





Part-II: TECHNICAL "6695-CMG-G00-CA-0021

Olant 1.0 MTPA ALUMINA REFINERY STREAM-5	Client NALCO	Contract Code NAL	Document ID 6695-CVC-G00-CA-0002_PART A	Contract No. 66-6695
	TECHNICAL SPECIFICATION & BILL OF QUANTITIES FOR PILING WORKS			 नेशनल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.
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tkIS India / Vendor		tkIS India / Owner / Client	
Category Codes (Submission Purpose)	<input type="checkbox"/> 1 For Approval <input type="checkbox"/> 2 For Review / Comments <input type="checkbox"/> 3 For Information <input type="checkbox"/> 4 For Engineering <input type="checkbox"/> 5 For Enquiry <input type="checkbox"/> 6 For Order Placement <input type="checkbox"/> 7 Final & Approved <input type="checkbox"/> 8 Released for Construction	Category Codes (Submission Purpose)	<input type="checkbox"/> 1 For Approval <input type="checkbox"/> 2 For Review / Comments <input type="checkbox"/> 3 For Information <input type="checkbox"/> 4 For Engineering <input type="checkbox"/> 5 For Enquiry <input type="checkbox"/> 6 For Order Placement <input type="checkbox"/> 7 Final & Approved <input type="checkbox"/> 8 Released for Construction
Acceptance Codes (Approval Codes)	<input type="checkbox"/> 1 Approved <input type="checkbox"/> 2 Approved for Manufacturing / Fabrication with Comments as marked <input type="checkbox"/> 3 Not Approved / Resubmit <input type="checkbox"/> 4 Retained for Information / Records <input type="checkbox"/> 5 Reviewed <input type="checkbox"/> 6 Reviewed as Noted / Resubmit	Acceptance Codes (Approval Codes)	<input type="checkbox"/> 1 Approved <input type="checkbox"/> 2 Approved for Manufacturing / Fabrication with Comments as marked <input type="checkbox"/> 3 Not Approved / Resubmit <input type="checkbox"/> 4 Retained for Information / Records <input type="checkbox"/> 5 Reviewed <input type="checkbox"/> 6 Reviewed as Noted / Resubmit
Remarks for AC2 : This marked-up drawings is hereby approved for fabrication / manufacturing and shall be re-submitted after revision. This drawing should be revised only to the extent of tkIS India / Owner / Client comments. Any other changes made by you will not be considered unless clearly highlighted in covering letter asking for approval.			
This approval / review does not absolve the supplier from the full responsibility for design and fabrication.			
Date : ___/___/___ Name : _____		Date : ___/___/___ Name : _____	

03		Issued for Tender	02.06.2020	BHK	02.06.2020	DMB/VBV	02.06.2020	GLP/SJP	
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1. INDEX

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2. INTRODUCTION

This document contains the construction specification to be followed by the contractor.



3. ADDENDUM TO STANDARD TECHNICAL SPECIFICATIONS

This addendum is to be read in conjunction with Technical Specifications Standard Doc. No



CI-UCH-016-Sections 01, 02 & 04

The changes are as follows:

Superseded Clause no. In Standard Doc. No CI-UCH-016	Revised Text as per change required	Reason for Change
-	Wherever UHDE INDIA / UHDE/ UHDE India Private Limited is mentioned in the document/s, the same shall be read as tkIS – India	
Section 2, Clause 2.3.6	ADD: In accordance with the guideline issued by OSPCB (Orissa State Pollution Control Board), use of fly ash as an admixture in concrete is encouraged and permitted. Contractor shall ensure that the fly ash used as admixture meets the requirements of this clause, IS 456 and IS 3812.	Client recommendation
Clause 1.3.6-d, 2.3	Wherever Grade of concrete is mentioned as M25, the same shall be read as M30 and where M20, it shall be read as M25.	



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TECHNICAL SPECIFICATIONS

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PREAMBLE

1. Only figured dimensions on the drawings shall be followed. If any dimension is not available on the drawing, it shall be obtained from the Engineer-in-charge.
2. Wherever a reference is made to any Indian Standard Code of Practice, it shall mean the latest version of the relevant standard in use. The latest revision will be with reference to the list of codes mentioned in the Civil - General Engineering Specifications Doc. No. 6695-CVC-G00-EC-0001.
3. Before the commencement of work, accurate surveys and levels of the ground, whether proposed to be excavated or filled up or not, shall be taken jointly by Engineer-in-charge/Owner and Contractor or his agent, and drawings of the levels so taken shall be prepared from such surveys and levels.
4. The Contractor shall build the brick / stone masonry for temporary Bench marks. All the pegs for setting out the work and fixing the necessary levels and lines required for the execution thereof, as desired and directed by Engineer, shall likewise be built in masonry or cement concrete at such places and in such manner as the Engineer may determine.
5. The material to be used in the work shall be of the best quality of their representative kinds as specified or described and all the material to be used in and about every part of the work may from time to time be subjected to tests by means of such machines, and shall be entirely at the expense of the Contractor. All samples subjected to any test or tests, shall not be returned or paid for.
6. Every portion of the work shall be kept clear of accumulation from time to time and delivered up clean and free from all defects of every kind at the conclusion of the works. As the work gets completed in any particular portion of the work area, the Contractor shall clear the portion so completed and make the same available for further construction activities. The Contractor shall have no claims whatsoever due to loss of working space or any obstruction due to further construction in the completion period of the work.
7. Working drawings and notes appended thereon shall be deemed to form part of specifications and to supersede the specifications in case of discrepancies. However, all documents shall be considered together in arriving at the interpretation.



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8. The Contractor shall be responsible for the true and proper setting out of the works, for the correctness of position, levels, dimensions and alignment, and shall provide of all necessary instrument appliances and labour in connection therewith at no additional cost to Owner. If at any time during, the progress of the works any error is detected in the position, levels, dimensions or alignment of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the correctness thereof and the Contractor shall carefully protect and preserve all bench marks, site-rails, pegs and other survey pedestals in setting out works. The tenderer is deemed to include all such cost into his rates.
9. The plea of "Custom Prevailing" will not on any account be permitted as an excuse for infringement on any of the specifications.
10. Materials and workmanship for the civil works in this Order shall be as per the given Technical specifications. Items for which specifications are not available, will be executed as per latest IS Codes or C.P.W.D. handbook Part I & II of State Government.
11. Unless otherwise specified in Technical Specifications all measurements shall be taken as per IS 1200.

Notation:

M³ or CUM in the unit column of the Bill of Quantities represents Metre Cube.

M ²	----- do -----	Metre Square
RM	----- do -----	Running Metre
LS	----- do -----	Lump sum
Nos.	----- do -----	Numbers
QRO	----- do -----	Quote Rate Only
M.T.	----- do -----	Metric Tonne

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TECHNICAL SPECIFICATIONS – PILING

1. GENERAL

Piles find application for foundations in low bearing capacity soils to transfer loads from a structure to competent subsurface strata having adequate load bearing capacity. Piles transfer axial loads through friction along its shaft and/or by the end bearing. The installation of piles demands careful control on position, alignment and depth and involve specialised skill and experience of working in soils of different characteristics.

These specifications cover scope of work, the material specification, installation, load test on piles, mode of measurement.



1.1. SCOPE OF WORK

The scope of work covers the construction of reinforced concrete load bearing piles, the load tests on the pile, installation and testing of test piles and guarantee of pile capacities, mix design including all materials and Kent ledge for testing. It also covers the preparation and submission of As-built drawings indicating the actual location of piles and the pile records for each pile.

1.2. APPLICABLE CODES & SPECIFICATIONS.

a) Unless otherwise specified the design materials and workmanship shall conform to the following standards.

- IS:456 : Code of Practice for Plain & Reinforced Concrete
- IS:269 : Ordinary Portland Cement
- IS:6909 : Specs. For Super Sulphated Cement
- IS:383 : Test of materials
- IS:1200 : Mode of Measurements for Civil Works
- IS:432 : Mild Steel & Medium Tensile Steel bars and wires for concrete reinforcement
- IS:1139 : Specs. For Mild Steel and medium tensile steel bars and high yield strength steel deformed bars for concrete reinforcement.
- IS:1786 : Cold twisted Steel Bars
- IS:1566 : Hard drawn steel wire fabric for concrete Reinforcement
- IS:2502 : Bending and fixing bars
- IS:2911 : (Part I to IV) - Design & Construction of Piled Foundations.
- IS:12330 : Sulphate Resisting Portland Cement

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IS:8112 : Specification for 43 grade cement

IS:2062 : Specs. for Structural Steel (Standard Quality)

IS:12269: Specs. for 53 grade cement

IS:2720 : Methods of Test for Soil



IS:1489 : Specs. For Pozzolona Portland Cement

b) tkIS's specification, standards and codes referred herein are made part of this specification and shall apply to work except as may otherwise be stated.

c) For such items of work which may arise and which are not covered by the specifications or by relevant Indian Standard Specification, the decision of the Owner/Engineer regarding specifications of such work shall be final and binding to the Contractor.

1.3. MATERIAL

1. CEMENT : The cement shall be conforming to IS-269 / IS 12269.
2. REINF. STEEL : Major reinforcement shall be conforming to IS:1786 Stirrups/spiral shall conform to IS:432.
3. AGGREGATE : All aggregates shall conform to IS:383 and IS:515, coarse aggregate shall be crushed from blue basalt/hard granite and shall be hard and free from weathering. The material shall be graded to achieve homogeneous mix.
4. FINE AGGREGATE : This shall be free from dust and silty sand and from original impurities. Sand shall be washed by the contractor at no extra cost to the client, if it contains silt more than 4%. River sand approved by Engineer/Owner must be used for RCC works. The grading of fine aggregates shall be determined as per IS:2386 (Part I) and shall be within the limits given in Table 4 of IS:383. Sand shall also have to be washed off if it contains silt more than allowable limits.
5. WATER : Water to be used shall be free from injurious and deleterious materials. Water safe for drinking shall be used. Clean water, free from acids and other impurities shall be used in the manufacture of concrete. Water shall be conforming to IS:456 Clause 5.4 & Table-1.
6. CONCRETE :
 - a. Materials and methods of manufacture of cement concrete shall in general be in accordance with the method of concreting under the conditions of pile installation.

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b. The slump for concrete shall be as follows:

	Min.	Max.
i) Driven cast-in-situ piles	100	180
ii) Cast-in-situ bored piles:		
a) water free unlined bore with wide space reinforcement.	100	180
b) Tremie concreting	150	180

c. Consistency of concrete to be used for the piles shall be suitable to the method of installation of piles. Concrete shall be so designed or chosen as to have a homogeneous mix having a slump/workability consistent with the method of concreting under the given conditions of pile installation.



d. The grade of concrete to be used for piling shall be Min M25 or as indicated in the BOQ, with the minimum cement content of 400 kg/Cu.M. Mixing shall be carried out in mechanical mixer only. In case of piles subsequently exposed to free water or in case of piles where concreting is done under water or drilling mud using method other than tremie, 10% extra cement over the design grade of concrete at the specified slump shall be used subject to a minimum quantity of cement specified above. The contractor shall carry out the mix design for the above grade of concrete and submit the report prior to concreting at no extra cost to the Owner. For the design purpose of bore cast-in-situ piles, the strength of concrete mix using above mentioned quantities of cement shall be taken as M20.

e. Concreting for the piles shall be done with tremie of suitable diameter.

f. Natural rounded shingle of appropriate size or locally available aggregate confirming to IS:383 and IS:515 may be used as coarse aggregate. It helps to give high slump with less water cement ratio. For tremie concreting aggregates having nominal size more than 20mm shall not be used.

g. Weigh Batching: The aggregate shall always be measured by weigh batching making due allowance for the water content in the aggregate. Volume batching of aggregate shall not be permitted.

1.4. The Contractor shall provide along with the bid, guarantee for pile load carrying capacities as mentioned in the tender. In case the Contractor differs on these capacities, the justification for same alongwith supporting calculations shall be provided. In case the contractor feels necessary to have

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additional exploratory investigation, the same shall be done by the contractor. The cost towards this investigation shall be included by the Contractor in his quoted rates for piling.



- 1.5. The Contractor shall be responsible for vertical, horizontal and uplift capabilities of proposed piles under all operating, erection and driving conditions for loads imposed by permanent structure resting on piles and for all damages due to the failure of pile foundation and hence the structure.

The guarantee will be operative for a period of 1 (one) year from the date of completion of complete work.

- 1.6. The tenderer / Contractor shall furnish the Quality Assurance plan alongwith the tender furnishing the name of the Engineer who will be responsible for the quality.

- 1.7. For each pile, record of the following data shall be kept:

- A. Type of Pile
- B. Identification mark with Drg.No. and Rev.
- C. Dia. of Piles
- D. Ground level
- E. Cut-off level of pile
- F. Founding Level
- G. Length of Pile
- H. Grade of Concrete
- I. W/C Ratio
- J. Reinforcement Details with Drg.No. and Rev.
- K. Piling - i) Starting Time
ii) Finishing Time
- L. Concrete - i) Starting Time
ii) Finishing Time

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1.8. LOAD TEST ON PILES

These would be conducted on piles on completion of 28 days after casting.

Two types of tests namely initial and routine tests, for each type of loading viz. Vertical, horizontal (lateral) pull out, are performed on piles.

Payment shall not be made for piles which show unsatisfactory results in routine / initial load tests.

Piles showing unsatisfactory results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer-In-charge at no additional cost to client.

1.8.1. Initial Tests

This test shall be performed to confirm the design load calculations and to provide guidelines for setting up the limits of acceptance for routine tests. It also gives an idea of the suitability of the piling system.

Initial Test on piles are to be carried out at one or more locations depending on the no. of piles required.

Load applied for the initial (cyclic) load test shall be 2.5 times the safe carrying capacity of the pile.

Loading for Initial Tests shall be conducted as per Appendix 'A' Clause 6.3 of IS-2911 Part IV.

1.8.2. Routine Tests

Selection of piles for the Routine Test shall be done by the Engineer subject to a maximum of 1/2% of total no. piles required. The no. of tests may be increased to 2% depending on the nature / type of structure.

The test load applied shall be 1 1/2 times the safe carrying capacity of the pile.



The Maintained load method as described in Clause 6.2 of IS-2911 (Part IV) 1985 shall be followed for loading for the Routine Tests.

This test will be performed for the following purposes:

- To ensure the safe load capacity of piles
- Detection of any unusual performance contrary to the findings of the Initial Test.

1.8.3. TESTS SHALL BE PERFORMED AT THE CUT-OFF LEVEL ONLY

1.8.4. The Contractor shall submit a detailed report for the test result in duplicate to client / consultant.

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1.8.5. Vertical Load Tests

This test will be carried out as stipulated in IS-2911 (Part IV) 1995.

Pile Head - The pile head shall be chipped off till sound concrete is met wherever applicable. The reinforcement shall be cut and head levelled with Plaster of Paris. A bearing plate with a hole shall be placed on the head for the jack to rest.

Reaction - Kentledge shall be suitably designed to get the desired reaction on the piles. Anchor piles (if required) shall be placed at a centre to centre distance of 3 times the pile diameter subject to a minimum distance of 2 M.

Settlement - 2 dial gauges for a single pile and 4 dial gauges for a group of piles with 0.01 mm sensitivity shall be used. They shall be positioned at equal distance around the piles on datum bars resting on immovable supports at a distance of 3D (min. of 1.5 m) where D is the diameter of pile or circumscribing circle for non-circular piles.

Application of load - It shall be applied as specified depending on the type of test (routine / initial). Each load shall be maintained till the rate of displacement of the pile top is either 0.1 mm in the first 30 minutes or 0.2 mm in the first one hour or 2 hours whichever occurs first. The next increment in the load shall be applied on achieving the aforesaid criterion.

The test load shall be maintained for 24 hours.

Initial Tests - The safe load on a single pile shall be the least of the following:



- $2/3^{\text{rd}}$ of the final load at which the total displacement attains a value of 12 mm unless otherwise required in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible.
- 50% of the final load at which the total displacement equals 10% of the pile diameter in case of uniform diameter piles or 7.5% of the bulb diameter in case of under reamed piles.

Routine Tests - Acceptance

The maximum settlement at test load should not exceed 12 mm.

1.8.6. Lateral Load Tests:

The jack should be placed horizontally, between two piles. The load on the jack shall be the same on both the piles. The load will be applied in increments of 20% of the estimated safe load and at the cut off level. The load will be increased after the rate of displacement is nearer to 0.1 mm per

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30 minutes. If the cut-off level is approachable, one dial gauge exactly at the cut-off level shall measure the displacement. In case the cut-off level is not approachable, 2 dial gauges 30 cms. apart vertically, shall be set up and the lateral displacement of the cut-off level calculated by similar triangles.

The safe load on the pile shall be the least of the following:

- 50% of the final load at which the total displacement increases to 12 mm.
- Final load at which the total displacement corresponds to 5 mm.

1.8.7. Pull out Tests

A suitable set up shall be designed to provide an uplift force to the piles. The load increments and the consequent displacements shall be as per the case of a vertical load test.



The safe load shall be the least of the following:

- 2/3rd of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible lift.
- Half of the load at which the load displacement curve shows a clear break.

1.8.8. PILE INTEGRITY TEST



Following is the suggested method to conduct this test. However, Contractor must submit the method statement for approval of Owner / Engineer before carrying out these tests.

- Pile integrity test shall be done on all piles including test piles (100%)
- Pile integrity test shall conform to ASTM D: 5882-96 / IS14893
- Surface for testing as required should be prepared by the testing agency. For cast in situ piles, integrity testing shall not be performed until the concrete has cured for a minimum of fourteen (14) days unless otherwise approved by the engineer. The pile head shall be free from water, dirt or other debris. The concrete at the pile top surface must be relatively smooth with sufficient space for both attachments of the motion sensing device and hammer impact area.
- Integrity tests shall be performed using accelerometer and the Pile Integrity Tester i.e. a compact built in data collector with finger touch screen. The test should be performed using digital data acquisition equipment. The signal conditioning and power supply must have very high signal-to-noise ratios since the reflected signals for long piles (and/or piles in high friction soils) are often very weak. The analog to digital resolution shall be at least 12 bits,

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and the sampling frequency at least 25,000 Hz. Data should be stored such that additional processing or further wave analysis is possible. The data must be displayed in the field for evaluations of preliminary data quality and interpretation.

5. The testing shall involve attachment of an accelerometer at pile head (or near) with the help of bonding material like candle wax, Vaseline etc. After attachment, pile shall be hammered with a hand held hammer, which generates a low stress wave into the pile. The resultant strains should be low enough not to cause any damage to the pile itself during testing.
6. The accelerations generated by the impact shall be measured by accelerometer attached on the pile top and are converted to velocity form for display onto the collector screen. Reflections from either pile toe / pile discontinuities, cross- sectional changes alter wave speed through the pile, which shall be graphically displayed.
7. Test shall involve collection of effects of several blows during the stage of testing. All such similar blows shall be averaged before display. This averaging technique shall ensure that random signals in any particular blow get cancelled while amplifying the effects of relevant repetitive response.
8. The signals shall be also exponentially amplified. Low strain signals generated due to hammer impact are often damped by skin friction. For long piles with high skin friction, reflections from pile toe may be small. By amplifying the records exponentially with time, this will enhance the identification of relevant reflections that have low energy.
9. The field testing shall be performed by an experienced technician with minimum two years of experience in integrity testing. The interpretation of the records, however, requires extensive experience by a graduate engineer with at least three years' experience in integrity testing.
10. The contractor shall present a report after performing the field test to provide the final test results and integrity evaluation. For each pile tested, the averaged, amplified velocity versus time record shall be included in the report, with a table summarizing results and conclusions. The report shall also include pictorial visualization of pile cross section along the depth of pile. Additional plots and analysis can be included as required or suggested by the testing engineer. Report should clearly indicate the acceptable piles and defective piles along with level of defect in pile.

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11. Shafts with no significant reflections from locations above the pile toe and with a clear pile toe reflection may be accepted. Where no clear toe reflection is apparent, the experienced test engineer shall state to which shaft depth the test appears to be conclusive. Where reflections from locations with significant reductions above the pile toe are observed, the pile has a serious defect. If the record is complex, the results may be deemed inconclusive. Construction records (concrete usage, grout pressure records, soil borings) may be valuable in result interpretations or additional numerical analysis modeling may be used to quantify the record. The decision to reject and replace, or repair, any defective shaft is at the sole discretion of the owner. The decision taken in this regard will be binding on the piling.

1.9. PILE HEAD



1.9.1. All the pile shall be concreted to a level at least 0.6 M above the cut off level. The extra height of pile to be cast shall be minimum as per IS stipulations and also so determined by contractor in such a way that after stripping to the cut off level, the concrete at the cut off level shall be dense and sound. This shall be taken into account and included in Contractor's rates for piles. A few piles will be exposed upto 4 to 5M depth by the contractor at his own cost for inspection of pile shaft. If the pile shaft shows defect, the Contractor shall rectify his equipments and methods.

1.9.2. In the circumstance where cut-off level is below ground water, the need to maintain a pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

In such case, if required the contractor may have to cast the pile above cut-off level upto overflowing the concrete, above ground.

1.10.CONTROL OF ALIGNMENT

Piles shall be installed as accurately as possible according to the drawings. Greater care shall be exercised in respect of installation of single pile or piles in two pile groups. For vertical pile a deviation of 1.5% of plumb shall not be exceeded. Piles shall not deviate more than 75mm or D/4 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their designed positions at the working level of piling rig. In the case of single pile under column, the position deviation shall not exceed 50 mm or D/4 whichever is less (100 mm in case of piles having diameter more than 600 mm). Piles not

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conforming to this requirement may at the discretion of the Engineer be totally rejected and extracted if necessary at the contractor's cost. All consequences of such rejection such as providing extra beams or any other measure whatsoever shall be at the Contractor's expenses.

2. BORED CAST-IN-SITU PILES

2.1. For this piling work, use of the following piling system is contemplated:-

Bored piles installed by boring holes of suitable diameter with the help of guide casing; the concrete being poured through a tremie pipe extending to bottom of hole. The DMC method with bentonite shall be used for boring. The Contractor shall prevent collapse of hole and ensure proper quality of concrete. The piles shall be capable of sustaining safe vertical downward load, vertical uplift and lateral load as shown in drawing.

Alternatively, casing shall be used for the loose / soft soil strata. As boring in soft material is liable for cavitation, boring tools should not be operated below the toe of the casing. The casing shall be driven down through the soft layer to penetrate hard strata not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter, the boring shall continue by means of boring tools until the approved bearing strata is reached.

- a The choice of the piling equipment is left to the Contractor provided he can achieve the desired strength, quality of concrete and the desired penetration into the hard bearing strata. Also the contractor should use such equipment so as to install piles where the clear distance between the outer face of the pile and obstruction (in the form of wall, footing existing structure etc.) is about 1.20 M from vertical face of obstruction to the centre of the pile. The final diameter/size of the cured pile shall be not less than that specified.

Contractor to mobilize the hydraulic rigs of adequate capacity which can chisel and penetrate to required depth in hard rock.

CHISELING CRITERIA FOR ROTARY PILES

WHERE CHISELING ENERGY LEVEL IS WORKED OUT AS

$$= \frac{2 \times \pi \times N \times T \times t}{A \times \delta}$$



N=REVOLUTIONS PER MINUTE (RPM)

T=TORQUE IN TON-M

t=TIME IN MINUTES

A=AREA OF C/S OF PILE IN M²

δ= PENETRATION IN CM.

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2.2. Construction technique and construction of pile foundation shall be as per IS:2911 (Part I). Section III and they should further conform to the following particular requirements :

2.3. For bored piles : Not leaner than M-25 mix or as specified in BOQ.

2.4. The lengths of bars to be left over the cut-off level of the pile shall be as shown in drawings.

2.5. The bored piles shall be socketed adequately / as specified in the drawings, unless otherwise noted.

2.6. Necessary chiselling shall be done to reach the founding level. Chiselling criteria shall be furnished by contractor based on the tools & tackles used.

2.7. The density of the freshly prepared bentonite solution should be between 1.03 and 1.10 gm/cm³.



2.8. The Contractor shall note that the pile shall be installed in such sequence that the carrying capacity of the previously installed pile is not reduced. The sequence for piling shall be as per working drgs. and/or instructions of the Engineer.

2.9. Immediately before concreting, the bore hole shall be cleaned of all loose materials debris and all the water shall be removed by pumping and bailing. Great care shall be taken to ensure that fluid alluvial soil does not fall between batches of concrete.

For marine situation, piles may be formed with permanent cases (liner). In case, liner is used and the bore is filled with water or drilled fluid the bottom part may be concreted using tremie method so that the liner is effectively sealed against ingress of ground water and then the upper part can be concreted in dry after proper inspection of the top surface of the concrete in so placed under water.

2.10. Jetting may have to be used to penetrate the pile through top stiff clay. The cost of such jetting is assumed to be included in basic pile cost and no additional payment will be made on this account.

2.11. The test pile shall be bored and cast as per design at the location. However, if the test pile fails, Contractor has to fabricate new test pile of suitable length and drive immediately, at no extra cost to client.

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Contractor to note that working pile shall not be driven until test piles satisfy load test requirement. However Contractor can keep his material, labour and equipments ready to fabricate the working piles in shortest time.



2.12. Clearance of site subsequent to pilling operations

Contractor must include in his rate clearing of muck arising out of pilling operations and depositing the same anywhere within site and dressing the same or disposing it of with a lead upto 1 to 5 Kms. as directed by the Engineer.

3. SEQUENCE OF PILING

The Contractor shall note that the pile shall be installed in such a sequence that the load carrying capacity of previously installed pile is not reduced. The sequence of piling shall be as per working drawings and/or instructions of Engineer.

In a pile group, the sequence of installation of piles shall normally be from the centre to the periphery of the group or from one side to that the soil is restrained from the flowing out during operations.

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4. MODE OF MEASUREMENT:

1. The length of piles shall be measured from the cut-off level to the lower edge of pile (i.e. pile toe) for the purpose of payment
2. Empty boring shall be paid separately in running metre measured from ground level to cut off-level.
3. No extra payment will be made for the casing to be provided during boring and grouting operations.
4. Reinforcement Steel shall be paid separately in M.T.
5. Excavation from existing ground level upto pile cut-off level to be included in pile rate for test piles.
6. The Contractor shall include in his unit rates the cost of setting and shifting of rigs, personnel, auxiliary equipment at different locations as required within the site premises of the project.
7. Payment of shoe plate left in the soil shall not be separately made to the Contractor.



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EARTH WORK: EXCAVATION, BACKFILLING & DISPOSAL**1.1 Scope**

The specification covers the general requirements of earthwork in excavation in different materials, filling in areas as shown in drawing, filling back around foundations and in plinths, transportation and / or disposal of surplus spoils or stacking them properly as shown on the drawings and as directed by engineer and all other operations covered within the intent and purpose of this specification.

1.2 General

1.2.1 Contractor shall furnish all tools, plants, instruments, materials and all consumables and every thing necessary, whether or not such items are specifically stated herein including temporary facilities like platform, walkways, etc. also including skilled/unskilled manpower along with supervisory personnel for completion of the job in accordance with requirements of specifications & standard practice.

1.2.2 The excavation shall be done to correct lines and levels. This shall also include where required, proper shoring to maintain sides of excavations, and strutting along with furnishing, erecting and maintaining of necessary barricades around excavated areas and warning lamps at night for ensuring safety.

1.2.3 The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by Engineer, within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by Engineer. As a rule all softer material shall be laid along the centre of heaps, the harder and more weather-resisting materials forming the casing on the sides and the top. Soft and hard rocks shall be stacked separately.

1.2.4 Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer. Any material obtained from the excavation, which in the opinion of the Engineer is useful, shall be stacked separately in regular stacks as directed by the Engineer.

1.3

Applicable Codes

The following Indian Standard codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

- a. IS:783 - Code of Practice for laying of concrete pipe.
- b. IS:1200 - Method of Measurement of Building work.
- c. IS:3764 - Safety code for excavation work.
- d. IS:4082 - Recommendation for stacking and storage of construction materials at sites.
- e. IS:3385 - Code of practice for measurement of civil Engineering Works.
- f. IS:2720
 - Part-II - Determination of Moisture Content.
 - Part-VII - Determination of Moisture Content Dry Density Relation Using Light Compaction.
 - Part-XXVIII - Determination of Dry Density of Soils, in place, by the Sand Replacement Method.
 - Part-XXIX - Determination of Dry Density of Soils, in place, by the Core Cutter Method.

1.4

Materials For Back-Filling & Soling

The materials and workmanship shall conform to provisions of the following codes and standard specifications :

- IS:1200 - Method of measurement for building work.
- IS:3764 - Safety code for excavation work.

Murrum - Murrum for backfilling shall be freshly excavated free from vegetation, boulders, silt and clay and as approved by the Engineer.

Sand - Sand for backfilling shall be medium, hard, free from organic and other deleterious materials, silt and clay and as approved by the Engineer. It should be suitable for attaining compaction of 90% of laboratory maximum dry density.

Rubble - Rubble for soling shall be hard, tough, durable and of approved quality. It shall be regular in shape and size of about 200 to 230 mm or as specified in the drawing.

All materials shall be obtained from sources approved by Engineer and shall conform strictly to samples initially approved by Engineer prior to start of supply at site. Change in source of materials shall be avoided. If unavoidable, the new sample and the source shall be again approved by Engineer before actual commencement of supply of materials at site from fresh sources.

1.5

Excavation

Excavation shall be carried out in any type of soil met at the site for items and to the lines, levels and contours as directed by the Engineer

Excavated materials shall not be deposited within 1.5M from edge of the excavation.

Suitable type of shoring and strutting, wherever necessary, shall be provided to avoid any collapse of earth or cutting in slope as per site requirement and as directed by the Engineer.

Pits shall not be excavated to final founding level unless concreting work is imminent. Last 15 cms. shall be excavated prior to providing, blinding layer with lean concrete (M5, unless otherwise specified in drawing). The contractor shall not undertake any concreting in foundation until the excavated pit is approved by the Engineer.

If any bottom of excavation is left exposed and has become deleteriously affected by atmosphere or water, it shall be dewatered and excavated to sound base, and shall be filled up to the required level with lean concrete of grade M-15 at the cost of Contractor. Similarly excess excavation than the required level also to be filled up with lean concrete at the cost of Contractor.



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Any obstacle, encountered during excavation shall be reported to the Engineer and shall be dealt as directed. Removal of buried piping or cables shall not be done without prior permission of Engineer and contractor shall provide all measures to protect such lines. Cost of such protective measures are deemed to have been included in the unit rates for excavation.

The contractor shall take adequate protective measures to ensure that the excavation operations do not damage the adjoining structures or dislocate underground services.

Excavated material shall be deposited within radius of 50M or as specified in the item of work. Selected excavated material, on approval by Engineer shall be back-filled in layers of maximum 15 cms. Watering, compacting shall be done as specified in method of backfilling.

The Contractor shall arrange to cut or transplant any trees coming in the alignment of the excavation or other work after obtaining prior approval and complying with all requirements of the concerned authority and remove the same wherever required. Unless otherwise stated no separate payment shall be made for the same.

The Contractor shall provide suitable drainage arrangements to prevent surface water entering foundation pits. The contractor shall engage pumps or other approved means to keep excavation free of water.

In cases, where during excavation, side slips occur, for reasons not attributable to the Contractor or in cases of pumping out water accumulated due to unforeseen reasons like watermains / drains broken accidentally by other agencies, springs etc., suitable payment shall be made separately at the rates mutually agreed.

Lowering of water table by well point system or other such special measures shall be paid separately against relevant item in the B.O.Q. or by mutual agreement.

1.6

Excavation In Rock:

By Blasting : Blasting shall be done by the licensed blaster approved by the Engineer. The contractor shall obtain licence from statutory bodies for undertaking blasting work as well as for obtaining and storing the explosive as per prevalent rules.

Blasting shall be done by using approved blasting powder or gelatine brought from licensed supplier.

Blasting shall be controlled blasting. Controlling shall be done by covering portion to be blasted with steel plates or woven mesh of wire ropes, meshed at 200 x 200 mm spacing and loaded with sand bags.

Blasting shall be done with ample precaution, normally during lunch time by :

- i. Evacuating the area within minimum distance of 100M from the region to be blasted. Guarding the boundaries of the excavated area by keeping persons, minimum four, with Red flags on the boundary to prevent entry of personnel during blasting operation.
- ii. It is preferred, if signaling system is provided to give signals before and after blasting.

Blasting shall conform to IS:4081, IS:10081.

Chiselling as required shall be carried out to obtain correct slopes, shape and pattern of excavation as per drawings. No extra payment will be made for chiselling.

The other specifications for earthwork shall also apply to excavation in rock in general.

1.7**Soil classification for purpose of measurement and payment**

All materials to be excavated shall be classified by Engineer, into one of the following classes and shall be paid for at the rate approved for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Engineer regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of any appeal or arbitration.

Any earth work shall be classified under any of the following categories; in accordance with IS-1200 part I.

a. Ordinary soils

These shall include all kinds of soils containing kankar, sand, silt, hard and soft murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc.. which can generally be excavated by spade, pick axes and shovel, and which is not classified under "soft and decomposed" and "hard rock" defined below.

This shall also include embedded rock, rubble not longer than 500 mm in one direction and not more than 300 mm in the other two directions. Removal of such ordinary soils by mechanical excavators, shovels, draglines etc. shall be payable at the rate for 'Ordinary soils'.

b. Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard micaceous, laterite and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges and pneumatic breaking equipment. The mere fact that Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'hard rock'. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders longer than 500 mm in one direction and not more than 500 mm in any one of the other two directions.



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c. Hard Rock

This shall include all rock occurring in large continuous masses, which cannot be removed except by blasting for loosening it. Hardened varieties of rock with or without veins and secondary minerals, which, in the opinion of engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. This will also include reinforced cement concrete (reinforcement to be cut through, but not separated from concrete).

1.8 Backfilling

Backfill material shall be either that part of excavated material, which is specially approved by Engineer as suitable for backfill and stacked separately for this purpose or material brought from outside sources as approved by Engineer.

The contractor shall not fill in and around any work, until it has been approved by the Engineer. Backfilling around liquid retaining structures shall be done only after testing of structures against leakage is done and approval from Engineer is taken.

Back filling shall be done in layers of thickness not exceeding 15 cms. Optimum watering shall be done to obtain maximum compaction and density free from pockets. Compaction shall be done with mechanical equipment such as plate vibrators, rollers. In exceptional cases hand compaction may be resorted to as directed by the Engineer.

The Engineer reserves the right to order compaction test in initial stages and whenever required during the progress of the work, to satisfy degree of compaction upto 90% of laboratory dry density (proctor) in the case of soils other than sand and 85% of relative density in the case of sand.

1.9 Rubble Soling

Rubble laying shall commence on required level in proper grade and on properly cambered sub-base. Stones shall be hand packed as close as possible and bedded firmly on broadest base. Voids shall be filled with chips and small stones. The interstices shall be filled up with selected (approved) earth/murum. If possible, this base shall be rolled with 8/10 T roller, with appropriate watering and refilling voids with consent of the Engineer. Further activities such as laying plain concrete will be carried out after the approval of the Engineer.

1.10 Mode of Measurement : 1200**1.10.1 Excavation Items**

The payment shall be made on cubic metre basis, on the measurement of column of pit size worked exactly as per dimensions of RCC/PCC given in drawing, (no allowance for excess excavation). The unit rate includes setting out and line out work, shoring / strutting, dewatering, backfilling, removal and disposal of surplus earth within lead of 50 M radius or as specified in the item of work, after backfilling with selected earth as specified. Any extra excavation for slopes, working space, collapses and additional working space required for painting the sub structures shall not be measurable / payable. The contractor may make such allowances in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation.

1.10.2 Filling in plinth with material brought from outside

The payment shall be made on Cu.m. basis of the finished compacted volume. Rate shall include cost of material, handling, transport for all leads, watering, compaction, labour and testing etc. complete.

1.10.3 Disposal of surplus earth

The payment shall be made on Cu.m. basis on the difference of measurements of the volumes of excavated material and the backfill. The rates shall include loading, transporting, dumping, levelling in the area demarcated by the Engineer.



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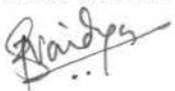
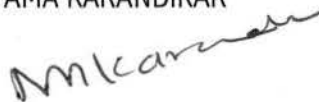

1.10.4 Rubble Soling

The payment shall be on Sq.m. basis. The rate shall include supply of rubble, stone chips, murrum, quarry spoil, handling, labour, watering, rolling, compaction etc. complete.

1.10.5 Measurement of Rock Excavation - will be made by final levels and payment shall be made on Cu.m. basis, exactly as per levels and dimensions of RCC/PCC given in drawing. No allowance shall be added for excess excavation and the same shall be assumed to be covered in quoted rates.

END



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2.1 SCOPE

This specification establishes the materials, mixing, placing, curing, etc, of all types of Cast-in-situ concrete to be used in foundation, underground and above ground structures, floors, etc. Any special requirement as shown or noted on the drawings shall govern over the provisions of this specification..

This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in scope of IS:456.

2.2 LIST OF APPLICABLE IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Specification, any other standard practice, as may be specified by the Engineer, shall be followed

IS:73	- Specification for Paving Bitumen
IS:216	- Specification for Coal Tar Pitch
IS:269	- Specification for Ordinary Portland Cement, 33 Grade.
IS:383	- Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.
IS:432(Part I)	- Specification for Mild steel and Medium Tensile Steel Bars for Concrete Reinforcement.
IS:455	- Specification for Portland Slag Cement
IS:456	- Code of Practice for Plain and reinforced Concrete.
IS:457	- Code of Practice for General Construction of Plain and Reinforced Concrete for dams and other Massive Structures.
IS:516	- Specification for Methods of Test for Strength of Concrete.
IS:1199	- Specification for Methods of Sampling and Analysis of Concrete.
IS:1200	- Specification for Methods of measurement.
IS 1311)	- Code of Practice for Non-Destructive Testing of Concrete.
(Part I & II	
IS:1322	- Specification for Bitumen felts for Waterproofing and Damp-Proofing
IS:1489	- Specification for Portland pozzolona Cement.
Part I	Fly ash based
Part II	Calcined clay based.
IS:1566	- Specification for Hard drawn steel wire fabric for Concrete Reinforcement.

- IS:1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts.
- IS:1786 - Specification for High Strength Deformed Steel bars and wires for Concrete Reinforcement.
- IS:1791 - Specification for Batch Type Concrete Mixers.
- IS:2062 - Steel for general structural purposes.
- IS:2185 - Specification for Hollow Cement Concrete Blocks.
- IS:2210 - Specification for Design of Reinforced Concrete shell Structures and Folded Plates.
- IS:2386 - Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII.
- IS:2502 - Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
- IS:2505 - General Requirements for Concrete Vibrators, Immersion Type.
- IS:2506 - General Requirements for Screed Board Concrete Vibrators.
- IS:2514 - General Requirements for Concrete Vibrating Tables.
- IS:2645 - Specification for Integral Waterproofing compounds for Cement mortar and Concrete.
- IS:2722 - Specification for portable Swing Weight Batchers for Concrete (Single and Double Bucket type).
- IS:2750 - Specification for Steel Scaffoldings.
- IS:2751 - Code of Practice for Welding of Mild steel Bars used for Reinforced Concrete Construction.
- IS:2770 - Specification for Method of Testing Bond in Reinforced Concrete.
- IS:3025 - Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry.
- IS:3201 - Specification for Design and Construction of Precast Concrete Trusses.
- IS:3366 - Specification for Pan vibrators.
- IS:3370 - Specification for Code of Practice for Concrete Structures for Storage of Liquids – Parts I to IV
- IS:3550 - Specification for Method of Test for Routine Control for Water used in Industry.
- IS:3558 - Code of Practice for use of Immersion Vibrators for Consolidating Concrete.
- IS:3590 - Specification for Load Bearing Light Weight Concrete Blocks
- IS:3696 - Safety Code for Scaffolding and Ladders.
- IS:3812 - Specification for Fly Ash for Use as Admixture for Concrete.
- IS:4014 - Code of Practice for Steel tubular scaffolding.
- IS:4031 - Specification for Method of Tests for hydraulic Cement.
- IS:4082 - Specification for Recommendation on Stacking and Storage of Construction Materials at site.
- IS:4090 - Specification for Design of Reinforced Concrete Arches.

- IS:4634 - Specification for Method of Testing Performance of Batch-type Concrete Mixes.
- IS:4656 - Specification for Form Vibrators for Concrete.
- IS:4925 - Specification for Concrete Batching and Mixing Plant.
- IS:4926 - Ready Mixed Concrete – Code of Practice
- IS:4990 - Specification for Plywood for Concrete Shuttering work.
- IS:4991 - Specification for Blast Resistant Design of Structure for Explosion above ground.
- IS:4995 - Specification for Design of Part-I&II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
- IS:4998 - Specification for Design of Reinforced Concrete Chimneys.
- IS:5512 - Specification for Flow Table for use in Tests of hydraulic Cement and Pozzolan Materials.
- IS:5513 - Specification for Vicat Apparatus.
- IS:5515 - Specification for Compaction Factor Apparatus.
- IS:5751 - Specification for Precast Concrete Copping Blocks.
- IS:5816 - Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
- IS:5891 - Specification for Hand Operated Concrete Mixers.
- IS:6452 - Specification for high Alumina Cement for Structural Use.
- IS:6461 - Glossary of terms relating to cement concrete.
- IS:6909 - Specification for Supersulphated cement.
- IS:7251 - Specification for Concrete Finishes.
- IS:7320 - Specification for Concrete Slump Test Apparatus.
- IS:7861 - Specification for Recommended Part-I & II - Practice for Extreme Weather Concreting.
- IS:7969 - Safety Code for Storage and Handling of Building materials.
- IS:8041 - Specification for Rapid Hardening Portland Cement.
- IS:8043 - Hydrophobic Portland cement.
- IS:8112 - 43 Grade Ordinary Portland Cement – Specification.
- IS:8142 - Specification for Determining Setting time of Concrete by Penetration Resistance.
- IS:8989 - Safety Code for Erection of Concrete Framed Structures.
- IS:9013 - Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS:9077 - Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
- IS:9103 - Specification for Admixtures for Concrete.

- IS:10262 - Specification for Concrete Mix Design
- IS 12269 - Specification for 53 Grade Ordinary Portland Cement (Part I & II)
- IS 12330 - Sulphate resisting Portland cement.
- IS 12600 - Low heat Portland cement.
- IS:13920 - Code of Practice for Ductile detailing of Reinforced Concrete Structures subjected to seismic forces.
- SP 23 - Handbook on Concrete Mixes (based on Indian Standards).

2.3 MATERIALS

2.3.1 Cement

- IS:269 - Ordinary Portland cement, 33 Grade
- IS:1489 - Portland pozzolona Cement.
- IS:455 - Portland Slag Cement.
- IS:8041 - Rapid hardening Cement.
- IS:8112 - High strength Cement.
- IS:12330 - Sulphate resisting portland cement.
- IS:8043 - Hydrophobic Cement
- IS:12600 - Low Heat Portland Cement

Generally cement shall be obtained from approved suppliers and shall be stored in a waterproof/weatherproof shed in a manner approved by the Engineer. No cement that has been allowed to deteriorate in quality or that has become caked or has perished by dampness or otherwise shall under any circumstances be used on the works. The concrete mix proportions shall be used on the weight of cement bags as delivered at the mixer and not on their theoretical weight. The contractor should allow in his rates for losses in weight of cement bags in transit and handling.

2.3.1.1 Storage

The Contractor shall follow accepted good practice in handling and storing cement. Cement may be stored on site in moisture proof bulk containers which shall be equipped with venting arrangements.

Cement delivered in bags shall be stored off the ground (at least 15 cms.) in dry, well ventilated, weather-proof/waterproof sheds, arranged in separate consignments as received from the manufacturer so that consumption of cement is insured in the order of receipt, i.e. 'First in First

Out' rule. The stacks of cement shall be such that there is easy access for proper inspection and identification. The bags shall be piled not more than 10 bags per pile and placed close together in the pile to reduce circulation of air. Each stack of cement shall be covered with good waterproof tarpaulin or thick polyethylene sheets.

Different types of cement shall be stacked and stored separately.

2.3.1.2 Use

Cement shall be used in the order in which it is received. Cement in bags in storage for more than 3 months shall be retested before use.

2.3.1.3 Testing

In addition to verification of manufacturer's test certificates, the Engineer may opt to carry out following tests :

Tests shall be carried out on cement delivered to the site for fineness, initial and final setting time, and compressive strength (IS:4031) and the results should be approved by the Engineer before use of the cement in permanent works. Samples shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be in accordance with IS:3535. The Engineer may specify other forms of sampling and tests, if in his opinion the cement is of doubtful quality, the costs of such additional tests, shall be borne by the Contractor, if supplied by him.

The decision of the Engineer will be final and binding on the contractor.

2.3.2 Fine Aggregate (sand) (IS:383)

2.3.2.1 It shall be river or pit sand or, if permitted by the Engineer, crushed stone sand (Produced from crushing stone suitable for concrete aggregates) and all fine aggregates shall be sharp, free from excess fines, loam, earth, vegetable matter, soluble salts and other harmful chemical/organic impurities and shall be clean. If considered by the Engineer as necessary, the same shall be washed. Washing shall be done at least one day before using it in concrete. The aggregate should be stored in such a manner as to avoid contamination.

2.3.2.2 Fine aggregates acceptable for the works shall normally be in a grading which falls within the GRADING LIMITS as specified in IS:383 .

If grading of fine aggregates can be improved by mixing two varieties of sand, the Engineer may at his discretion specify such mixing, and may permit the use of crushed sand as one of the two sands forming the mixture. The provisions of two types of sand and their mixing in the specified proportions shall be done at Contractor's cost.

2.3.3. Coarse Aggregate

Coarse aggregate for the works shall be river gravel or crushed stone obtained from sources approved by the Engineer and shall conform to IS:383

Aggregates shall be properly screened and if necessary washed and cleaned before use.

Coarse aggregates containing flat or flaky pieces or mica shall be cleaned of such impurities before use.

2.3.3.1 The grading shall conform to IS:383 for Grading Limits for Single Sized Coarse Aggregate

Limits for use of single sized coarse Aggregate in various type of structures shall be as follows:

Use	Size
Ordinary plain concrete/ Reinforced concrete foundation.	40mm
Slabs and Walls 200mm or more in thickness.	20mm to 10mm
Columns and Girders with least dimension under 300mm	20mm to 10mm
Very narrow space	10mm
Mass concrete	80mm

2.3.4 Tests of Aggregates

Before commencing the trial mix design, and in course of the work, whenever the apparent quality / source of the aggregates changes, the Engineer may ask for tests on aggregates to be conducted in an approved laboratory and test results to be submitted to Engineer and approved by him. The tests may generally include determination of particle size and shape, organic impurities, surface moisture and 10% fine value.

2.3.5 Water

Before commencing the trial mix design, and in course of the work whenever the source of water changes, or whenever there is in the opinion of the Engineer reason to suspect a change in water quality, the contractor shall get the water to be used for mixing, tested in an approved laboratory. The water in general shall comply with the requirements as specified in IS:456

2.3.6 Mineral Admixtures

The engineer may permit the use of Mineral Admixtures as specified in IS:456. This may be permitted only if

- a. the concrete is manufactured in batching plant OR
 - b. Ready mix concrete is used.
- and provided that uniform blending with cement is ensured

2.4 TRIAL MIXES

The contractor shall be entirely responsible for the design of the concrete mixes. The design is however to be approved by the Engineer before commencing any concreting in the works. The contractor shall make trial mixes using samples of coarse aggregates; sand, water and cement, typical of those to be used (discarding the first batch).

- 2.4.1 Design mix concrete is preferred to nominal mix. If design mix concrete can not be used for the work for grades of M20 or lower, nominal mixes may be used with permission of the Engineer.

<u>Grade</u>	<u>Volume</u> (Cement : Sand : Aggregate)
M-10	- (1:3:6)
M-15	- (1:2:4)
M-20	- (1:1½:3)
M-25	} Not recommended
M-30	
M-35	
M-40	

2.4.2 Concrete Mix design

Concrete mixes for various specified design strengths shall be worked out by the contractor, generally as per the requirements of IS:456 / IS:10262.

- a) The mixes designed by the contractor shall be used on works only after obtaining a written approval of the Engineer. It is to be understood that the mix design shall be entirely the responsibility of the contractor and such approval by the Engineer shall not relieve the contractor of his responsibility in respect thereof.

- b) The contractor shall prepare all calculations, tabulation, graphs, etc. pertaining to concrete mix designs and / or test results and supply copies of such calculations, tabulations, graphs etc. as required by the Engineer.
- c) Either Ordinary Portland or Portland Pozzolana Cement or Sulphate resistant Cement will be supplied /used. No deviation either in rate or schedule of work will be entertained on this account. The mix design should be based on the use of Ordinary Portland Cement/Portland pozzolana Cement/sulphate resistant cement. Due regard should also be taken regarding minimum cement specified as above.
- d) Contractor shall furnish the cement content assumed for various mixes for approval by the Engineer within one (1) week after award of contract. In case it becomes necessary to use Portland Pozzolana Cement during the course of the work, the contractor shall design fresh mixes and the difference in the consumption of cement due to use of pozzolana cement shall be taken into account for reconciliation purpose also.

In all cases the contractor shall make trial cubes from each consignment of cement and test the same before actually using in the work.

- 2.4.3 Whenever there is a significant change in the quality of any of the ingredients of concrete, the Engineer may at his discretion order the carrying out of fresh trial mixes. All costs for trial mixes and tests shall be to the Contractor's account & to be included in the contract rates.
- 2.4.4 Before commencing the works the contractors shall submit to the engineer, for approval full details of all preliminary trial mixes and tests.
- 2.4.5 When the proportions of the concrete mix have been approved by the Engineer, the Contractor shall not vary the quality or source of the materials or the mix without the written approval of the Engineer.

2.5 CONCRETE BATCHING

Concrete batching shall be as per IS456

All tests shall be carried out at regular intervals and records of the results shall be kept at site. Copies of records shall be sent to the Engineer for reference.

To ensure that the grading of the aggregate remain the same as the grading to which the mix design is based, sieve analysis shall be carried out regularly and charts showing the results shall be prepared. Copies of these information shall be kept a site and supplied by the contractor as instructed. If a change in grading is unavoidable the mix shall be redesigned and got approved.

Record of theoretical and actual consumption of cement shall be maintained by the contractor for each work separately and regularly.

2.6 MIXING

Concrete mixing shall be as per IS456

Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:1791. Should any mixer at any time produce unsatisfactory results, leak mortar or cause waste of materials, its use shall be promptly discontinued until it is repaired. Blades shall be replaced on showing signs of wearing down.

Hand Mixing:

Normally hand mixing shall not be permitted except in special cases such as far away isolated places, if allowed by the engineer.

When hand mixing is authorised by the Engineers subject to adding 10% extra cement, it shall be done on a water tight platform. The materials shall be turned at least three times after the water is added and until the batch is homogeneous in appearance and colour.

Batching Plant where used shall conform to IS:4925.

Concrete shall be poured and consolidated in its final position within half an hour of mixing. Tampering with concrete which has partially hardened, i.e. remixing with or without additional cement, aggregate or water, shall not be permitted.

2.7 TRANSPORTATION, PLACING, COMPACTION

2.7.1 Transportation:-

Concrete shall be transported from place of mixing to the place of laying as rapidly as possible by methods which will prevent segregation or loss of any of the ingredients and maintaining the required workability. Buckets, containers or conveyors which are leak proof shall be used for this purpose. During hot or cold weather, concrete shall be transported in deep containers or other suitable methods to reduce loss of water by evaporation in hot weather and heat loss in cold weather.

2.7.2 Placing:-

Transportation, placing, compaction of concrete shall be as per IS456

Before depositing the concrete, all debris and dirt shall be removed from the space to be occupied by concrete. Concrete shall not be placed until the formwork, placement of reinforcement; embedment's etc. have been checked and approved by Engineer. The formwork shall be sufficiently rigid. During the placing and compaction of concrete, care shall be taken to ensure that there is no loss of water from concrete and no segregation takes place. The method of placing and compaction employed in any particular section of the work shall be to the entire satisfaction of the Engineer.

To ensure bond and water tightness between old concrete surface and the concrete to be placed, the surface should be cleaned and roughened. The bonding old and new concrete should be done by applying the cement slurry after thoroughly watering the old concrete surface and removing all loose particles.

Unless otherwise approved, concrete shall be placed in single operation to the full thickness of slabs, beams and similar members and shall be placed in horizontal layers not exceeding 1 M. deep in walls, columns and similar members. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer.

Concreting shall not be started unless the Electrical conduits or any other piping wherever required are laid by the concerned agency. The Civil Contractor shall

provide all the facilities, and maintain coordination of work with other agencies engaged in electrical and such other works as directed by the Engineer.

Where concrete is placed on soil, it shall be placed only on firm undisturbed ground. Any concrete that is placed on a well compacted fill shall have the prior approval of the Engineer. Concrete shall not be placed in standing water on subgrade or in foundation excavation.

2.7.3 Compaction:-

The concrete after being laid shall be compacted by means vibrators of approved type under proper supervision as directed by the Engineer. Vibration shall not be confined only to the top surface, but the whole mass of concrete shall be well vibrated until the dense mass assumes jelly like appearance and consistency. Water just appearing on surface shall be avoided. Care should be taken to avoid segregation and formation of air bubbles. Vibration shall be accomplished by means of "spud" type internal vibrators with flexible shaft of 6000 vibration / min. The vibrator shall not be left in any position for more than 5 sec. The Immersion type vibrators shall be inserted in a vertical position at intervals of about 600 mm and fully worked around reinforcement, embedded fixtures and into corners of formwork without directly coming in contact with reinforcement steel and formwork. Over vibration shall not be permitted.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced persons. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators the contractor will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against

rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The whole process starting from the mixing of concrete to the placing and compaction shall not take more than 20 min. The process shall be completed before the initial setting takes place.

All chutes, pipes and other placing equipment shall be kept clean and free from coatings of hardened concrete by cleaning and thoroughly flushing, with water after each run, and water used from flushing shall be discharged clear of the concrete already in place.

No concrete shall be deposited until the Engineer has inspected the forms, reinforcing steel, inserts, hollow clay tile units, sleeves, etc, and given permission to place. Concrete, shall be deposited only in the presence of representative of the Engineer.

2.7.4 Extreme weather concreting-

In very hot weather precaution shall be taken to see that temperature of wet concrete does not exceed 38 deg.C while placing. During cold weather, concreting shall not be done when the temperature falls below 4.5 deg.C. During hot weather (atmospheric temperatures above 40 deg.C) or cold weather (atmospheric temperatures below 5 deg.C), the concreting shall be done as per the procedure set out in IS 7861.

Rock at foundation level or construction joint of concrete kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

2.7.5 Underwater Concreting:-

Concreting shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the Engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1 1/2 times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be got approved by the Engineer. Concrete shall be deposited continuously until it is

brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be avoided. The concrete shall be deposited under water by one of the approved methods such as tremie method, drop buckets, bags, groutings etc. as per details given in IS:456. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way.

2.8 CURING SHALL BE DONE AS PER IS456

Following methods shall be employed for effective prevention of loss of moisture from concrete:-

2.8.1 Moist Curing:-

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least seven days from date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used.

The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In case of mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

2.8.2 Membrane curing:-

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer-in-charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membranes such as polyethylene sheeting covering closely the concrete surface may also be used to provide effective barrier against evaporation.

2.9 TESTS:-

2.9.1 Slump test:-

This test shall be carried out for every compressive strength test (cube test)

2.9.2 Cube test:-

The quality of hardened concrete will be verified by the following procedure:

The Engineer shall select random batches of concrete for examination without warning the contractor and sampling will generally be done at the point of discharge from the mixer.

2.10 ACCEPTANCE CRITERIA

The sampling, testing and "Criteria of Acceptance" for concrete shall be as per IS:456.

- 2.10.1 If the concrete produced at site does not satisfy the above strength requirements, the Engineer will reserve the right to require the contractor to improve the methods of batching, the quality of the ingredients and redesign the mix with increased cement content if necessary. The contractor shall not be entitled to claim any extra cost for the extra cement used for the modifications stipulated by the Engineer for fulfilling the strength requirements specified.
- 2.10.2 If from the test results it appears that some portion of the works has not attained the required strength, the Engineer may order the testing of the suspected as well as adjacent portions of the structure. Such testing shall be at the Contractors cost. The Engineer may also reject the work and order its demolition and reconstruction at the contractor's cost.
- 2.10.3 If the strength of concrete in any portion of the structure is lower than the required strength, but in the opinion of the engineer demolition is not necessary, the Contractor shall be paid a lower rate for such lower strength concrete as determined by the Engineer.

2.11 QUALITY CONTROL

Contractor shall exert proper quality control at the various stages of concrete production and placement.

As frequently as Engineer may require, testing shall be carried out in the field for:

- 1) Moisture content of sand
- 2) Moisture content of aggregates.
- 3) Silt content of sand
- 4) Grading of sand

The contractor shall provide and maintain all items, (until the works are completed) equipment and staff required for carrying out these tests.

The Contractor shall grant the Engineer or his representative full access to this laboratory at all times and shall produce on demand complete records of all tests carried out in site. Alternatively, the Contractor may also avail of the services of the local testing laboratory with prior approval of the engineer.

2.12 CONSTRUCTION JOINTS

Construction joints shall in general conform to the relevant clauses of IS:456.

When the placing of concrete is interrupted and a construction joint is formed, provision shall be made for interlocking with the succeeding layer by the embedment or saturated wooden blocks or strips, smoothened on four sides to facilitate their removal. Prior to the next pour the wooden pieces shall be loosened and removed in such a manner as to avoid damage to the concrete.

Such construction joints shall be approved by the Engineer and shall be so located and formed as to least impair the strength and the appearance of the structure.

They shall be made in the positions as specified or as approved. Such joints shall be truly vertical or horizontal as the case may be except that in an inclined or curved member the joints shall be strictly at right angles to the axis of the member.

Construction joints shall be rebated to an approved profile and an approved water stop shall be placed in the joints when specified.

Construction joints shall be made horizontally in the foundations and 75mm below the lowest beams soffit at the head of columns. Concrete in the ribs and slab of small tee and other beams shall be placed in one operation but for large beams concrete in the rib upto a level 25mm below the slab, soffit shall be placed first. Concrete in haunches or splays on beams, or braces and concrete in the head of adjoining position of the column shall be placed at the same time and at junction of walls and slabs shall be placed at the same time as that in the slab. Construction joints in slab and beams shall be located at one third span and keyed and dowelled as specified.

2.12.1 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:-

- a) If concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface.

2.13 ENCASING ROLLED STEEL SECTIONS

Before concrete work is started, the Engineer shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust / scales etc. Where so specified, ungalvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them, shall be wrapped round the section to be encased in concrete and paid for separately.

2.14 FINISHING OF CONCRETE

On stripping the formwork, all blowholes and honey combing observed shall be brought to the notice of Engineer. The Engineer may, at his discretion allow such honeycombing or blowholes to be rectified by necessary chipping and packing or grouting with concrete or cement mortar. If mortar is used, it shall be 1:3 mix, or as specified by Engineer. However, if honeycombing or blowholes are of such extent as being undesirable, the Engineer may reject the work totally and

his decision shall be final and binding. No extra payment shall be made for rectifying these defects. All humps and uneven faces shall be rubbed smooth with the help of carborundum stone.

The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish equal to that of the rubbed down shuttered faces. Concealed concrete faces shall be left as from the shuttering except that honeycombed surface shall be made as detailed above. The top faces of slabs not intended to be surfaced shall be leveled and floated to a smooth finish as the levels or falls shown in the drawings or elsewhere. The floating shall not be executed to the extent of bringing excess fine materials to the surface.

The top faces or slabs intended to be covered with screed, granolithic or similar finishes, shall be made rough when wet with wire brush. Faces of concrete intended to be plastered shall be roughened by approved means to form a key.

2.15 PROTECTION OF CONCRETE

Care shall be exercised to protect the completed concrete from damage by subsequent construction operation. No equipment shall be run over the complete slabs until they are at least two weeks old, special case shall be taken on concreting in hot weather. The forms must be thoroughly wetted first before the concrete is placed and the exposed surface of the concrete shall be kept continually damp, by sprinkling for two days.

Heavy loads shall not be placed on or moved across floor slabs until curing is complete. Care shall be taken to prevent floor surface from being marred during curing period. For freshly laid concrete, formwork shall not be jarred. Concrete placed under water shall be protected from falling earth during and after placing.

Walking on concrete shall not be permitted for at least twenty four hours after it has been placed in the forms and for such additional length of time as the Engineer may direct.

2.16 CRACKS

If cracks, which in the opinion of the Engineer may be detrimental to the strength of the structure, developed in concrete construction, the contractor at his own expense shall test the slab or other construction as specified in Special Conditions. If under such test loads the cracks develop further, the contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto, at his cost.

If any cracks develop in the concrete construction, which in the opinion of the Engineer have suffered damage either in appearance or stability owing to such cracks. The Engineer's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.

2.17 DEFECTIVE CONCRETE

Should any concrete be found honeycombed or in any way defective, such concrete shall on the instruction of the Engineer be cut out by the Contractor and made good at his own expenses.

2.18 EXPOSED FACES. HOLES AND FIXTURES

On no account shall concrete surface be patched or covered up or damaged concrete rectified or replaced until The Engineer or his representative has inspected the works and issued written instructions for rectification. Further to observe this procedure will under that portion of the works liable to rejection; in which case it will be treated as rejection which has failed to meet specified strength requirements.

2.19 APPROVAL BEFORE CONCRETING

Pour card system to be followed. No concreting shall be carried out by the Contractor until the Engineer or his representative has inspected formwork and reinforcement and certified in writing that concreting may proceed. Any concrete poured without such prior written approval shall be cut out and removed by the Contractor at his own cost.

2.20 CONCRETE FOR FLOORING ON GRADE

Concrete for flooring on grade shall be over well packed stone metal /pcc levelling course or on earth as specified with or without reinforcement, placed in alternate bays not exceeding more than 6M x 3M or as specified including hacking the joints or adjacent bays. The water cement ratio shall not exceed 0.4 and cement content shall not be less than 320 kg/m³ of finished concrete. The stiff mix shall be thoroughly vibrated and finished to receive the floor finish.

2.21 PRECAST CONCRETE

2.21.1 General Requirements:-

Precast reinforcement concrete units such as columns, fencing posts, door and window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of grade of mix as specified and cast in forms or moulds. The forms/ moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be cast in one operation.

2.21.2 Concrete used for precasting the units should be well proportioned, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honey combing.

2.21.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angle of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.

2.21.4 The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric posts where the minimum cover shall be 25 mm.

2.21.5 Curing:-

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

2.21.6 The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled.

2.21.7 Marking:-

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

2.21.8 Precast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged.

2.22 PRECAST CEMENT CONCRETE JALI:

The jali shall be of cement concrete 1:2:4 (1 cement 2 coarse sand:4 stone aggregate 6 mm nominal size) reinforced with 1.6mm thick mild steel wire, unless otherwise specified.

2.22.1 Fixing:-

The jali shall be set in position true to plumb and level before the joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

2.22.2 Measurements:-

The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

2.22.3 Rate:-

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering.

2.23 EXPANSION AND ISOLATION JOINTS

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified herein after, if not, otherwise mentioned in the drawings. In case of liquid retaining structures, Contractor is responsible for achieving watertight concrete. All materials are to be procured from reliable manufactures and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications.

Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

2.23.1 Bitumen Board/Expanded Polystyrene Board.

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of atleast 25mm after application of an approved primer.

The sealing compound and the primer shall be applied as specified by the manufacturer.

2.23.2 Metal Sealing Strips / water stops

Metal sealing strips shall be either G.I, Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leakproof, longer lap lengths and different method of

brazing which will render it leakproof, will be adopted by the contractor without any additional cost to the Owner.

The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I Strips

G.I strip shall be minimum 1.5mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant India Standards for heavy duty work. At the joints, the overlapping should be for a minimum length of 50mm.

b) Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS:737 of 19000 grade or 31000 grade (Designation as per IS:6051). A minimum lap of 50mm length is required at the joints.

2.22.3 Non-metallic Sealing Strips / water stops

These will be normally in rubber or P.V.C can be of shape having any combination of the following features:-

- a) Plain
- b) Central bulb
- c) Dumb-bell or flattened ends
- d) Ribbed and Corrugated Wings
- e) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

2.22.3.1 Installation & Jointing Techniques of non metallic sealing strips.

One of the main advantages of PVC water-stops is that they can be installed very easily. The jointing can be carried out by simple heat fusion/welding process. The installation consists of embedding one half of the water-stop across its width in concrete leaving the second half open.

After completion of the first half, the concrete would be poured and the second half would also be embedded leaving the centre bulb free for expansion and contraction.

It is important that during pouring of concrete the water-stops should not be deformed due to impact. The concrete should be properly vibrated so that it develops intimate contact with the water-stops. Care should be taken so as not to reduce effective cross section of the water-stops.

It is necessary that PVC water-stops are placed near the centre of the concrete walls. During installation, PVC water-stops are often required to be jointed. There are essentially two types of joints :

- 1) Straight Joints
- 2) Mitred Joints

Straight joints are very simple and can easily be carried out at the site.

Fabrication of PVC water-stops can be carried out by means of simple tools; they are:

1. Hand saw or sharp knife for cutting.
2. Heating source like blow lamp or any other means.
3. A metal strip plate of suitable width and about 500 - 600 mm length with simple holding device like a wooden handle.
4. Metal or wooden templates with suitable marking/grooves for 45 Deg.C and 90 deg.C angle cuttings.

The following jointing method is recommended :

1. Water-stops are cut by means of cutting device. Clean cuts provide the best results.
2. The metal strip is heated to about 200 Deg.C which would be adequate to melt the water-stops material. The strip should not be overheated so as to prevent charring of PVC material.
3. Two ends of PVC water-stops to be joined are pressed uniformly against the hot metal strip. When sufficient fusing of PVC is attained, the metal strip removed and both the ends are pressed together. It is necessary to ensure that the entire cross section is uniformly heated and fused. It is also essential to attain alignments of the complete cross section and particularly of centre bulbs both the ends are well pressed until the joint cools down to ambient temperature.

4. The metal strip should be cleaned by means of wire brush and cotton waste before the next welding is carried out.

2.23.4 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, free from moist or dry earth or any other deleterious material.

2.24 **GROUTING UNDER MACHINERY or STRUCTURAL STEEL BASES.**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor.

2.24.1 Cement Sand Grout:-

In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone-chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly.

2.24.2 Cementitious Non shrink grout:-

Non-shrink type grout using cementitious base material shall be from approved manufacturer and shall be free flow type. The minimum compressive strength of the grout shall not be less than 650 kg/cm². The grout material shall be expansive to ensure the full contact between the base plate and grout. It should not shrink during setting process. Necessary formwork shall be used around the portion to be grouted. The water cement ratio shall be as per manufacturer's specification and in no case shall be more than 0.18. To achieve the workability for the minimum horizontal flow of 1000 mm, when the grout is poured from one end, necessary plasticizers may be added as recommended by the manufacturer. These additives / admixtures shall be added by the manufacturer only and shall not be added by the contractor at site in the ready mix grout.

2.24.3 Non-Shrink Epoxy Grout:-

Grout shall be a 100% solids system with the ability to be placed in flowable state. Non shrink Epoxy shall have a minimum allowable compressive strength of 800 kg/cm² at 7 days as determined by tests on 50 mm cubes as per ASTM C579, Method B. Epoxy grouts whose resin component has an SPI rating higher than II shall not be used, due to potential local atmospheric contamination making the installation area hazardous.

The grout surfaces shall be made completely dry prior to grouting. Epoxy grout component ratios shall not be changed from that recommended by the manufacturer. No solvents or thinners shall be added to the mix. The grouts are usually supplied in a 3-pack form consisting of: Resin, Hardener, Aggregate (Filler).

2.25 **WATERPROOFING CONCRETE STRUCTURE**

2.25.1 General:-

Water proofing of concrete structures shall be done by either suitable extraneous treatments like applying paints, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant IS Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

If it is found that water / liquid is leaking, the contractor shall carry out rectification work by injection grout method or any other method as directed by the Engineer at no additional cost to the Owner.

2.25.2 Waterproofing Admixtures:-

In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the

services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

2.26 SUPPLY & SPECIFICATION OF READY MIX CONCRETE (RMC) AS PER IS 4926:

- 2.26.1 Ready Mix concrete (RMC) generally be supplied to the Contractor in grades as required at site by the Owner. In such cases the contractor shall inform the Owner well in advance and inform the Engineer in writing / prescribed form his requirement time, date and quantity so that the Engineer / Owner can organise such supplies. If the total quantity asked for could not be poured at site, the contractor shall pay for such excess quantity as per mutually agreed rates. It is to be noted that RMC, on arrival at site, shall be immediately pumped to the location of pouring. Pumps and hoses to be supplied by RMC vendor. In case of any delay occurring because of site of pouring being not ready, thus resulting in rejection of RMC because of initial set or otherwise, the entire cost of the rejected batch at mutually agreed rates shall be borne by the Contractor.
- 2.26.2 In case, RMC is supplied by the Contractor as per contract, the same shall be supplied from M/s. ACC or any other reputed approved supplier. Approval for such supplies shall be given by the Engineer after contractor supplies all information about the supplier as required by the Engineer.
- 2.26.3 Contractor shall obtain from the manufacturer the test certificates for all materials forming RMC including details of concrete mix design and submit for Engineer's approval.

2.27 FORMWORK

- 2.27.1 If it is desired by the Engineer, the contractor shall prepare, before commencement of actual work design and drawings for formwork and get them approved by the Engineer.
- 2.27.2 The arrangement and alignment of formwork, shall be approved by the Engineer prior to concreting. However, this shall not relieve the Contractor from his responsibility of doing accurate work and rectifying the same if required.
- 2.27.3 Formwork for concrete shall be of plywood, steel, good seasoned timber of other approved materials, properly designed easy to remove and clean and shall give smooth and even surface after removal thereof. It shall be sufficiently tight to prevent loss of cement slurry from the concrete.

As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum no. of nails shall be used.

All joints and holes in the formwork shall be caulked with putty, jute cloth or other approved materials to the satisfaction of the Engineer. The inner face of the shuttering shall be cleaned and thoroughly wetted or greased with approved material. Care shall be taken that such coating is kept free from contact with the reinforcements. All formwork shall be levelled and aligned and all rubbish, particularly, chippings, wood shavings, saw dust and adhering grout shall be removed from the interior of the forms by compressed air or any other approved method before the concrete is placed. Good quality shuttering oil to be used. Burnt black oil will not be permitted.

The contractor shall obtain approval of the Engineer as to the design, fabrication, and erection of the formwork. Form and false work shall be designed as per IS 14687.

Wherever it is specified on the drawings that concrete surface will be left untreated, the pattern of joints in the formwork shall be subject to the approval of the Engineer, and no extra will be paid for special care in shuttering.

Temporary openings shall be provided at columns and wall forms and other places to facilitate inspection and cleaning. Before concrete is placed, all forms shall be carefully inspected to ensure they are properly placed sufficiently rigid and tight and approved by the engineer before the reinforcement bars are placed in position. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the work shall be stopped until the defects have been corrected.

All corners and angles shall be formed with 45 deg. mouldings to form chambers or fillets on the finished concrete as directed by the Engineer. Formwork shall be cambered at centre (at free end for cantilevers) as specified in the drawings and as per instructions of engineer in charge.

2.27.4 Tolerance shall be as per IS 456 unless the values are specifically mentioned on design drawings.

2.27.5 The contractor shall submit his design and detailing of formwork before starting the work for the approval of the Engineer. The number of props, their sizes and location shall be such as to be able to safely carry the full dead load and construction loads. However, approval of the

Engineer to this effect shall not relieve the contractor of his responsibility for proper work and safety.

- 2.27.6 All formwork for beams, slabs and similar members shall be so designed and erected that the sides can be removed without disturbing the soffit and its supports. Vertical props shall be supported on wedges or sole plates or by any other suitable means whereby the props can be gently lowered while commencing the removal of shuttering. Column shuttering shall not be more than 2.5 M in height per piece if not otherwise approved by the Engineer.
- 2.27.7 The stripping time for the shuttering and formwork shall in general conform to the provisions in the relevant clauses of IS:456.

2.28 EMBEDMENTS

Contractor shall not do concreting unless Electrical conduits, pipes, fixtures etc. wherever required, are laid by the concerned agency. Embedded items shall be placed and maintained in correct position while concreting. Embedded items shall be properly anchored to develop required strength.

2.29 MODE OF MEASUREMENT

2.29.1 Mode of Measurement for Concrete Work


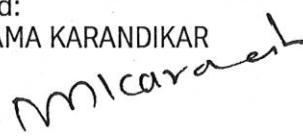
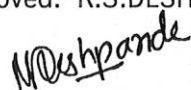
Payment for all concrete work shall be made on cubic metre basis. The pre-cast members shall be measured on Sq.Metre basis. The measurements shall be as per relevant part of IS:1200. The rates shall be inclusive of taxes, levies, labour, equipments, material, curing, pouring at different heights, working platforms etc. all complete.

Reinforcement and formwork shall be paid separately, if not otherwise mentioned in the Contract.

2.29.2 Formwork

The payment for formwork items shall be on Sq.m. basis of the actual area in contact with concrete cast unless noted. The rate shall be inclusive of all props, struts, bracings, centering and shall be for all heights, with camber, chamfering etc. and keeping formwork for full period as required including all false shuttering and staging for high structures and all taxes and levies.



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4.1 SCOPE

This specification covers the general requirements of reinforcement steel. All work shall be strictly in accordance with the technical specification unless other wise given in writing by the Engineer in charge.

4.2 APPLICABLE CODES

- IS:432 - Mild steel & medium tensile steel bars and hard drawn steel wires for concrete reinforcement :
Part-I - Mild Steel and medium tensile steel bars.
Part-II - Hard drawn steel wire.
- IS:1566 - Specification for hard - drawn steel wire fabric for concrete reinforcement.
- IS:1786 - High strength deformed steel bars and wires for concrete reinforcement - Specification.
- IS:2502 - Code of practice for bending & fixing of bars for concrete reinforcement.
- IS:2751 - Recommended practice for welding of mild steel plain & deformed bars for reinforced construction.
- IS:4082 - Stacking and storage of construction materials and components at site — Recommendations.
- IS:5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS:9077 - Code of practice for corrosion protection of steel reinforcement in RB & RCC construction.
- IS:9417 - Recommendations for welding cold worked bars at reinforced concrete construction.
- IS:13620 - Fusion bonded epoxy coated reinforcing bars - Specifications.
- SP:34 - Handbook on concrete reinforcement detailing.

4.3 MATERIAL

The reinforcement steel grades shall be as specified in B.O.Q. item for following: -

- a) High strength deformed bars conforming to IS:1786.
- b) Mild steel reinforcement conforming to IS:432.
- c) Hard drawn steel wire fabric conforming to IS:1566 - For Hard drawn steel wire fabric, wire diameter each way and mesh size shall be as specified on drawings.
- d) 16 SWG soft black annealed wire as per IS:280 for binding wire unless noted otherwise.

4.4 STORAGE

The steel reinforcement shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Bars of different classification, sizes and length shall be stored separately to facilitate issue of such sizes and lengths to minimize wastage cutting from standard lengths. All reinforcement shall be stored clear of ground or on elevated platforms. In case of storage for long period, steel shall be protected from rain, moisture by covering by tarpaulins. In case of any damage occurring to the material on account of faulty storage or negligence, the same shall be borne by the contractor at his own cost.

4.5 METHOD OF INSTALLATION

4.5.1 General - Before cutting, bending and placing, all reinforcement shall be clean and free from pitting, loose mill scales, dust, loose rust and coats of paints, oil or other coatings which may destroy or reduce the bond. Any defective or damaged reinforcement shall be brought to the notice of the Engineer and replaced with good quality bars.

4.5.2 Bar Bending Schedules - General construction details and workmanship related to reinforcement including bar bends, lap splices and installation shall be in accordance with IS:2502 and IS:456. The contractor shall prepare bar bending schedules and get them approved by Engineer in charge before proceeding with cutting of bars. The contractor shall in all cases verify for himself the correctness of the schedule giving the numbers, length and the bending details of the bars.

4.5.3 Cutting and Bending - All bars shall be cut and bent as per the bending schedules indicated in the drawing or supplied separately relevant to the particular drawing. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 850°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching. However, such bending will be allowable only with the approval of the Engineer. No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re-bending can be done only if approved by the Engineer.



- 4.5.4 Fixing - The number, sizes, shape and position of all the reinforcement shall be strictly in accordance with the design drawings unless otherwise directed or authorized by the Engineer. The reinforcement shall be adequately secured and held in position by metal wires, chairs and spacers. Bars crossing one another at inter-sections shall be tied with binding wire. Whenever conduit, piping inserts, sleeves etc interfere with placing of reinforcement, proper adjustment in the spacing of bars shall be made as approved by the Engineer. No bars shall be made rest on or against forms nor on or against the earth in excavation.

Only bars of full length shall be used as shown in the drawings. Splices and laps in reinforcement shall be provided only as shown in the drawings or as otherwise approved by the Engineer and shall be lapped to the extent indicated in drawings at the splices.

The contractor must obtain the approval of the Engineer for the reinforcement laid, before any concrete is placed in the forms. The reinforcement at this time shall be free from loose rust or scale or other coatings that may destroy or reduce bond.

Concrete / PVC spacer blocks of same strength as of parent concrete shall be used to ensure correct cover to the reinforcement. The clear cover shall be as shown on the drawings or as per instructions of the Engineer.

All the reinforcing bars shall be so tied as to form a rigid cage to prevent displacement before or during concreting. Necessary wooden planks supported independently of the reinforcement shall be provided for the labourers to move.

The vertical distance required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars inserted at such interval that the main bars do not perceptibly sag between adjacent spacer bars.

Chair bars at regular interval shall be provided for supporting the reinforcement in concrete elements of higher thickness like raft, pile caps etc. as required.

- 4.5.5 Welding – This shall be carried out only with prior approval by the Engineer under certain conditions for fixing reinforcement. Welding shall be as per IS:2751 and IS:9417. Welding shall be done by skilled and qualified welders only. Suitable safeguards shall be taken by the contractor for welding.

4.6 PROTECTION OF REINFORCEMENT STEEL AGAINST CORROSION

The requirement of protective measures against corrosion of reinforcement steel as specified in B.O.Q. for following types:

- a) Inhibited cement slurry coating system based on CECRI technology (as per IS:9077).
- b) Cement polymer composite coating system (CPCC) based on CECRI technology.
- c) Fusion bonded Epoxy coating conforming to as per IS:13620.
- d) Corrosion resistant reinforcement (CRS) steel - The reinforcement rods shall be procured from approved supplier of tested and well-known brand of corrosion resistant steel. The supplier shall guarantee the special chemical composition for corrosion resistance. The mechanical properties like tensile strength, elongation etc. shall conform to the requirements of the corresponding grades of bars as per IS-1786. The contractor shall submit all test certificates as required.

Above protective coatings shall be applied by approved agencies / manufacturers for corresponding type of coating.

4.7 TESTING

Tests shall be carried out on reinforcement and the results should be approved by the Engineer before use of the same. Samples shall be taken immediately on receipt of reinforcement at site. The methods and procedure of sampling and testing shall be in accordance with IS:1786. The engineer may specify other forms of sampling and tests, if in his opinion the reinforcement is of doubtful quality. The costs of all additional tests shall be borne by the contractor, if supplied by him. Alternatively, the Engineer at his discretion may accept test certificates of the manufacturer.

4.8 MODE OF MEASUREMENT

The payment of all reinforcement steel bars or Hard drawn steel wire fabric shall be on the basis of weight. The weight shall be derived from the sizes and corresponding weights given in the relevant I.S. Handbook. Standard hook lengths, chairs, spacer, bars and authorized laps only will be included in the weight calculated. Binding wire will not be weighed nor otherwise measured. Measurements for weight shall not include cutting allowance, wastage etc. Concrete cover blocks will not be measured and are deemed to be included in the reinforcement rates.

4.9 RATE

The rate quoted for reinforcement should include cost of labour and material required for all operations described such as supply, receiving, storing, cleaning, straightening, cutting, bending, placing in position, binding, with contractor's own binding wire, welding if specified, including wastage, cutting allowance, rolling margin and preparation of bar bending schedule (if specified in B.O.Q.) transporting, handling, machinery, tools, tackles, taxes and levies, etc complete.

