

SECTION - 3

ENCLOSURES TO THE SPECIFICATION

Customer's Specification

General Requirements of Civil Works (1 page)

General Specification for General Items - P20 to 23 & P28 to 38 (Total 15 pages)

GENERAL REQUIREMENTS OF CIVIL WORKS

- 1.1) Minimum grade of concrete mix shall not be less than M 25 for major structures and for PCC
1:4:8 or M 7.5
- 1.2) High yield steel deformed bars (HYSD) steel reinforcement confirming to IS 1786 shall be used.
- 1.3) The successful bidders shall submit detailed design calculation along with construction drawings and shall be got approved from C E (Tr. Proj), Mumbai.
- 1.4) 100 mm thick bed concrete shall be provided in P C C 1:4:8 for foundation
- 1.5) Gravel /metal spreading shall be of 150mm thickness which shall consist of layers of stone dust and 40 mm & 20 mm size machine crushed stone as per normal switchyards practice.
- 1.6) Excavation of earth for civil works shall be done only manually, blasting is not allowed.
Please find enclosed herewith the general specification of excavation & cement concrete.,
- 1.7) Proper cleaning shall be done by the contractor after completion of the work.

GENERAL SPECIFICATIONS FOR GENERAL ITEMS

B.1. EXCAVATION

Excavation for foundation including shoring and strutting as necessary and disposing of excavated stuff as directed

General :- The excavation will generally refer to open excavation of foundation wet or dry.

- B.1.1. Clearing Site** : The site on which the structure is to be built shown on the plan and the area required for setting out and other operations should be cleared and all obstructions, loose stones, materials and rubbish of all kinds, stumps, brush wood and trees obtained will be the property of Government and materials pronounced useful by the Engineer will be conveyed and properly stacked as directed within the specified lead. Useless materials will be burnt or otherwise disposed of as directed by the Engineer.
- B.1.2 Setting Out** : After clearing the site, the centre, the centre lines will be given by the Engineer and it will be the responsibility of the contractor to install substantial reference marks, bench marks, etc., and maintain them as long as required true to line, curve, level and slopes. The contractor will assume full responsibility for alignment, elevation, and dimension of each and all parts of the work. Labour, materials, etc. required for setting out and establishing Bench Marks and other reference marks shall be arranged by the contractor at his own cost.
- B.1.3 Excavation** : Foundation excavation shall include removal of all materials of whatever nature and whether wet or dry, necessary for the construction of foundation and substructure exactly in accordance with the lines, levels, grades and curves shown on the plans or as directed by the Engineer. It shall be taken to the exact width of the lowest step of the footing and the sides shall be left plumb where the nature of soil admits it. Unless there is a specific extra provision in the contract for shoring or for cutting of slopes to a safe angle or both as approved by the Engineer when the strata need such treatment. The contractor shall notify the Engineer before starting excavation to enable him to take cross sectional levels for purposes of measurements before the ground is disturbed.
- B.1.4 Preparation of Foundation for Footing** : The bottom of foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, final surface should be slightly watered and rammed. If any soft patches come to light in inspection or ramming, these shall be dug out and dealt with as ordered by the Engineer. No footing will be allowed to bring the foundation to level. If by contractor's mistake, excavation is made deeper than shown on the plans or ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation grade as directed by the Engineer and at the cost of the contractor. All rock or other hard foundation shall be cleaned of all soft and loose material and cut to a firm surface, either levelled, stepped, or serrated as on the plan will be considered as approximate only and the

Engineer may order such changes in the dimensions and elevation of the foundation as may be deemed necessary to secure satisfactory foundation.

After each excavation is completed the contractor shall notify the Engineer to that effect and no footing will be allowed to be laid until the Engineer has approved the depth and dimensions of excavation and the nature of the foundation material and the levels and/or measurements are recorded.

- B.1.5 Shoring** : Unless separately provided for in the contract, excavation of slopes to prevent falling in of sides or providing, fixing, maintaining and removing shoring, bracing, etc., shall not be paid for. The contractor would be responsible for the design of shoring for the excavation to be properly upheld. Shoring shall be of sufficient strength to resist side pressure and ensure safety from slips and blows and to prevent damage to work and property and injury to persons. It shall be removed as directed after all the items for which it is required are completed.
- B.1.6. Protection** : Near towns and all frequented places foundation pits, well pits and similar excavation shall be strongly fenced and marked with red lights at night in charge of watchman to avoid accidents. Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures. All measures required for the safety of the excavation, the people working in and near the foundation trenches, properly and the people in the vicinity shall be taken by the contractor at his own cost, he being entirely responsible for any injury to life and damage to property caused by his negligence or accident due to his constructional operations.
- B.1.7 Disposal of Excavated Materials** : No materials excavated from foundation trenches of whatever kind may be are to be placed even temporarily nearer than 1.5 m or greater distance prescribed by the Engineer from the outer edge of excavation. All materials excavated will remain the property of Government. Rate for excavation, includes sorting out of useful materials and sacking them separately as directed within the specified lead. Materials suitable and useful for backfilling or other use shall be stacked in convenient places but not in such a way as to obstruct free movement of men, animals and vehicles or encroach on the area required or constructional purposes. It shall be used to the extent required to completely backfill the structure to original ground level or the elevation shown on the plans or as directed by the Engineer. For backfilling, the materials shall be placed in 15 to 20 cm. layers, moistened, and well compacted. Materials not useful in any way shall be wasted as directed by the Engineer. If useful excavated rubble is required by the contractor for use in other items, it shall be paid for at the rate fixed in the tender and if not so provided, at the rate in the divisional schedule current at the time of tendering or at mutually agreed rate if there is no rate in the divisional Schedule. The site shall be left clean of all debris on completion.
- B.1.8 Dewatering** : Unless specially provided for as a separate item in the contract, the excavation rate would include bailing or pumping out all water which may accumulate in the excavation during the progress of the work either from seepage, springs, rain or any other cause and diverting surface flow if any, by bunds or other means. The bunds shall be removed after their purpose is served.

Pumping out water from any foundation enclosure or trenches shall be generally in such a manner to preclude the possibility of any damage to the foundation trenches, concrete or masonry to any adjacent structure. The excavation shall be kept free from water (1) during inspection and measurement, (2) when concrete and/or masonry are in progress and till they come above the natural water level, and (3) till the Engineer considers that the mortar is sufficiently set.

B.1.9 Slips and Blows : If there are any slips or blows in the excavation they shall be removed by the contractor without cost to the Department so as to provide the correct dimensions required from the foundation.

B.1.10 Backfilling : All timber shoring and form-work shall be removed after their necessity ceases and trash of any sort shall be cleaned out from the excavation. All space between foundation masonry or concrete and the sides of excavation must be refilled to the original surface with approved materials, in layers of 15 cm. to 20 cm. in thickness, watered and rammed.

B.1.11 Blasting : Blasting shall be carried out according to specification No. B.2

B.1.12 Classification : All the materials encountered in the excavation would be mainly classified in the following groups.

1. Soils of all sorts, gravel, murum and other similar soft or loose materials.
2. Hard murum.
3. Hard murum and boulders.
4. Soft Rock.
5. Hard Rock (blasted)
6. Hard Rock (chiselled, wedged or line drilled)
7. Laterite.

1. Soils of all Sorts, Sand, Gravel, Soft Murum and other similar soft or loose materials : Soils of all sorts, sand, gravel, soft murum, softman, chopan yellow soil etc. shall include all materials of earthy or sandy nature which can be easily ploughed or small shingle and gravel which can be easily removed. Removal of small boulders not exceeding 0.03 cu.m. or 30 liters occurring such strata will be included in the rate of this item.

2. Hard Murum : This shall include all kinds of disintegrated rock or shale or indurated clay free from boulders larger than 0.03 cu.m. or 30 liters and can be removed with pick and shovel though not without some difficulty.

3. Hard Murum and Boulders : This shall include all kinds of disintegrated rock or shale or indurated clay interspersed with boulders less than half a cubic meter and larger than 0.03 cu.m. or 30 liters which do not normally need blasting and can be removed with pick, bar, wedges, and hammer. Boulders bigger than 1/2 cu.m. will be paid for as soft or hard rock according as it is soft or hard rock.

4. **Soft Rock** : This shall include all material which is rock or hard conglomerate, all decomposed or weathered rock, highly fissured rock, old masonry and also soft rock, boulders bigger than 1/2 cubic meter and other varieties of rock which would normally be removed with pick, crow bars, wedges and hammer with some difficulty.
5. **Hard Rock (Blasted)** : This shall include all rock occurring in masses or boulders bigger than half cubic meter each, which can best be removed by blasting and where in the opinion of the Engineer, blasting is necessary Manjra rock shall be considered as hard rock.
6. **Hard Rock (Chiselled, Wedged or line Drilled)** : This shall include all rock occurring in masses which can best to be removed by blasting but which owing to the proximity of structures, possibility of shattering the rock below or for any other reason should be cut by means of cold chisels or wedges or line drilling.
7. **Laterite** : This shall include Laterite rock soft and hard which can be removed with Dhokans or blasting. Laterite murum which has not hardened into stone shall be classified as hard murum.

The classification of the excavation would be decided by the Engineer and his decision shall be final and binding on the contractor.

Rock referred to above would include trap, granite, quartzite, gneiss, laterite and other types.

B.1.13 If

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B.6. ORDINARY CEMENT CONCRETE FOR PLAIN AND REINFORCED WORK

B.6.1 General : This specification covers the requirements of ordinary cement concrete of the specified proportions for use in various concrete items. Special requirements for a particular item will be laid down in the specifications for that item I.S. 456-1964 shall apply except for deviations laid down in this specification.

B.6.2 Materials :

- 1) **Cement :** Cement shall conform to specification No.A.2 When type of cement is not specified, Ordinary Portland cement shall be used.
- 2) **Water :** Water shall conform to specification No. A.5.
- 3) **Fine Aggregate :** Fine aggregate 0.15mm. to 5mm. I.S. sieve Nos. 15 to 480 shall conform to specification No.A.6.
- 4) **Coarse Aggregate :** Coarse aggregate 5mm. to 80mm. shall conform to specification No.A.7 and shall conform to specification No. A.6.

Size : The maximum size of coarse aggregate shall be as large as possible but normally not greater than 1/4th of the minimum thickness of the concrete member provided that in the case of R.C.C. This size presents no difficulty to surround the reinforcement thoroughly and fill up the corners of the formwork fully and is less than the minimum cover by 6mm. For plain cement concrete, maximum size of the coarse aggregate may be upto 80mm. subject to the above limitation and provided no limiting size is specified in the special provisions.

For heavily reinforced concrete members such as ribs of beams, etc., the maximum size of aggregate shall be restricted to 6mm. less than the minimum clear lateral distance between the reinforcement bars or 6mm. less than the cover whichever is smaller.

Generally a maximum size of 20mm. should be found satisfactory for reinforced concrete work.

The grading between the maximum size and minimum size of 5mm. shall be such as to produce a dense concrete of the specified proportion and consistency that will work readily into position without segregation and without the use of excessive water content and shall be within limits given in A.7.3.

B.6.3. Proportioning Mix : In ordinary concrete, although proportion of cement to fine and coarse aggregate is specified by volume, the quantity of cement shall be determined by weight assuming one bag of cement weighing 50 kg. net to be equivalent to 35 liter. Fine and coarse aggregate shall be measured by dry volumes in suitable wooden boxes. Due allowance shall be made for bulking in the fine aggregate due to moisture if any, at the time of mixing.

Ingredients required for concrete containing one 50 kg. bag of cement for different proportions of mix be as under :

Mix	Cement	Fine Agregate	Coarse Agregate	Water
1:1 :	250 Kg. bag)	35 liters	70 liters	23 to 27 liters
1:1 1/2 :	do.	53.5 liters	105 liters	23 to 30 liters
1:2:4 ..	do..	70 liters	140 liters	27 to 32 liters
1:3:6 ..	do..	105 liters	210 liters	37.5 to 45 liters
1:4:8 ..	do..	140 liters	280 liters	47.5 to 57 liters
1:5:10 ..	do..	175 liters	350 liters	56 to 68 liters

The ratio of the volume of the fine and coarse aggregates may be varied within limits of 1:2 1/2 to 1:2 1/2 as directed by the Engineer to suit the maximum size of coarse aggregate, the grading, density, workability and strength without extra cost. But the sum of the volumes of fine and coarse aggregates so adjusted shall however be equal to the sum of the volumes of fine and coarse aggregates given above for the particulars mix.

The quantity of water shall be just sufficient, but not more than sufficient, to produce a dense concrete of required workability for its purpose. An accurate control shall be kept on the quantity of mixing water.

An allowance shall be made for surface moisture present in the aggregate when computing water content as indicated in I.S. 456-1964.

In the case of reinforced concrete work, the workability shall be such that the concrete will surround and properly grip all the reinforcement. Water cement ratio will be such as will give concrete just sufficiently wet to be placed and compacted without difficulty.

For vibrated concrete water content may be reduced by 15 percent to 20 percent to give the required reduced slump.

B.6.4 Mixing : For all important works concrete shall be mixed in a mechanical mixer at the site of work. Care shall be taken to see that the mixer and other accessories are in first class working condition and maintained so throughout the construction. Mixing shall be continued till there is a uniform colour is obtained and each individual particle of the coarse aggregate shall show a complete coating of mortar containing its proportionate amount of cement. In no case mixing shall be done for less than 1 1/2 minutes. The water cement ratio shall range between 0.55 to 0.64 for 1.2.4. mix.

When hand mixing is permitted by the Engineer it shall be done on a smooth water tight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor the mixing water shall flow out.

The cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine aggregate required, also spread in a layer of uniform depth in the making platform. Dry sand and cement shall then be mixed thoroughly

by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose and the mass turned over till a mortar of required consistency is obtained. The measured quantity of coarse aggregate shall then be placed on the mixing platform and wetted and the mortar added and the entire mass turned and returned until all the particles of the coarse aggregate are fully covered with mortar and the mixture is of a uniform colour and required consistency. In hand mixing, quantity of cement shall be increased by 5 per cent. above that specified in para B.6.3 without any extra cost.

Concrete shall have a consistency such that it will be workable in the required position and in the case of R.C.C. flow around reinforcing steel also.

For vibrated concrete, slump shall range between 2.5 c, to 5 cm. For hand tamped concrete, slump shall range between 8 cm. to 13 cm. according to the type and nature of concrete item. The slump shall be the least permitted by workability. The slump shall be determined as detailed in appendix G of I.S. 456-1964 and maintained throughout the concreting operation of a member.

The concrete shall be placed in its final position and rammed, vibrated and finished with 30 minutes of adding water to cement retempering or remixing of partially hardened concrete shall not be permitted.

- B.6.5a. Scaffolding :** All scaffolding, hoisting arrangements and ladders etc. required for the facility of concreting shall be provided by the contractor at his own expenses and removed on the completion of work. The scaffolding, hoisting arrangements and ladders, etc. shall be strong enough to withstand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer. However the contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangements, ladders, work and workman. The contractor shall pay all the necessary compensations arising out of the use of the scaffolding hoisting arrangements and ladders and for damages to work, property and injuries to persons.

The scaffolding, hoisting arrangements and ladders shall allow easy approach to the work spot and afford easy inspection.

- B.6.5b. Forms :** Forms shall generally comply with I.S. 456- 1964.

- B.6.5b.1 Design :** The detailed designs of the form work shall be prepared by the contractor and got approved by the Engineer well in time. Such an approval, however, will not relieve the contractor of his responsibility for the adequacy and strength of the formwork and falsework.

- B.6.5b.2 Materials :** The forms and false work shall be made of wood or metal.

The timber from which the forms are prepared should preferably be partially seasoned as too dry a timber will swell from absorption of moisture while green timber will dry and shrink. It shall be free from sap, shakes, loose knots, wormholes or other defects. The planks and scantlings shall be sawn straight and all edges and planes shall be straight and free from warps. Partially seasoned soft wood is generally preferable for formwork as it is difficult to drive nails in hard wood. The dimensions of

scantlings should confirm to the design. The strength of the wood shall not be less than that assumed in the design.

In metal forms, steel sheets of the designed gauge strengthened with framing of angle or other sections shall be used.

Wooden forms may also be lined with thin steel sheets or plywood to give the required surface or finish.

B.6.5b.3 Fabrication: The timber planks and scantlings of the designed dimensions shall be used in the formwork with appropriate spacing of studs, yokes, joists, girders, etc. as provided in the design. All timber in contact with concrete shall be wrought on one face and two edges, the unwrought face being on the outside. The joints should be made mortat tight. This may be done either by providing tongued and proved or rebated joints or by caulking or nailing metal strips or applying adhesive tape on the joints. The forms shall be built with sufficient strength and rigidity and held in shape by bolts, clamps, ties, nails, wales or other contrivances to prevent distortion or collapse due to pressure of concrete and other loads incidental to the construction operations. The nuts and bolt heads inside the formwork adjoining the concrete should be countersunk. The form work should allow finished concrete to have a smooth surface and conform to the shapes, lines and dimensions shown on the plans and true to line and grade. The effect of vibration shall be taken into account in the design and fabrication of forms and false work.

Form shall be so designed and constructed as to be removable in sections without damaging the surface of the concrete and with facilities of removal in the ascending order of removal time, without disturbing the remaining forms required to be removed later.

B.6.5b.4 Treatment of the Inside of Forms : Before placing concrete, the inside of the forms which comes in contact with the concrete shall be coated with mineral oil or any other suitable material approved by the Engineer which will prevent adhesion of concrete to the forms but will not discolor the concrete. When oil is used, it shall be applied before reinforcement is placed. Care shall be taken to see that reinforcement does not come in contact with the coating. All chippings, saw dust and other rubbish shall be removed from the interior of the forms before concreting.

B.6.5b.5 Formwork: Formwork shall be built on foundation or base of sufficient strength to carry the loads without settlement. Formwork which cannot be founded on solid footing must be supported by piles or other similar devices. formwork shall be designed to carry the full loads including that due to construction operations coming upon it.

B.6.5b.6 Erection : The falsework and formwork shall be erected with an eye for absolute safety of the formwork and concrete work before, during and after pouring concrete. Watch should be kept to see that the behaviour of centering and formwork is satisfactory during concreting. Erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed later.

If there is failure of false work and/or formwork the contractor shall be responsible for the consequent damages to work, injury to life and damage to property.

B.6.5b.7 Inspection: The forms and false work will be inspected, checked and approved by the Engineer before concreting is commenced. But this will not relive the contractor of his responsibility for strength, adequacy and safety of the formwork and falsework.

B.6.5b.8 Removal of Forms : Formwork shall be removed carefully without damaging the concrete or giving sudden shocks. It should be ascertained from the exposed sides of concrete that it has gained adequate strength before the bottoms and supports of the formwork are removed.

Unless otherwise specified in the special provisions, forms of concrete work using ordinary portland cement may be struck after expiry of the following periods in normal circumstances :

- | | |
|--|-----------|
| i) Vertical sides of slabs, beams, columns | 48 hours. |
| ii) Bottoms of slabs upto 4.5 m span | 7 days |
| iii) Bottoms of slabs of more than 4.5 m span,
bottoms of beams and archribs upto 6 m span. | 14 days |
| iv) Bottoms of beams and archribs of more than 6 m span | 21 days |

In important structures, the sequences of striking formwork shall be approved by the Engineer.

B.6.5b.9 Reuse : Before reuse, all forms shall be thoroughly scraped and cleaned, joints gone over and repaired and insides retreated to prevent adhesion, all to the entire satisfaction of the Engineer. The shape, strength, rigidity, mortar tightness and surface smoothness of reused forms shall be maintained at all times.

B.6.6. Transporting : The concrete shall be handled from the place of mixing to the final position as quickly as practicable by methods which will prevent segregation and loss of ingredients. In no case shall the operation take more than 15 minutes.

B.6.7. Placing : The concrete shall be placed into its final position, compacted and finished within 30 minutes of mixing the water and before setting commences. The method of placing shall be such as to avoid segregation. Placing shall be done in a balanced manner to avoid eccentric loads on formwork.

As far as practicable the concrete for a particular portion shall be done in one continuous operation. The construction joints when required shall be made only where located on the plans or shown in the pouring schedule unless otherwise approved by the Engineer. The joint shall be regular and vertical and shall be made by placing a bulk head at the joint. Before commencing subsequent concreting, all loose particles, laitance, etc. shall be removed and the surface shall then be covered by thick cement slurry as part of placement. Care shall be taken during the placing not to disturb the forms or the reinforcement. Concrete compacted manually, shall preferably be laid in layers of 15 cm. to 20 cm. the layers being decided by the time lapse between the successive layers. The time of layer shall not exceed 30 minutes. The successive layers shall commence within 30 minutes.

When work is to be resumed on a surface which has hardened, such a surface shall be roughened and scrubbed with brushes to remove laitance, care being taken to avoid dislodgment of coarse aggregate, swept clean, thoroughly wetted and covered with 6 mm thick mortar layer composed of cement and sand in the same proportion as the cement and sand in the concrete, immediately before the commencement of concrete, for securing good bond.

The concrete shall be normally laid in the dry. If the area is under water, it shall be pumped dry and kept so while placing concrete and till it sets. Where it is necessary to deposit concrete under water, it shall be done as per I.S. 456-1984 para 7.1.7. No extra payment will be made for the special arrangements, plant, etc. needed for the purpose or for the additional 10 per cent. cement required to be added.

- B.6.8. Compacting :** The concrete shall be thoroughly compacted during depositing to get a dense concrete and thoroughly worked into the edges and corners of the formwork as also along its faces and around reinforcement in the case of R.C.C. by means of suitable tools such as spades and rods to get a good cast finish without honey combing. Concrete shall not be disturbed once it is set.

For important or big works where stiffer mix with less slump is adopted, use of mechanical vibrators is essential. The vibrators shall have not less than 3,600 and preferably about 5,000 impulses per minutes and shall be worked at an interval of about 60 cm. It shall be worked in one place for only such time as will allow formation of dense concrete without sinking and segregation of the coarse aggregate. Over vibration shall be avoided. Vibration shall be aided by spading and rodding.

- B.6.9. Curing:** The concrete shall be initially protected from damage on of impact. undue pressure, excessive heat of sun, rain etc. and covered with wet sacking, hessian or similar absorbent material soon after the initial set. After the final set, the concrete shall be kept continuously wet preferably by ponding water for a period of not less than 14 days from the date of placement. On sundays, holidays and days of cessation of work, arrangement shall be made to keep it continuously watered.

Should the contractor fail to water the concrete continuously, the Engineer may provide Labour, materials and equipment required for watering and recover the cost from the contractor.

When atmospheric temperature exceeds 40°C (104°F) following precautions should be taken.

1. **Stacking aggregates under shade and keeping them moist.**
2. Using cold water.
3. Reduce the time between mixing and placing to the minimum.
4. Cooling formwork by sprinkling water.
5. Starting curing before concrete dries out.
6. Restricting concreting to mornings and evenings.

- B.6.10. Finishing :** Immediately after the removal of forms, any undulations, depressions,

cavities, honeycombing, broken edges or corners, high spots and other defects shall be made good and finished with cement mortar 1:2. But the necessity of such finishing must be exceptional and the total surface requiring finishing shall not exceed 1 percent on an average. If the initial experience shows that this percentage is exceeded the methods of working itself should be changed to get the required cast finish.

Where the concrete surface is to receive plaster, the surface shall be roughened immediately after removal of forms and within a day thereof to secure a hold for the plaster. The rate for concrete is inclusive of this roughening and finishing. Concrete after finishing shall be cured for the full period.

B.6.13.

B.6.11. Retempering : Concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial set shall not be used. Concrete which is partially hardened shall not be retempered or re-mixed but shall be destroyed or thrown away.

B.6.12. Sampling and Testing : Sampling of materials and concrete shall be done carefully by the contractor under the direct supervision of the Departmental staff as per I.S. 456-1964 at the cost of the contractor. All necessary labour, materials, equipment, etc. for sampling, preparing test cubes, curing, etc., shall be provided by the contractor. Testing of the materials and concrete will be arranged by the department in approved laboratory at the cost off the contractor. No plea will be entertained later on the ground that casting of the test specimen was faulty and that the result of the test specimen did not give a correct indication of the actual quality of concrete. ~~Compressive strength of ordinary concrete shall not be less than those specified below :~~

B.6.14.

No.	Mix	Work test on cubes	
		Kg./sq.cm at 7 days	Kg./sq.cm at 28 days
1.			
2.			
3.			
4.			
5.			

B.6.15.

One set of six 15 cm. cubes shall be prepared from the concrete to be used in the work of compression test on each of the first three days operation and thereafter for every 60 cu.m. of concrete or three day's work whichever is less, by the contractor in the presence of a responsible officer of the Department of a rank not less than that of an overseer. If the source of aggregate or grading is changed, one set of six test cubes shall be taken for each changed batch. Three cubes shall be used for test of 7 day's age and three at 28 days.

B.7.1.

After the relation between strengths at 7 days and 28 days is reliably established for the particular set of materials from the same sources, subsequent tests may be carried out only on three cubes at 7 days. If the average strength of the cubes show

B.7.2

ultimate compressive strength less than the above the Engineer shall have a right to order a change in the mix or water content for the remaining concrete without extra cost. Defective concrete having strength below 80 per cent of the required strength is liable to be rejected. Concrete of strength upto per cent of the required strength may be accepted as substandard work at a reduced rate provided such weak concrete is restricted to such members and in such quantities as will not endanger the safety of the structure.

B.6.13. Keeping record : A day-to-day record authenticated by a responsible officer of the department and the representative of the contractor, in the proforma approved by the Engineer shall be maintained by the contractor on the work site and kept open for inspection. This shall contain important information such as receipt of cement on the work site, daily use with details of use on various items, time of starting concreting and closure, number of batches through the mixer, sources of water, water cement ratio of concrete, slump, dates of erection of formwork, passing of formwork by the competent authority, dates of striking of forms, periods, and method of curing and other events worthy of notes. On completion of the work, the record shall be handed over to the Department.

B.6.14. Item to Include : 1. All labour, materials, use of equipment, tools and plant, installing and removal of scaffolding, false work and forms and bracing necessary for the satisfactory completion of the item except reinforcement steel.

2. Providing cement concrete of specified proportion including transporting, placing and compacting, curing, finishing to the dimensions and shapes shown on the plans or as ordered by the Engineer.

3. Necessary sampling and tests for materials of concrete.

4. Compensation for injury to persons and damages to work or property.

B.6.15. Mode of Measurement and Payment : The contract rate shall be for a unit of one cubic meter of concrete. The concrete shall be measured for its length, breadth and depth, limiting dimensions to those specified on the plan or as ordered by the Engineer. No deduction shall be made for reinforcement in concrete in R.C.C. work. Individual dimension shall be measured correct to one cu.m. and quantities shall be worked out correct upto three places of decimals of a cubic meter.

B.7. CONTROLLED CEMENT CONCRETE

Controlled concrete is that concrete in which proportions of aggregates, cement and water are determined by preliminary tests of the materials to be actually used to obtain the specified strength with the use of minimum quantity of cement. It shall generally comply with relevant provisions in I.S. 456- 1964.

B.7.1. Materials : Ordinary Portland cement, fine aggregates, coarse aggregate and water shall comply with specifications laid down for the respective items in specification No. 2.6 for ordinary concrete.

B.7.2. Proportioning Mix : The mix of the fine aggregates, coarse aggregate and water shall be designed by preliminary tests to give the densest concrete requiring the

minimum quantity of cement paste for binding the materials to give the required strength. Water content shall be such as to suit the required consistency. Water content and the water cement ratio shall be determined from the results of preliminary tests of concrete to give the specified strength with the materials proposed for actual use in the work, carried out before the work is started, adopting the consistency suitable for the work & method of compaction that will be actually used on site.

B.7.3 Tests : Tests shall conform to the specification laid down in I.S. 456-1964. These tests shall be got done in an approved laboratory at the cost of the contractor.

B.7.3.1 Preliminary Tests : In preliminary tests, three separate tests shall be carried out on samples collected from different stacks. Each test shall be carried out with six samples of 15 cm. cubes and 3 of these shall be tested at 7 days and 3 at 28 days. In preliminary tests the average crushing strength attained shall be 33 per cent. higher than that required on work tests.

B.7.3.2 Work Tests : For each of the works tests, 6 samples shall be prepared from the concrete being used on the work, 3 samples being tested at 7 days and the remaining 3 samples at 28 days. Works test shall be carried out on each of the first six days and subsequently once in three working days or for every 60 cu.m. of concrete whichever is less and also whenever the quality or grading of the materials is changed. When a relation between the strengths at 7 days and 28 days is established only 3 samples may be prepared and tested at 7 days only. This normal number of control specimen tests may be increased if the Engineer considers it necessary.

B.7.4. Field Mix : The actual proportions of the fine and coarse aggregates will be determined by preliminary tests. In the work tests, bulkage of sand due to moisture actually present at the time of mixing. This moisture will be taken into account in controlling the mixing water also. The proportions once fixed by preliminary tests shall not be changed so long as the materials are the same, subject only to the quantities of fine aggregate and water being adjusted to compensate for bulkage due to the moisture in sand and free water in fine aggregate at the time of use.

No change of materials shall be allowed unless fresh tests with new materials show satisfactory results.

Water and cement content per batch of concrete as determined by preliminary tests shall be maintained constant except for suitable allowances to be made for surface moisture of the aggregates at the time of actual use.

The minimum quantity of cement to be used in controlled concrete shall not be less than 305 kg per cu.m. of finished reinforced cement concrete of (M-150) grade and 395 kg. per cu.m. of finished reinforced cement concrete of (M-200) grade.

For any particular item, compressive strength required to be attained by the concrete at 28 days in the preliminary and works tests on 15 cm. cubes, minimum cement content required to be used and approximate proportions of approved fine and coarse aggregates shall be specified in the special provisions. These particulars will be only for the guidance of the contractor for quoting rates.

Immediately upon the receipt of the award of the contract, the contractor shall inform the Engineer the exact location of the sources of the acceptable materials which he proposes to use and get the materials approved. The mix with the actual approved materials to be used shall be got designed in an approved laboratory by the contractor with minimum quantity and cement to give the specified strength in the preliminary tests and the proportions got approved by the engineer in writing. These proportions shall be used so long as the materials continue to be of the same quality and from the same sources subject only to slight changes in the relative quantities of fine and coarse aggregates for the purpose of promoting workability provided the works tests also show the required strengths.

If during the progress of the work, the contractor wishes to change the materials, the proportions shall be fixed on the basis of fresh preliminary test to give the required strength after the Engineer is satisfied that the materials satisfy the specifications. No adjustment of cost shall be made for change of proportions of cement fixed in the original preliminary tests.

- B.7.5. **Mixing** : Mixing shall comply with specification No. B.6.4. Mixing shall be done only by Mechanical mixers.
- B.7.6. **Forms** : Forms shall comply with specification No.B.6.5(b).
- B.7.7. **Transporting** : Transport shall comply with specification No. B.6.6.
- B.7.8. **Placing** : Placing shall comply with specification No. B.6.7.
- B.7.9. **Compacting** : Compacting shall comply with specification No. B.6.8.
Compacting shall necessarily be done by mechanical vibrators. No hand compaction will be permitted except (i) to supplement vibration near the edges and faces of forms, to fill the corners completely and to prevent honey combing or (ii) in members where vibration is not possible nor desirable in the opinion of the Engineer.
- B.7.10. **Curing** : Curing shall comply with specification No.B.6.9.
- B.7.11. **Finishing** : Finishing shall comply with specification B.6.10.
- B.7.12. **Retempering** : Specification No. B.6.11. shall be followed.
- B.7.13. **Sampling and Testing** : Sampling and testing shall comply with B.7.3 above, special provision in the tender and relevant provision of B.6.12.
- B.7.14. **Keeping Records** : Records shall be maintained and dealt as per specification No.B.6.13.
- B.7.15. **Item to include** : All the provisions prescribed in specification No. B.6.14 and also the preliminary laboratory tests to determine the exact proportions of the concrete mix to give the specified strength and control tests during the concreting operations.
- B.7.16. **Measurement** : Measurement shall be as per specifications of B.6.15

The bidder shall ensure that the cement procured by him from open market shall be from fresh stock and of superior quality. It shall be his responsibility to get the mix design and use cement in quantities as obtained from the mix design tests for giving desired quality of controlled concrete as specified in the item.

The employer shall not accept any responsibility for any variation in the quantity of cement due to procurement of low grade or inferior grade cement by the bidder. Any extra liability on account of excess requirement of cement than the standards consumption factor as indicated under the respective items of Schedule 'B' shall be on the score of the bidder. No value adjustment charges shall be payable/recoverable for more/less use of cement than the standard consumption.

The contractor shall have to substantiate his claim about quantity of concrete by cube results. The minimum, requirement of cement consumption per Cu. M of concrete as mentioned in B.7.4 shall however be strictly adhered to.