SECTION -3

EARTH WORK EXCAVATION

Indian Standard

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3.1 Classification

3.1.1 The materials to be excavated shall be classified as under

(a) **Soft or loose Soil** :- Generally any soil which yields to the ordinary application of pick and shovel or to phowara, rake or other ordinary digging implements such as vegetable or organic soil, turf gravel, soil classified under soil group SP, SC, ML, OL, MI, CI, OI, MM, CH and OH having soil dry density less than 1.80 gm/ cc as per IS 1498-1970. This will also include mud phuska, etc.

(b) **Hard or Dense Soil** :- Soil group as per IS-1498-1970 other than covered under (a) above; gravel, cobble stone, hard shale, soft conglomerate where stone can be detached from the matrix with picks and shovels. This will also include hard core, soling of roads, path etc; macadam surface of any description (water bound, grouted, tarmac); lime concrete stone masonry in lime mortar and brick work in lime or cement mortar below ground level.

**Note**:- Cobble stone is rounded to angular, bulky, hard rock particle, average diameter smaller than 300 mm but retained on 80mm IS sieve.

(c) **Mud** :- A mixture of soil and water in fluid or weak solid state.

(d) **Soft or Disintegrated Rock (Not requiring blasting)**:- Rock or boulders which may be quarried or spilt with crowbars. This will also include laterite and hard conglomerate; plain cement concrete which can be broken up with crowbars or picks and stone masonry in cement mortar below ground level.

(e) **Hard Rock**:- Any rock (excluding laterite and hard conglomerate) or boulder for excavation for which blasting is required. This will also include plain cement concrete for the excavation for which blasting is required; reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level.

(f) **Hard Rock (Blasting Prohibited)** :- Hard rock requiring blasting as described under (e) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling or any other agreed method.

3.2.2 A broad classification of soil and rock for earthwork, suitable for conditions generally occurring in practice, has been given. The classification of the soil shall be made by the consultant and Engineer In Charge during the process of excavation and the contractor shall give due notice for inspection at every stage of excavation and to record the classification of soil according to the strata present. 

SIGNATURE OF TENDERER WITH SEAL

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3.1.2 Authority of Classification:

The Classification of soils shall be decided by the consultant and Engineer – in – Charge and this decision shall be final and binding on the contractor. Merely the use of Explosives in excavation shall not be considered as a reason to classify hard rock, unless blasting is clearly authorized by the Engineer – in – Charge.

3.2 Types of Excavation

3.2.1 Rough Excavation:

Excavation not requiring dressing of sides and bottom and reduction to exact levels such as winning earth from borrow pits; hillside cutting etc., shall be described as ‘rough excavation’.

3.2.2 Surface Excavation:

Excavation exceeding 1.5 m in width as well as 10 sq. m area on plan; but not exceeding 30 cm in depth shall be described as ‘surface excavation’.

3.2.3 Excavation over Areas:

Excavation exceeding 1.5 m in width as well as 10 sq. m area on plan and exceeding 30 cm in depth shall be described as ‘excavation over areas.’

3.2.4 Excavation in Trenches for Foundations for pipes, Cables etc.:

Excavation in trenches for foundations and for pipes, Cables, etc. (not exceeding 1.5 m in width) and excavation for manholes, Shafts, Cesspits, Wells and the like not exceeding 10 sq. m on plan, shall be described as ‘excavation in trenches’.

3.2.5 Excavation in Post Holes:

Excavation in independent post holes (or similar holes) each not exceeding 0.5 cu. m shall be described as ‘excavation in post holes’ and shall include return, filling and removal of surplus spoil.

3.2.6 Surface Dressing:

Trimming of natural ground, rough excavated surface and filled up area to remove vegetation and or small inequalities not exceeding 15 cm deep shall be described as ‘surface dressing’.

3.3 Antiquities and Useful Materials:

Any finds such as relics or antiquity, coins, fossils or other articles of value shall be delivered to the EIC and shall be the property of the HAL.

3.3.1 Any Useful Material obtained from the excavation shall be stacked separately in the regular stacks as directed by the EIC and shall remain the property of the HAL. The decision of the EIC as to what is useful and what is useless shall be final and binding.

3.3.2 Any useful material, directed to be used by the contractor in lieu of his own supply will be charged to the contractor at the agreed rates or paid excluding the cost of such materials.

3.4 Inspection of site:

The contractor shall be responsible to inspect the site of work and ascertain the nature of the ground in which the excavation is to be carried out.

3.5 Site Clearance:

Before the work is started, the area coming under cutting and filling shall be cleared of shrubs vegetation, grass, bush weed, trees and saplings not exceeding 30 cm in girth, measured at a height of 1 m above the ground level. Useful materials shall be stacked and rubbish / useless materials disposed off at the place directed by the Engineer – in – Charge. Roots of trees and saplings shall be removed as described under felling of trees and the hollows filled up with earth, levelled and rammed.
3.6 **Felling of Trees:**

Trees exceeding 30 cm in girth when measured at the height of 1 m above ground level and which are to be cut shall be so approved in writing by the EIC and marked at site. Felling of trees shall include digging out roots up to 60 cm below the ground level or 50 cm below the formation level, whichever is lower. All holes and hollows, formed in the ground by, digging of roots shall be carefully filled with earth, well rammed and leveled. Boulders which may interfere with the work shall be removed, after breaking down, if necessary.

3.6.1 The trunk and branches of the trees shall be cut into suitable pieces as directed. Useful materials shall be initially stacked at site of work as directed by EIC and will be property of the HAL. All serviceable material and rubbish shall be removed to a distance up to 1.5Km outside the periphery of the area under clearance and burnt or otherwise disposed off as directed.

3.7 **Setting out and making profiles:**

3.7.1 All excavation, embankments, traverses etc., shall be set out to the true line, curve, level or slope required. The contractor shall be responsible for the accuracy of all setting out.

3.7.2 Masonry pillars shall be erected at suitable points in the area to serve as benchmarks for the execution of the work. These benchmarks shall be connected with any permanent benchmark. In case of filling necessary profiles with pegs, bamboos, and string or burjis shall be made to show the correct formation level before the work is started. In case of cutting, levels may be marked by the designing pits and embedding bricks bats at the required levels. The profiles and burjis shall be maintained during the execution of the work.

3.7.3 The ground levels shall be taken on roughly level ground ordinarily at 15m distance. In sloping and undulation areas, levels shall be taken at lesser distance depending on ground conditions. The ground level shall be recorded in the field level books and plotted on plans, and signed jointly by EIC and the contractor before the earthwork is started. The labour required for taking levels shall be supplied by the contractor at no extra cost to HAL.

3.8 **Surface Dressing**

Uneven surfaces of the natural ground, rough excavated surfaces and filled up area where ordered shall be trimmed to an uneven surface, horizontal or sloping, by removing vegetation and by scraping high patches and filling in low patches with the scraped soil to give an even and neat look to the site. The maximum depth of cutting shall not exceed 15 cm.

3.9 **Rough Excavation**

The locations and depths of borrow pits and the extent of hillside cutting shall be indicated by the EIC. Sufficient number of telltales or dead man shall be left in position as indicated by the EIC for proper measurements of excavation. Such tell tales shall not be removed until after the measurements of rough excavation have been recorded in the measurement book. Where practicable, borrow pits shall be drained to prevent stagnation of water in them.

3.10 **Excavation Generally**

3.10.1 All excavation (except rough excavation) shall be paid to the exact dimensions and profiles as shown on the drawing and the Quoted rate shall include cost for working space / allowances as per applicable standards or as directed by the EIC. However authorized width as per SSR or IS 1200 will be paid.

3.10.2 Disused foundations drains or other obstructions met with during excavation shall be grubbed up and cleared away to the extent required.

3.10.3 **Damage to the existing Drains, Water mains, cables, etc:**

During excavation the contractor shall take particular care to avoid damage to the existing drains, water mains, cables or other underground work. Where required, existing pipes, cables etc. shall be properly slung or otherwise supported and report to the Engineer – in – Charge for receiving instruction regarding further course of action.
3.10.4 Top spit and other vegetable matter shall be separated from excavated material if so directed.

3.10.5 Bad Ground:

If during excavation the contractor encounters, expansive soil or other bad ground, he shall immediately notify it to EIC for his instructions in writing.

3.10.6 Inspection and Approval:

The contractor shall notify the EIC when excavation is ready for inspection. The excavation shall be inspected and passed by the EIC in writing, measurements recorded in the measurement book before foundation is laid.

3.11 Excavation in Trenches and Over Areas in Soil

3.11.1 In firm soil the sides of excavation shall be kept vertical up to a depth of 1.5 m from the bottom. For greater depth excavation profile may be widened or the sides sloped or shored up, depending up on the nature of soil. As ordered by the EIC in writing. It shall be responsibility of the contractor to take complete instructions from the EIC, in regarding the extent and manner of stepping, sloping or shoring and timbering to be done for excavations, where necessary.

3.11.2 Excavation shall be done from top to the bottom. Undermining and underpinning shall not be allowed.

3.11.3 The bed of excavation shall be formed to the required level, slope or grade shall be made firm by watering and ramming. The side of excavation shall be dressed or trimmed. Soft defective spots shall be dug out and filled with concrete of the same mix as that of the base concrete or approved dry filling as directed by the EIC.

3.11.4 If the excavation is done to a depth greater than that shown in the drawings or directed; the excess depth shall be made good by the contractor at his own expense with the concrete of the same proportion as base concrete. However, for excavation in drain work the excess depth shall be made good with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched.

3.11.5 In trench excavation for pipes etc., grips shall be dug, if required, to take sockets, collars and joints of pipes.

3.12 Blasting of Rocks

3.12.1 The contractor shall obtain license from the district authorities, where applicable, for undertaking blasting work and for obtaining and storing the explosives as per the Explosives rules, 1940, corrected up to date. The contractor shall purchase explosives, fuses, detonators only from the licensed dealers. He will be responsible for their safe custody and shall maintain an appropriate account of the explosive materials. The EIC or his authorized representatives shall have access to check the contractor's stock of explosives.

Fees, License or any other statutory provisions shall be strictly complied with and all the expenses towards the same shall be borne by the contractor.

3.12.2 Precautions:

Blasting operations shall be carried out under careful supervision of a responsible authorized person preferably during certain specified hours. Only trained person shall be employed. The blasting time shall be notified in advanced to the surrounding areas.

All precautions shall be taken to avoid accidents and to ensure safety of workers, public and property during blasting operations. Red flags shall be prominently displayed around the area to be blasted and all the people on work except those who actually light the fuses, shall withdraw to a safe distance of not less than 200 m from the blast.

All the procedures and safety precautions for the use of explosives, drilling and loading of the explosives'
before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081-1986, safety code for blasting and related drilling operations. The EIC shall be informed by the contractor of all cases of misfires their causes and the steps taken in that direction. The Insurance with respect to blasting requires to man and materials shall be obtained. This shall be either specifically covered in the Contractors all risk policy as stipulated in the General Condition of Contract or separate insurance policy shall be obtained for specific purpose.

3.13 Balling / Pumping of water

All water that may accumulate in excavations during the progress of work from subsoil water, springs or any other cause shall be bailed / pumped out or otherwise removed. The foundations 'shall be kept dry during excavation and laying of foundations. Pumping shall be done directly from the foundation trenches or from a sump outside the excavation as necessary in such a manner, as to preclude the possibility of movement of water through any fresh concrete or masonry and washing, away the parts of concrete or mortar. No pumping shall be allowed during laying of concrete or masonry and for a period of at least 24 hours thereafter unless it is done from a suitable sump separated from concrete or masonry by effective means. Pumping shall be done in such a way as not to damage to the work or adjoining property by blows, subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby. Dewatering / Bailing out of water in all locations of work site and from the excavated trenches, pits / area shall be bailed out / pumped out as necessary by the contractor at his own cost. The contractor shall arrange sufficient mechanism to pump out the water depending upon the accumulation of water in the trenches etc.

3.14 Protection

The contractor shall protect the excavation from the effect of frost other damage and shall make good such damage to the satisfaction of the EIC. Fencing and other precautions such as red flags and red lights at night etc. as necessary for protection against risk of accidents due to open excavation shall be provided. While carrying out excavation near a building, care shall be taken to see that proper shoring etc required is 'provided so as not to adversely affect, the foundation of adjacent building.

3.15.1 Filling Excavated Earth in Foundation Trench, in plinth and Under Floor etc.

The earth used for filling shall be free from salts, organic and other deleterious matter. Highly expensive soils like black cotton soil shall not be used, unless so specified. All clods of earth exceeding 50 mm shall be broken or removed. Earth obtained from borrow pits and surplus earth from excavation, if any, shall be directly used for filling and double handling avoided to the extent practicable.

3.15.2 Filling sides of trenches:

As soon as the work in foundation has been completed and measured, the space around foundation masonry in trenches shall be cleared of all debris, brickbats, etc. and filled with earth in layers not exceeding, 250 mm, each layer being watered, rammed and compacted before the succeeding one is laid. Earth shall be rammed with iron rammer where feasible and with the butt ends of crowbar where rammer cannot be used.

3.15.3 Filling Plinth, Under Floor and hardstanding etc.

Filling shall be started from the lowest level in regular horizontal layers each not exceeding 250 mm in depth. Each layer shall be compacted by ramming with rammers of7 to 10 kg weight. Earth filling shall be adequately watered for 'achieving maximum compaction. Special care shall be taken to compact the filling at the junctions of the floors with walls and columns. The top surface of the filling shall be neatly dressed level or to slope or grade as directed. In large floors, like factory floors/ hangers, hard standing etc., each layer of earth filling shall be compacted by the mechanical means such as by sheep foot-roller or by hand roller or by power roller, compactors/rammers to 90 to 95 percent of standard Proctor's density under optimum moisture conditions.

3.16 Filling in Trenches for pipes, drains, cables, etc.

3.16.1 Material for filling:

Earth used for filling shall be free -from salts, organic or other deleterious matter. All clods of earth exceeding 50 mm shall be broken or removed. Unless otherwise indicated, where the excavated material is mostly rock, the rock fragment shall be broken into pieces not bigger than 150 mm size and mixed with fine
material consisting of decomposed rock moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling.

3.16.2 Filling Trenches:

Filling in trenches for pipes and drains shall be commenced only after the joints of pipes and drains have been tested and passed by the EIC in writing.

3.16.3 Where the trenches are excavated in soil the filling shall be done with earth on both the sides simultaneously and on top of pipes in layers not exceeding 250 mm thick, watered, rammed and compacted; taking care that no damage is caused to the pipe below.

3.16.4 In case of excavation in rock, the filling up to a depth of 300 mm above the crown of pipe shall be done with fine material such as earth, moorum or pulverized decomposed rock according to the availability at site, in the same manner as described for trenches excavated in soil. The remaining filling shall be done with rock fragments mixed with fine material as available to fill up the voids, watered, rammed and compacted, in layers not exceeding 250 mm thick. Particular care shall be taken in a back-filling to avoid future troubles from bursts and leakages due to differential settlement.


3.17.1 Moorum or Red bajri

Moorum or Red Bajri shall contain silicious material, and natural mixture of clay of calcareous origin. These shall not contain any admixture of ordinary earth. Bajri shall be dark red in colour consisting of coarse grains, free from mica, and other foreign matter. Size of moorum/red bajri shall vary from dust to 40 mm gauge.

3.17.2 Sand:

Sand shall be clean, free from dust, organic and other extraneous matter. It shall not contain more than 5 percent clay / silt.

3.17.3 Shingle:

Shingle shall be clean and free from foreign matters and obtained from river or nullah beds. Shingle of all in size ranging from 40 mm down to 4.75 mm gauge shall contain a sufficient proportion of fine material to fill all interstices and ensure binding when consolidated.

3.17.4 Filling:

Filling shall be done in a manner similar to earth filling in plinth except that thickness of individual layer shall not exceed 15 cm. Shingle or ballast filling shall be blinded with earth before ramming / consolidation. The surface of the compacted moorum, red bajri. Sand or shingle shall be dressed to the required level, grade or slope. In the case of moorum and sand filling, surface shall be flooded with water for at least 24 hours, surface allowed to dry and compacted and graded. When the filling in floors etc. has nearly dried, any developing cracks shall be tapped and a thin layer of the same material as used for filling and earth in case of shingle filling shall be spread over the surface evenly and tapped in.

3.18 Embankments and Traverses

3.18.1 Clearing the Site

Prior to commencement of earth work, the site shall be cleared of all obstruction and vegetation including trees, undergrowth grass, rubbish etc. All stumps shall be cut down below ground level as specified under felling of trees.

3.18.2 Embankments for road work etc shall be set out true to alignment, gradient, camber super elevation etc as indicated or directed by the EIC.

3.18.3 Compacting Original Grounds:

Original ground shall be compacted as much as possible by rolling or by other means like tamping where
rolling is not feasible. All empty pockets or depressions left in the soil as a result of clearing and grubbing operation shall be filled and compacted. Any unsuitable materials occurring in the embankment foundation shall be removed and replaced with approved materials.

3.18.4 Where an embankment is to be placed on steep sloping ground, the surface of the ground shall be benched in step or broken up in a manner that the new materials would bond with the existing surface.

3.18.5 Embankment work shall not proceed unless the foundations have been inspected by the EIC for satisfactory conditions and approved.

3.18.6 Earth for Filling:

Only approved earth shall be used in the embankment. All clods of earth exceeding 50 mm shall be broken or removed. Soils having maximum dry density of less than 1.44 gm/cc are ordinarily unsuitable and shall not be used unless specifically approved in writing by the EIC. Similarly soils having maximum dry density of 1.52 gm/cc are ordinarily considered not suitable for use in embankments exceeding 3 m in height or in embankments of any height subject to long periods of inundation. The work shall be so executed that the best available earth, is saved for the top portion of the embankment. Where highly expansive soils exhibiting marked swell and shrinkage properties indicated to be used in filling, these shall be deposited at the bottom of the embankment and no such materials shall be placed in the top 50 cm portion of the embankment below the subgrade.

3.18.7 Placing Soil:

Earth shall be deposited in layers not exceeding 25 cm. When a sheep foot roller is used, the thickness of the layer shall not exceed the length of the stamping foot by more than 5 cm. For adequate compaction the embankment shall be constructed in uniform layers spread over the entire width of embankment. Successive layers shall not be placed unless the layers under construction have been thoroughly compacted to satisfy the specified requirements.

3.18.8 Compaction:

Each layer shall be thoroughly compacted with sheep foot and/or power road roller of weight not less than 8 tones till the soil behaves as an elastic material and gets compressed under the load of the roller. In location where consolidation by power roller is not possible, manually or mechanically operated rammers shall be employed for Compaction. The embankment shall be finished to the lines, grades and cross section as directed. The compaction of earth filling in embankments shall be carried out under optimum conditions, so as to obtain at least, 95 percent of standard Proctor density for each layer. Dry density shall be determined in accordance with IS-2720 (Pt VII). Method of tests for soils (Part VII)-Determination of water content-dry density relation using light compaction. The moisture content of each layer of soil at the time of compaction should be from 1% above to 2% below the optimum moisture content. Highly expansive clays (such as black cotton soil) where specified to be used, should be compacted at a moisture content of 3-4 percent above the optimum to a density not exceeding 90% of standard Proctor's density.

3.18.9 Allowance for Settlement:

To allow for subsequent settlement of embankment, the finished level of the embankment shall be set higher than the specified level by 1-2 percent of the height of the embankment.

3.18.10 Compaction Control:

Proper record of compaction tests carried out shall be maintained. Density measurements shall be done at the rate of 1 test per 500-1000 Sqm of the compacted area, except where otherwise indicated.

3.19 Subsidence And Shrinkage

The contractor shall make good all subsidence and shrinkage in all earth fillings, embankments, traverses etc. during execution of work and thereafter until the expiry of defect liability period.

3.20 Timbering / planking and Strutting

3.20.1 When the depth of a trench in a soft but firm soil exceeds 1.5 m, stepping sloping and or planking and strutting of sides shall be done as ordered, in writing by the EIC. In the case of loose and slushy soil
the depth at which these precautions are to be taken shall be determined by the EIC according to the nature of the soil

3.20.2 It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of the trenches from collapse. Regarding the necessity or otherwise of timbering or any other safety measures, the contractor shall be responsible to obtain the decision of the EIC, in writing, failing which the contractor shall be liable for any damage caused due to non- adoption of proper timbering or other safety measures.

3.20.3 Deep excavation shall be inspected by the Contractor after every rain; storm or other hazard increasing occurrence and protection against slides and caving shall be increased, if necessary and as directed by the EIC.

3.20.4 Planking and strutting shall be ‘close’ or ‘open’ type depending on the nature of soil and the depth of trench. The type of planking and strutting shall be as indicated by the EIC. Where distinctly different types of soil strata are encountered, each strata shall be treated separately as required by its characteristics

3.20.5 Timbering shall be of sufficient strength to resist earth pressure and ensure safety from slips, damage to the property or injury to person. Where excavation has also to stand vibrations from adjacent machinery, vehicles, railroads, blasting and other sources, additional bracings shall be provided. Generally the specification and sizes and spacing of sheeting, wales and struts used for timbering for different depths of trench shall be as given in IS 3764-1966 Safety code for excavation work. Shoring shall extend 30 cm above the vertical sides.

3.20.6 The withdrawal of timbering shall be done very carefully to prevent collapse of the sides of excavation and any damage to the work, executed in the excavated area. No Claim shall be entertained for any timber, which cannot be withdrawn and is lost or buried unless ordered by the EIC writing to be left permanently in position.

3.21 Preconstruction Anti-termite Chemical Treatment:

3.21.1 Chemical:

Anti termite treatment shall conforming to the IS 6313 specification in water emulsion shall be applied uniformly at the prescribed rate in all stages of treatment.

3.21.1.2 Concentration of the chemical as emulsifiable concentrate will be as indicated on the sealed containers. For obtaining, the specified concentration, chemical shall be diluted with water in the required quantity before it is used. Graduated containers shall be used for the dilution of the chemical. For example, to dilute chemical of 30 percent concentration, 59 parts of water to one part of the chemical shall be added to achieve 0.5 percent concentration.

3.21.2 Mound Treatment:

If termite mounds are found within the plinth area of the building these shall be destroyed by pouring chemicals into the mounds at several places, after breaking open the earthen structure, and making holes with crow-bars, at the rate of 4 liters of chemical emulsion per cubic metre of mound.

3.21.3 Conditions of formation:

Barrier shall be complete and continuous under the whole of the building / structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. On loose, sandy or porous soils where loss of treating solution through piping or excessive percolation is likely to occur, preliminary moistening to fill the capillary spaces in soil may be done.

3.21.4 Soil treatment should start when foundation trenches and pits are ready to take mass foundation concrete. Laying of foundation concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or when the soil is wet with rain or-subsoil water. This applies also in the case of treatment to the filled earth surface within the plinth area before laying the sub-grade for the floor.

3.21.5 Disturbance:

Once formed, treated soil barriers shall not be disturbed. If treated soil barriers are distributed, immediate
steps shall be taken to restore the continuity and completeness of the barrier system.

3.21.6 Treatment of Masonry Foundations and Basement:

The bottom surface and the sides (up to a height of about 300 mm) of excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres per square metre surface area. After the masonry foundations and the retaining wall of the basements come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 7.5 litres per square meter of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centers close to the wall surface and working the rod backward and soil should be tamped, in place. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the masonry surfaces so that the earth in contact with these surfaces is well treated with these chemicals.

3.21.6.1. Treatment for RCC Foundations and Basements:

The treatment shall start at a depth of 500 mm below the ground level except when such ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 500 mm shall be determined from the new soil level resulting from the filling or cutting mentioned above, and soil in immediate contact with the vertical surfaces of RCC foundations shall be treated at the rate of 7.5 liters per square meter.

3.21.7 Treatment of Top Surface of plinth filling:

The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 liters per square meter of the surface before the sand bed / hardcore or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centers both ways may be made with 12 mm dia mild steel rods on the surface to facilitate saturation of the soil with the chemical emulsion.

3.21.8 Treatment at Junctions of the wall and the floor:

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level upto the level of the filled earth surface. To achieve this, a small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-base) and the rod holes made in the channel up to the ground level 150 mm apart and the iron rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 liters per square meter of the vertical wall or column surface so as to soak the soil right to bottom. The soil should be tamped back into place after this operation.

3.21.9 Treatment of soil along External Perimeter of Building:

After the building is complete but before laying plinth protection, holes shall be made in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and these holes shall be filled with chemical emulsion at the rate of 7.5 liters per sq. meter of vertical surface of perimeter of the external wall.

3.21.9.1 Treatment of soil under apron along external perimeter of building:

Top surface of the consolidated earth over the apron is to be laid shall be treated with chemical emulsion at the rate of 5 liters / Sqm of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centre both ways may be made with 12 mm diameter mild steel rod on the surface to facilitate saturation of soil with chemical emulsion.

3.21.10 Treatment of soil surrounding pipes and conduits:

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the point of entry shall be loosened around each such pipe or conduit for a distance of 150 mm and to a depth of 75 mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75 mm for a distance of over 300 mm
3.21.11 Safety precautions:

The chemicals used for treatment are poisonous and hazardous to health. Therefore necessary safety precautions shall be taken by the Contractor in handling and use of the chemicals and emulsions.

3.22 Hard Core

3.22.1 Hard core shall be of hard broken stones or boulders, quarry waste, gravel, bricks of old broken concrete, as indicated. Material for hard core shall be hard, tough, clean and free from dust and other deleterious matter. The material for hard core shall be well graded for providing a dense and compact sub-grade. Where the gravel or concrete rubble, etc, are not well graded, it shall contain sufficient fine material for its proper compaction.

3.22.2 Unless otherwise indicated, materials for hard core shall be broken to gauge not exceeding 63mm. Hard core of gauge upto 100mm may be specified and used when laid in hard standing and pavements where power roller is used for consolidation.

3.22.3 Brick aggregate shall be from well burnt or slightly over burnt bricks and shall not contain any appreciable solution of sulphate content when used on a wet side.

3.22.4 Coarse ungraded gravel and rock may be used as a base layer for hard core exceeding 15cm thick covered by a layer of well graded material.

3.22.5 Concrete rubble shall be clean and suitably graded. Care shall be taken with rubble from general building demolition which may contain mixtures of material.

3.22.6 Hard core filling shall be spread and levelled in layers not exceeding 15cm thick, watered and well rammed or rolled where indicated.

Disposal of Surplus Excavated Material:

All Materials considered surplus shall be moved to destinations within the specified and disposed off as directed.

Measurements:

The measurement of Earthwork shall be done as specified in MES SSR 2004 – Part II and IS 1200.

Excavation shall be measured in CUM for each class of material encountered, limited to the dimension shown in the drawing including authorized widths or as directed by the consultant and Engineer – in – Charge. Excavation over increased width, cutting of slopes, shoring, shrutting and planking shall be deemed as convenience to the contractor in executing work and shall not be measured and paid for separately.

Rate:

Unless otherwise specified, the rate shall include the following:

Surveying, Setting Out,
Levelling the bottom to the required level/ Gradient, slope as directed by the consultant at all lifts and leads as specified in the BOQ for respective Items.
All Labour, material, tools, plants, equipments, Instruments in completing the excavation.
Following all the required and standard safety precautions.
Cost to Comply all statutory provisions as applicable.
Trimming the sides and bottom
Dewatering and keeping the work free from water
Disposal including loading, unloading, spreading initial staking etc., to the specified destinations and leads.
Excavation manually or by use of machinery. However machinery will not be permitted where service lines are passing through or it may cause damage/affect the adjoining structure.
**SECTION-4**

**CONCRETE**

**Indian Standards**

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>I.S. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>10262 -1982</td>
<td>Recommended Guide Lines for Concrete Mix Design</td>
</tr>
<tr>
<td>383-1970</td>
<td>Specification for coarse and fine aggregates from natural sources for concrete (Second revision)</td>
</tr>
<tr>
<td>516-1959</td>
<td>Method of test for strength of concrete.</td>
</tr>
<tr>
<td>1199-1959</td>
<td>Method of sampling and analysis of concrete.</td>
</tr>
<tr>
<td>2185 (part-I)-1979</td>
<td>Specification for load bearing, hollow concrete blocks (second revision)</td>
</tr>
<tr>
<td>2185 (Part-II)-1983</td>
<td>Specification for concrete masonry units Hollow and solid light weight concrete blocks (first revision)</td>
</tr>
<tr>
<td>2185 (Part-III)-1984</td>
<td>Specification for concrete masonry units Auto cleaved cellular (aerated) concrete blocks (first revision)</td>
</tr>
<tr>
<td>2645-1975</td>
<td>Specification for integral cement water proofing compounds (first revision)</td>
</tr>
<tr>
<td>4926 - 2003</td>
<td>Ready Mixed Concrete – Code of practice</td>
</tr>
<tr>
<td>7861 (part-I)-1971</td>
<td>Code of practice for extreme weather concreting Part 1-Recommended Practice for hot weather concreting</td>
</tr>
<tr>
<td>8112-1989</td>
<td>Specification for 43 Grade Ordinary Portland Cement</td>
</tr>
<tr>
<td>12269 - 1987</td>
<td>Specification for 53 Grade Ordinary Portland Cement</td>
</tr>
</tbody>
</table>

**MATERIALS :**

**Cement :**

Unless otherwise indicated, cement used shall be Ordinary Portland Cement 43 grade confirming to IS 8112 of approved make. Use of any other grade of cement in case of extreme emergency shall be with the specific approval from the consultant and Engineer – in – Charge. Cement older than 3 months from the date of manufacturing shall not be used for the work.

**Storage:**

Cement in bags shall be stored in dry waterproof sheds to protect the cement from dampness and to minimize warehouse deteriorations. Where cement has been stored and for any reason the stored cement shows signs of deterioration or contamination, it may be tested before use for its strength, setting time, etc., cement which has fully or partially set shall not be used.

Storage of cement at the site of work shall be at the contractor’s expense and risk. In the event of any damage occurring to cement due to faulty storage in contractor’s sheds or on account of negligence on his part, such damage shall be the liability of the contractor. The storage shall be planned considering optimum utilization as per planned progress and shall not allow storage of cement for longer period than the specified.

**Precautions in storage:**
Cement bags shall not be piled against the wall. A space of 60 cm all round shall be left between the walls and the piles, bags shall be piled off the floor on wooden planks. Bags shall be kept close together in the pile to reduce circulation of air as much as possible and shall not be piled more than 10 bags high to avoid lumping under pressure. The width of pile shall not be more than about 3m. For extra safety during the monsoon, or when it is expected to store the cement for an unusually long period, the pile shall be completely enclosed by a waterproof membrane such as polythene, tarpaulin etc. Each consignment of cement shall be stacked separately to permit easy access for inspection and facilitate removal. Cement shall be used in the order in which it is received.

Aggregates from Natural Sources:

Quality of Aggregates:

Aggregates from natural sources shall consist of (crushed or uncrushed) stones, gravel and sand or combination thereof conforming to IS 383. Specification for coarse and the fine aggregates from natural sources used for concrete. They shall be hard, strong, dense, durable, clean and free from veins and adherent coatings and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky and elongated pieces shall be avoided. Aggregated shall be obtained from approved sources as indicated.

Coarse aggregates shall be obtained from crushed granite, trap, basalt or similar stones from approved quarry. Sampling and testing shall be as per IS : 2386.

Deleterious Materials:

Aggregates shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, organic impurities, soft fragments, sea shells, etc., in such quantities as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any material liable to attack the steel reinforcement. Aggregates, which are chemically reactive to alkalis in cement, shall not be used in cement concrete.

Limits of Deleterious Materials:

The maximum quantities of deleterious materials in the aggregates shall not exceed the limits laid down in IS 383.

4.3.3.1 If the quantities of deleterious materials in the aggregates exceed the limits mentioned above the aggregates shall be washed in fresh and clean water to the satisfaction of E.I.C before use.

4.3.3.2 Use of sea-sand shall not be allowed for any description of mortar and concrete works, in any location.

4.3.4 Aggregate Crushing Value:

The aggregate crushing value shall not exceed 45 percent for aggregate used for concrete other than for wearing surfaces and 30 percent for concrete for wearing surfaces such as runways roads and pavements.

4.3.5 Aggregate Impact Value:

As an alternative to aggregate crushing value, the aggregate impact value shall not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways roads and pavements.

4.3.6 Aggregate Abrasion Value:

The abrasion value of aggregate, using Los Angeles machine shall not exceed the following value:

a) For aggregates to be used in concrete for wearing surfaces-30 percent

b) For aggregates to be used in other concrete-50 percent

4.3.7 Size and Grading of Aggregates:
(1) Graded Coarse Aggregate: - Grading shall be within the limits given in the following table:

### GRADING OF COARSE AGGREGATE:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage Aggregate</th>
<th>Passing for graded of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>63 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>20 mm</td>
<td>30-70</td>
<td>95-100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>-</td>
<td>90-100</td>
</tr>
<tr>
<td>10 mm</td>
<td>10-35</td>
<td>25-55</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>0-5</td>
<td>0-10</td>
</tr>
</tbody>
</table>

### GRADING OF FINE AGGREGATE:

(2) Fine Aggregate (Sand): - The grading of fine aggregates shall be within the limits given in the following table and shall be described as fine aggregates Grading zone I, II, III & IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 micron I.S. Sieve, by a total amount not exceeding 5 percent, it shall be regarded as falling within that Grading Zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. Sieve or to percentage passing any other size on the coarser limit of grading Zone I or the finer limit of Grading Zone IV.

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing for Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zone I</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
</tr>
<tr>
<td>300-micron</td>
<td>5-20</td>
</tr>
<tr>
<td>50 micron</td>
<td>0+10</td>
</tr>
</tbody>
</table>

NOTE 1: For crushed stone sands the permissible limit on 150 micron I.S. Sieve shall be increased to 20 percent. This does not affect the 5 percent allowance, as already permitted, applicable to other sieve sizes.

NOTE 2: Fine aggregate conforming to Grading Zone IV shall not be used in reinforced concrete, unless tests (which shall be recorded) have been made to ascertain the suitability of proposed mix proportions and prior written approval of EIC for use of such fine aggregate is obtained.

(3) All-in Aggregate: - Grading of all in aggregate shall be within the limits given in the following table:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing for All-in-Aggregate of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>20 mm</td>
<td>45-75</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>25-45</td>
</tr>
<tr>
<td>600 micron</td>
<td>8-30</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-6</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL  

EMployer
NOTE: For carrying out tests on all-in-aggregates, the fractions passing through 4.75 mm IS sieve and the fractions retained on 4.75 mm IS sieve shall be first separated and there shall comply with the requirements (except grading) specified for fine aggregates and coarse aggregate respectively.

44 Water Proofing Compound:

Integral cement waterproofing compound where indicated shall be used and the same shall confirm to the requirements of IS 2645-1975. Specifications for integral cement water proofing compound or as specified in the BOQ.

45 Water:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than 6. Potable water is generally considered satisfactory for mixing concrete.

Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

WORKMANSHIP

4.6 Plain and Reinforced Cement Concrete:

4.6.1 Cement Concrete:

Cement concrete shall be of the specified Grade or volumetric mix as indicated. Cement concrete and reinforced cement concrete shall be provided in accordance with IS 456-2000, code of practice for plain and reinforced concrete, except as otherwise stated.

4.6.2 Concrete Mix Proportioning:

Where concrete is specified by its Grade i.e., characteristic compressive strength, determination of proportions of cement, aggregates and water to attain the required strength shall be made by designing the concrete. Mix (Design mix concrete).

Design Mix Concrete:

The mix shall be designed to produce the grade of concrete having the required workability and the characteristic strength not less than that specified. The contractor shall conduct all necessary tests and analysis of the materials and provide necessary test/analysis data required for design of the concrete mix. The contractor shall also make trial mixes of concrete and conduct necessary tests to arrive at the approved mix proportioning and strength at his cost. As long as the quality of materials does not change a mix design done earlier may be considered adequate for later work. The mix design shall be done/tested from the Government Laboratories preferably located at NASIK.

4.6.2.1 MINIMUM CEMENT CONTENTS:

The minimum cement contents for design mix concrete of various grades shall be as indicated.

Volumetric Mix Concrete:

Where indicated concrete will be of the specified volumetric mix. For volumetric mix concrete, the proportions of cement and aggregates are defined by bulk. Volumetric mix shall be designated as 1:4:8, 1:3:6 etc., the figures denote the relative proportions of cement, fine aggregate in dry condition and graded coarse aggregate respectively. If fine aggregate is moist, necessary allowance shall be made for bulking. To determine bulk, 50 kg of cement shall be taken as equal to 0.035 cum. Quantities of fine and coarse aggregates shall be determined by Volume separately and accurately in proper gauge boxes. The gauge boxes shall be of such dimensions that 50 kg of cement forms a unit. The equivalent size of a box for 50 kg cement bag will measure 40x 35x 25 cm internally. Consolidation of aggregates in the gauge boxes by ramming or shaking shall not be allowed.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
4.6.3 Batching:

In proportioning design mix concrete, the quantity of both cement and aggregates shall be determined by weight. Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked. All materials for controlled concrete shall be batched as per approved design in suitable weigh batcher of adequate capacity and of approved design.

4.6.3.1 The material shall be stockpiled for several hours, preferably a day before use. The grading of coarse and fine aggregates shall be checked as frequently as possible, the frequency for a given job being determined by the EIC to ensure that the specified grading is maintained.

4.6.3.2 Where the aggregates supplied are not graded, different sizes shall be blended in right proportions; the different sizes being stacked in separate stock piles.

4.6.3.4 Water cement ratio shall be maintained at its correct value.

4.6.3.5 No substitutions in the materials used on the work or alterations in the established proportions shall be made without additional test to show that the quality and strength of concrete are satisfactory.

4.6.4 Workability of concrete:

The concrete shall be of adequate workability for the placing condition of the concrete and proper compactions with the means available. Suggested ranges of values of workability of concrete for some placing conditions, measured in accordance with IS 1199-1959, are given below:

<table>
<thead>
<tr>
<th>Placing conditions</th>
<th>Degree of workability</th>
<th>Values of Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concreting of shallow sections with vibration</td>
<td>Very low</td>
<td>20-10 seconds vee-bee time OR 0.75-0.80 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly Low reinforced sections with vibration</td>
<td>Low</td>
<td>10-5 seconds vee-bee time OR 0.80-0.85 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections without vibration, or heavily reinforced section with vibration</td>
<td>Medium</td>
<td>5-2 seconds vee-bee time OR 0.85-0.92 compacting factor 6-25mm slump for 12.5 mm aggregate OR 25-75mm slump for 20 mm aggregate</td>
</tr>
<tr>
<td>Concreting of heavily reinforced section without vibration</td>
<td>High</td>
<td>Above 0.92 compacting factor OR 75-125mm slump for 20 mm aggregate</td>
</tr>
</tbody>
</table>

4.6.5 Mixing:

Concrete shall be mixed in a mechanical mixer. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. If there is segregation after unloading from the mixer, the concrete shall be re-mixed. The mixing time may be taken as 1-1/2 to 2 minutes.

4.6.6 Form Work:

4.6.6.1 General:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings. All forms shall be sufficiently watertight to prevent leakage of mortar. Forms shall be constructed so as to remove in sections. Formwork shall be provided finished fair and even as specified in section 7-
oodwork. The formwork shall be properly designed so that it is rigid enough to remain free from bulging, sagging or displacement while placing the concrete and consolidation.

4.6.6.2 Cleaning and Treatment of Forms:

All rubbish particularly chippings; shavings and sawdust shall be removed from the interior of the forms before the concrete is placed. The formwork in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition to prevent adhesion between formwork and concrete. Care shall be taken that such approved composition is kept out of contact with the reinforcement.

4.6.6.3 Stripping Time:

Forms shall not be struck until the concrete has attained strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing of the work. Where so required formwork shall be left longer. In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods: For other cement stripping time shall be indicated:

| (a) | Walls, columns and vertical faces of all structural members | 2 days |
| (b) | Slabs (props left under) | 3 days |
| (c) | Beam Soffits (props left under) | 7 days |
| (d) | Removal of props under slabs |
| | (1) Spanning up to 4.5 m | 7 days |
| | (2) Spanning over 4.5 m | 14 days |
| (e) | Removal of props under beams and arches |
| | (1) Spanning up to 6 m | 14 days |
| | (2) Spanning over 6 m | 21 days |

In case of bad weather these periods may be increased at the direction of EIC.

The number of props left under, their sizes and disposition shall be such as to be able to safely carry the dead load of slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

4.6.6.4 Removal of Form work:

Formwork shall be removed in such a manner as would not cause any shock or vibration that would damage the concrete. Before removal of soffits and props concrete surface shall be exposed to ascertain that the concrete has sufficiently hardened.

4.6.6.5 Where the shape of the element is such that formwork has re-entrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

REINFORCEMENT:

4.6.7 Assembly of Reinforcement:

Reinforcement shall be bent and fixed as specified in section 10 Steel and Iron work. All reinforcement shall be placed and maintained in the position shown in the drawings during concreting. Crossing bars shall not be tack welded for assembly of reinforcement, unless otherwise indicated. All Reinforcement shall be of tested Quality and specified Diameter as per the design. Test reports shall be submitted to Engineer – in – Charge / Consultant for approval.

4.6.7.1 Tolerance on Placing of Reinforcement:

Unless otherwise directed, reinforcement shall be placed within the following tolerance:

(a) For effective depth 200 mm or less + 10 mm
For effective depth more than 200 mm + 15 mm

4.6.7.2 Welded joints or mechanical connectors:

Welded joints in reinforcement may be used where indicated / directed but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of the bars connected.

4.6.8 Cover to Reinforcement:

4.6.8.1 Reinforcement shall have concrete cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as follows, unless otherwise indicated:

a) At each end of reinforcing bar, not less than 25 mm or less than twice the diameter of such bar;

b) For a longitudinal reinforcing bar in a column not less than 40 mm nor less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under whose reinforcing bars do not exceed 12 mm, a cover of 25 mm may be used;

c) For longitudinal reinforcing bar in a beam, not less than 25 mm nor less than the diameter of such bar;

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than 15 mm nor less than the diameter of such bar; and

e) For any other reinforcement, not less than 15 mm nor less than the diameter of such bar.

4.6.8.2 Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals acid vapour, saline atmosphere sulphurous smoke, etc., and such increase of cover may be between 15 mm and 50 mm beyond that specified in 4.6.8.1, as indicated.

4.6.8.3 In all cases the cover shall not exceed 75 mm.

4.6.9 Transporting:

Concrete shall be transported from the mixer to the formwork as rapidly as possible by methods, which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. During hot or cold weather, concrete shall be transported in deep containers.

Other suitable methods like transporting by transit mixers may be adopted. Special care should be taken to reduce loss of water by evaporation in hot weather and heat loss in cold weather during transportation. Sufficient numbers of transit mixtures shall be employed for maintaining continuity of concreting process.

Concrete line-pumps of suitable capacity and sufficient numbers shall be engaged for pouring concrete in pavements.

4.6.10 Placing:

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of placing should be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of formwork. The concrete, which is deposited or otherwise disturbed after initial setting commences shall be immediately removed from the site.

4.6.10.1 Before placing the concrete in trenches or on sub-grade or sub-base, the sub-grade / sub-base shall be cleaned of all injurious or foreign matter, watered and well consolidated, if necessary.

4.6.10.2 The final layer of concrete shall be laid to such levels and falls as may be directed.

4.6.10.3 When concrete has to be lowered to any depth below 15 m, it shall be conveyed in suitable receptacles or by chute. The delivery end of the chute shall be as close as possible to the point of deposit. The chutes shall be thoroughly flushed with water before and after each working period, the water for this purpose shall be discharged outside the formwork.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
4.6.11 Compaction:

Concrete shall be thoroughly compacted and, fully worked around the reinforcement, around embedded fixtures and into the corners of the formwork. Mechanical vibrators shall be employed for compacting concrete. Over vibration or vibration of very wet mixes is harmful and shall be avoided; under vibration is also to be avoided. Sufficient numbers of reserve / vibrators in good working condition shall be kept at all times so as to ensure that there is no slacking / interruption in compacting. Vibrators of specified sizes shall be used depending upon the quantum of concreting.

4.6.11.1 Where vibration is to be applied externally, the design of formwork and the disposition of vibrators shall be such as to ensure efficient compaction and to avoid surface blemished.

4.6.12 Construction Joints:

Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be as indicated or directed by the consultant and Engineer – in – charge.

4.6.12.1 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints neat cement slurry at the rate of 2.50 kg of cement per sqm shall be applied on the surface before it is dry. For horizontal joints surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand ratio as the cement and sand in the concrete mix. The layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of concrete.

4.6.12.2 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes. Care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surfaces shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150mm in thickness shall first be placed and shall be well rammed against old work; particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way.

4.6.12 Curing:

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by covering with a layer of sacking, canvas, Hessian or similar materials or a layer of sand or by ponding for at least seven days from the date of placing of concrete. Approved curing compounds may be used in lieu of moist curing with the permission of EIC. Such compounds shall be applied to all exposed surface of the concrete as soon as possible after the concrete has set.

4.6.13 Protection:

The concrete shall be carefully protected after it is laid against the action of frost and shielded from exposure to sun to avoid rapid drying. Care shall be taken to protect the concrete from all shaking and other disturbances during construction. No traffic shall be allowed on the finished concrete surface for at least 7 days. This period may be increased or decreased at the discretion of EIC.

4.6.14 Inspection:

Immediately after stripping the formwork, all concrete shall be carefully inspected for any defective work and defects either removed or made good before the concrete has thoroughly hardened.

4.6.15 Exposed Surfaces:

4.6.15.1 The contractor shall use proper formwork so that the concrete in contact with removal of formwork present an even surface. Concrete while being poured against formwork shall be adequately tampered, or vibrated where directed, so that fines are drawn towards the surface and honey combing is avoided.

4.6.15.2 Exposed surfaces of concrete shall be "Finished fair and Even in Forms".

Exposed surfaces after striking off formwork shall be such as to present a fair and even surface and shall not be plastered unless otherwise specified. The surface shall be presentable without any further treatment.
Any irregularities and protruding formwork marks shall be removed and minor honeycombing made good with cement and sand mortar 1:3. Lines along the formwork joints may however show.

4.6.15.3 Exposed surfaces of concrete which are indicated/required to be plastered shall be roughened with wire brushes and hacked out closely immediately after removal of formwork.

4.6.15.4 Openings and Inserts:

Openings and Positions of Inserts shall be made as per the drawing or as directed by the Consultant and EIC. This shall be done with utmost accuracy/precision and any deviation from the Drawing or instruction by the Consultant or EIC, the same shall be rectified by the Contractor at his own cost. No Extra payment shall be admissible for making openings/inserts etc.

4.6.16 Sampling and testing of concrete:

Samples from fresh concrete shall be taken as per IS 1199-1959. Method of sampling of concrete and cubes shall be made, cured and tested at 28 days in accordance with IS 516-1959, Method of test for strength of concrete.

4.6.16.2.1 Where indicated, tests on beams for modulus of rupture at 72 ± 2hrs or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength alone shall be the criterion for acceptance or rejection of the concrete.

4.6.16.3 Test Specimen:

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for such purpose as to determine the strength of concrete at 7 days or to check the testing errors.

4.6.16.4 Test Strength of samples:

The test strength of the sample shall be the average of the strength of three specimen. The individual variation shall not be more than +/− 15 percent of the average.

4.6.16.5 Acceptance Criteria:

The concrete shall be deemed to comply with the strength requirement when both the following conditions are met:

a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in Column No. 2 Table –11 of IS 456 -2000

b) Any individual test results complies with the appropriate limits in column No.3 of Table -11 of IS 456-2000.

If the concrete is deemed not to comply pursuant to acceptance criteria, it shall be dismantled and redone at the contractor’s expenses.

Concrete of each grade shall be rejected if it is porous or honey-combed; its lacing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-charge.

4.6.16.5 Standard Deviation:

Standard deviation of concrete of each grade shall be determined separately as stated below. When result of sufficient number of tests (at least 30) are not available, than depending on the degree of quality control expected to be exercised at the site, the value of standard deviation given in the following table may be adopted for guidance. Grade of Concrete Suggested Values of S.D

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>S.D. for different degree of control in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Good</td>
</tr>
<tr>
<td>M 10</td>
<td>2</td>
</tr>
<tr>
<td>M 15</td>
<td>2.5</td>
</tr>
<tr>
<td>M 20</td>
<td>3.6</td>
</tr>
<tr>
<td>M 25</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Control expected for this work is “Very Good” and the contractor shall deploy weigh batcher as required to attain the required control.

### 47 Waterproof Concrete:-

Where indicated, cement concrete shall be waterproofed by adding integral waterproofing compound conforming to IS 2645-1975, Specification for integral cement waterproofing compounds at the time of making concrete as per the manufacturer's instructions. The quality of waterproofing compound shall be as indicated but in no case shall be less than the quality recommended by the manufacturers and not exceeding 3 percent by weight of cement.

### 48 Work in Extreme Weather Concreting:

Concreting during hot and cold weather shall be done as per the procedures set out-in IS: 7861 (part-I) Code of practice for extreme weather concreting; part I Recommended practice for hot weather concreting, or IS7861 (part-II)-1981 Code of practice for extreme weather concreting; Part II Recommended practice for cold weather concreting.

### 49 Reinforced Concrete Work in water Retaining Structure:

#### 4.9.1 Special care shall be taken to get the most suitable grading of aggregate so as to produce the densest possible concrete. Mix proportion shall be indicated. Water cement ratio shall be controlled consistent with the requirements of workability to produce impervious concrete.

#### 4.9.2 The concrete between the reinforcement and the formwork on the water face shall be well compacted and the board joints tight, so as to produce a face free from honey-combing or pores. External vibrators viz. shutter vibrators at the rate of one vibrator per 2.5 m² of shutter area shall be used to produce a compact concrete with a dense skin which shall not, however, contain an excess of cement, wherever it is not possible to use shutter vibrator, pin vibrator shall be used after the approval of EIC.

#### 4.9.3 Construction, Contraction & Expansion Joints.

All vertical, horizontal construction and expansion joints in water retaining structures shall be located and executed as shown in the drawings and no deviation shall be permitted without the specific permission of EIC. Where days' work joints are formed whether horizontally or vertically, they shall be rebated as called out on drawings. Care shall be taken to remove from the earlier lift over all loose pieces of gravel, stone chips, wooden chips, country nails or any other foreign materials. All laitance shall also be thoroughly removed. If necessary, the face of the old concrete shall be well hacked to expose the aggregate and after washing the surface, a thin coat of mortar or grout (1 cement: 1 sand) shall be applied immediately before resuming concreting.

Water bar installation along the joints shall be done by embedding one half of the water bar in each side of the joint by suitable jigs / supporting arrangements between the adjacent sections of the concrete as per the manufacturer's specifications and directions of the EIC. Water bars shall be properly aligned and placed in position during embedding. To achieve the continuity of the water bar all along the joint at crossing and at change of alignment, the water stops shall be welded (in T,X or L shapes as the case may be) as per manufacturer's specifications and directions of EIC. Suitable jigs manufactured out of reinforcing bars may be used for fixing the water bars.

#### 4.9.3.3 Fittings:

Pipes and outer fittings passing through the walls and bottom shall be well embedded in the concrete and shall be provided with normal puddle flanges. Opening in the walls, and floor slabs if any shall be provided as per the relevant drawings.

### 4.9.4 Curing:

Concrete in water retaining portion shall be cured minimum for 21 days.
4.9.5 Hydraulic Testing:

Structures shall be tested strictly in accordance with IS: 3370 (Part I) for water tightness. For underground tank, the total maximum drop in water surface level over seven days shall not exceed 40 mm.

4.10 Pre-cast Reinforced Concrete-Generally

4.10.1 Pre-cast reinforced concrete articles such as manhole cover and frame, columns, fencing posts, door and window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of the grade or mix as indicated and cast in forms or moulds. The forms shall be of timber or of steel for better finish. Provisions 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 that shall be adequately oiled provided the surface finish is of the same standard as obtained in the forms. Each unit shall be cast in one operation.

4.10.2 Concrete shall be proportioned, mixed, placed and thoroughly compacted by vibration or tamping to give a dense concrete free from voids and honeycombing.

4.10.3 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 or to impair the strength or the performance of construction. All angles of the precast units with the exception of the angles resulting from the splayed or the chamfered faces shall be true right angles. The rises shall be clean and sharp except those specified to be rounded. The wearing surface shall be true and out of winding. On being fractured, the interior of the units shall present a clean, homogeneous appearance.

4.10.4 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.

4.10.5 Curing:

After placing, the concrete shall be adequately protected during setting and in first stages of hardening from shocks and from the harmful effects of sunshine, drying winds and cold. The concrete shall be cured for at least 7 days.

4.10.6 Maturing:

From the date of casting, the precast articles shall be matured for 28 days before erection or being built up.

4.10.7 Concrete shall have sufficient strength to prevent damage to units when first handled.

Flyash:

Addition of flyash may be considered to the extent of 10% only and not more for footings, pedestals, columns, slabs and beams. Flyash shall not be used for Pavements and floors.

Nevertheless of what is specified herein above or not, IS – 456,516,10262 and 1199 shall be followed related to all the matters of concrete specified therein.

4.10.8 Marking:

Precast articles shall be clearly marked to indicate the top of member and its location and orientation in the structure. While the concrete is still green, each unit shall be marked with the date of casting. Precast units shall be stored, transported and placed in position in such a manner that they will not be over stressed or damaged.

4.11 Epoxy resin concrete bonding agent

Scope of work.

For bonding new cementitious materials to existing cementitious surfaces. For use on horizontal surfaces and on vertical surfaces where mortar or concrete can be supported by formwork. Where extension to existing structure or similar work is ordered. The following strengths should be achieved as per table.
Adhesive strength to concrete: In general the bond strength will always exceed the tensile strength of M30 concrete.

The Tests shall be carried out at manufacturers laboratory and results shall be submitted to the consultant / EIC for approval

**Specification clauses**

The bonding agent shall be an epoxy based two component resin system pre packed in distinct colours to give visual evidence for proper mixing. The bonding agent should remain in tacky state after application for a minimum period of 6 hours at 30°C. There shall not be bond failure of the specimen when tested by slant shear method according to BS 6319 pt 4.

**Application instructions**

**Preparation**

All surfaces to be treated must be firm, dust free and clean. All laintence should be removed by etching with Reebaklens and wire-brushing. Where ever necessary, the existing concrete must be chipped to a sound substrate. Where surfaces are contaminated with oil or grease, this should be removed by using a strong industrial detergent or organic degreaser. Surface should be washed thoroughly with water and dried before the application.

**Mixing**

The entire contents of the hardener shall be poured into the resin container and the two materials thoroughly mixed until a uniform colour is obtained. To facilitate application at temperatures below 10 °C the separate components should be warmed in hot water to a maximum of 25 °C before mixing.

**Coating**

Mixed Epoxy resin bonding agent should be brush applied to the prepared surface. The new concrete should be placed within 6 hours at 30°C to the coated substrate, when it is in a tacky state.

**Rate**

The rate shall include the cost of all labour and materials involved in all the above operations and testing (including surface preparation) described above. No Extra Payment shall be made for Testing.

4.12 High strength, non-shrink, cementitious grout

**Description of work:** It is used for grouting of base plates of Columns, stanchions, and similar applications etc.,

**Description of material:** This material is supplied as a ready to use dry powder. The addition of a controlled amount of clean water produces a free flowing, non-shrink grout for gap thicknesses up to 100mm.

This material is a blend of Portland cement, graded fillers and chemical additives which impart controlled expansion in the plastic state whilst minimizing water demand. The low water demand ensures high early strength. The graded fillers are designed to assist uniform mixing and produce a consistent grout.

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**Table of Mechanical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength BS 6319 Pt - 2</td>
<td>@ 7 days 50 N/mm²</td>
</tr>
<tr>
<td>Flexural strength BS 6319 Pt 3</td>
<td>@ 7 days 35 N/mm²</td>
</tr>
<tr>
<td>Tensile strength BS 6319 Pt 7</td>
<td>@ 7 days 20 N/mm²</td>
</tr>
<tr>
<td>Shear strength BS 6319 Pt 4</td>
<td>@ 7 days 10 N/mm²</td>
</tr>
</tbody>
</table>
The Tests shall be carried out at at approved Govt. laboratory and results shall be submitted to the consultant / EIC for approval

Specification Clauses

Performance specification

All grouting shown on the drawing must be carried out with a pre packed cement based product which is chloride free. It shall be mixed with clean water to the required consistency. The grout must not bleed or segregate. A positive volumetric expansion shall occur while the grout is plastic by means of gaseous system. The compressive strength of the grout must exceed 50 N/mm$^2$ at 7 days and 60 N/mm$^2$ at 28 days as per Code (BS 1881 - Part 116: 1983). The flexural strength of grout must exceed 9N/mm$^2$ @ 28 days as per Code (BS 4551, 1998). The fresh wet density of the mixed grout must exceed 2150 kg/ m$^3$.

The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

Application instructions

Preparation Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. If the concrete surface is defective or has laitence, it must be cut back to a sound base. Bolt holes and fixing pockets must be blown clean of any dirt or debris.

Pre-soaking

Several hours prior to placing, the concrete substrates should be saturated with fresh water. Immediately before grouting takes place any free water should be removed with particular care being taken to blow out all bolt holes and pockets.

Base plate

It is essential that this is clean and free from oil, grease or scale. Air pressure relief holes should be provided to allow venting of any isolated high spots. Leveling shims If these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leak proof. This can be achieved by using foam rubber strip or mastic sealant beneath the constructed formwork and between joints. In some cases it is practical to use sacrificial semi-dry sand and cement formwork. The formwork should include outlets for pre-soaking.

Unrestrained surface area.

This must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. It is advisable, where practical, to have no gap at the flank sides.

Mixing and placing

Mixing

For best results a mechanically powered grout mixer should be used. When quantities up to 50kg are used, a heavy duty slow speed drill (400-500 rpm) fitted with a paddle is suitable larger quantities will require a heavy duty mixer.

To enable the grouting operation to be carried out continuously, it is essential that sufficient mixing capacity and labour are available. The use of a grout holding tank with provision to gently agitate the grout may be required.
Consistency of grout mix

The quantity of clean water required to be added to a 25kg bag to achieve the desired consistency as given in table below:

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pourable</td>
<td>4.125 litres</td>
</tr>
<tr>
<td>Flowable</td>
<td>4.500 litres</td>
</tr>
</tbody>
</table>

Placing

At 30°C place the grout within 20 minutes of mixing to gain full benefit of the expansion process. Grouting material can be placed in thicknesses up to 100mm in a single pour when used as an under plate grout.

For thicker sections it is necessary to fill out grouting material with well graded silt free aggregate to minimize heat buildup. Typically a 10mm aggregate is suitable. 50 - 100% aggregate weight of grouting material can be added.

Rate

The rate shall include the cost of all labour and materials involved in all the above operations and testing as described above. No Extra Payment shall be made for Testing.

BATCH MIXING PLANT

Central Mixed Concrete Batching Plant specified capacity in General Conditions of Contract (Volume I) shall be set up by the contractor

4.13 READY MIX CONCRETE

(IF SPECIFICALLY PERMITTED BY ENGINEER IN CHARGE ON EMERGENCY)

SPECIFICATIONS for RMC:

Contractor shall make ready mixed concrete with who is expert in the field, would supply designed mix. The RMC producer accepts the responsibility for the design of the mixture for the desired performance. The contractor shall specifies aggregate size, slump, air content, cement content, or weight of cement per cubic meter of concrete, maximum water content and admixtures required. The contractor shall accept the responsibility for concrete strength and its performance.

PROPORTIONING OF RMC:

The proportioning of an RMC aims at obtaining the properties, such as workability, strength, durability and appearance. The following basics of a good concrete mix should be considered while proportioning RMC. Concrete aggregates should be clean, strong and durable. Fly ash or other supplementary cementitious materials added as directed if necessary by EIC to RMC to enhance concrete properties. Admixtures are commonly used to improve the rate of setting and strength of development of concrete as directed by EIC.

CENTRAL- MIXED CONCRETE:

Concrete batch plants include a stationary, plant mounted mixer that mixes the concrete before it is discharged into a truck mixer. While traveling to the job site the drum is turned at agitating speed (slow speed). After arriving at the job site, the concrete is completely mixed. The drum is then turned for 70 to 100 revolutions, or about 5 minutes, at mixing speed. Concrete mixed in the yard or central batching plant: The drum is turned at high speed or 12-15 rpm for 50 revolutions. This allows quick check of batch. The concrete is then agitated slowly while driving to the job site. Concrete mixed in transit: The drum is turned at medium speed or about 8 rpm for 70 revolutions while driving to the job site.

DELIVERY OF RMC:

Ready mix concrete can be delivered to the construction site in truck-mounted, rotating drum mixers. Truck mixers have a revolving drum with the axis inclined to horizontal. To load or charge the raw materials from
a transit mixed plant or central mixed plant into the truck, the drum must be turned very fast in the changing
direction. After the concrete is loaded and mixed, it is normally hauled to the job site with the drum turning
at the speed of less than 2 rpm. The truck mixer shall have discharge units to convey through the pump to
desired location in the site.

INSPECTION AND TESTING:

Specific control tests and evaluations are required during the manufacturing process to produce
predictable high quality concrete. The concrete shall undergo all the specified test for concrete as per IS
codes.

4.14 Plasticizer

Scope of work
To produce high workability concrete without loss of strength and to promote high early and ultimate
strengths by taking advantage of water reduction whilst maintaining workability. To produce high quality
concrete of improved durability and impermeability. At higher dosages, advantages can be taken of the
retardation of initial setting time of concrete especially in large pours.

Standards compliance
Plasticizer should conform to IS: 9103-1999 and carries license from Bureau of Indian Standards. It should
complies with IS 2645: 1975 and BS 5075 Part 3 and ASTM C494 Type F and chloride content should
be nil as per IS 456

Description of material
Plasticizer is based on a blend of specially selected organic polymers and disperses the cement particles
effectively in the concrete mix and hence exposes a larger surface area to the hydration process. This
effect is used either to increase the strength or to produce high workability concrete or reduce cement
content of concrete or to retard the setting time of concrete

Application instructions
Application process as per manufacturer’s specifications and contractor should submit the technical
literature & get approval from the EIC and the material should be used within the shelf time.

SECTION-5

BRICK WORK

5.1 Indian standards

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>LS. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>195-1963</td>
<td>Specification for fire clay mortar for laying fire clay refractory bricks (second revision)</td>
</tr>
<tr>
<td>702-1988</td>
<td>Specification for industrial bitumen (second revision)</td>
</tr>
<tr>
<td>1077-1986</td>
<td>Specification for common burnt clay building bricks (fourth reversion)</td>
</tr>
<tr>
<td>1526-1960</td>
<td>Sizes and shapes for fire bricks (230mm. series)</td>
</tr>
<tr>
<td>1580-1969</td>
<td>Specification for bituminous compounds for water proofing and caulking purposes (first reversion)</td>
</tr>
<tr>
<td>1905-1980</td>
<td>Code for practice for structural safety of building masonry wall (second revision)</td>
</tr>
<tr>
<td>2116-1980</td>
<td>Specification for sand for masonry mortars (first revision)</td>
</tr>
<tr>
<td>2386 (Part II) 1963</td>
<td>Methods of test for aggregates for concrete. Part II -Estimation of deleterious materials and organic impurities.</td>
</tr>
<tr>
<td>2691-1988</td>
<td>Specification for burnt clay facing bricks (second revision)</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>4832 (Part II) 1969</td>
<td>Specification for chemical resistance mortars, Part II, Resin type.</td>
</tr>
<tr>
<td>5454-1978</td>
<td>Methods for sampling of clay building brick (first revision)</td>
</tr>
<tr>
<td>6165-1971</td>
<td>Dimension for special shapes of clays bricks.</td>
</tr>
</tbody>
</table>