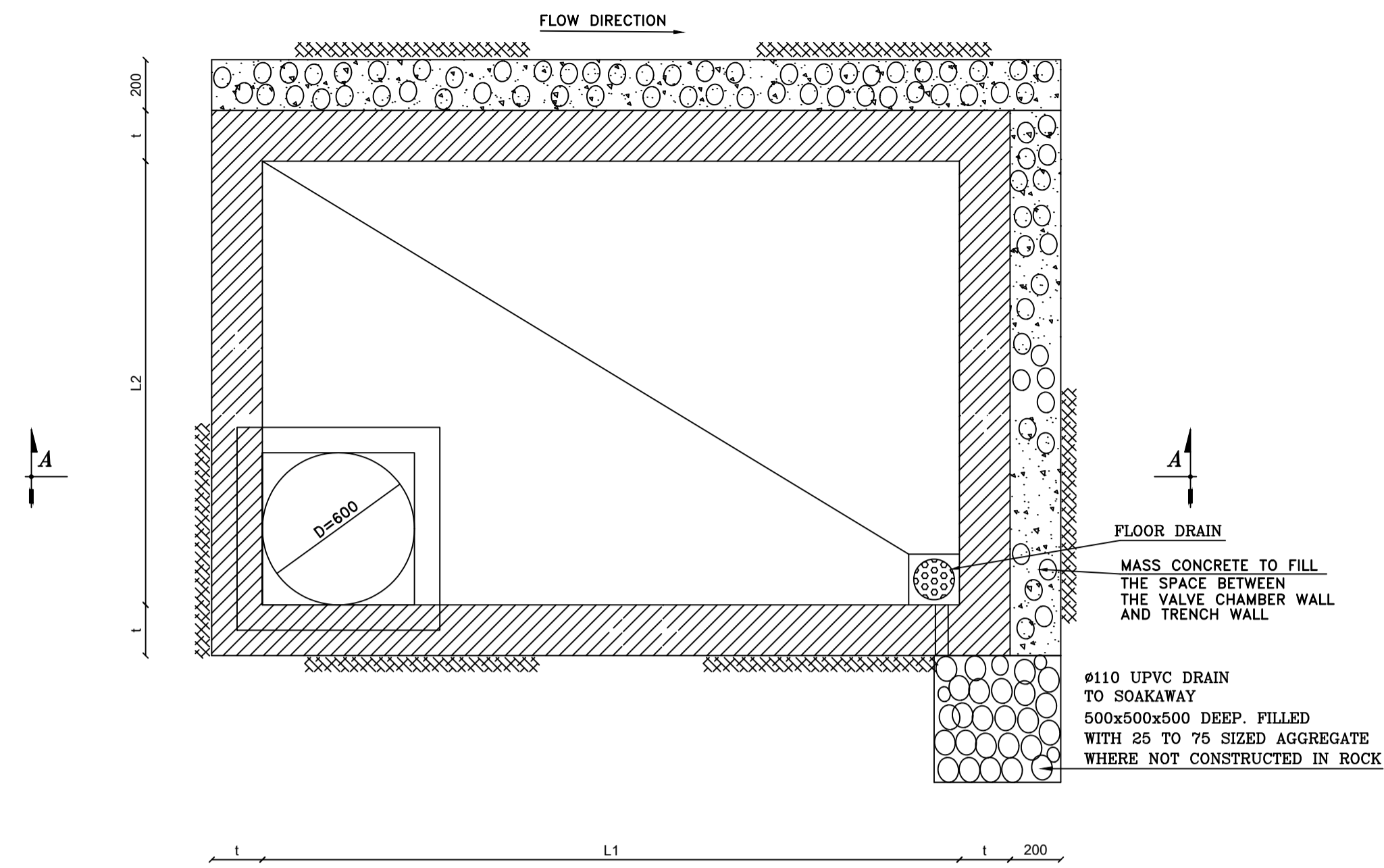
TEL:(04) 712157 / 712158
FAX: (04) 712159

PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
WITH SAFE, RELIABLE, AND SUSTAINABLE
WATER SERVICES

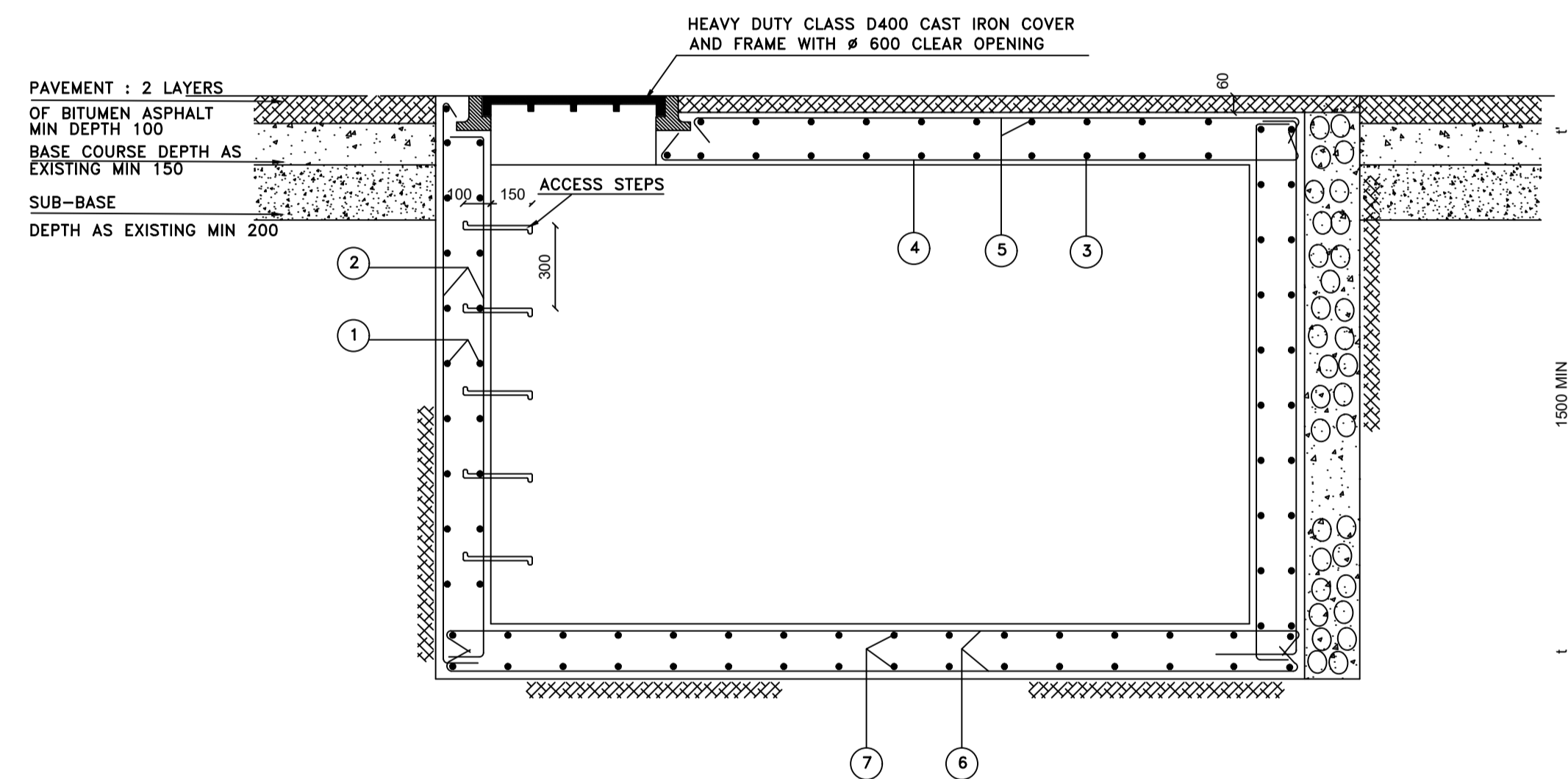
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | REINFORCEMENT - FENCE REINFORCEMENT |
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| 667W | J.Y. | R.S. | T.G. |

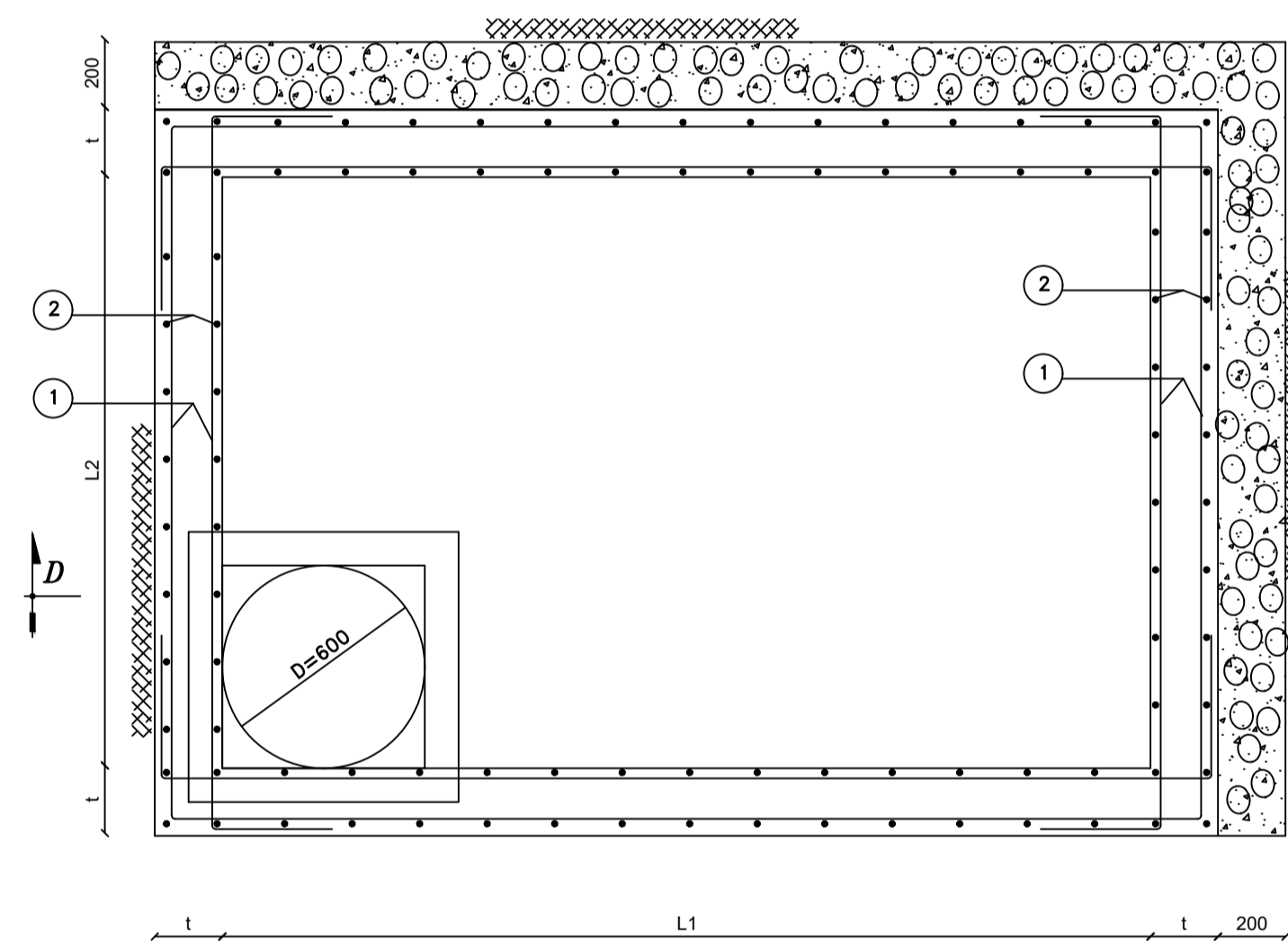
| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|--------------|
| MARCH 2023 | 1/20 | 25 | 667W-02STR25 |



TYPICAL CHAMBER'S PLAN VIEW



SECTION A-A



| VALVE CHAMBER DIMENSIONS | |
|--------------------------|-----------|
| TYPE | LxL2 |
| R42 | 4000x3000 |

REINFORCEMENT STEEL TABLE

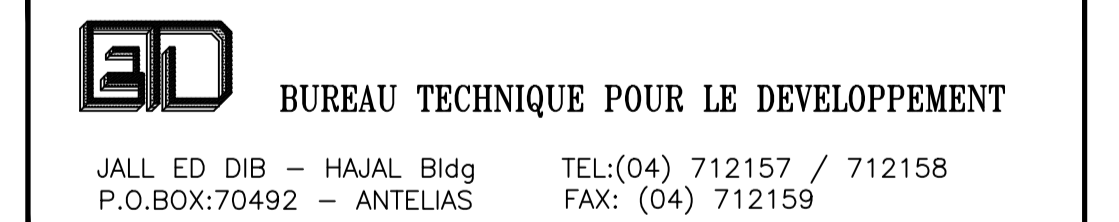
| VALVE CHAMBER | THICKNESS | | REINFORCEMENT | | | | | | |
|---------------|-----------|-----|---------------|----------|----------|----------|------------|----------|----------|
| | t | t' | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| R42 | 300 | 300 | T16 Ø165 | T16 Ø165 | T20 Ø165 | T14 Ø165 | 2xT12 Ø165 | T16 Ø165 | T16 Ø165 |

NOTES

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- NORMAL PORTLAND CEMENT
- Grade C30 : CEMENT RATIO 350 Kg/m³ FOR ALL CONCRETE ELEMENTS.
- Grade C30 : CEMENT RATIO 400 Kg/m³ FOR ALL CONCRETE ELEMENTS OF THE WATER TANKS INCLUDING RAFT AND ROOF SLAB.
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- STRESSES:
- SEVERE CONTROL.
- CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS FOR GRADE C30:
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 - ON A CYLINDER φ=150mm, h=300mm : 30N/mm²
- CONCRETE COVER:
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- REINFORCEMENT:
- DEFORMED HIGH STRENGTH STEEL BARS: SYMBOL T
- YIELD STRESS: F_y=420 N/mm².
- MILD STEEL BARS: SYMBOL Ø YIELD STRESS: F_y=215 N/mm².
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- (φ = BAR NOMINAL DIAMETER)
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REPUBLIC OF LEBANON



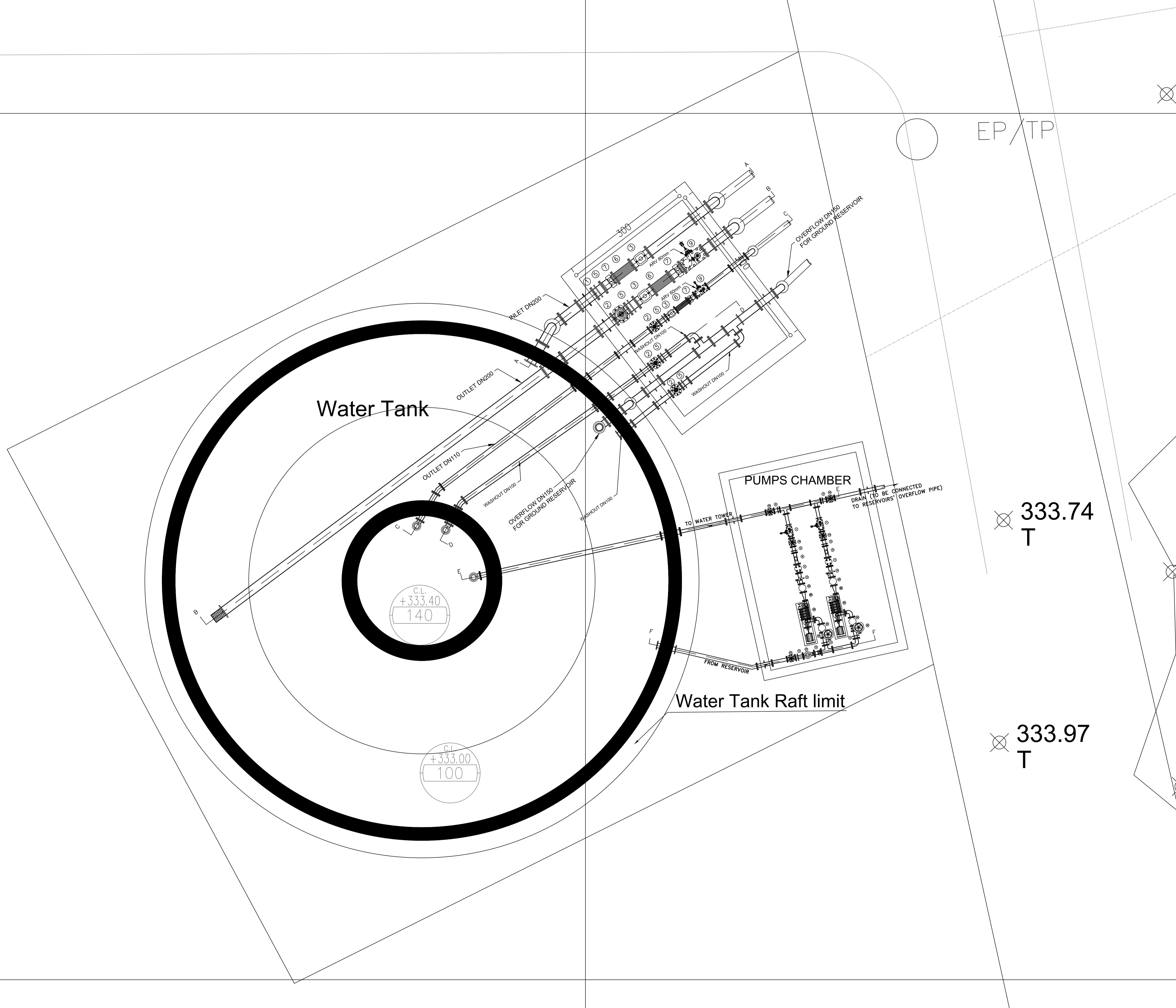
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME WITH SAFE, RELIABLE, AND SUSTAINABLE WATER SERVICES

PROPOSED 750m³ RESERVOIR AND 100m³ WATER TOWER

TYPICAL VALVE CHAMBER DETAILS

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | F.GHANEM | F.GHANEM | Z. SABA |

| DATE | SCALE | SHEET No. | DRAWING No. |
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| MARCH 2023 | N.T.S | 26 | 667W-02STR26 |



- LEGEND:
- ① : INSERT
 - ② : GATE VALVE
 - ③ : FILTER
 - ④ : PRESSURE REDUCING VALVE
 - ⑤ : DISMANTLING JOINT
 - ⑥ : FLOW STAIGHTENER
 - ⑦ : WATER METER
 - ⑧ : BUTTERFLY VALVE
 - ⑨ : AIR RELEASE VALVE + GATE VALVE
 - ⑩ : FLOOR DRAIN

| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
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REPUBLIC OF LEBANON



BD BUREAU TECHNIQUE POUR LE DEVELOPPEMENT
 JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
 P.O.BOX:70492 - ANTELIAS FAX: (04) 712159

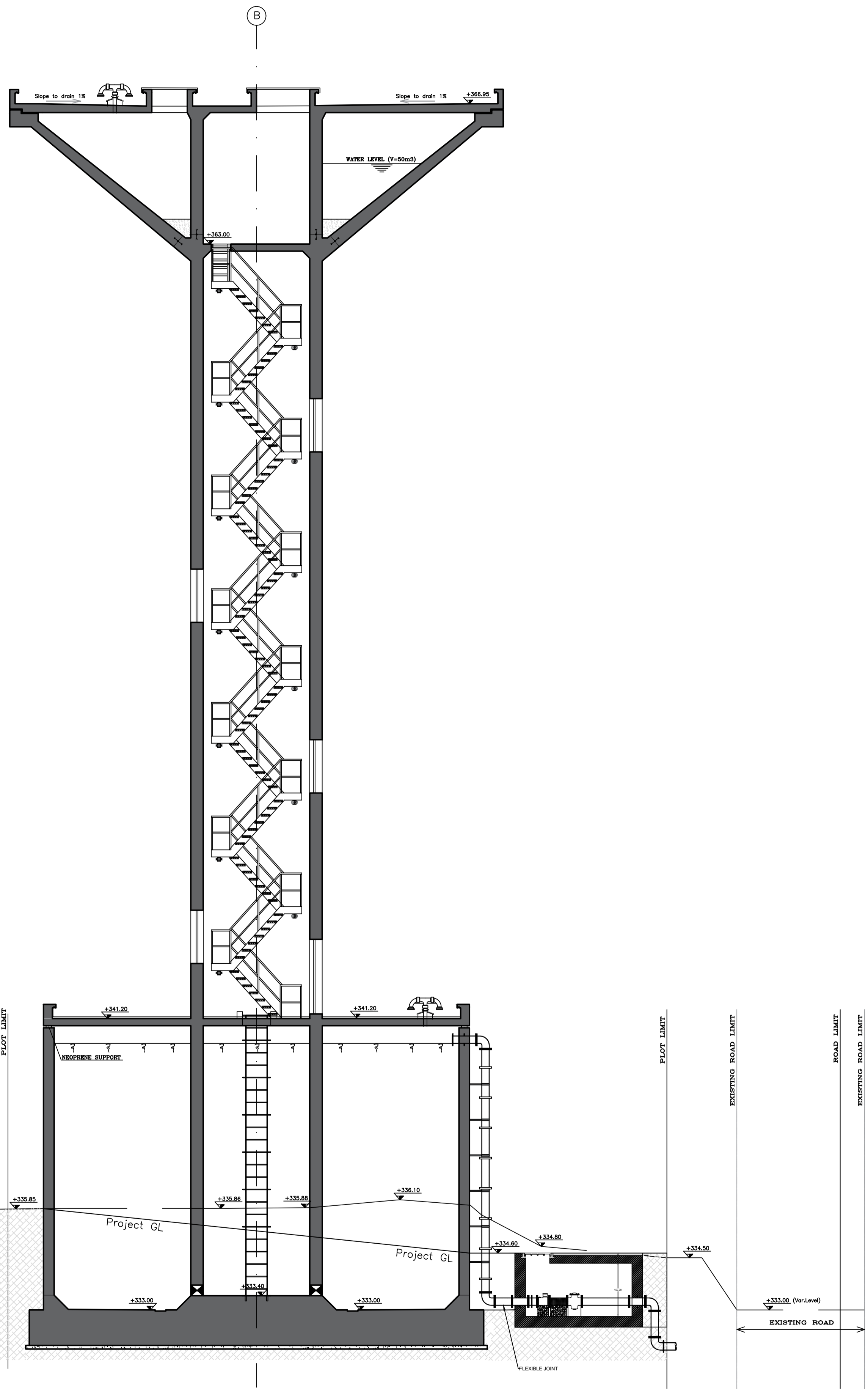
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

PROPOSED 750m3
 RESERVOIR AND 100m3
 WATER TOWER

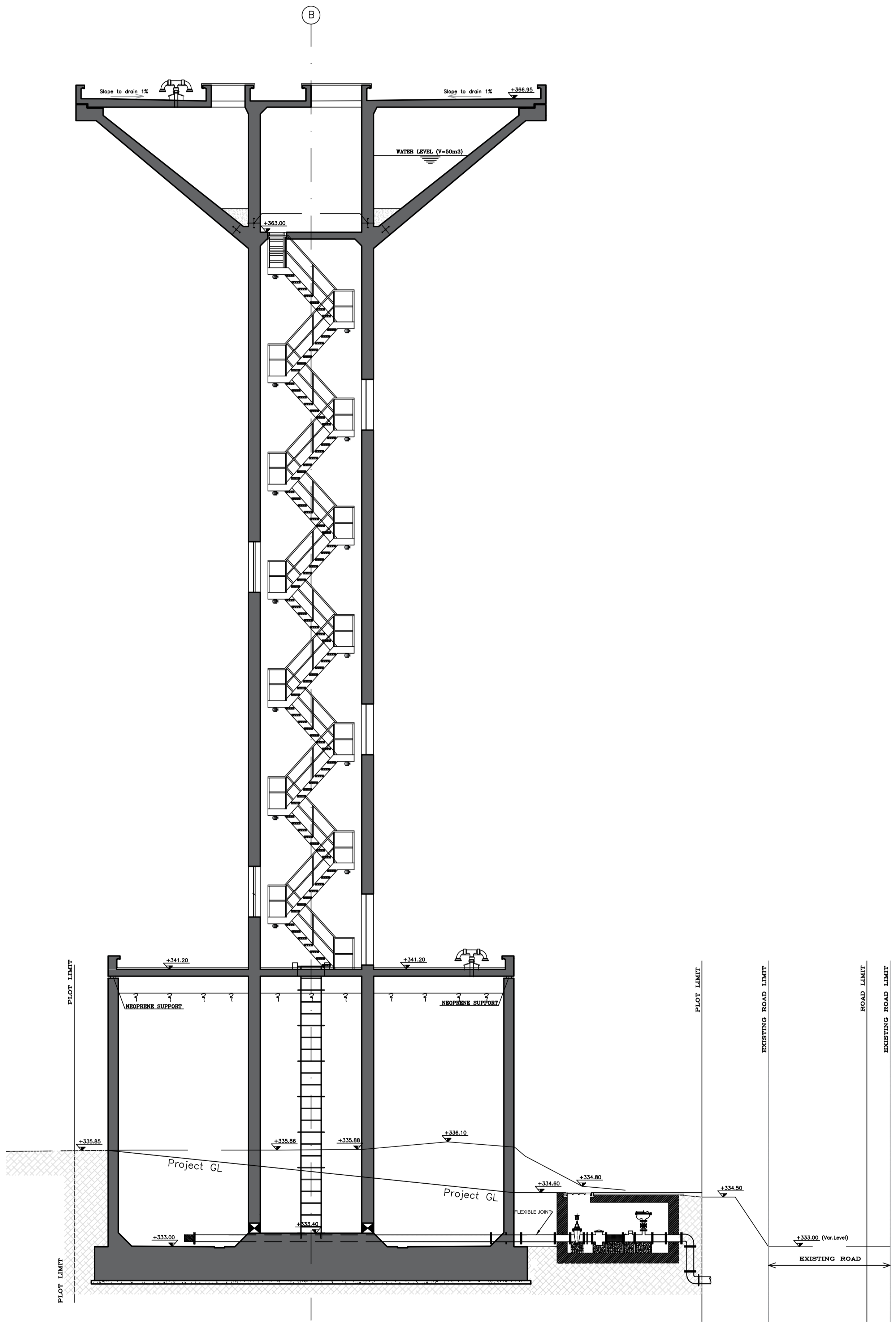
PIPING LAYOUT (1 OF 4)

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|------------|------------|
| 667W | E. LTEIF | R. CHAMMAA | E. LTEIF |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|--------|-----------|-------------|
| MARCH 2023 | N.T.S. | 27 | 667W-TR01 |



SECTION A-A (INLET PIPE ø200mm)



SECTION B-B (OUTLET PIPE ø200mm)

- LEGEND:
- ① : INSERT
 - ② : GATE VALVE
 - ③ : FILTER
 - ④ : PRESSURE REDUCING VALVE
 - ⑤ : DISMANTLING JOINT
 - ⑥ : FLOW STAIGHTENER
 - ⑦ : WATER METER
 - ⑧ : BUTTERFLY VALVE
 - ⑨ : AIR RELEASE VALVE + GATE VALVE
 - ⑩ : FLOOR DRAIN

| Rev. | Date | Dsgn | Drawn | Chk'd | Appr'd |
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

| | |
|--|------------------------|
| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | PIPING LAYOUT (2 OF 4) |
|--|------------------------|

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|------------|------------|
| 667W | E. LTEIF | R. CHAMMAA | E. LTEIF |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|--------|-----------|-------------|
| MARCH 2023 | N.T.S. | 28 | 667W-TR02 |

LEGEND:

- ① : INSERT
- ② : GATE VALVE
- ③ : FILTER
- ④ : PRESSURE REDUCING VALVE
- ⑤ : DISMANTLING JOINT
- ⑥ : FLOW STRAIGHTENER
- ⑦ : WATER METER
- ⑧ : BUTTERFLY VALVE
- ⑨ : AIR RELEASE VALVE + GATE VALVE
- ⑩ : FLOOR DRAIN

| Rev. | Date | Dsgn | Drawn | Chk'd | Appr'd |
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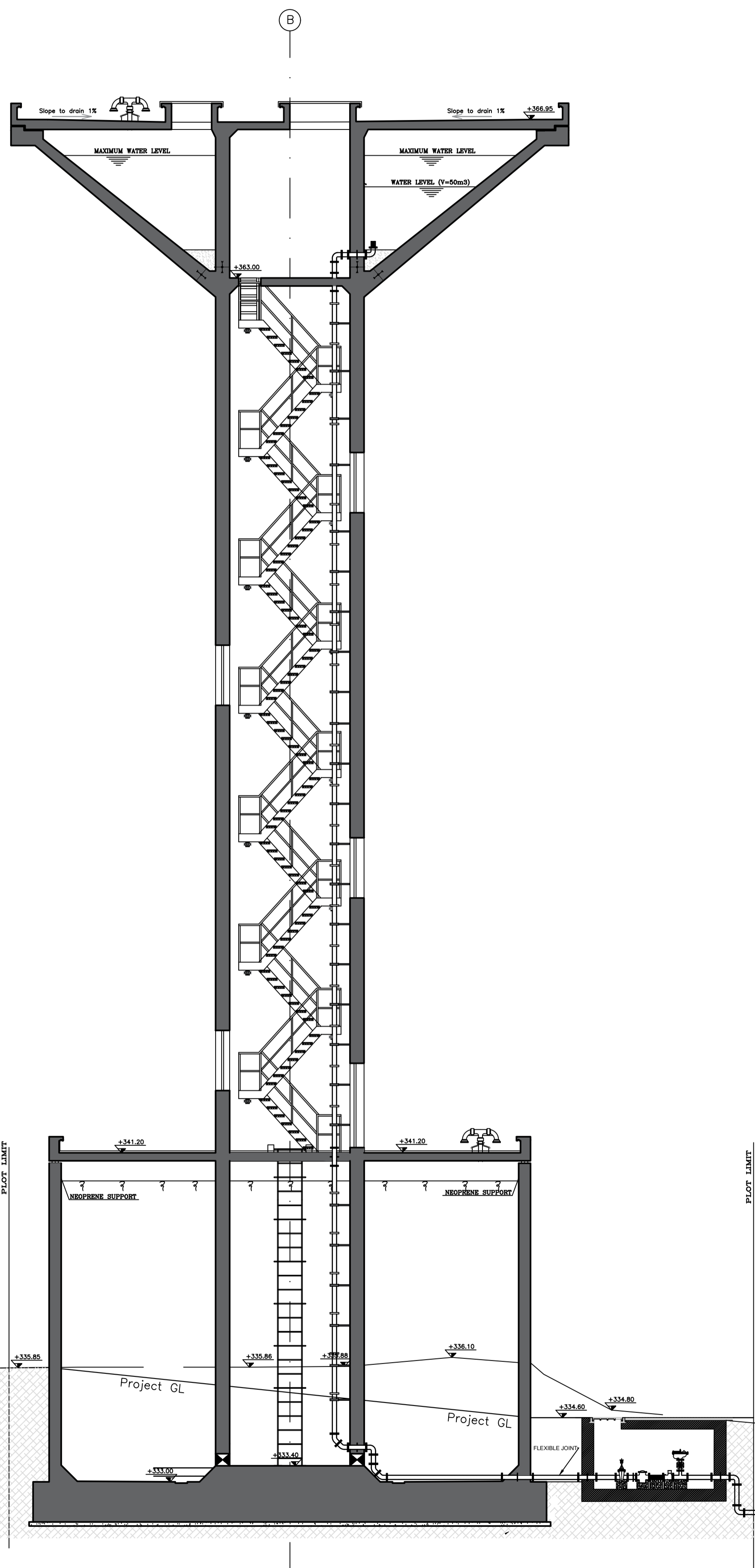
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

PROPOSED 750m3
 RESERVOIR AND 100m3
 WATER TOWER

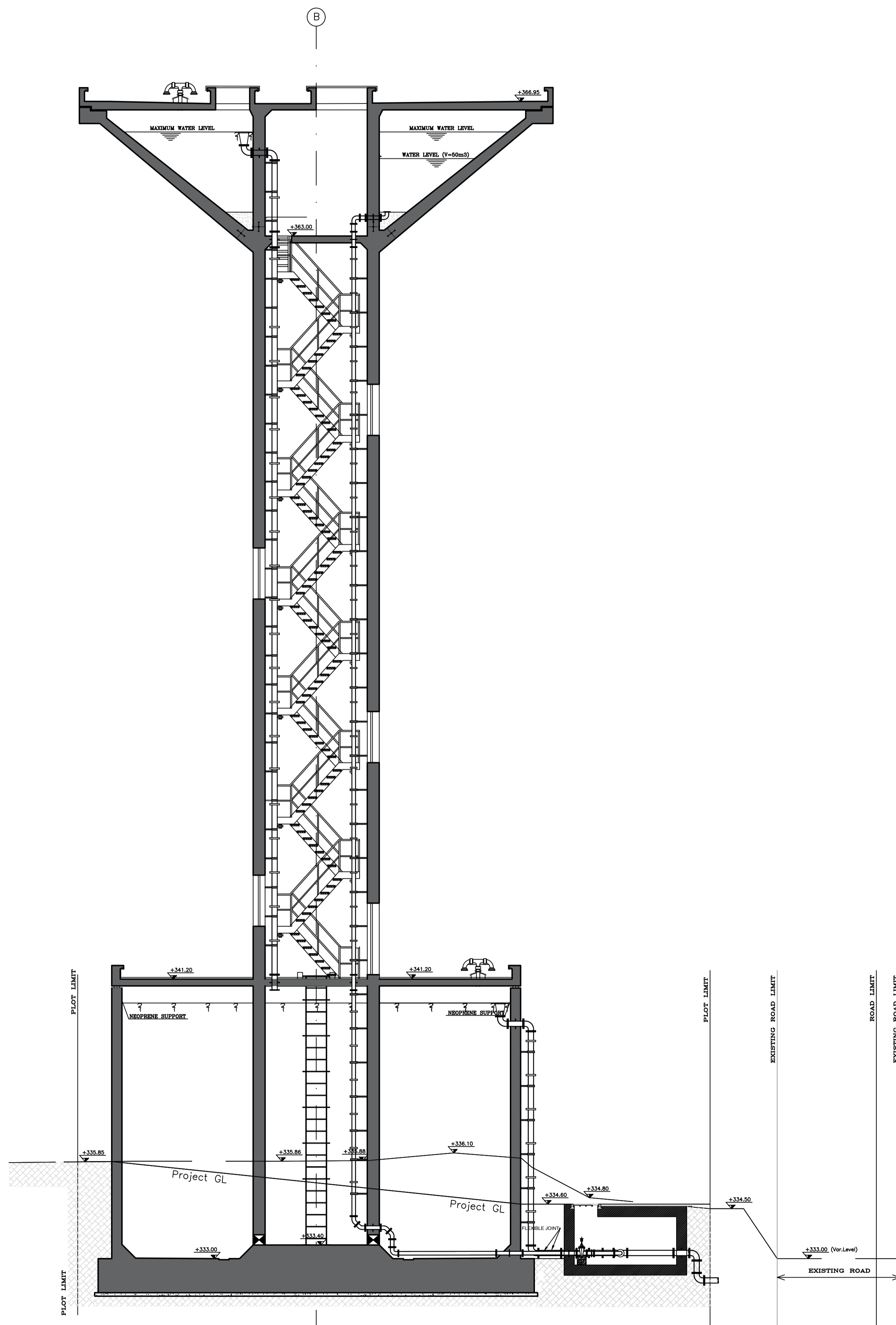
PIPING LAYOUT (3 OF 4)

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| 667W | E. LTEIF | R. CHAMMAA | E. LTEIF |

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| MARCH 2023 | N.T.S. | 29 | 667W-TR03 |



SECTION C-C (OUTLET PIPE Ø110mm)



SECTION D-D (OVERFLOW PIPE Ø150mm
 & DRAINAGE PIPE Ø100mm)

LEGEND:

- ① : INSERT
- ② : GATE VALVE
- ③ : FILTER
- ④ : PRESSURE REDUCING VALVE
- ⑤ : DISMANTLING JOINT
- ⑥ : FLOW STRAIGHTENER
- ⑦ : WATER METER
- ⑧ : BUTTERFLY VALVE
- ⑨ : AIR RELEASE VALVE + GATE VALVE
- ⑩ : FLOOR DRAIN

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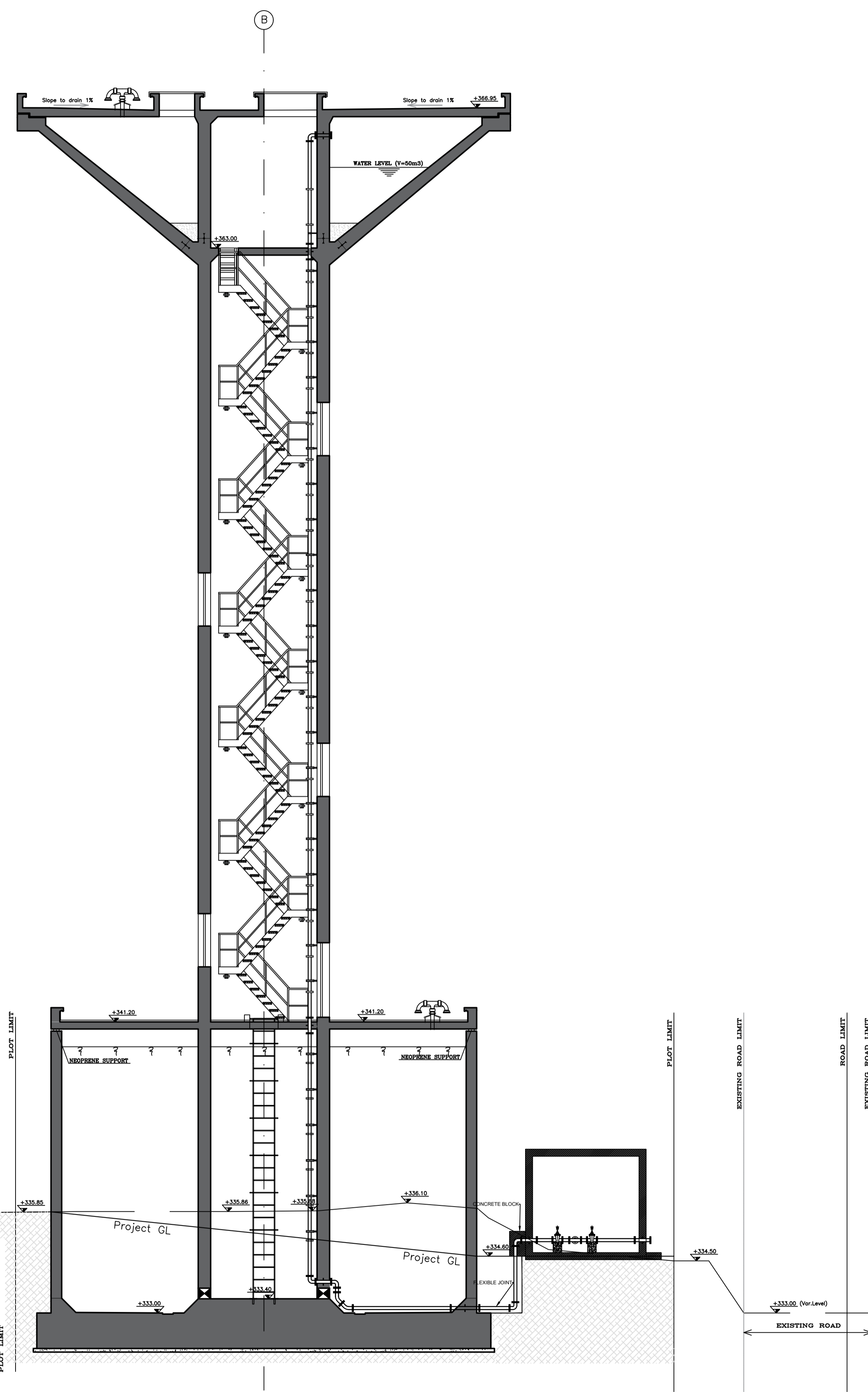
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

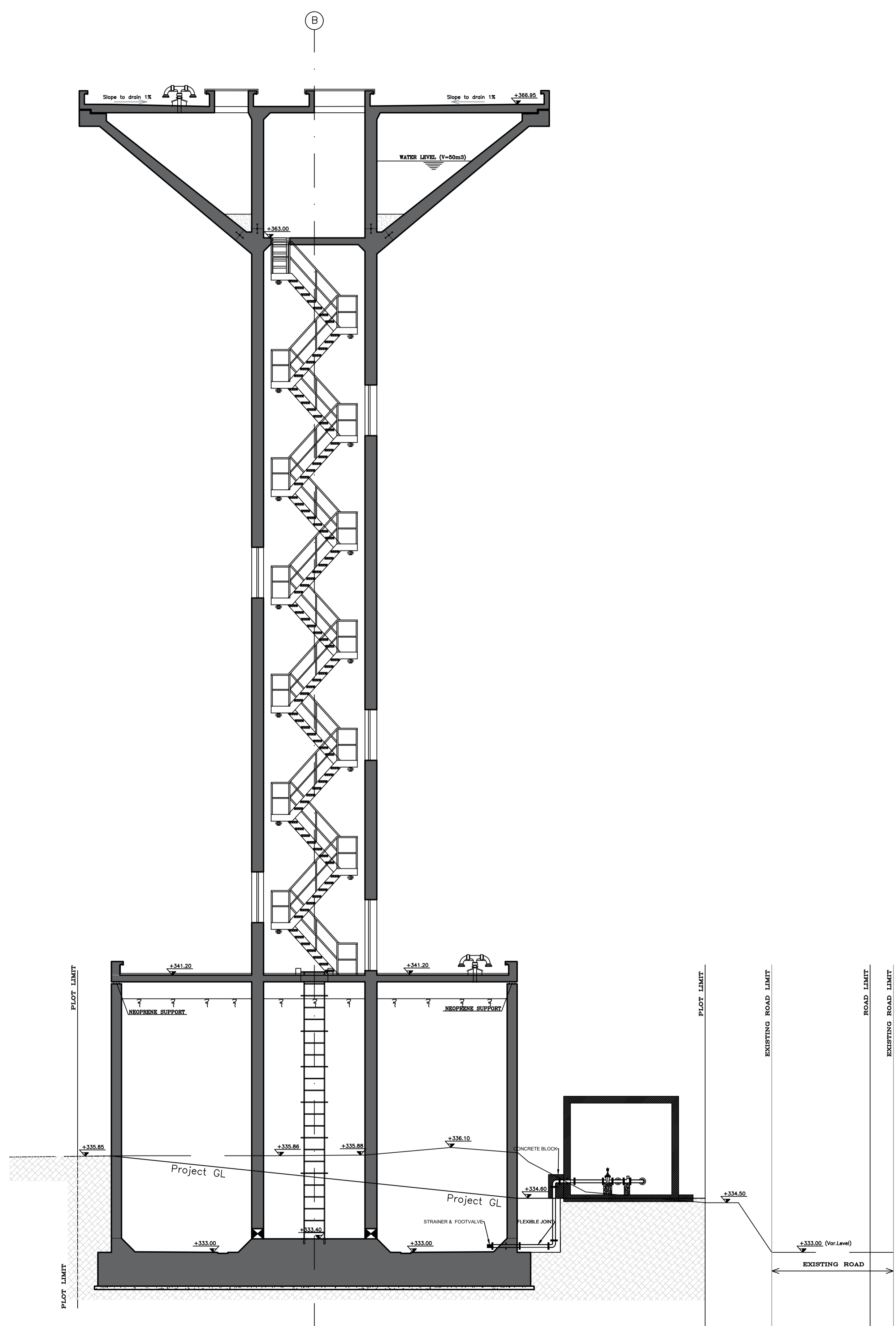
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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | PIPING LAYOUT (4 OF 4) |
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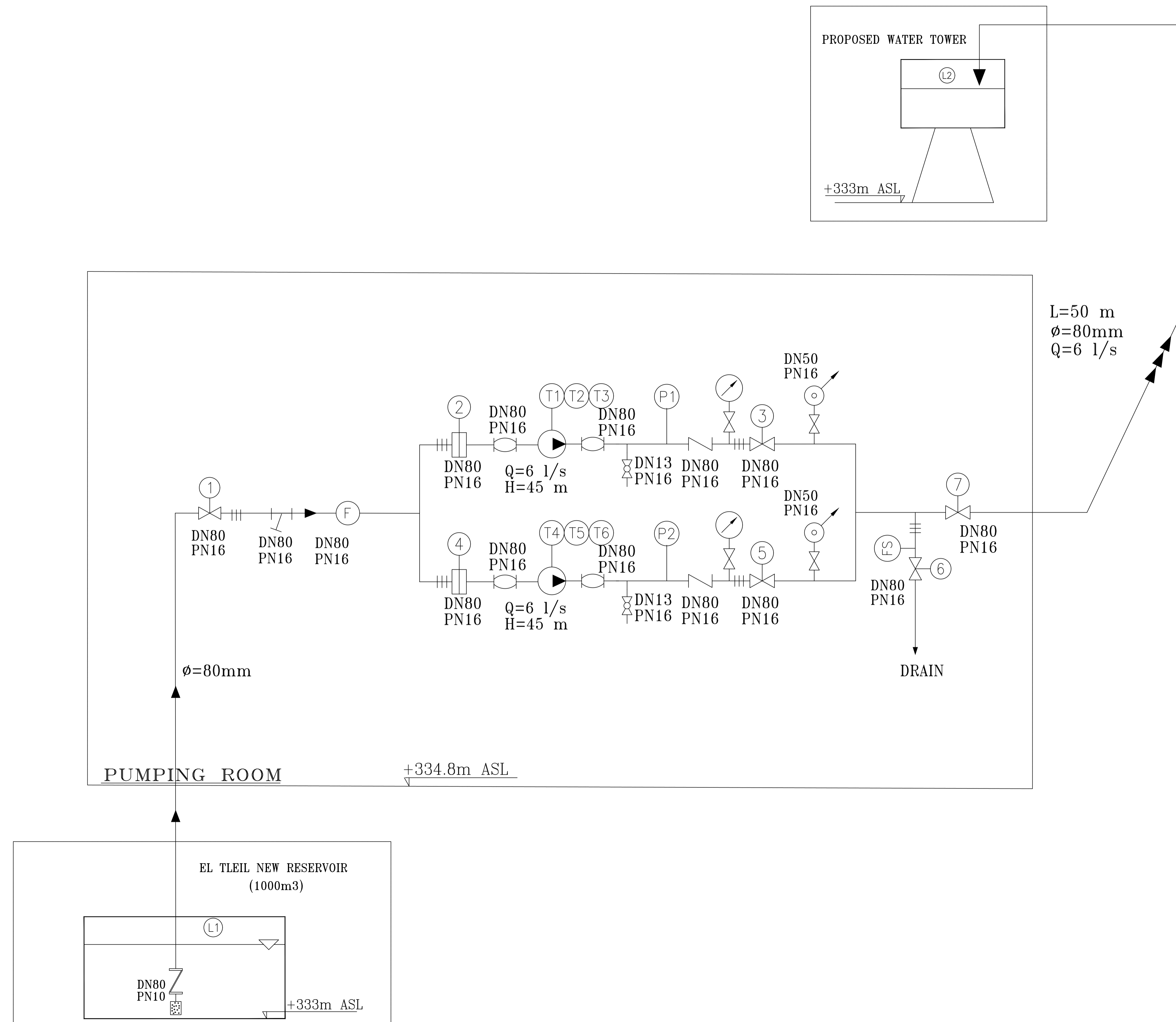
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SECTION E-E (PUMPING LINE TO ELEVATED WATER TANK & DRAIN ø80mm)



SECTION F-F (SUCTION PIPE FROM MAIN WATER TANK ø80mm)



- LEGEND:**
- : SUBMERSIBLE PUMP
 - DN : NOMINAL DIAMETER
 - PN : NOMINAL PRESSURE
 - : PRESSURE MEASUREMENT
 - : FLOW SWITCH
 - : TEMPERATURE MEASUREMENT
 - : LEVEL MEASUREMENT
 - : FLOW MEASUREMENT
 - : GLYCERINE FILLED MANOMETER Ø100 WITH 3 WAY VALVE.
 - : SURGE SUPPRESSION EQUIPMENT.
 - : PIPELINE
 - : DOUBLE AIR RELEASE VALVE WITH ISOLATING VALVE.
 - : ELECTRIC ACTUATOR
 - : GATE VALVE
 - : CHECK VALVE (ANTI SLAM TYPE)
 - : SAMPLING VALVE
 - : PERFORATED CHECK VALVE
 - : DEMOUNTABLE JOINT
 - : SURGE ANTICIPATION VALVE
 - : GLOBE VALVE
 - : BUTTERFLY VALVE
 - : PUMPING LINE
 - : GRAVITY LINE
 - : REGULATING VALVE
 - : FLEXIBLE JOINT
 - : CHLORINE INJECTION
 - : STRAINER
 - : RUBBER SPHERICAL FLEXIBLE JOINT.
 - : STAINLESS STEEL FLEXIBLE JOINT.
 - : PRESSURE REDUCING VALVE
 - : Y STRAINER
 - : CONE
 - : FOOT VALVE

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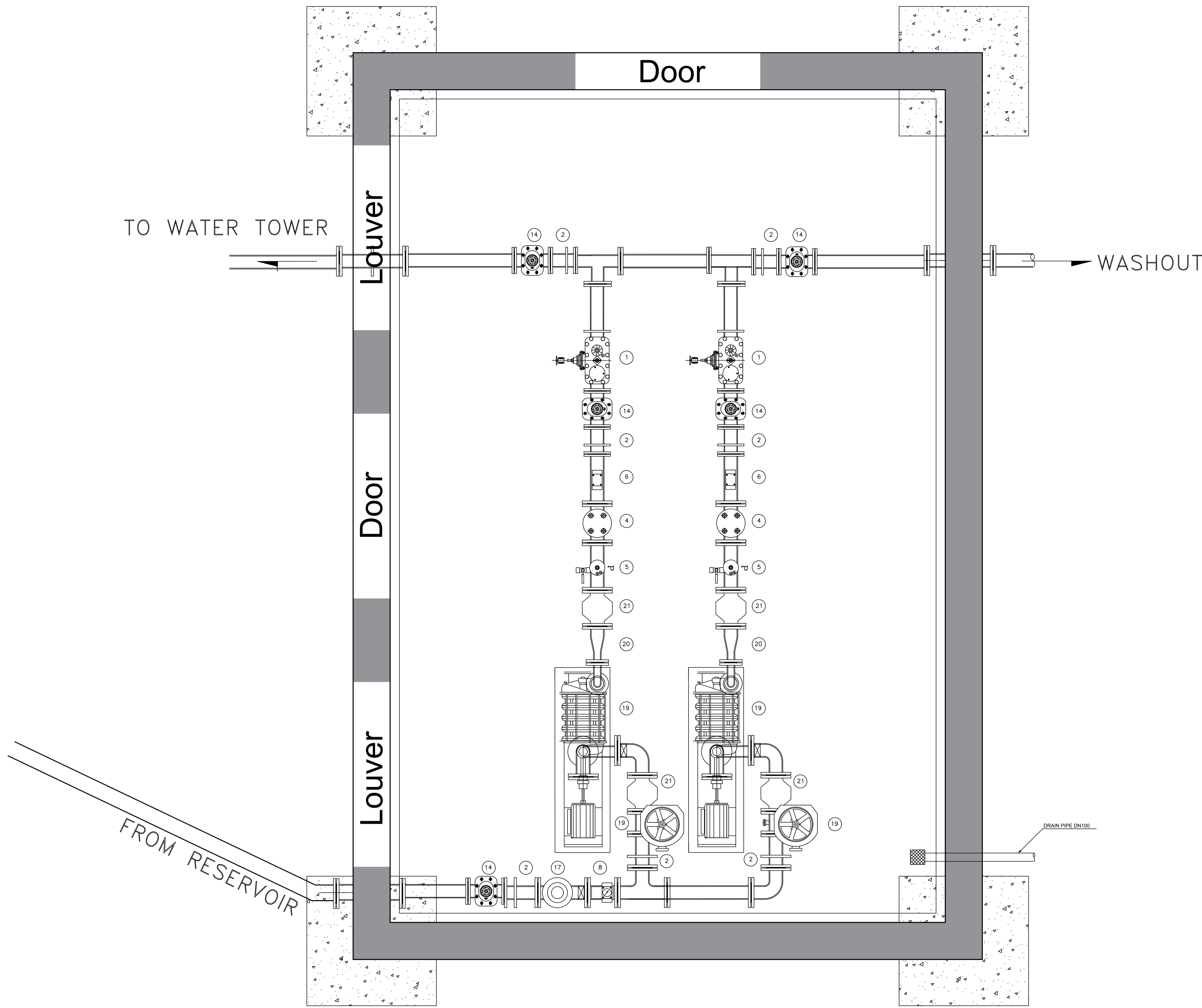
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

| | |
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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | BOOSTER PUMP STATION HYDRAULIC SCHEMATIC |
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- LEGEND**
- ① : ANTI-SHOCK 3F AIR RELEASE VALVE WITH ISOLATING VALVE
 - ② : DISMANTLING JOINT
 - ③ : MOTORISED GATE VALVE
 - ④ : NON RETURN VALVE (NOZZLE TYPE)
(CHECK-VALVE)
 - ⑤ : PIESORESISTIVE PRESSURE SENSOR
 - ⑥ : MANOMETER WITH THREE WAY ISOLATING VALVE
 - ⑦ : SAMPLING VALVE 1/2"
 - ⑧ : ELECTROMAGNETIC FLOWMETER
 - ⑨ : FLOW SWITCH
 - ⑩ : DRAIN
 - ⑪ : NIPPEL 1" FOR CHLORE
 - ⑫ : PIPE SUPPORT
 - ⑬ : LEVEL SENSOR
 - ⑭ : MANUAL GATE VALVE
 - ⑮ : SURGE ANTICIPATION VALVE
 - ⑯ : REINFORCED PIPE SUPPORT
 - ⑰ : SUCTION STRAINER
 - ⑱ : MANUAL GLOBE VALVE
 - ⑲ : MANUAL BUTTERFLY VALVE
 - ⑳ : REDUCER
 - ㉑ : RUBBER FLEXIBLE JOINT

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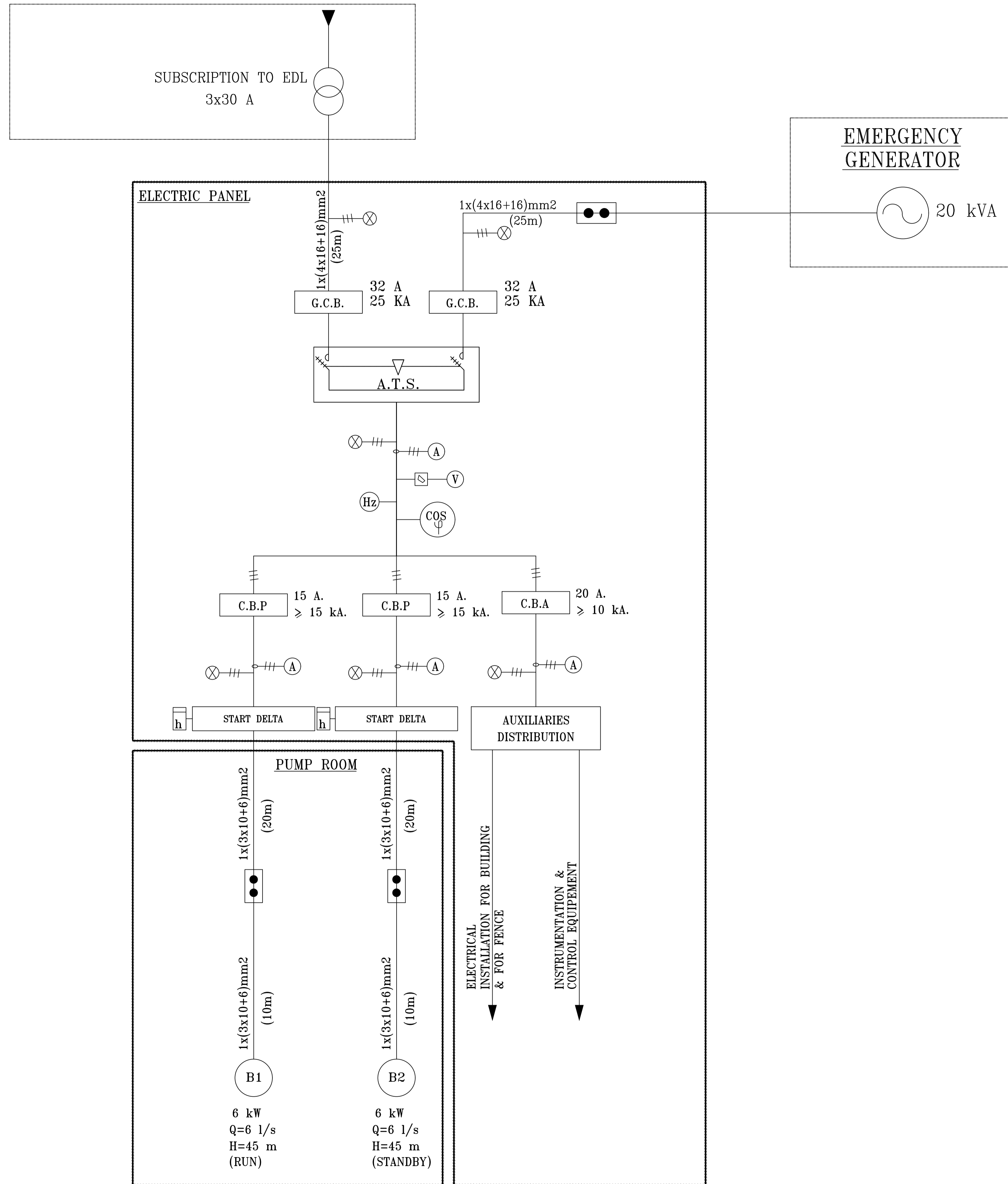
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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | BOOSTER PUMP STATION MECHANICAL LAYOUT |
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| MARCH 2023 | N.T.S | 32 | 667W-02M02 |



NOTES

- : POWER FACTOR MEASUREMENT
- : INDICATING LAMP
- : SELECTOR SWITCH
- : FREQUENCY METER
- : VOLTMETER
- : AMPERMETER
- : HOURMETER
- : CIRCUIT BREAKER
- : JUNCTION BOX IP67
- : TRANSFORMER HV/LV
- : SUBMERSIBLE MOTOPUMPSET
- : SURFACE MOTOPUMPSET
- : MANUAL TRANSFER SWITCH (M.T.S.)
- : EMERGENCY GENERATOR
- : GENERAL CIRCUIT BREAKER
- : CIRCUIT BREAKER FOR PUMPSET
- : CIRCUIT BREAKER FOR AUXILIARIES

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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

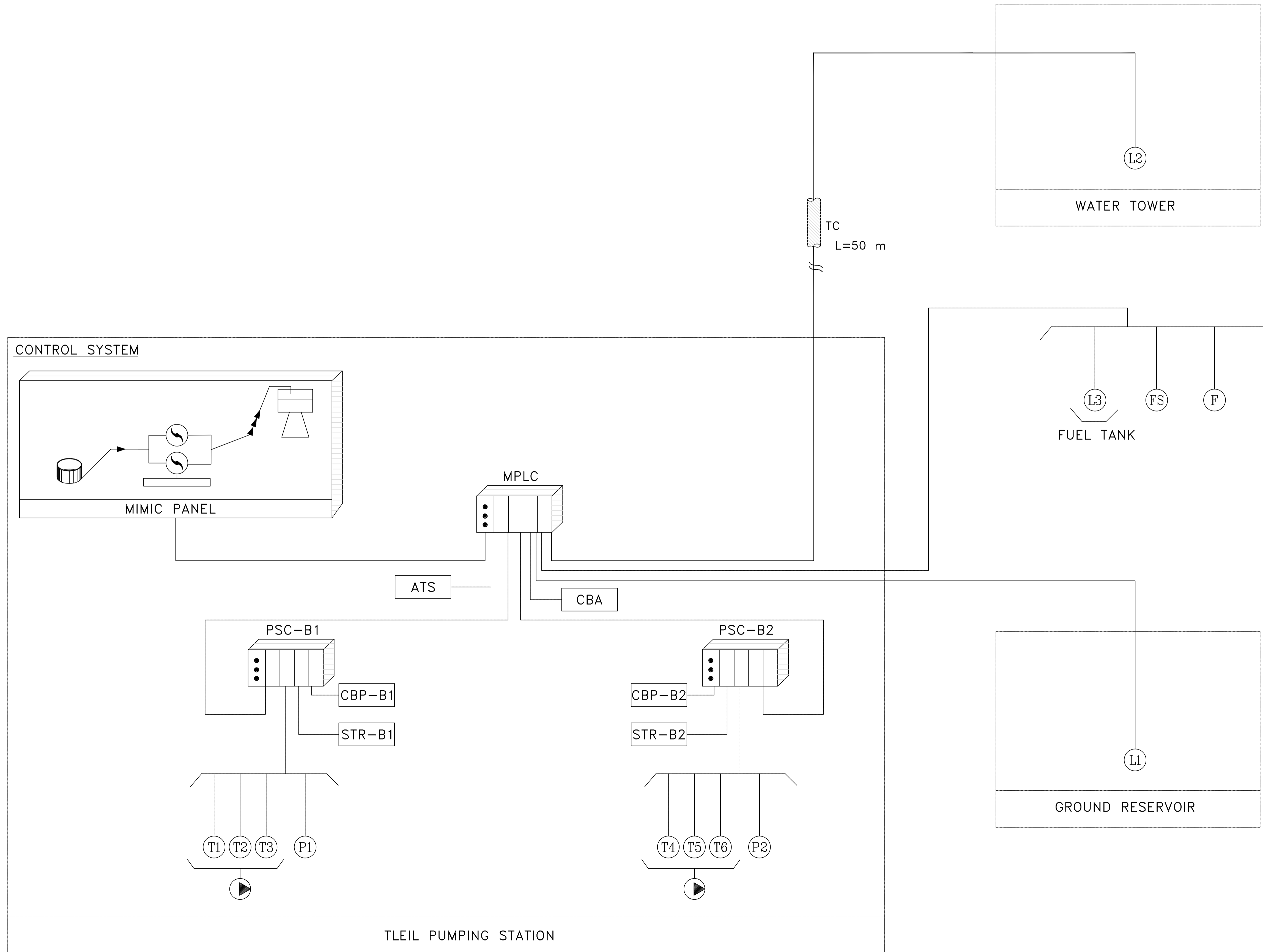
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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | BOOSTER PUMP STATION ELECTRICAL SCHEMATIC |
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| MARCH 2023 | N.T.S | 33 | 667W-02E01 |

NOTES

-  : PROGRAMMABLE LOGICAL CONTROLLER (PLC)
- MPLC : MAIN PLC
- RTU : REMOTE TERMINAL UNIT
- : DATA CABLES
- ^{TC} : TELEMETRY CABLE IN CONDUIT
- AWH : ANTI WATER HAMMER
- FS : FLOW SWITCH
- VS : VACUUM SWITCH
-  : RESERVOIR
-  : BOREHOLE MOTOPUMPSET
- ATS : AUTOMATIC TRANSFER SWITCH
- PSC : PUMPSSET CONTROLLER
-  : FLOW MEASUREMENT
-  : LEVEL MEASUREMENT
-  : PRESSURE MEASUREMENT
-  : TEMPERATURE MEASUREMENT
-  : CHLORINE
- STR : STARTER
- CBP : CIRCUIT BREAKER FOR PUMPSSET
- CBA : CIRCUIT BREAKER FOR AUXILIARIES
- GCB : GENERAL CIRCUIT BREAKER
-  : SURFACE MOTOPUMPSET
-  : ELECTRIC ACTUATOR
-  : ANTI WATER HAMMER



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PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | BOOSTER PUMP STATION CONTROL SCHEMATIC |
|--|---|

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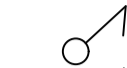
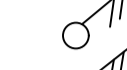
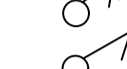
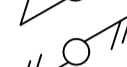



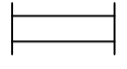


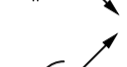

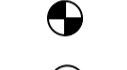
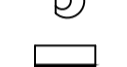




10 EMERGENCY LAMPS TO BE
INSTALLED ALONG ALL THE SHAFT

10 LAMPS TO BE
INSTALLED ALONG ALL THE SHAFT

DOUBLE DIRECTIONS SWITCH TO BE
INSTALLED AT THE HIGHEST LEVEL OF THE CORE

LEGEND:


-  IP56 SIMPLE SWITCH
-  IP56 DOUBLE SWITCH
-  IP56 TRIPPLE SWITCH
-  IP56 DOUBLE DIRECTION SWITCH
-  IP56 DOUBLE SWITCH, DOUBLE DIRECTION
-  IP56 TRIPPLE SWITCH, DOUBLE DIRECTION
-  IP65 TRIPPLE DIRECTION SWITCH
-  IP56 SINGLE PHASE POWER OUTLET (1-PH P.O.)
-  IP56 3-PHASE POWER OUTLET (3-PH P.O.)
-  SURFACE MOUNTED WEATHERPROOF IP65, 1200 MM LONG, 2*40W LED LIGHTING FIXTURES, 4000 LUMENS, 5000 K
-  WALL MOUNTED LED 60 W LIGHTING FIXTURE IP65
-  WALL MOUNTED LED 100 W LIGHTING FIXTURE IP65
-  EMERGENCY EXIT LIGHTING FIXTURE
-  EMERGENCY LIGHTING FIXTURE 9W LED, 3 HRS AUTONOMY
-  ELECTRICAL PANEL BOARD-PRINCIPAL OR COMPLETE
-  ELECTRICAL PANEL BOARD-SECONDARY

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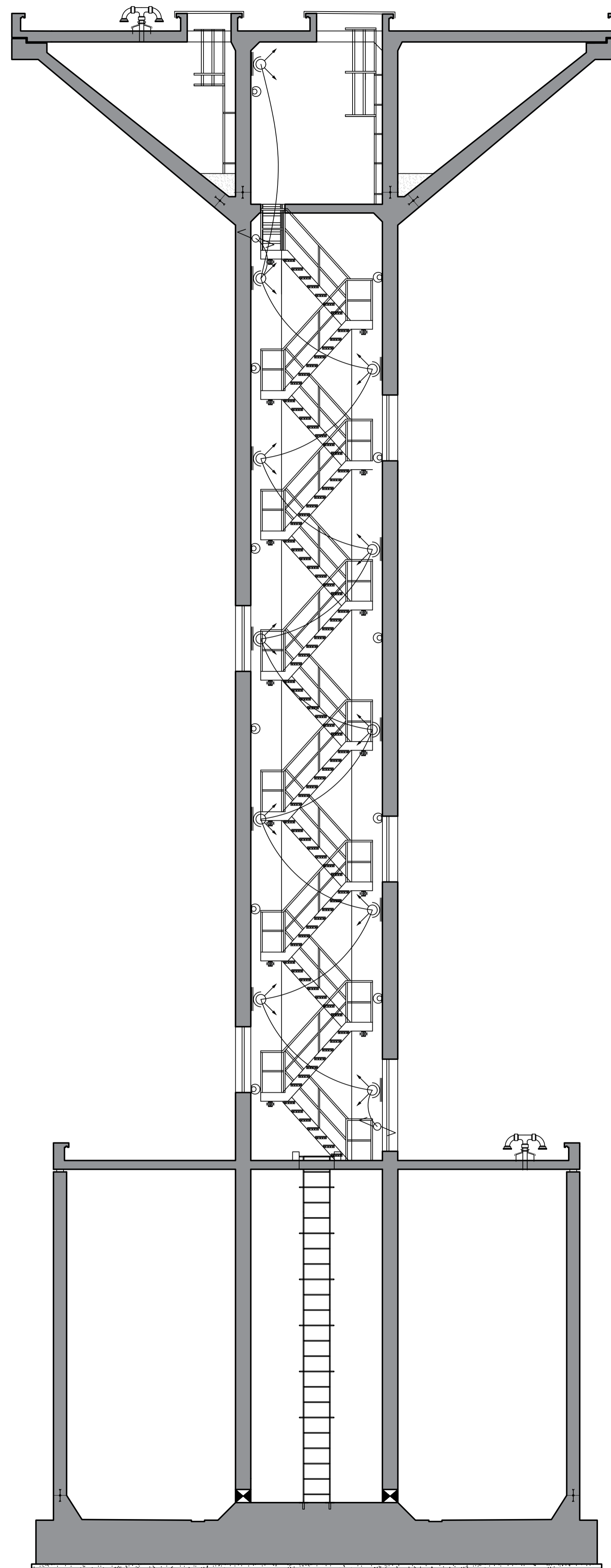
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WATER SERVICES

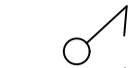
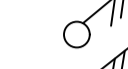
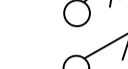
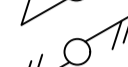

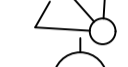

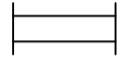


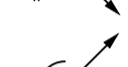

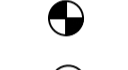
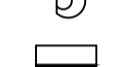


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| PROPOSED 750m3 RESERVOIR AND 100m3 WATER TOWER | LIGHTING SCHEMATIC FOR THE WATER TOWER CORE PLAN VIEW |
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LEGEND:

-  IP56 SIMPLE SWITCH
-  IP56 DOUBLE SWITCH
-  IP56 TRIPPLE SWITCH
-  IP56 DOUBLE DIRECTION SWITCH
-  IP56 DOUBLE SWITCH, DOUBLE DIRECTION
-  IP56 TRIPPLE SWITCH, DOUBLE DIRECTION
-  IP65 TRIPPLE DIRECTION SWITCH
-  IP56 SINGLE PHASE POWER OUTLET (1-PH P.O.)
-  IP56 3-PHASE POWER OUTLET (3-PH P.O.)
-  SURFACE MOUNTED WEATHERPROOF IP65, 1200 MM LONG, 2*40W LED LIGHTING FIXTURES, 4000 LUMENS, 5000 K
-  WALL MOUNTED LED 60 W LIGHTING FIXTURE IP65
-  WALL MOUNTED LED 100 W LIGHTING FIXTURE IP65
-  EMERGENCY EXIT LIGHTING FIXTURE
-  EMERGENCY LIGHTING FIXTURE 9W LED, 3 HRS AUTONOMY
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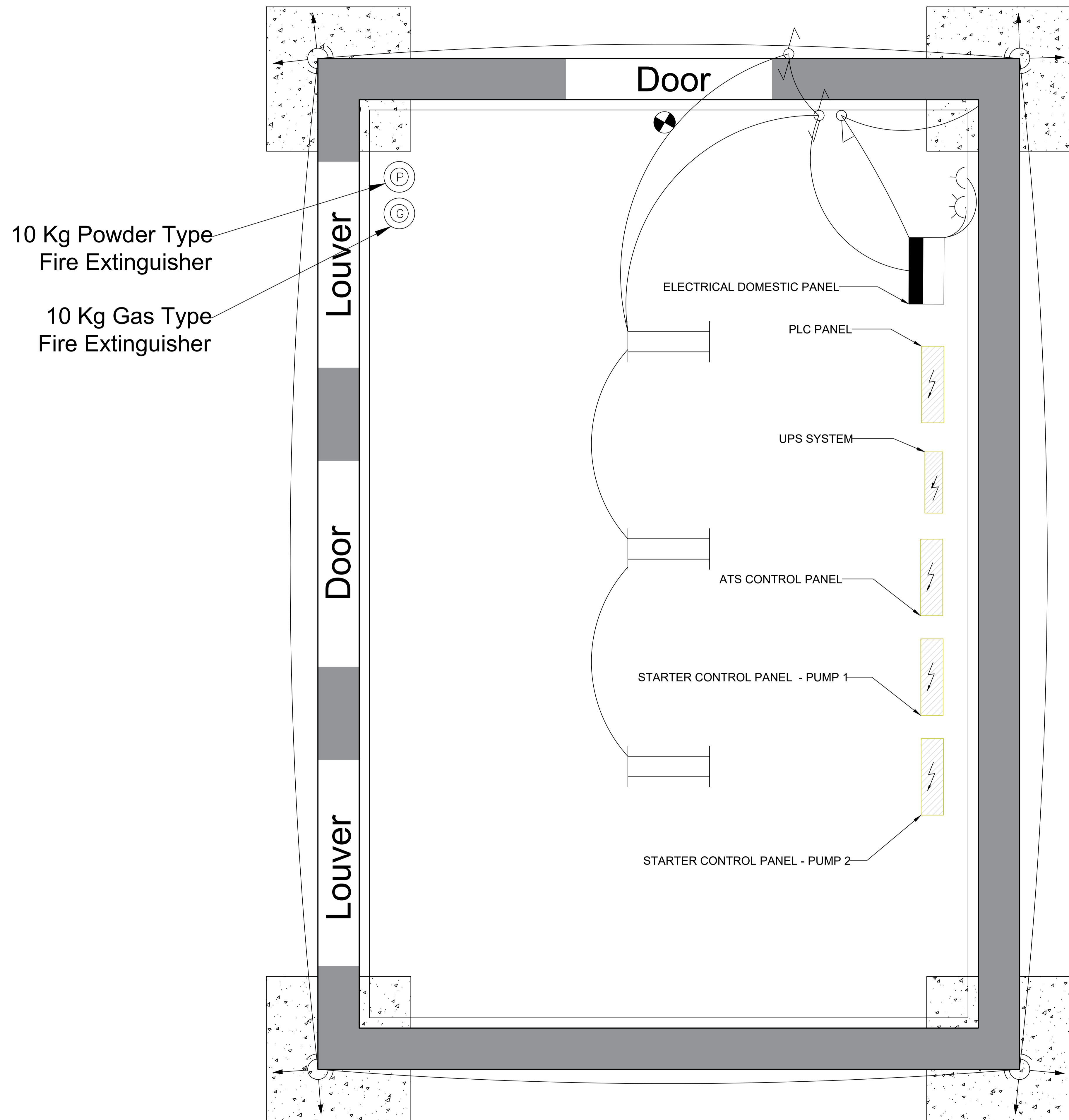
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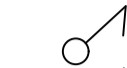
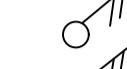
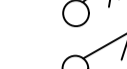
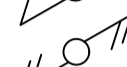



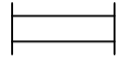


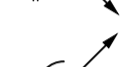

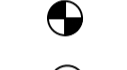
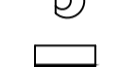


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| PROPOSED 750m ³ RESERVOIR AND 100m ³ WATER TOWER | LIGHTING SCHEMATIC FOR THE WATER TOWER CORE SIDE VIEW |
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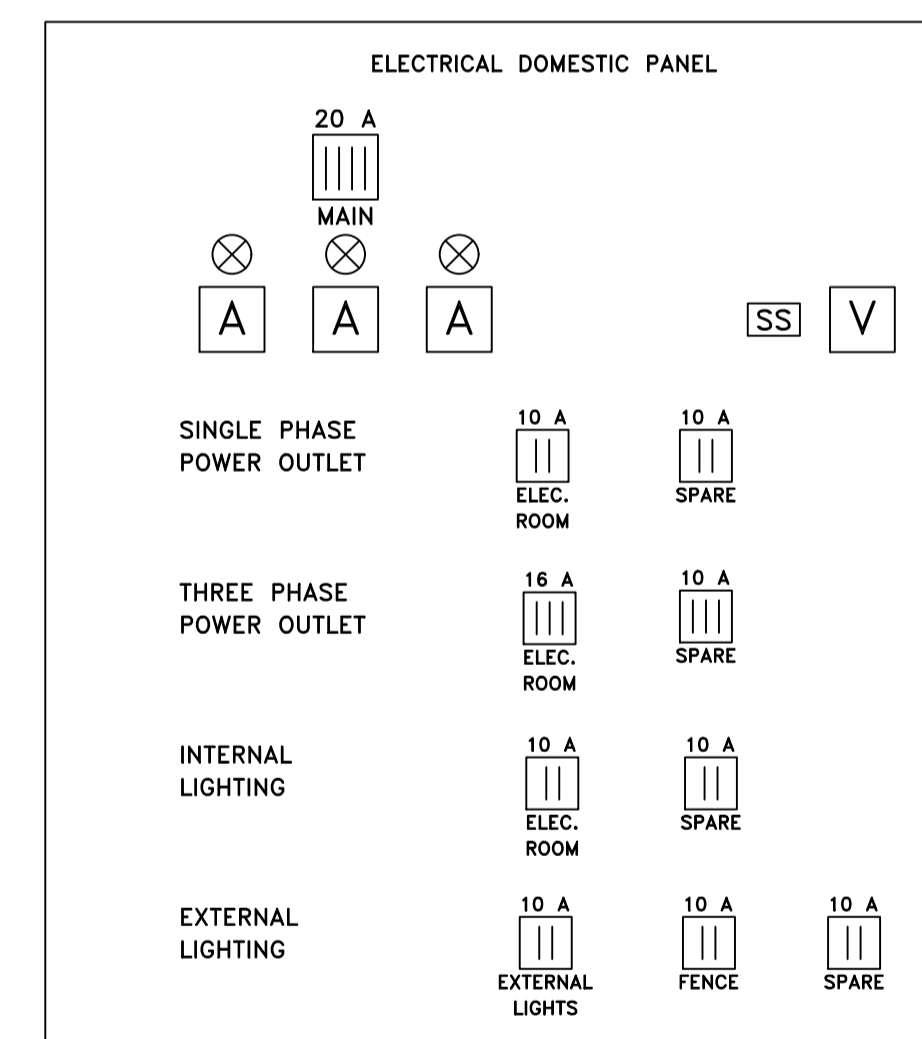
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| MARCH 2023 | N.T.S | 36 | 667W-02E04 |



LEGEND:

-  IP56 SIMPLE SWITCH
-  IP56 DOUBLE SWITCH
-  IP56 TRIPPLE SWITCH
-  IP56 DOUBLE DIRECTION SWITCH
-  IP56 DOUBLE SWITCH, DOUBLE DIRECTION
-  IP56 TRIPPLE SWITCH, DOUBLE DIRECTION
-  IP65 TRIPPLE DIRECTION SWITCH
-  IP56 SINGLE PHASE POWER OUTLET (1-PH P.O.)
-  IP56 3-PHASE POWER OUTLET (3-PH P.O.)
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-  EMERGENCY EXIT LIGHTING FIXTURE
-  EMERGENCY LIGHTING FIXTURE 9W LED, 3 HRS AUTONOMY
-  ELECTRICAL PANEL BOARD-PRINCIPAL OR COMPLETE
-  ELECTRICAL PANEL BOARD-SECONDARY



| Rev. | Date | Dsgn | Drwn | Chk'd | Appr'd |
|------|------|------|------|-------|--------|
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 JALL ED DIB - HAJAL Bldg TEL:(04) 712157 / 712158
 P.O.BOX:70492 - ANTELIAZ FAX: (04) 712159

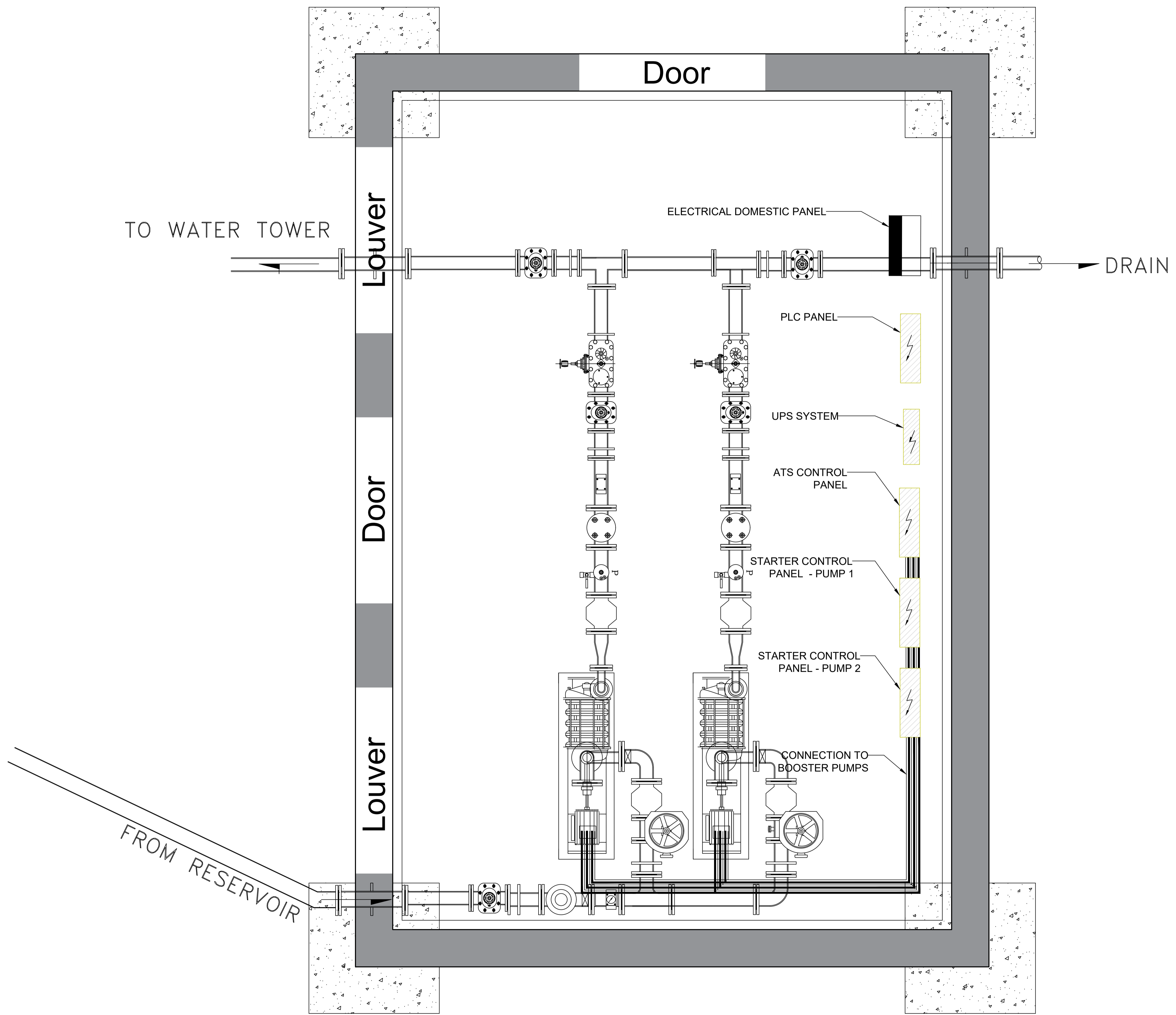
PROVIDING TLEIL, HAYTLA, SAIDNAYA AND MZEIHME
 WITH SAFE, RELIABLE, AND SUSTAINABLE
 WATER SERVICES

PROPOSED 750m3
 RESERVOIR AND 100m3
 WATER TOWER

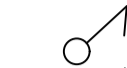
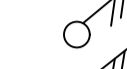
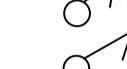
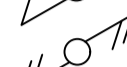

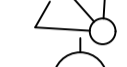

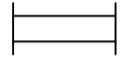


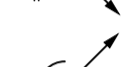

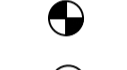
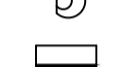


LIGHTING SCHEMATIC FOR
 THE MECHANICAL ROOM

| FILE | DESIGNED BY | DRAWN BY | CHECKED BY |
|------|-------------|----------|------------|
| 667W | T.RMEITY | A.CHREIM | T.RMEITY |

| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|-------------|
| MARCH 2023 | N.T.S | 37 | 667W-02E05 |



LEGEND:

-  IP56 SIMPLE SWITCH
-  IP56 DOUBLE SWITCH
-  IP56 TRIPPLE SWITCH
-  IP56 DOUBLE DIRECTION SWITCH
-  IP56 DOUBLE SWITCH, DOUBLE DIRECTION
-  IP56 TRIPPLE SWITCH, DOUBLE DIRECTION
-  IP65 TRIPPLE DIRECTION SWITCH
-  IP56 SINGLE PHASE POWER OUTLET (1-PH P.O.)
-  IP56 3-PHASE POWER OUTLET (3-PH P.O.)
-  SURFACE MOUNTED WEATHERPROOF IP65, 1200 MM LONG, 2*40W LED LIGHTING FIXTURES, 4000 LUMENS, 5000 K
-  WALL MOUNTED LED 60 W LIGHTING FIXTURE IP65
-  WALL MOUNTED LED 100 W LIGHTING FIXTURE IP65
-  EMERGENCY EXIT LIGHTING FIXTURE
-  EMERGENCY LIGHTING FIXTURE 9W LED, 3 HRS AUTONOMY
-  ELECTRICAL PANEL BOARD-PRINCIPAL OR COMPLETE
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| DATE | SCALE | SHEET No. | DRAWING No. |
|------------|-------|-----------|-------------|
| MARCH 2023 | N.T.S | 38 | 667W-02E06 |

