**2. 10.6 Measurement**

The quantity of steel sheet piles to be measured under this Section shall be computed weight in metric ton of piles supplied and accepted as shown on the Drawings. This measurement also includes the cost supply of all materials according drawings and BOQ, and included all taxes, freights, incidental charges, etc. Complete as per direction of Engineer- in- charge. In computing the weight to be measured, the theoretical weights of piles of the cross section shown on the Drawings or authorized shall be used. ]

The driving of steel sheet piles will be area measured in square meter on driven piles as per drawing and direction of Engineer In charge.

**2.10.7 Payment**

**Payment Item shall be made at the unit prlce8 Included In the BOQ as Follows:**

**Sheet Piles in Metric ion (BOQ: Bill NO.04: Item No.4.08 i))**

**Driving Of sheet pile In Sqm (BOQ: NO.04; Item No.4.08 [i)**

**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).

**1.12 M.S. Work for Reinforcement**

**2.12.1 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.

**2.12.2 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 | 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 |