**Section 8 Particular Specification.**

**1. Joint Measurement Team**:

All the measurement will be carried through Joint Measurement Team (JMT).Within 3(three) days of Signing of the Contract, the Project Director and the Contractor shall nominate their respective representative for the Joint Measurement Team for every reach/site/structure notify it to the Project Manager The Project Manager shall constitute the Joint measurement team and notify it to the Project Director and the Contractor (Sample Letter of Nomination and JMT formation is attached in Annex-I: Standard form for communication and measurement). It will be constitute following members. The highest ranked BWBD official included in the committee shall be the convener.

|  |  |  |
| --- | --- | --- |
| SL No | Designation |  |
| 1. | Concerned Sub-Divisional Engineer |  |
| 2. | Concerned SAE/SO. |  |
| 3. | Concerned Field Supervision Engineer. |  |
| 4. | Concerned Field Inspector. |  |
| 5. | Representative of the Contractor |  |
| 6. | Representative of the Project Director |  |

**1.2 The followings shall be the job specification for this committee:**

1. JMT will submit measurement of work executed by the contractor for every reach/site/structure in every 15 days to the Project Manager with copy to the Project Director and the Contractor. The Contractor shall use this measurement for preparation of his IPC.
2. In addition to preparing measurement JMT will ensure that every quality test mentioned in the specification has been done and results are acceptable. They will sign every test report done in this regard and submit it to the Project Manager with copy to the contractor and the Project Director.
3. JMT will submit monthly quality control report for every site/reach/structure. The form and content of the report is described in Annex-III. The contractor shall enclose copy of this report along with his monthly IPC.
4. After Completion of the work JMT will inspect the whole work and prepare a defect liability schedule and submit it to the Project Manager with copy to the project director.
5. All other duty and responsibilities mentioned in this specification.

**1.3 Dispute resolution in measurement:** If any measurement by JMT is not acceptable to the contractor or the Project Director then he will notify it to the Project Manager. Project Manager will appoint other person/team to re measure, which is acceptable to both the Project Director and the Contractor. After re-measurement he will decide the matter as per his power mentioned in GCC Clause 23.1.A format of letter for such communication is attached in Annex-I (Standard form for communication and measurement).

**2. Work Programme and Site Meeting:**

Within 15 (Fifteen) days of signing the Contract, the Contractor shall submit to the Project Manager for the approval a complete and practicable construction programme (GCC Clause 42.1) showing the orderly performance of the Works. An indicative work programme is attached with this specification as Annex-II. Contractors work programme shall be based upon this. The Project Manager shall approve the work programe in consultation with the Project Director.

**3. Site /Progress Meetings:**

The site meeting will be held on every 15 days. The Convener of the JMT will preside over the meeting. The Contractor must attend meeting to review the progress of the work. Among other things the meeting report shall include the followings:

1. physical progress for the preceding 15 days and estimated progress for next 15 days;
2. completion schedules (target and actual) based on the approved Construction Programme;
3. a tabulation of construction equipment, listing the major items and pieces of equipment which were utilized for performance of the Works during the last 15 days;
4. a tabulation of employees, showing the supervisory staff and the numbers of several classes of laborers employed by the Contractor in the previous 15 days ;

The Report format for this site meeting is included as Annex-III with this specification.

Progress Meeting: Progress Meeting will be held on every month presided by the Project Manager. The Contractor must attend meeting to review the progress of the work.

**4. Construction and Repair of Submersible Embankment:**

**4.1. Construction Procedure of Embankment:**

1. Embankments designated on the Drawings to be mechanically compacted shall be demarcated to the lines and grades shown on the Drawings. Initially on fixing the center line alignment of embankment with GPS by the surveyor the bed width of embankment to be measured from design drawing and dug bailing, stripping or ploughing the base of embankment and borrow pit area, removing roots and stumps of trees if any are to be done.
2. The Contractor’s operations in the excavation of material designated for use in compacted embankments or compacted backfill shall be such as will result in an acceptable gradation of soil material, as specified.
3. The specified soil when available in borrow pit or collected from elsewhere shall have to be acceptable to the JMT. Contractor is to provide grain size distribution analysis certificate (Sieve and hydrometer ASTM D-422) of soil to be supplied by him from borrow pit or carried soil from elsewhere. The soil gradation shall have to be prior approved by the JMT and the Project Manager before placing on embankment body. Further laboratory compaction test certificate (With Modified proctor test ASTM D- 1557) of the soil to be used shall have to be supplied by the Contractor at the same time.
4. The specified soil shall be stockpiled nearby the designated location of embankment and moisture content of piled soil shall be checked by the JMT and the Project Manager.
5. If the moisture content is less than desired moisture content for desired compaction (85% of MDD with modified proctor test, ASTM D-1557), the moisture shall be supplemented by sprinkling and reworking the material at the site of compaction. If the moisture content is more than required moisture content for compaction, the material shall be dried by reworking, mixing with dry materials or other approved means.
6. The material to be compacted shall be deposited in horizontal layers not more than 230 mm thick and the distribution of materials shall be such that the compacted material will be homogeneous and free from lenses, pockets, streaks or other imperfections. 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. The compaction operation shall preferably be spread over reaches of around 500m.
7. Each layer of material shall be compacted uniformly by use of adequate and appropriate compaction equipment (Bulldozer/ Sheep Foot RolIer / Vibratory Compactor) approved by the JMT. Compaction shall be done in a longitudinal direction along the embankment and generally begin at the outer edges and progress towards the center in such a manner that each receives equal compaction effort.
8. The compacted soil in each layer shall be tested for specified dry density of about 85% of laboratory Maximum dry density (Modified proctor test ASTM D-1557) at optimum moisture content.
9. The JMT will take samples for each layer of soil being compacted and will perform tests required to determine that the compaction is meeting the requirements of these specifications. On satisfying the compaction requirement of each layer, next layer of soil to be dumped and compaction operation to be repeated. The JMT will decide the location of the Test and collect geo reference. All the test result shall be initialed by the all members of the JMT. The test results along with geo reference shall be duly recorded in the tabular form and certified by the Convener of JMT and this shall be submitted to Project Manager with monthly quality control report. The project Director upon recommendation of the Project Manager will approve the Report.
10. The in situ dry density of the compacted fill shall be determined by the sand replacement method described in ASTM D-1556 and frequency for sampling is stated in schedule of tests for this item of work.
11. A typical cross section showing construction of embankment layer by layer is shown later in this report (Annexure-IV).
12. If the material being excavated from canal or other waterlogged areas for use as embankment and material is saturated, then it shall be initially stockpiled to drain the excess water before placing it for construction of embankment.
13. Location of borrow pits from the toe of embankment are shown in the sketch (Annexure-V). Borrow pits should be kept at least 20m away from the toe of the embankment if earth is borrowed for the river side and 50 m away from the toe of the embankment if earth is borrowed from the country side and should not be made deeper than 2.5m from the ground level.
14. The contractor shall make continuous video of whole compaction work for each layer. No payment will be made for embankment construction without this video document.

**4.2 Fine Dressing and Close Turfing:**

**General:**

The work shall consist of furnishing all top soil, grass and fertilizers, placing, and incorporating the same on embankment slopes and other locations as shown on the Drawing or directed by the JMT/Consultant/Project Manager. Fine dressing and Close turfing including ramming, watering until the turf grows properly, maintaining etc. on the slopes and crest of the embankment should be done with 75mm thick good quality durba or charkanta sods of size 200mmX200mm.Other grass types (like vetiver) proven to grow well under the local conditions may also be used subject to the prior approval of the Manager.

**Material:**

Grass shall be harmless inoffensive to person and animals and not of kind recognized as nuisance to agriculture. It shall be free of disease and noxious weeds, deep rooted and sufficiently rapid growing and spreading to give complete cover over the planted area with the final inspection period.

**Construction Procedure:**

1. The crest and slope of the embankment shall be shaped to slope and levels, fully compacted then fine dressed with approved top soil in layer of not less than 50mm thick before being covered by good quality Durba grass turf or a similar approved turf from a source approved by the JMT/Project Manager. The turf should be approximately 200mmX200mmX75mm thick and be placed closed together in a staggered pattern with 100% coverage. The turf shall be set firmly into the top soil dressing and watered immediately after planting then daily until the grass is well established and new growth is clearly visible.
2. Sodding or turfing shall be planted with their root system substantially undamaged, well buried in firm material and packed around moist earth in which they have grown.
3. Grass planting shall be started well in advance of the monsoon season to ensure establishment of growth before the rain sets in and shall not be performed when ground is middy or when the soil or weather condition would otherwise prevent proper soil preparation and subsequent operations.
4. The contractor shall be responsible for satisfactory growth and shall water, fertilize and mow the grass to ensure 100% ground coverage of live grass all though the defect liable period.
5. Fertilizer shall be approved lime or mixture of plant nutrients or both. Fertilizer shall consist of standard commercial material such as Nitrozen-Phosphate-Potassium shared in ratio 16.:5:12 or in other suitable ratio. Application rate shall be determined through soil analysis of soil sample taken from the area to be grassed.
6. All sodded areas shall be watered until the grass grows fully. Areas that do not grow or wash out shall be repaired and returned with fresh sods at the Contractor’s expense.

**Schedule of Test for Embankment Construction:**

Following Test shall be carried out at the frequencies shown in the Table to check the suitability of materials, moisture contents of the fill material and dry density of compacted fill as per specifications;

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Name of Test** | **Frequency of Test** | **Test Method** |
| 1 | Atterberg's Limit  (Plastic Limit &  Liquid Limit) | 1. For each source of fill materials  2. One Sample for each 10,000 Cum of fill material  3. Change in the Characteristics of the material noticed on visual examination. | ASTM D 4318  or Equivalent |
| 2 | Grain Size Distribution | As stated above | ASTM D 422  or  Equivalent |
| 3 | Standard Proctor Test | 1. For each source of fill material;  2. As per direction of the Project Manager. | ASSTO T 180 |
| 4 | Moisture Content | I .For each 5000 cum of fill material  2. As per direction of the Project Manager. | ASTM D 4346 & ASTM D 4944  or V Equivalent |
| 5 | Dry Density V | 1. One Sample for each 1000 sqm of compacted surface in each layer  2. As per direction of the Project Manager. | AAHSTO T191  or  Equivalent |
|  |  |  |  |

**Measurement:**

Embankment shall be measured in cubic meter based on pre-work and post-work survey. RTK GPS shall carry the pre-work and post work survey in presence of JMT.The convener of JMT shall collect raw data of RTK and submit it to the project manager with monthly quality control report. Printed copy of measurement of volume of work done from the survey shall be duly signed by the all member of the JMT.The Contractor will arrange RTK and Surveyor for all survey work and notify the project manager with date of surveying with copy to Project Director. The project manager shall notify the JMT to take measurement.

Turfing will be measured only for well-grown continuous grass. No sporadic measurement shall be given. Minimum surface area for measurement shall be................................................. and average minimum grass height shall be …………………..

**Payment:**

Construction of embankment will be paid from BoQ item No:…….. of Bill No:02.The surveyor and RTK GPS will be paid from the day of work.

**5 Type A Slope Protection Work:**

**5.1 Casting of C.C Block:**

CC Blocks Casting/Concreting yards should be leveled well compacted ground with neat sand-cement mortar finished brick soling/lean concrete finish over it. Casting Moulds/Forms are to be placed over thick polythene sheeting to prevent leakage through bottom of the shutter. Inner sides of the Moulds/Forms are to be cleaned and oiled before each batch of casting operation takes place.

Mixing of concrete shall be done by modern automated mixing plant/machine. Unless otherwise permitted by the Engineer, hand mixing of concrete is prohibited. Mixing should be done thoroughly to ensure that concrete is of uniform color and consistency. The concrete shall be placed in the Moulds/Forms in full and be thoroughly compacted by vibrators supplemented by hand spading and tamping. In no way the vibrator should touch the Mould/Form during vibration operation. The vibrators shall at all times be adequate in numbers to compact the concrete properly and quickly throughout the whole operation of Block casting in each batch. The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Care should be taken that no leakage of cement mortar takes place. After compaction, the exposed concrete at top surface shall be struck off smooth with hand held steel floats.

The Moulds/Forms shall not be opened until the concrete is firmly set. Honey combed or partly damaged blocks shall not be acceptable.

The contractor shall arrange all land required for the CC Blocks Casting/Concreting yards, preparation of yard with brick soling, polythene sheeting, oiling of Moulds / Forms etc for which no extra cost will be paid. All compensations in this regards are deemed to have covered by the BoQ item "Cement Concrete Blocks (CC Blocks)"

**Curing Concrete Blocks**

Concrete Blocks shall be protected from the effects of sunshine, dry wind, rain, running water or mechanical damage for a continuous period, until the concrete has reached at least three quarters of its 28 day strength, but for not less than 10 days. The Contractor shall submit his proposals to achieve this protection for Engineer's approval. The water used for concrete curing shall be fresh water, clean and free from any substances injurious to the concrete. The use of saline water for curing purposes will not be permitted. Curing and protection of concrete may be done following the methods:

(i)By water spray in continuous operation or a layer of water;

(ii) By covering with Hessian or similar absorbent material, or sand, kept continuously wet;

(iii) After thorough wetting, by covering with a layer of water proof fabric kept in contact with concrete surface;

(iv)All materials spray equipment and an ample supply of water for curing shall be ready on site before manufacturing of Precast C.C Block starts. C.C Blocks that is, in the opinion of the JMT/Consultant/Project Manager, not cured according to the approved curing procedure will be regarded as inferior and shall be dealt with as damaged blocks.

**Numbering of Blocks**

Each block shall be marked with a consecutive number and the date of casting. The Contractor shall maintain a manufacturing register with signature of quality control personnel. The number, date of casting, date and location of placing of each block shall be recorded in the register and shall make the register available at all times for inspection by the Engineer.

**Stockpiles of Blocks**

Blocks shall not be stockpiled until they have been cured for at least 21 days. They should be stockpiled with consecutive numbers and in measurable stack. The stacks shall not contain more than 4 layers and shall not be stacks very closed to the riverbank.

**Damaged Blocks & Rejected Blocks**

Blocks which are found unspecified through visual inspection by the Project Manager/JMT/Consultant shall be rejected. If laboratory test result are found not conforming to the desired strengths, all the Blocks manufactured on the day representing the date of sample of collection shall be rejected (all the Blocks manufactured on the date representing the Test). All Those Blocks shall be stacked separately. Blocks which are damaged during stockpiling, transport or handling and shall be rejected and stacked separately. The Contractor shall remove those rejected and damaged Blocks from the site within 24 hrs. ordered by Project Manager/JMT/Consultant. The contractor has to supplement the damaged or rejected number of blocks at his/his or her own cost.

**Schedule of Test**

Following Test shall be carried out at the frequencies shown in the Table to check the properties of construction materials (Cement, Sand, Gravels, Admixture), Concrete Blocks as per specifications;

|  |  |  |  |
| --- | --- | --- | --- |
| Sl. No. | Name of Test | Frequency of Test | Test Method |
| 1 | Cement:   1. Fineness 2. Soundness 3. Initial Setting Time and Final Setting Time 4. Compressive Strength 5. Tensile Strength 6. Unit Weight | 1. For each fresh Consignment arriving at Site 2. For each 100 M. Ton 3. As approved or directed by the Project Manager. | ASTM C786,  ASTI C403,  ISO 679:2009  or  Equivalent |
| 2 | Fine Aggregate (Sand)  i) Fineness Modulus  ii) Chemical Test | 1. 1(one) Sample for each 350 Cum or part thereof 2. At least 1 Sample in a week 3. As approved or directed by the Project Manager. | ASTM C 33  or  Equivalent |
| 3 | Coarse Aggregate (Stone Chips)   1. Gradation Test 2. Water Absorption 3. Aggregate Impact Value (AIV) 4. Loss Angeles Test | 1. 1(one) Sample for each 700 Cum or part thereof 2. At least 1 Sample in a week 3. As approved or directed by the Project Manager. | ASTM C330,  AASHTO T-85, BS-  812,  ASTM C-535  or  Equivalent |
| 4 | Water  Suitability of Water for Concrete Mixing | 1. For Each source of Water 2. As approved or directed by the Project Manager. | BS EN BS EN  1008:2002 |
| 5 | Concrete   1. Slump 2. Water Cement ratio 3. Cylinder Test (Compressive Strength) 4. Non-destructive Test (Rebound Hammer) 5. Concrete Core Test | 1. Rebound Hammer Test will be carried out as frequent as the Project Manager considered 2. Concrete Core Test will be carried out for at least one block for each days casting 3. As approved or directed by the Project Manager. | BS 1881,  ASTM C-42  Or  similar standard |

**Measurement:**

Measurement of concrete blocks shall be made on blocks in numbers (size-wise) casted, cured and stockpiled and accepted. Separate Items for manufacturing of C.C Blocks for the different types of C.C Blocks have been provided in the BoQ.

**Payment :**

Payment shall be made in number at the unit rate of block (size-wise) rate stated in the BOQ.

**5.2 Geo-textile Filter:**

All geo-textile fabric shall meet in full the requirements of Physical, Mechanical and Hydraulic properties. The geo-textile manufacturer must be ISO 9001 certified by an accredited register. Geo-textile in standard rolls shall be clearly marked at regular intervals (every square meter or continuous marking at 1 m distance) with the product name and grade. Marking in every 100 sqm. is required to identify the supplier. Each roll of geo-textile shall be protected in a plastic foil wrapper, clearly labeled with the roll number, production of lot number and description of the product, product name, grade and manufacturers details. Geo-textile filter shall be protected from ultra violet ray and any sort of damage during handling and placing.

The geo-textiles shall be manufactured from polypropylene or polyester fabric and shall be non-woven needle-punched and not solely thermally bonded. The thermal bond shall not influence the flexibility under water. The required porosity of geo-textile shall be minimum 80%. Porosity is a calculated value out of tested material characteristics and the specific weight of the fibers.

**Specification**

The geo-textiles shall be manufactured from polypropylene fabric and shall be non-woven and needle punched and not solely thermally bonded. The thermal bond shall not influence the flexibility of the sand bags including their launching behavior. The Geo-textile shall comply the following properties:

|  |  |  |
| --- | --- | --- |
| **SI** | **Test Parameter** | **Standard Value** |
| 1 | Mass per unit area | =>400 gm/m2 |
| 2 | Thickness under a pressure of 2 kPa | =>3 mm |
| 3 | Apparent / Effective Opening size | >0.08 mm |
| 4 | Horizontal Permeability | > 3 x 10E-3 mlsec |
| 5 | Vertical Permeability - | > 4.5 x 10E3 m/sec |
| 6 | Grab Tensile Strength | => 1500 N |
| 7 | Strip Tensile Strength | =>23 KN / m |
| 8 | CBR Puncture Resistance | => 3800 N |
| 9 | Elongation at maximum force (machine direction MD) | =>60% and <=100% |
| 10 | Elongation at maximum force (CMD) | >40% and <=100% |
| 11 | Permeability (Velocity Index for a head loss of 50 mm- V H50 | => 2 x 103 m/sec |
| 12 | Ultra-Violet (UV) Resistance | =>70% of original tensile strength before exposure |

**Testing Geo-textiles**

1. Geo-textile delivered at site should be certified by ISO with brand name.
2. The properties of geo-textile to be delivered at site shall be tested at BRTC, BUET according to relevant test standard given in the specification.
3. Tests shall be carried out from each quantity of 10,000 square meter of geo-textile fabric supplied. Seams shall be tested for tensile strength every 10,000 m of seam. If quantity required at any reach of work is less than 10000 square meter one test shall be carried out.
4. The sample size for the fabric shall be 2 m2 and shall be marked to indicate its upper side, longitudinal and transverse directions, type of geo-textile and the date that the sample was taken. Seam samples shall be at least one meter in length and the ends of the threads are to be firmly tied off by the Contractor or Supplier at the time the samples are taken. Each test shall be carried out on at least three samples.
5. The Contractor shall bear the expenses of all routine tests. Notwithstanding the submission of repots to the effect that the geo-textile conforms to the Specification. The Project Manager shall at all times be entitled to have additional samples of geo-textile tested if he is of the opinion that the geo-textile does not conform to the Specification. The Project Manager shall only select samples from, any lot procured at site by the contractor.

**Construction**

The Geo-textile fabrics shall be placed above the inverted filter on the surface of slope of embankment / river bank/loose apron/top of embankment as per design and drawing. The fabric shall be placed in position, providing machine seamed joints (with 100% polypropylene or nylon thread) minimum 35 cm lap in dry condition and minimum 100 cm lap under water Inducing protecting the geo-textile materials from UV sun ray and from any other damages.

**Measurement**

Measurement of Item geo-textile filter shall be made based on the area in square meters measured parallel to the face on the slopes as shown on the drawings or as approved or directed by the Project Manager . No additional payment will be made for fabric used to provide specified laps.

**Payment.**

Payment of Item of Geo-textile Filter Fabric shall be at the unit rate per Square Meter as included in the Bill of Quantities.

**5.3 Supplying & Laying Sand Filter:**

**General:**

The fine filter shall consist of natural sand of FM 1.010 1.5 or as specified in the drawing. The material shall not contain any flint, chirp or lime. The quantity of silt, clay and dust, determined in accordance:   
with the decantation method given in BS 812, shall not exceed 3% by weight of the sample. The content of mica shall not exceed 3% by weight of the sample. The material shall not contain any deletenous material in such form or in sufficient quantity as to affect adversely on the geo-textile filter above.

**Construction:**

The foundation for the sand filter shall be thoroughly compacted and graded to the elevations shown on the Drawings prior to the placement. The filter material shall be placed in a uniform layer of the thickness shown on the drawing or approved or directed by the Engineer. Minimum 100 mm thickness sand or as specified in the drawing having FM 1.0 to 1.5 shall be placed on. prepared, well dressed and compacted slope/surface.

**Measurement**

Measurement of item sand filter shall be made in cubic meter. Separate Items for supplying and laying of sand filter for structure and protective works have been included in the BoQ

**Payment**

Payment of item Sand Filter for structure and protective works shall be made at the unit rate per Cubic Meter against separate items as included in the Bill of Quantities.

**5.4 Pea Gravel Filter:**

**Construction Methods:**

The aggregate filter materials shall be laid on two layers of equal thickness or as shown in the drawings. The filter material of thickness **100 mm** (40mm to 20 mm well graded at top & 20mm to 5mm at bottom) shall laid in accordance with the grading shown on the drawings.

**Measurement**

Measurement of item gravel filter shall be made in cubic meter. Separate items for supplying and, laying of gravel filter have been included in have been included in the BoQ.

**Payment**

Payment of item Pea Gravel Filter shall be at the unit rate per Cubic Meter as included in the Bill of Quantities.

**5.5 Embankment Construction:**

Shall conform all relevant specification mentioned in paragraph “***4.Construction and Repair of Submersible* Embankment”** for embankment construction including measurement and payment except close for turfing which is not required in this type of slope protection work.

**6 Type B Slope Protection Work:**

**6.1 Geotextile Filter:**

Shall conform all relevant specification mentioned in paragraph “**5.2 Geo-textile Filter”** including measurement and payment.

**6.2 Geo Bags:**

**Geo Textile Specification**

The geo-textiles shall be manufactured from polypropylene fabric and shall be non-woven and needle punched and not solely thermally bonded. The thermal bond shall not influence the flexibility of the sand bags including their launching behavior. The Geo-textile shall comply the following properties:

|  |  |  |
| --- | --- | --- |
| **SI** | **Test Parameter** | **Standard Value** |
| 1 | Mass per unit area | =>400 gm/m2 |
| 2 | Thickness under a pressure of 2 kPa | =>3 mm |
| 3 | Apparent / Effective Opening size | >0.08 mm |
| 4 | Horizontal Permeability | > 3 x 10E-3 mlsec |
| 5 | Vertical Permeability - | > 4.5 x 10E3 m/sec |
| 6 | Grab Tensile Strength | => 1500 N |
| 7 | Strip Tensile Strength | =>23 KN / m |
| 8 | CBR Puncture Resistance | => 3800 N |
| 9 | Elongation at maximum force (machine direction MD) | =>60% and <=100% |
| 10 | Elongation at maximum force (CMD) | >40% and <=100% |
| 11 | Permeability (Velocity Index for a head loss of 50 mm- V H50 | => 2 x 103 m/sec |
| 12 | Ultra-Violet (UV) Resistance | =>70% of original tensile strength before exposure |

**Testing Geo-textiles**

1. Geo-textile delivered at site should be certified by ISO with brand name.
2. The properties of geo-textile to be delivered at site shall be tested at BRTC, BUET according to relevant test standard given in the specification.
3. Tests shall be carried out from each quantity of 5000 nos of bags square meter of geo-textile fabric supplied. Seams shall be tested for tensile strength every 5,000 m of seam. If quantity required at any reach of work is less than 10000 nos of bags one set of test shall be carried out.
4. The sample size for the fabric shall be 2 m2 and shall be marked to indicate its upper side, longitudinal and transverse directions, type of geo-textile and the date that the sample was taken. Seam samples shall be at least one meter in length and the ends of the threads are to be firmly tied off by the Contractor or Supplier at the time the samples are taken. Each test shall be carried out on at least three samples.
5. The Contractor shall bear the expenses of all routine tests. Notwithstanding the submission of repots to the effect that the geo-textile conforms to the Specification. The Project Manager shall at all times be entitled to have additional samples of geo-textile tested if he is of the opinion that the geo-textile does not conform to the Specification. The Project Manager shall only select samples from, any lot procured at site by the contractor.

**Required Properties of Geo-Textile Bags:**

All geo-textile bags shall be supplied from a single source and grade of geotextile shall comply in full with the following specification.

|  |  |  |  |
| --- | --- | --- | --- |
| Bag Size(Empty) | Weight (Kg)  (When filled with dray sand) | Filled Volume | Min seam strength EN ISO 10321 |
| 950mmx750mm | 125 | Fill Vol: 0.0840 cum | 18 n/m |
| 1075mmX800 mm | 175 | Fill Vol: 0.1164 cum | 18 n/m |

**Preparation and sewing:**

1. The geo-bags shall be prepared by sewing on two longitudinal sides as per drawing. The Transverse top side shall be kept open for subsequent closing.
2. Sewing shall done by machine at machine or cross-machine direction.
3. The number of stich in every 25mm should not be less than 6 nos.The stich shall be double thread chain stich type (type 401 under ISO 4915/DIN 61400) or two thread type with lock stich (type 301 under ISO 4915/DIN 61400).
4. At the bottom end of each seam (at the folded side) the stich shall be locked either by stitching one time back and forth for length of minimum 25mm from the end of the bag or by joining ends of the two threads e.g by gluing, knotting or other appropriate method acceptable to the JMT/Consultant/Project Manager.
5. The two lines of stiches shall be within 5mm distance with a margin of 25 mm from the edge of geotextile to the centerline between two seams. The tolerance is 3mm in each direction.
6. The thread used for stitching should be of same material as the geo-textile or of materials more durable than the material of geo-textile (polypropylene).
7. The thread used must be of high quality and equivalent stability of UV exposure as geotextile material.

**Filling, Sewing and Stacking of Geo-bags**

The filling sand shall be non-saline clean natural sand and have fineness modulus > 1.00.The amount of silt, clay and fines shall not exceed 5%.The geo-textile bag shall be filled up with dry specified sand. After filling bag shall be checked by weighing scale and close the mouth by specified seam (04 lines) using double needle sewing machine.Geo bags shall be marked by synthetic enamel paint during counting.

**Measurement:**

Measurement of geotextile bags shall be made on actual number of bags placed.

**Payment:**

Payment of item geotextile bags shall be at the unit rate per number as included in the Bill of Quantities.

**6.3 Embankment Construction:**

Shall conform all relevant specification mentioned in paragraph “***4.Construction and Repair of Submersible* Embankment”** for embankment construction including measurement and payment.

**7 Construction of Flood Fuse:**

**7.1 Ring Cofferdam/ Ring Bundh construction:**

**General**   
The term ‘Cofferdam/ Ring Bundh’ denotes any temporary or removable structure, constructed to hold the surrounding earth, water or both, out of the foundation pit whether such structure is constructed by earth, timber, steel, concrete or any combination of these. The Cofferdam/ Ring Bundh shall be constructed with the suitable earth obtained from the excavation of foundation trench of structure or borrowed earth or with combination of both as the case be in the field. The Contractor shall be fully responsible for arranging land, borrowing & carrying earth to Cofferdam in Ring bundh area with the aid of equipment labors or any other means.

Cofferdam/Ring Bundhs shall be constructed to control water to preclude sliding and caving-in of the walls of the excavation. The interior dimension of cofferdam/ring bundhs shall be such as to give sufficient clearance for the construction and removal of any required forms and the inspection of the interior and to permit pumping.

The Contractor shall submit Drawings showing his proposed method of cofferdam/ring bundh at least ten days prior to the commencement of construction. However, the Contractor shall remain fully responsible the adequacy of the design strength and stability and the safety of the people working therein.

Construction Procedures

1. The earth borrowed from the foundation pit of structure or land shall be placed along the alignment of Cofferdam/Ring Bundh in horizontal layers parallel to the finished grade not exceeding a loose thickness of 150 mm. The earth of each bucket/basket is to be placed near to the earth placed before it and spread systematically. Throwing/dumping of earth in heaps will not be allowed.
2. The clods of earth shall be broken down to a maximum size of 100 mm by striking the clods with the back of a spade or by other suitable method before the next bucket/basket of earth is thrown close to it. The earth shall be compacted manually using rammers made of wood, iron or concrete weighing =>7 kg, fitted with shafts of about 1.5 m long. Ramming shall reduce the voids and to be continued until no further shrinkage of earth is possible by ramming.
3. Before commencing ramming, the moisture content of the soil shall be increased or decreased as necessary by sprinkling the soil with water or by allowing natural drying of the soil as necessary so that the ramming can achieve the compaction as specified. Both wetting and drying may be aided by furrowing the fill and then re-spreading when the moisture content is suitable.
4. The preceding operations shall continue layer after layer until the top of the cofferdam/ring bundh attain the desired level.
5. Where the Cofferdam/Ring Bundh crosses a flowing channel, a bypass /diversion channel has to be constructed to keep the flow unobstructed as per approval of the Project Manager. The land required for such bypass /diversion shall have to be arranged by the contractor at his own cost.

**Removal of Cofferdam! Ring Bundh:**

The Contractor shall remove the Cofferdam/Ring Bundh after satisfactory completion of the intended structure. The contractor shall not remove the Cofferdam/Ring Bundh without written permission of the Project Manager, following his satisfactory inspection of the works. Prior to the commencement of the works, the Project Manager shall confirm in writing the length of cofferdam/ring bundh that are to be removed. Removed earth shall not be stockpiled within the area of drainage channel, which obstruct the flow. It can be used for construction of approach embankment. The contractor shall ensure that the cofferdam ring bundh and its associated elements are carefully and completely removed without causing any harm to the permanent works.

**Measurement**

The cofferdam ring bundh will be measured in cubic meter

**Payment**

Payment of Cofferdam/Ring Bundh shall be made in cubic meter at the rates included in the BOQ.

**7.2 Foundation Excavation**

**General:**

The work consists excavation in any type of soil/material for foundation of structures, construction of Cofferdam/Ring Bundh with excavated earth and it removal, disposal of excavated unsuitable earth sheeting and other temporary work in protecting the stability arid safety of excavated foundations. The Contractor shall construct and maintain accurate benchmarks so that the JMT/Project Manager can easily check levels.

**Excavation plan:**

Excavation shall mean the removal of materials so that structures can be constructed to the lines grades and dimensions shown on the Drawings. Excavation area shall be such adequate so that it provides necessary working space for placing forms, installation of any other Temporary Works etc. required during construction. The Contractor shall prepare, submit and obtain approval from tile Project Manager for excavation plans including details of any surface and/or sub-surface dewatering prior to the start of any excavation.

**Clearing of Site:**

The site shall be cleared as required to remove all stumps, roots, vegetable and other objectionable materials specifically within areas for structure excavation, structures, appurtenance and any other   
facilities indicated on the Drawings or designated by Project Manager. The cleared material shall be deposited in approved areas off site or burnt as directed by the Project Manager. Cleaning of site includes cutting jungles, uprooting stumps and demolition of existing minor structures.

**Excavated Spoil Earth:**

Excavated earth if found suitable shall be used for construction of Cofferdam/Ring Bundh as per specification. Unsuitable/surplus earth shall be removed from the site by hauling to any distance at approved locations.

**Over Excavation:**

Except as may be directed by the Engineer, excess excavation for the convenience of the Contractor or over excavation performed by the Contractor for any purpose or reasons, shall be at the expense of the Contractor. If the excavation for foundations exceeds the depths specified, back filling shall be undertaken as fill works at the expense of the Contractor. If back filling is to be undertaken it shall be done by sand and shall have a fineness modulus.(FM) between 1.0 and 1.50 or as approved or directed by the Engineer.

**Final Finishing of Excavation:**

When excavating to specified foundation levels, the Contractor shall not excavate the last 150 mm until immediately before commencing the construction work, except that the Project Manager shall permit otherwise. Any damage to the work due to the Contractors operations shall be repaired at the expense of the Contractor.

**Removal of Unsuitable Materials:**

When the specified levels or limits of excavation are reached, the Project Manager will inspect the ground exposed. If the Project Manager considers that any part of the ground is by its nature unsuitable, he may direct that the unsuitable material be further excavated to a depth from the lowest excavation level shown on the Drawings or as approved or directed by the Project Manager and be replaced by a suitable backfill approved by the Engineer.

If the materials forming the bottom of any excavations, which is acceptable to the Project Manager at the time of his inspection, subsequently become unacceptable to him due to exposure to weather condition or due to flooding or have become puddle, soft or loose during the process of the works, the Contractor shall remove such damaged softened, or loosened material and excavate further manually. Such further excavation shall be held to be excess excavation and the cost of the excess excavation and subsequent replacement with a suitable backfill shall be at the expense of the Contractor.

**Measurement:**

The quantity of foundation excavation of earth for structures to be measured in cubic meter.   
**Payment:**

The work measured shall be paid as per unit prices per Cubic Meter as shown in the Bill of Quantities.

**7.3 Sand Filter :**

This item shall be conformed to all relevant specification of Paragraph **“5.3 Supplying & Laying Sand Filter”** including measurement and payment.

**7.4 Geotextile Filter:**

This item shall be conformed to all relevant specification of Paragraph **“5.2 Geo-textile Filter”** including measurement and payment.

**7.5 Geotextile Bags:**

This item shall be conformed to all relevant specification of Paragraph **“6.2 Geo-textile Bags”** including measurement and payment.

**7.6 Gravel Filter:**

This item shall be conformed to all relevant specification of Paragraph **“5.4 Pea Gravel Filter”** including measurement and payment.

7.7 CC Blocks:

This item shall be conformed to all relevant specification of Paragraph **“5.1 Casting of C.C Blocks”** including measurement and payment.

7.8 Brick Flat Soiling:

Description:

This item consists of providing single layer brick flat soling on foundation.

Methods:

The bricks shall be laid flat on a 75 mm thick compacted sand cushion layer over the prepared surface. Bricks shall be laid in a regular and uniform manner. Interstices of bricks shall be filled with sand, and water shall be applied by sprinkling. No bricks shall be laid on loose earth or earth filling, which has not been compacted to the required density, and no bricks shall be laid on any surface, which has not been inspected and approved by the Project Manager.

**7.9 Form Work:**

**Description:**

The Formwork consists of furnishing all materials, labor, equipment, manufacturing, installation and removal of formwork. The materials required for manufacturing of formwork may be timber, plywood, bamboo, steel, paint etc. In all hydraulic structures, steel shutter shall only be used except minor joints and chamfer.

It shall be the responsibility of the Contractor to perform the work by engaging well trained and experienced staff or by the sub-contractor who shall have enough number of well trained and experienced staff to coordinate his activities with the other operatories. However, the Contractor shall be responsible for the quality of work performed by the sub-contractor as per the requirements of these specifications.

**Concrete Formwork**

1. The Contractor shall submit for the approval of the Project Manager details of the methods and materials proposed for formwork to each section of the work, Details of all proposed wrought formwork and formwork to produce special finishes are to be submitted, for approval in writing to the Project Manager before any materials are brought on to the Site. If the Project Manager so requires, samples of formwork shall be constructed and concrete placed so that the proposed methods and finish effect can be demonstrated.
2. Formwork shall be constructed from sound materials of sufficient strength, properly braced strutted and shored as to ensure rigidity throughout the placing and compaction of the concrete without visible deflection. Formwork shall be so constructed that it can be removed without shock or vibration to the concrete.
3. All joints shall be close fitting to prevent leakage of grout and at construction joints the formwork shall be tightly secured against previously cast or hardened concrete to prevent stepping or ridges to exposed surfaces.
4. Where the Contractor proposes to make the formwork from standard sized manufactured formwork panels, the size of such panel shall be approved by the Project Manager before they are used in the construction of the work. The finished appearance of the entire elevation of the structure and the adjoining structures shall be considered when planning the patterns of joint lines caused by formwork and by construction joints to ensure continuity of horizontal and vertical lines.
5. Formwork shall be constructed to provide the correct shape, lines and dimensions of the concrete shown on the Drawings. Due allowance shall be made for any deflection which will occur during the placing of concrete within the formwork. Panels shall have true edges to perm accurate alignment and provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified of approved.
6. Formwork shall be provided for the top surfaces of sloping work where the slope exceeds 15 with the horizontal and shall be anchored to enable the concrete to be properly compacted and prevent floatation; care shall be taken to prevent air being entrapped. Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete.
7. Forms Panels shall be supported by scaffolding pipe and steel joist sufficient enough to withstand all impact, weight of green concrete, moving loads etc.

**Formwork for Exposed Concrete Surfaces**

1. Unless otherwise stated on the Drawings, wrought formwork shall be used for all permanently visible concrete surfaces. Wrought formwork shall be such as to produce a smooth and even surface free from perceptible irregularities. Tongued and grooved planed boards, plywood or steel forms shall have their joints flush with the surface. The formwork shall be formed from approved standard sized panels. The panels shall be arranged in a uniform approved pattern, free from defects likely to be detected in the resulting concrete surface.
2. Formwork for structural concrete permanently exposed to public inspection shall be faced with plain 28/28 gauge steel sheet fitted over 38 mm thick wooden plank panels suitably braced or steel framing faced with minimum 12/14 BWG mild steel sheet.
3. The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.
4. The panels I forms shall be supported by scaffolding pipe and steel joist sufficient enough to withstand all impact, weight of green concrete, moving loads etc.

**Formwork for Non-Exposed Concrete Surfaces:**

Unless otherwise stated on the Drawings, rough formwork may be used for all surfaces which are not permanently exposed. Rough formwork may be constructed of plain butt joined sawn timber but the Contractor shall ensure that all joints between boards shall be grout tight.   
The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.

**Preparation of Formwork:**

1. Before concrete is placed, the surfaces of formwork shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter.
2. Before placing concrete all reinforcement bars, anchoring, steel, beams, cables, fixing truss, bolts, pipes or conduits or any other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without the approval of the Engineer.
3. All exterior and interior angles on the finished concrete shall be given 20 mm by 20 mm chamfers unless otherwise shown in Drawings or ordered by the Engineer. When chamfers are to be formed, the fillets shall be accurately cut to size to provide a smooth and continuous chamfer:
4. No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such supports embedded in reinforced concrete shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50mm from the surface. Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.
5. After cleaning, the formwork in contact with the concrete shall be treated with suitable no staining mould oil or approved form oil to prevent adherence of the concrete. Care shall be taken to prevent the oil from coming in contact with reinforcement or mixing with the concrete. At construction joints, surface retarding agents shall be used only where ordered by the Engineer.
6. The use of spacer blocks for the reinforcement shall be prohibited whenever the same effect can be achieved by properly dimensional spacer rings mounted directly on the reinforcement All spacer blocks and rings shall be of the same strength as the concrete iii which they are embedded and shall be adequately cured before use.
7. Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with concrete to affect the strength nor shall it give any color. It shall be applied in such a manner as not to contaminate the reinforcement and other fixtures to be embedded in concrete.

**Removal of Formwork :**

1. Formwork shall be removed in such a manner as will not damage the concrete. No formwork shall be removed until the concrete has gained sufficient strength to support itself. Centers and props may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety.
2. The following table is a guide to the minimum periods which must elapse between the completion of the concreting operations and the removal of formwork. No formwork shall be removed without the permission of the Project Manager and such permission shall not relieve the Contractor of his responsibilities for the safety of the structure.

**Minimum period** of curing **before removal of formwork**

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

**Openings**

Temporary and permanent opening in concrete shall be framed neatly with provisions for keys or reinforcing steel as shown on the drawing, approved, or directed by the Engineer.

**Defects in Formed Surfaces**

Workmanship in formwork and concreting shall be such that concrete shall normally require no repair to surfaces being perfectly compacted and smooth.

If any blemish is revealed after removal of formwork, the Engineers decision concerning remedial measures to be undertaken shall be obtained immediately. These measures may include, but shall to be limited to, the following:

|  |  |
| --- | --- |
| Type and Position of Formwork | Approximate Period (days) |
| Side of beams, walls and columns (unloaded) | 3 |
| Slab soffits (props supporting) | 14 |
| Removal of props to slabs | 21 |
| Beam soffits (props supporting) | 21 |
| Removal of props to beams | 28 |

1. Fins, pinholes, bubbles, surface discoloration and mirror defects may be rubbed down with sacking immediately the formwork are removed;
2. Abrupt and gradual irregularities may be rubbed down with carborundum stone and water after the concrete has been fully cured;
3. Deep honey combed concrete shall be repaired within 24 hours of stripping the formwork by cutting back to sound concrete. The concrete shall be cut back at least 50mm behind face reinforcement. Cut edges shall be regular and not feathered. Recasting shall be with the same concrete as the original casting; the Engineer shall approve the Contractors formwork and method of placing.
4. Under some circumstances, abrupt and gradual irregularities of shallow honey combed concrete may be repaired by cutting back and reforming with an approved epoxy resin or mortar in accordance with the Manufacturer’s instructions.

**Holes to be filled :**

1. Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry pack mortar made from one part by weight of Ordinary Portland Cement/Portland Composite Cement and three parts of specified fine aggregate approved by the Engineer. The mortar shall be mixed with only sufficient water to make the materials stick together when being molded in the hands.
2. The Contractor shall thoroughly clean any hole that is to be filled and break out any loose, broken or cracked concrete or aggregate, removing any dry cement in the hole. The surrounding concrete shall be soaked until the whole surface that will come into contact with the dry pack mortar has been covered and darkened by absorption of the free water by the cement. The surface shall then be dried so as to leave a small amount of free water on the surface.
3. The-dry pack material shall then be placed and packed in layers having a compacted thickness not greater than 10mm in thickness. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry pack against the sides of the hole;
4. After compaction the surface of each layer shall be scratched before further loose material is added. The hole shall be slightly over filled and the surface shall be finished by laying a hardwood block against the dry pack fill and striking the block.

**Design Joints**

1. Design joints shall be formed in the positions and manner shown on the Drawings and shall be shuttered square to the work to provide a smooth surface to the concrete. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The face of the joint first formed shall be smooth, dense and free from irregularities and honeycombing. The plane of the joint shall extend completely through the structure unless shown otherwise on the Drawings.
2. Caulking grooves shall be provided as shown on the Drawings or in accordance with the joint sealant manufacturer’s recommendations. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried It shall be primed and caulked with approved sealant compound applied in accordance with the manufacturer’s instructions.
3. Filters, as specified on the Drawings, shall be placed between the joints and adjacent earth surface.

**Contraction Joints**

Contraction joints are defined as joints placed in structures or slabs to provide for volumetric shrinkage of monolithic unit or movement between monolithic units. The joints shall be constructed so that there will be no bond between the concrete surface forming the joints.

**Expansion Joints**

Expansion joints are intended to accommodate relative movement between adjoining parts of a structure. The size of expansion joints shall up to 40mm depth and 20-25mm wide.

Compressible filler shall be placed between the joint faces to provide freedom for the two adjacent concrete masses to expand. Care shall be taken to ensure that the material fails the joint completely and that no concrete or hard material is left in the joint after the second face of the joint has been cast.

**Measurement:**

The item formwork shall be measured in Square Meter of the exposed concrete surface including all designed joints.

**Payment:**

Payment shall be made at the rate Square Meter as included in BoQ.

**2.11 Structural Concrete**

**2.11.1 Description**

Concrete is a composite construction material made primarily with aggregate, cement and water. There are many formulations of concrete, which provide varied properties, and concrete is the most used man-made product in the world

All concreting shall be carried out in accordance with the cement British Standard BS 8500-2 and as specified by the Engineer.

All sampling and testing of constituent materials shall be carried out in accordance with the provisions of the appropriate British or American Standard and all sampling and testing of fresh and hardened concrete shall be carded out in accordance with the provisions of BS 1881 "method of Testing Concrete" or similar.

**2.11.2 Materials**

**2.11.2.1 Cement**

The cement used in the Works shell be obtained from manufacturers approved in writing by the Engineer and shall be Ordinary Portland Cement/Portland Composite Cement complying with the requirements Of ASTM C150 Type 1 or BS 12 or equivalent standard. Special cements shall conform to the requirements laid down by the Engineer.

The Engineer may make any tests, which he considers advisable or necessary to ascertain if the cement has deteriorated in any manner during transit or storage. Any cement which, in the opinion of the Engineer, is doubtful quality shall not be used in the Works until it has been re-tested and test result sheets, showing that it compiles in all respects with the relevant standard, have been delivered to and accepted by the Engineer.

Cement containing lumps, which be broken to original fineness by finger pressure, Will be rejected irrespective Of age and Shall be removed from the Site

The Engineer shall ask to carry out the sampling, inspection and testing of all cement as he may consider necessary. Samples shall be taken as instructed Yom the site store, or from elsewhere on the works or from any places where cement is used for incorporation in the works. Cement may be rejected, at the discretion of the Engineer, if it fails to meet any of the requirements of the specification the compressive strength and tensile strength of standard cubes and briquettes respectively shall be not less than as follows:

**Table: 2.11.2.1 Minimum strength of cement**

|  |  |  |
| --- | --- | --- |
| **Days** | **Compressive (n/mm2)** | **Tensile strength (N/mm2)** |
| 3  7  28 | 13  20  28 | 1.00  2.00  2.50 |

The initial setting time shall be not less than 45 minutes and the final setting time shah be not more than 8 hours. The cement when tested for fineness shall have a specific surface of not less than 160 m2/kg. The cement when tested for soundness shall not have an expansion of more than 10 mm. The unit weight of cement shall be 14.16 KN/m3.

Cement shall be delivered to the work site in sound and properly sealed jute/paper bags, each plainly marked with manufactures name or registered mark. The cement shall be protected from the weather by tarpaulins or other approved covering during transit. The weight of individual bag containing cement shall be 50 kg and weight of all bags shall be uniform. The weight of cement shall be legibly marked on each bag. Bags in broken or damaged condition shall be rejected.

Each consignment of cement delivered to the site must be accompanied by a certificate showing the place of manufacture and the results of standard tests carried out on the bulk supply from which the cement was extracted.

The Contractor shall provide waterproof and well ventilated pucca godowns at the specified or approved location at the site, having a floor of wood or concrete raised at least 450 mm above the ground. The sheds shall be large enough to allow a minimum 300mm gap between the stacked cement and the godown walls, to store sufficient cement stored to ensure continuity of work and to permit each consignment to be stacked separately therein to permit easy access for inspection. All storage facilities shall be subject to approval by the Engineer. Immediately upon arrival at the site, cement shall be stored In the godowns with adequate provision to prevent absorption of moisture. The Contractor shall use the consignments in the order in which they are received. Cement delivered to the site in drums or bags provided by the supplier or manufacturer shall be stored in the drums or bags until used in the Works. Any cement in drums or bags which have been opened shall be used immediately after opening. The cement shall not be stored in a godown for more than four months or a lesser period as approved or directed by the Engineer After this period has expired, any unused cement shall be removed from the site.

**2.11.2.2 Fine Aggregates**

Fine aggregates shall be non-saline clean natural sand and have a fineness modulus between 1.5 and 2.5 and conform to the following ASTM standard grading. The amount of silt, clay and lines shall not exceed 5%. Fine aggregate shall not be used in work until it has been tested and test result sheet. Showing that it complies with the relevant standard.

**Following shall be deleterious substance tolerance:**

i Friable particle <0.5% by mass

ii Coal and lignite <0.5% by mass

iii Passing 0 075 mm <3% by mass

|  |  |  |
| --- | --- | --- |
| **Sieve No** | **Sieve Size (mm)** | **Percentage by weight passing** |
| 4 | 4.76 | 95-100 |
| 16 | 1.18 | 45-80 |
| 50 | 0.30 | 10-30 |
| 100 | 0.15 | 2-10 |
| Pan | - | 2-7 |

**2.11.2.3 Coarse Aggregates**

i) Coarse aggregates shall consist of crushed stone (25 mm downgraded) for producing Concrete class A, B. The pieces of aggregates shall be angular in shape and have granular or crystalline or smooth, but not glossy non-powdery, surfaces.

ii) The amount of clay, fine silt, and fine dust occurring in a free state or as a loose adherent shall not exceed 1 percent. The sum of the percentages of all deleterious substances in any size shall not exceed 3 percent, by weight. After a minimum period of 6 hours immersion in water, the previously dried sample shall not have gained in weight more that 5 percent for use in reinforced concrete not more than 10 percent for use in plain concrete. The specific gravity shall not be less than 2.80.

v) Coarse aggregates shall be tested according to ASTM Designation C330 or equivalent. Gradations for 50mm, 40mm, 25mm and 20mm size aggregates, unless otherwise specified shall conform to the following requirements.

**Table: 2.11.2.3 grading of coarse aggregate for structural concrete**

|  |  |
| --- | --- |
| **25 mm downgraded size** | |
| Sieve Size (mm) | % Passing by Weight |
| 38.10 mm (1.5 inch) | 100 |
| 25.4 mm (1.0 inch) | 95-100 |
| 12.70 mm (0.5 inch) | 25-60 |
| 4.76 mm (3/16 inch) | 0-10 |
| 3.17 mm (118 inch) | 0-5 |

**Stone chips shall satisfy the following criteria:**

(i) Water absorption as determined by STP 7.5 or AASHTO T-85 or BS-812 shall not be more than 2% and soft fragments < 2% by mass.

(ii) Materials passing through 0.075 mm sieve < 0.50 % if Clay, < 1:5% if fractured dust by mass.

(iii) The Aggregate Impact Value (AN) shall not exceed 30% as per BS 812

(iv) The percentage of wear according to Loss Angeles Test shall not exceed 35 as per ASTM C-535, The Flakiness Index <30% and TPFV)150 KN

**2.11.3 Water**

The water used for concrete mixing and curing shall be drinkable water, clean and free from any substances injurious to the finished product. It shall be taken from an approved source and free from objectionable quantities of silt, organic matter, alkali, salt and other impurities. Whenever required to do so by the Engineer, the Contractor shall take samples of the water being used or which is proposed to be used for mixing concrete and test them in accordance with 85 EN BS EN 1008.2002. No concrete shall be made with unapproved water. **Special attention in this connection is drawn to the fact that underground water at the project sites is salty and no way suitable for concreting work. So, the Contractor has to make arrangement to store sweet water by digging sufficient numbers of pond at the construction site.**

**2.11.4 Admixtures**

Admixtures shall mean materials added to the concrete materials during mixing for the purpose of altering the properties of the concrete mix. The Contractor shall obtain the Engineer's written permission before using admixtures the methods of use and the quantities of admixture used shall be subject to the Engineer's approval, which approval or otherwise shall in no way limit the Contractors obligations under the Contract to produce concrete with the specified strength and workability.

**2.11.5 Type of Concrete**

The structural concrete shall be of compressive strength as shown on the Drawings or as approved or directed by the Engineer. Each mix shall be designed to ensure optimum workability, prevent segregation and produce a dense, durable concrete by adjusting the fine and coarse aggregate proportions following the procedures set out in the specification. The required strength of the structural concrete is given in the following table.

**Table 2.11.5 Specifications for structural concrete**

|  |  |
| --- | --- |
| **Concrete Type** | **28 day Cylinder Strength (N/mm2)** |
| Structural Concrete | 22.0 |

**2.11.6 Concrete Mix Design**

When designing the concrete mix, the contractor shall consider:

i. Strength (As per 2.11.5)

ii. Water/cement Ratio (<0.45)

iii. Minimum cement content ( As per 2.11.5)

iv. Minimum Filler content <0.25mm+cernent for 20 mm 435kg/m3

v. Coarse Aggregate (as per 2.11.2.3)

vi. Fine Aggregate (as per 2.11.2 2)

vii. Workability (Slump < 75mm)

viii. Temperature

**2.11.6.1 Trial Mixes**

After the Contractor has received approval for the cement and aggregate to be used, he shall prepare trial mixes with concrete of designed proportions to prove and establish workability. Strength, water cement/ratio, surface criteria etc. Methods of transporting fresh concrete and the compaction equipment shall be provided to the Engineer for his approval. The trial mixes shall be made and compacted in the presence of the Engineer, using the same type of plant and equipment for each trial mix, cylinders or cubes shall be made and tested in accordance with and shall be used for the Works.

The margin of the trial mix should be taken as 1.5 times of the characteristics strength of the concrete twelve concrete cylinder samples shall be made from the trial mix in the presence of the Engineer. The concrete cylinders shall be made, cured, stored and tested in accordance with BS 1881 Six cylinders shall be tested at 7 days and six cylinders shall he tested at 28 days. If the strength of any of the cylinders tested at 28 days is below the characteristic strength, the Contractor shall redesign the mix, make further preliminary mixes for the Engineer's approval, then undertake additional trial mixes and test the resultant samples until a satisfactory mix. Is obtained and approved by the Engineer. The trial mix proportions should be approved if the required strength is obtained from tests carried out and the consistency and surface is to the satisfaction of the Engineer.

When a mix has been approved, no variations shall be made in the mix proportions, or in the type, size, grading zone or source, of any of the constituents without the consent of the Engineer, who may require further trial mixes to be made before any such variations are approved.

*Until the results of trial mixes for a particular class have been approved by the Engineer, no concrete of the relevant class shall be placed in the Works.*

**2.11.7 Slump Test**

i. The Contractor shall undertake slump tests of the freshly made concrete in accordance with BS 1881 and the slump shall be within the range of 50 to 100 mm unless otherwise indicated in the drawings or approved by the Engineer

ii. Slump tests shall be carried out on each batch of concrete of 50m3 or less frequently it or as directed by the Engineer

iii. The records of slump tests shall be maintained in a register and be made available to inspection.

**2.11.7.1 Water Content and Slump**

i. Water cement ratio shall not exceed 0.45, unless otherwise indicated in the Drawings or approved by the Engineer.

ii. Throughout concrete production the actual water cement ratio shall be strictly monitored and the patch quantities of aggregates and water regularly adjusted to maintain the design water cement ratio.

iii. Total water for each batch of concrete shall be the minimum amount necessary to produce a plastic mixture of the strength specified with adequate density, uniformity and workability.

**2.11.8 Proportioning of Mix**

The approved mix shall be proportioned by weight or, except cement, by volume, if volume belching is approved by the Engineer. Allowance shall be made for the moisture content of the aggregates.

Fine and coarse aggregate and water may only be measured by volume in boxes or containers approved by the Engineer. Cement shall be added to concrete mixers by whole number of bags only.

**2.11.9 Mixing Concrete**

All concrete shall be mixed In modern mechanically operated mixers capable of combining aggregate, cement and water into a uniform mixture and discharging without segregation. Mixers shall be to the approval of the Engineer. Mixing time shall be at least one minute after the last ingredient has been added to the mixer or so much more time as may be recommended by the manufacturer of the mixer. Hand mixing of concrete shall not be allowed without the written permission of the Engineer 2.11.10 Quality Control of Concrete

1) The Contractor shall be responsible for providing samples of concrete and its constituent materials either for testing by him or for testing at the Engineers laboratory or laboratory designated by the Engineer. For this purpose concrete test cylinders, which shall be made in accordance with BS 1861, shall be deemed to be 'samples'. All sampling of constituent materials shall be carried out in accordance with the provisions of the appropriate British Standard, and all sampling of fresh and of hardened concrete shall be carried out In accordance with the provisions of BS 1881 unless such provision is at variance with the Specification.

2) The tests, which the Contractor is required to undertake himself on behalf of the Engineer, are those to be carried out on fresh concrete at the place of final deposit, or elsewhere on the Site as directed by the Engineer. These tests comprise:

i) The Contractor shall test aggregates for moisture content and so determine the water cement ratio of the fresh concrete. Determinations of water/cement ratio shall be carried out as required by the Engineer and the results and calculations submitted to him.

ii) The Contractor shall undertake slump tests on each batch of the freshly made concrete or less frequently if approved or directed by the Engineer. The slump of concrete to be used in the Works shall not exceed the slump of the trial mix by more than 10% and steal in any case not he more than the maximum specified.

iii) The sampling of concrete for concrete cylinders shall, where possible, be undertaken at the place of deposition of the concrete. Each sampling shall provide sufficient concrete to make six cylinders and allow a slump test.

3) After stripping, each cylinder shall be indelibly marked with the date taken, location in the structure and prescribed number.

4) Samples shall be taken for each 50 m$ for structural concrete of concrete batched or at frequency agreed by the Engineer the cylinders shall be cured properly and tested In the Field Laboratory. If the Engineer for his satisfaction desires to test the Concrete Cylinders at any recognized Laboratory other than Field Laboratory, the Contractor shall make such arrangements. All cost of such tests shall be borne by the Contractor.

**2.11.11 Unspecified Concrete**

i) If cylinders taken at site during the progress of the works fail to attain the specified strength no further concreting shall take place until the cause of the failure has been established and corrective measures taken to the satisfaction of the Engineer.

ii) The Engineer may require that core samples be taken and tested in accordance with ASTM Designation C-42 or a similar standard or other test be performed on sections of the works made from the suspect concrete: the cost of all such testing being borne by the Contractor. If such testing fails to demonstrate the integrity of the sections of the works, then all sections made with the suspect concrete shall be removed from the site

**2.11.12 Transporting, Placing and Compacting Concrete**

i) Concreting shall not be commenced without the written approval of the Engineer or his Representative. This approval shall be in the form a standard check list approved by the Engineer prior to the commencement of the work The check list shall be filled in and approved by the Engineer's representative during his Inspection and acceptance of materials, plant and equipment, concreting arrangements, the positioning, fixing and condition of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability of the containing surfaces or formwork.

ii) Concrete shall be conveyed from the mixer/belching plant as rapidly as possible by Methods, which will prevent segregation or drying out and ensure that the concrete is of the required workability at the point and time of placing. The re-mixing of concrete will not be permitted.

iii) The concrete shall be placed in the position and sequences indicated on the Drawings and Specification or as approved or directed by the Engineer. The concrete shall be placed in clean, oiled formwork and compacted before Initial set has occurred, and in any event, not later than thirty minutes from the time of mixing. The concrete shall be placed in layers not greater than 450 mm thick and each layer thoroughly compacted by power driven internal type vibrators supplemented by hand spading and tamping.

iv) The concrete shall be deposited as far as possible in its final position without re-handling or segregation and in such a manner so as to avoid displacement of the reinforcement and other embedded items or formwork. Where chutes are used to convey the concrete, their slopes shall not be such as to cause segregation and suitable spouts or baffles shall be provided where necessary. Concrete shall not be dropped through a height greater than 1200 mm except with the approval of the Engineer who may order the use of bankers and the turning over of the deposited concrete by hand before being placed. v) The vibrators shall at all times be adequate in numbers, amplitude and power to compact the concrete properly and quickly throughout the whole of the volume being compacted to the satisfaction of the Engineer. Spare vibrators shall be readily on hand in case of breakdown. The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall on no account be continued after water or excess grout has appeared on the surface.

vi) The concreting shall be carried out in such a way that the exposed faces of concrete shall be plain, smooth, sound and solid, free from honeycombing and excrescencies. After compaction the exposed concrete surface shall be struck off smooth with hand held steel floats. No plastering of imperfect concrete faces will be allowed. Any concrete that is defective in any way shall, if so ordered by the Engineer, be cut out and replaced to such depth or be made good in such manner as the Engineer may direct.

vii) Where concrete is required to be placed against undisturbed ground, the entire space between the finished concrete surface and the ground, including any over break, is to be completely filled with concrete of the specified class. The concrete shall be well rammed and compacted to ensure that all cavities are filled and the concrete is everywhere in contact with the ground. Where permitted by the Engineer, any extensive patches of over break may first be filled with concrete Class C as approved or directed by the Engineer.

viii) Where concrete is required to be placed against a metal surface to which it is required to adhere, care shall be taken to work the concrete well into the re-entrant angles and to ensure contact by hammering the metal part on its free side provided that this is done without damaging the metal or its protective coating, if any.

ix) The placing of concrete under water will be permitted only in exceptional circumstances and with the prior approval of the Engineer. Where concreting under water is allowed, 25 per cent additional cement must be added. Concrete shall be deposited continuously in each section by the use of termite pipes or other approved means and no horizontal construction joints will be permitted to be made under water. Approved and adequate protection against possible damage or movement due to scour must be provided.

x) The Contractor shall organize the casting of mass concrete to minimize thermal cracking. The Contractor's proposal and his casting sequence shall be submitted to the Engineer and concreting shall not commence until the Engineers written approval is received.

xi) Construction joints shall be famed in the work where indicated on the Drawings or as previously approved by the Engineer. Where necessary, the Contractor shall allow for working beyond ordinary working hours in order that each section of concrete may be completed in a continuous pour with the concreting carried up to each construction joint

**2.11.13 Concreting In Adverse Conditions**

Concreting during periods of constant heavy rain shall not be permitted unless aggregate stockpiles, batching and mixing plants, transporting equipment and the precast yard are adequately covered. During showery weather, the Contractor shall ensure that work can be concluded at short notice. Adequate covering shall be provided to protect newly placed concrete from the rain.

In hot weather, the aggregate stockpiles shall be shielded or sprayed with water and the mixing water shall be adequately cooled or insulated to ensure that the temperature of the concrete when placed shall not exceed 309C.

**2.11.14 Curing Concrete and Protection**

Concrete shall be protected from the effects of sunshine, dry wind, rain, running water or mechanical damage for a continuous period, until the concrete has reached at least three quarters of its 28 day strength, but for not less than 10 days. The Contractor shall submit his proposals to achieve this protection for the Engineers approval. The protection and curing of concrete, which has achieved Its final set, shall be by one or more of the following methods:

i by water spray in continuous operation or a layer of water;

ii by covering with hessian or similar absorbent material, or sand, kept constantly wet;

iii after thorough wetting, by covering with a layer of water proof fabric kept in contact with the concrete surface.

iv the use of saline water for curing purposes will not be permitted.

**2.11.15 Concrete Surface Finishing**

i) Finishing of concrete surfaces shall be performed by skilled workmen to the satisfaction of the Engineer. Exposed flat concrete surfaces shall be screened to produce an even and uniform surface then they shall be given a trowel finish unless otherwise specified on the Drawings. All exposed and unprotected edges shall be given 20 mm x 20 mm chamfers. Concrete stairs and bridge decks shall have a broom finish.

ii) The Concrete surface finish on upward facing horizontal or sloping faces shall be, except for blinding concrete or otherwise stated on the Drawings, a "fair" surface. A lair surface shall be obtained by screeding and troweling with a wood float.

iii) Screeding shall be carried out following compaction of the concrete, by the slicing and tamping action of a screed board running on the top edges of the formwork or screeding guides to give a dense concrete skin true to line and level.

iv) Wood float trowelling shall be carried out after the concrete has stiffened and the film moisture has disappeared. Working should be kept to the minimum compatible with a good finish and the surface shall be true to the required profile to line tolerance. Whenever necessary the Contractor shall provide and erect overhead covers to prevent the finished surface from being marred by raindrops or dripping water.

v) Where a 'fine" surface is indicated upon the Drawings this shall be obtained In a similar manner to "fair" surface save that a steel float shall be used in lieu of the wood float.

vi) Formed surface for painting, exposed to view and waterway surfaces shall be smooth and free from projections, and shall be rubbed smooth immediately after the forms are removed. Formed surfaces shall be classified as follows:

vii) Unexposed concrete surfaces upon or against which backfill or concrete is to be placed require no treatment except the removal and repair of detective concrete.

viii) Exposed and hydraulic surfaces of water ways shall have a very smooth. sound surface by control of form work, concrete placement and repair of abrupt surface irregularities by grinding or rubbing of high spots and filling of voids

**2.11.16 Embedded Items**

All embedded items shall be firmly and securely fastened in the place as indicated on the Drawings or as required by the Engineer.

**2.11.17 Construction Joints**

i) Concrete surfaces upon or against which concrete is to be placed and to which new concrete is to be placed, that have become so rigid that the new concrete cannot be incorporated Integrally with that previously placed, are defined as construction joints. Formed vertical or Inclined construction joints as well as unformed joints which are due to interruption of concrete placement will only be permitted where shown on the Drawings or approved or directed by the Engineer. All exposed faces of construction joints shall be made absolutely straight, level or plumb and normal to finished surface.

ii) Surfaces of construction joints shall be prepared as early as possible after casting. The preparation shall consist of the removal of all laitance, loose or defective concrete coatings, sand and other deleterious materials. Preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impracticable with suitable tools so that no smooth skin of concrete that may be left from the previous work is visible.

vi) The prepared joint face shall be thoroughly cleaned by compressed air and water jets or other approved means and brushed and watered immediately before depositing concrete. If so. Ordered the roughened surface shall be covered with cement mortar prior to placing the new concrete.

**1.11,18 Schedule of Test**

Following Test shall be carried out at the frequencies shown in the Table to check the properties of construction materials (Cement, Sand and Stone Chips), Water and Concrete Strengths as per specifications;

| **SI No.** | **Name of Test** | **Frequency of Test** | **Test Method** |
| --- | --- | --- | --- |
| 1 | Cement  i. Fineness  ii Initial Setting Time and Final Setting Time  iii Compressive Strength  iv Tensile Strength  v Unit Weight | 1 For each fresh Consignment arriving at Site  2 One Sample for each 200 M. Ton  3 As approved or directed by the Engineer | ASTM C786,  ASTM C 403,  ISO 679:2009  or  Equivalent |
| 2 | Fine Aggregate (Sand)  i Fineness Modulus  ii Chemical Test | 1. 1(one) Sample for each 350 Cum or part thereof  2. At least 1 Sample in a week  3. As approved or directed by the Engineer | ASTM C 33  or  Equivalent |
| 3 | Coarse Aggregate (Stone Chips)  i Gradation Test  ii Water Absorption  iii Aggregate Impact Value (AIV)  iv Loss Angeles Test | 1. 1(one) Sample for each 700 Cum or pad thereof  2. At least 1 Sample in a week  3. As approved or directed by the Engineer | ASTM C330 ,  AASHTO T-85 ,  BS. 812,  ASTM C.535  or  equivalent |
| 4 | Water  Suitability of Water for Concrete Mixing | 1. For each source of Water 2. As approved or directed by the Engineer | BS EN 10082002 |
| 5 | Concrete  i Slump  ii Water Cement ratio  iii Cylinder Test ( Compressive Strength)  iv Concrete Core Test  v Non-destructive Test (Rebound Hammer) | 1 One set of Cylinder (One set comprises 6 Not Test Cylinder) for each 50 cum or pad thereof of fresh concrete produced with correspondence Slump and Water Cement Ratio  2 Rebound Hammer Test will be carried out as frequent as the Engineer considered  3 Concrete Core Test will be carried out if any Test Cylinder fails to pass the specified strength  4 As approved or directed by the Engineer | BS 1881  ASTM C-42  or  Equivalent |

**1.11.19 Nondestructive Testing**

The Contractor shall provide onsite a 'rebound' (Schmidt or similar) testing hammer for use by the Engineer for checking the in-situ strength of the concrete. Testing shall he carried out at the frequency and in the locations approved or directed by the Engineer. Any concrete structures found to be of strength less than specified will be removed from the Works site and replaced by the Contractor.

**1.11.20 Measurement**

The concrete of the specified type completed in place in accordance with the specifications stated herein and/ or as per provisions of the BOQ or as shown on the Drawings or as directed by the Engineer shall be measured In Cubic Meter. In computing quantities, the dimensions used shall be those shown on the Drawings. No deduction from the measured quantity shall be made for drainage, pipes less than 200mm diameter, conduit, chamfers, reinforcement bars, expansion joints and water stops.

Reinforcing steel bars shall be measured for payment as described in the specifications Clause **2.12**.

Construction joints, expansion joints, dowel bars, polythene, hessian cloths, cork sheets etc. shall not be measured separately but shall be deemed to be an integral part of the structural concrete item and to be constructed as per design and drawing

**2.11.20 Payment**

Payment for Concrete will be made on **Cubic Meter** (as Specified in the Bill of Quantities).

**M.S. Work for Reinforcement**

General:

The steel reinforcement shall be prepared and fixed in accordance with the Working Drawings furnished by the Engineer. This work shall consist of furnishing and placing bars of the grade, type and size shown in accordance with these specifications and in conformity with the requirements shown on the Drawings The Contractor shall provide the Engineer with bar bending schedules detailing the reinforcement required for the Permanent Works. Such schedules are to be approved by the Engineer prior to the commencement of work. Approval shall not relieve the Contractor from his responsibilities under the Contract for providing the materials called for on the Drawings. All further working drawings and lists of reinforcement necessary to carry out the Works shall be provided by the Contractor at his own cost. All reinforcement delivered to the site shall be stacked prior to use off the ground and kept free from dirt, oil, grease and avoidable rust.

**Steel Reinforcement:**

Reinforcement bars shall be mild steel made from billet structural grade of 60 and shall conform to following specifications. (1) Code or standard

|  |  |
| --- | --- |
| (1) Code or Standard | Standard of equivalent code: ASTM A575, A615  Grade 60 |
| (2) Physical Properties | Yield Stress - 414 N/mm2 minimum  Tensile Stress - 483 N/mm2 minimum  Percentage elongation - 20% minimum.  (min. gauge length-5 dia). |
| (3) Standard Dimensions and Weight | According to table 2.13.1 |
| (4) Dimensional tolerance | Below 28mm bar +/-0.5mm  Above 28mm bar +/-0.6mm |
| (5) Weight tolerance | The difference between calculated Weight and actual  shall be within +/-3.5% |

Reinforcing Steel shall be deformed bar. All reinforcement bars shall be Mild Steel made from Billet Structural Grade of 60 and shall conform to following specifications. Test will be carried out for each fresh consignment and at the frequencies as per directions of the Engineer.

**Table Dimension & Weight:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Bar Diameter** | | **Cross Sectional**  **Area** | | **Perimeter** | | **Unit Weight** | |
| **in** | **Mm** | **in2** | **nm2** | **in** | **Mm** | **ib/ft** | **kg/m** |
| **1/4** | **6.35**  **6** | **0.05** | **28.27** | **0.79** | **18.85** | **0.167** | **0.249**  **0.22** |
| **5/16** | **7.94**  **8** | **0.07** | **50.26** | **0.98** | **25.13** | **0.261** | **0.370**  **0.395** |
| **3/8** | **9.525**  **10** | **0.11** | **78.54** | **1.18** | **31.42** | **0.376** | **0.56**  **0.62** |
| **1/2** | **12.70**  **12** | **0.20** | **113.10** | **1.57** | **37.70** | **0.668** | **0.99**  **0.89** |
| **5/8** | **15.875**  **16** | **0.31** | **201.06** | **1.96** | **50.27** | **1.043** | **1.56**  **1.58** |
| **3/4** | **19.05**  **20** | **0.44** | **283.53** | **2.36** | **59.69** | **1.502** | **2.24**  **2.23** |
| **7/8** | **22.23**  **22** | **0.60** | **380.13** | **2.75** | **69.12** | **2.044** | **3.05**  **2.98** |
| **1** | **25.40**  **25** | **0.79** | **490.87** | **3.14** | **78.54** | **2.670** | **3.98**  **3.85** |
| **1-1/8** | **28.65**  **28** | **1.00** | **615.75** | **3.54** | **87.96** | **3.400** | **5.06**  **4.83** |
| **1-1/4** | **31.75**  **32** | **1.27** | **804.25** | **3.99** | **100.53** | **4.303** | **6.42**  **6.31** |

**Cutting and Bending**

All cutting and bending shall be in accordance with standard approved practice. Straightening of bends and re-bending of incorrectly bent bars shall not be permitted. Bars shall be bent cold by use of an approved bending machine. Bending radii shall be as specified on the drawings with bends made round a former having a diameter of at least three times the diameter of the bar. If the radii are not shown on the Drawings, ACI standards shall be followed. Where splices or overlapping in reinforcement are required the bars shall, unless otherwise shown on the Drawings, have an overlap of not less than thirty times the diameter where a U-hook is employed on each of the overlapping bars and forty-five times the diameter for bars without hooks.

**Placing and Fixing Reinforcing Steel**

All reinforcement shall be securely and accurately fixed in position shown on the drawings usingapproved spacer blocks and chairs. Tolerance allowance for placing reinforcement shall not exceed 12mm. No splices of reinforcement shall be made other than as shown on the Drawings or approved by the Engineer All intersections of bars shall be secured with No 22 to 18 gauge galvanized iron wire, the ends being turned into the body of the concrete. The reinforcement shall be held securely in place to the lines and grades shown on the Drawings by approved concrete supports, spacers or ties with particular care being taken during placing of the concrete. The specified concrete cover as shown in the drawing to reinforcement shall be maintained with the aid of approved supports and spacer pieces. Top reinforcement in slabs shall be maintained in position by means of chairs made out of mild steel, the diameter and quantity being sufficient to ensure security of the reinforcement shall be used to support access ways, working platforms, or the placing equipment or for the conducting of an electric current. Reinforcement supports and spacers shall be sufficient to maintain reinforcement in place throughout the concreting operation and shall not be exposed on the concrete face or discolor the finished concrete. Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete, which may adhere to the exposed bars during concreting operations, shall be removed.

**Concrete Cover to Reinforcement**

Unless specified on the Drawings, the clear concrete cover to reinforcement shall be as tabulated below:

**Table Clear concrete cover to reinforcement**

|  |  |  |
| --- | --- | --- |
| **Description of Concrete Element** | **Clear Cover (mm)** | |
| **Normal Exposure** | **Saline Water** |
| Wall and floor slab: - Contact with earth  - Exposed to weather and water  Regulator Pier  Regulator Deck Slab  Railing | **60**  **50**  **50**  **40**  **25** | **75**  **60**  **60**  **40**  **25** |

Cover shall be maintained by the use of the minimum practical number of purpose made concrete blocks, approved spacers and reinforcement chairs. Concrete spacer blocks shall be made from cement, sand and small aggregate to match the mix proportions of the surrounding concrete as far as practical to ensure comparable strength, durability and appearance.

**Splicing**

Reinforcing shall be furnished in the lengths indicated on the Drawings. When the Contractor wishes to use more splices than are indicated and / or necessary, the Contractors shall furnish Working Drawings to the Engineers for approval in accordance with the guidelines provided on the Contract Drawings. If such additional splices are approved, the extra weight occasions by such splices shall be included in the measurement of reinforcement for payment.

All splices for high yield deformed steel bars and mild steel plain steel bars shall have lap lengths as shown on the Drawings. Lap splices shall generally be located at points of minimum tension in bars, Except where otherwise shown on the Drawings lap splices shall be made with the bars placed in control and security wired together.

**2.12.7 Welding of Reinforcement**

Reinforcement which is specified to be welded shall be welded by any process the Contractor can demonstrate by bend and tensile tests which will ensure that the strength of the parent metal is not reduced and that the weld possesses strength no less than that of the parent metal. The welding procedure established by the successful test weld shall be maintained and no departure from this procedure shall be permitted. Following the establishment of satisfactory welding procedures, each welder to be employed on the work shall carry out welder performance qualification tests on reinforcing bars of the same metal and size as those on the works.

**2.12.8 Dowel Bar and Cap**

Where shown on the Drawings, dowel bars shall be incorporated in movement joints and bridge bearings. The dowel bars shall be a round mild steel bar of the diameter and length indicated on the Drawings and the top of the bar shall be covered with an approved dowel cap. The capped end of the dowel bar shall be sawn square; bar cropping will not be permitted.

Where dowel bars are to be provided through movement joints the part of the bar to be free to move shall be coated with an approved bond breaking bitumen paint and fitted with a compressible cap. The cap shall be of such a diameter to provide a sliding fit on the bar and of length indicated on the Drawings. The cap shall be partially filled with approved compressible filler

**2.12.9 Measurement**

The quantity of reinforcement to be measured under this Section shall be computed as weight in kilograms and accepted as shown on the Drawings provided that the quantity shall not include the reinforcement in any item of work for which the basis of payment include the reinforcement. In computing the weight to be measured, the theoretical weights of bars of the cross section shown in the Drawings shall be used. The weight shall be calculated based on a constant mass of 0.00785 kg/mm per metre run.

The computed weight shall not include the extra material incurred when bars larger than those specified are used, or the extra material necessary for splices when bars shorter than those specified are used with permission of the Engineer, or the weight of any devices used to support or fasten the reinforcement in the correct position including any necessary chairs

**Payment**

Payment shall be made in kg as per unit rate included in BoQ Item. The rate shall include all cost of material including cutting, binding, welding, providing Dowel bar etc.



