

BNPM/TEN/CO/ 183 /Concrete road at ETP/2017-18, Dated: 10-10- 2017.	Bank Note Paper Mill India Private Limited (BNPM)	Volume 3
	Mysuru	
	Tender Document for concrete road work at ETP area.	

Concrete Road works at ETP area					
Schedule of quantities					
SL.NO.	DESCRIPTION	Unit	Qty.	Rate	Amount
1	Earth work in excavation for site grading by mechanical means at sit as per site grading in all classes of soil including slope cutting as per standard specification and carting selected excavated stuff for filling in low laying areas up to a lead of 1000m. as directed by engineer .(No manual excavation is permitted. Rate shall include cost of equipment involved)	cum	82.00		
2	sub grade preparation for road works by dressing excavated surface or making filled up surface to suit road camber and required level, assuring the formation level, slope etc by treading the surface and rolling with vibro rollers etc complete as directed by Engineer In Charge.	Sqm	600.00		
3	Providing and filling in Road or where directed including compaction, using 12 ton vibro-rollers, to achieve 95% standard proctor Density in layers not exceeding 200mm in depth complete as directed by Engineer In Charge.				
	A) With selected excavated earth owners premises	cum	250.00		
	B) With murum/ soil brought from outside the Owner's premises including it's supply and transport.	cum	200.00		
4	Laying dry stone Rubble soling with maximum 230mm size hard stone set in regular lines, hand packed and interstices thoroughly	cum	140.00		



BNPM/TEN/CO/ 183 /Concrete road at ETP/2017-18, Dated: 10-10- 2017.	Bank Note Paper Mill India Private Limited (BNPM)	Volume 3
	Mysuru	
	Tender Document for concrete road work at ETP area.	

	filled with small chips including filling in with good quality murum brought from outside and compacted with 8 to 10 ton rollers and spreading 12 mm layer of grit on top etc. complete as directed by Engineer In Charge				
5	KSRRB M400-Wet Mix Macadam KSRRB M400-17. Providing, laying, spreading and compacting crushed stone aggregates of granite/ trap/ basalt to wet mix macadam specifications including premixing the material with water at OMC in mechanical mix plant carriage of mixed method of tipper to site, laying in uniform layers with paver in sub-base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density complete as per specifications. MORTH Specification No.406	cum	100.00		
6	Providing and laying cement concrete using 20 mm and down size granite coarse aggregates and fine aggregates of ready mixed concrete (RMC) M20 for R.C.C. works laid in 15 cms thick layers and well compacted vibrating, curing, for raft foundation column footing, main and secondary beams with all lead and lifts etc., complete (exclusive of cost of steel and fabrication charges.) (VDF finish)	cum	120		
7	KSRB 4.9.2 : Providing mild steel reinforcement for R.C.C. work including straightening, cutting, bending, hooking, placing in position, lapping and / or welding wherever required, tying with	Tonne	4.50		

BNPM/TEN/CO/ 183 /Concrete road at ETP/2017-18, Dated: 10-10- 2017.	Bank Note Paper Mill India Private Limited (BNPM)	Volume 3
	Mysuru	
	Tender Document for concrete road work at ETP area.	

	binding wire and anchoring to the adjoining members wherever necessary complete as per design (laps, hooks and wastage shall not be measured and paid) cost of materials, labour, HOM of machinery complete as per specifications.				
8	KSRRB M2600.3 (ii) Providing & fixing 20 mm thick compressible fibre board in expansion joint complete as per drawing & Technical Specification complete as per specifications. MORTH Specification No.2605	R.mt	152.00		
9	KSRB 4-6.1: Providing and removing centering, shuttering, strutting, propping etc., and removal of form work for foundations, footings, bases of columns for mass concrete including cost of all materials, labour complete as per specifications. Specification No. KBS 4.6.2	Sqm	60.00		
10	Providing and fixing to correct line, level, 1:2:4 precast concrete Kerb stone (with two coat painting) of size 150mm thk & vertical of 450 mm height. The cost shall include the 75 mm thick X 20mm wide pcc (continuous) which is to be used as base for placing the kerbs as directed	R.mt	250		
(Inclusive of GST) Gross amount in Rs.					
In words:					



TECHNICAL SPECIFICATION

1. EXCAVATION IN ALL KINDS OF SOILS

- 1.1** All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.
- 1.1** During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.
- 1.2** In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal : 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in- Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.
- 1.3** The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.
- 1.4** In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for leveling/ bed concrete for foundations. Soft/defective spots at the bed of



the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

- 1.5** While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost 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. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.
- 1.6** In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.
- 1.7** In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on the account shall be done by the contractor at his own cost.
- 1.8** The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour /mechanical equipment and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

2. EXCAVATION IN ORDINARY ROCK

- 2.1** All excavation operations shall include excavation and 'getting out' the excavated matter. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead.



- 2.2** During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.
- 2.3** Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified in para 2.6 and chiseling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-in-Charge and nothing extra shall be payable for chiseling.
- 2.4** Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling.
- 2.5** In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting.
- 2.6** If the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge. The excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.
- 2.7** In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling with earth duly watered, consolidated and rammed.
- 2.8** In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost.
- 2.9** Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.



2.10 The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour /mechanical equipment's and other factors involved Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

3. EXCAVATION IN HARD ROCK

- 3.1** All excavation operations shall include excavation and 'getting out' the excavated matter. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead.
- 3.2** During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.
- 3.3** Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified in para 3.6 and chiseling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-in-Charge and nothing extra shall be payable for chiseling.
- 3.4** Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling.
- 3.5** In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting.
- 3.6** If the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge. The excess



depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

- 3.7 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling with earth duly watered, consolidated and rammed.
- 3.8 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost.
- 3.9 Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.
- 3.10 The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

4. SPECIFICATIONS FOR MOORUM AND SAND FILLING IN FOUNDATIONS, PLINTH AND IN FLOORS

- 4.1 **Moorum** - Moorum shall be obtained from approved pits and quarries of disintegrated rocks, which contain silicon material, and natural mixture of clay of calcareous origin. These shall not contain any admixture of ordinary earth. Size of moorum shall vary from dust to 40 mm gauge.
- 4.2 **Sand** - Sand shall be clean, free from dust, organic and other extraneous matter. It shall not contain more than 5 percent of clay/silt.
- 4.3 **Shingle** - Shingle shall be clean and free from foreign matter and obtained from river or canal 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.



4.4 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 binded with earth before ramming/consolidation. The surface of the compacted moorum, 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 then compacted and graded.

4.5 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.

4.6 Measurements

4.6.1 The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters.

4.6.2 In case of the ground is fairly uniform and where the site is not required to be leveled, the engineer may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead men, the position of which shall be fixed by the engineer, shall be left by the contractor to permit accurate measurements being taken with steel tape on the completion of the work. Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and earth so removed is utilized in the work. In the later case nothing extra will be paid for their removal as subsequent operation.

4.6.3 Where ordinary rock and hard rock is mixed, the measurement of the excavation shall be made. The two kinds of rock shall be stacked separately and measured in stacks. The net quantity of the two kinds of rocks shall be arrived at by applying deduction of 50% to allow for voids in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of the two types of rocks. If in the opinion of the engineer stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross-sectional measurements.



4.6.4 Where soil, ordinary rock and hard rock are mixed, the measurements for the entire excavation shall be made. Excavated materials comprising hard rock and ordinary rock shall be stacked separately, measured, and each reduced by 50% to allow for voids to arrive at the quantity payable under hard rock and ordinary rock. The difference between the entire excavation and the sum of the quantities payable under hard rock and ordinary rock shall be paid for as excavation in soil or hard soil as the case may be.

4.6.5 Where it is not possible or convenient to measure the depth of cutting by recording levels, quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earth work so computed shall be reduced by 10% in case of consolidation is done by heavy mechanical machinery to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of consolidation by heavy mechanical at optimum moisture.

4.7 .Rates - Rates for earthwork shall include the following;

- a) Excavation and depositing excavated material as specified.
- b) Handling of antiquities and useful material as specified.
- c) Protection as specified.
- d) Site clearance as specified.
- e) Setting out and making profiles as specified.
- f) Forming (or leaving) dead men or 'Tell Tales' in borrow pits and their removal after measurements.
- g) Bailing out or pumping over water from excavations.
- h) Initial lead of 50 m and lift 1.5 m.
- i) Blasting operations for having rock as specified.

4.8 RUBBLE STONE SOLING

4.8.1 The rubble stone shall be of best variety of black trap / granite / basalt or other approved variety of stone available locally. The stone shall be hard, durable, free from defects and of required size and shall be approved by the Engineer in-charge before incorporation in the work.

4.8.2 Preparation of Surface & laying:



- 4.8.3 The bed on which rubble soling is to be laid shall be cleared of all loose materials, levelled, watered and compacted and got approved by the Engineer In-charge before laying rubble soling. Cable or pipe trenches if shown in the drawing and as required by the Engineer in-charge shall be got done before the soling is started.
- 4.8.4 Over the prepared surface, the stone shall be set as closely as possible and well packed and firmly set. The stones shall be of full height and shall be laid so as to have their bases of the largest area resting on the sub-grade. Soling shall be laid in one layer of 230mm or 150mm or other specified thickness and no stones shall be less than 230mm or 150mm depth or specified thickness of soling with a tolerance of 25mm.
- 4.8.5 After packing the stones properly in position, the interstices between them shall be carefully filled with quarry spoils of stone chips of larger size possible to obtain a hard, compact surface. Spreading of loose spoils or stone chips is prohibited.
- 4.8.6 The entire surface shall be examined for any protrusions and the same shall be knocked off by a hammer and all interstices shall be filled with approved murrum. Excess murrum if any over the surfaces shall be removed. Unless otherwise specified, the murrum shall be supplied by the contractor at his own cost from the selected areas. The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers as approved by the Engineer in-charge to give the required slope or level and dense sub-base. After compaction, the surface shall present clean look. Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.

4.9 HARD CORE FOR FOUNDATIONS

4.9.1 PROCEDURE FOR PREPARATION OF "HARD CORE" LAYER

1. The "hard core" layer shall consist of well graded hard broken stone, 40 mm nominal size (as given in clause 3.02.00 below), with voids filled with clean river sand. This is to be done in the following sequence.
 - (i) The hard core layer shall be laid in layers of not more than 150 mm thickness each. For the first layer, place a thin layer of clean river sand, 50 mm thick, after compaction of the underlying soil layer.



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Then place not more than 150 mm thick well graded hard broken stone layer, over the thin sand layer. If the bottom of excavation is sand, there is no need for the thin layer of sand. In this case, the well graded hard broken stone layer can be 150mm thick.

- (ii) Place clean river sand, about 50 mm thickness on top of the broken stone layer, and it shall be copiously watered using a water jet in order to force the sand in to the void spaces of the broken stone. When most of the sand goes in to the voids of the broken stone, one more thin layer of clean river sand shall be placed again and using water jet, force it in to the voids of the broken stone. The process shall be repeated until no more sand and water get into the void spaces of the broken stone.
- (iii) Look for pockets or areas where water may flow in to the layer. This indicates that there are void spaces below such pockets. Identify such pockets, place more sand over the pockets and force the sand into the void space below, using water jet.
- (iv) Forcing sand into the void spaces of the broken stone using water jetting shall be done right up to the edges of the layer.
- (v) Then place the second layer of hard core of thickness not more than 150mm by placing 40 mm nominal size metal, over the first layer of hard core. Repeat steps given in (ii) to (iv).

4.9.2 The broken stone used in the hard core layer mentioned above shall be well graded hard broken stone of 40 mm nominal size, conforming to the following gradation (reproduced from IS: 383 – 1970, Specification for coarse and fine aggregates from natural sources for concrete, Table–2).

IS Sieve Designation	% Passing
80 mm	100%
40 mm	95 – 100%
20 mm	30 – 70%
10 mm	10 – 35%
4.75 mm	0 – 5%



5. CONCRETE WORK

5.1 MATERIAL:

5.1.1 Coarse Aggregate

5.1.1.1

General: Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved/ authorized sources.

(a) *Stone Aggregate:* It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. It shall conform to IS 383 unless otherwise specified.

(b) *Gravel:* It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coating, alkali, vegetable matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall conform to IS 383 unless otherwise specified.

(c) *Brick Aggregate:* Brick aggregate shall be obtained by breaking well burnt or over burnt dense brick/ brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil, vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete. It shall conform to IS 306 unless otherwise specified.

(d) Light weight aggregate such as sintered fly ash aggregate may also be used provided the Engineer-in-Charge is satisfied with the data on the proportion of concrete made with them.

5.1.1.2

Deleterious Material: Coarse aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete.

Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalis of cement shall not be used. The maximum quantity of deleterious material shall not be more than five percent of the weight of coarse aggregate when determined in accordance with IS 2386.

5.1.1.3

Size and Grading

(i) *Stone aggregate and gravel*: It shall be either graded or single sized as specified. Nominal size and grading shall be as under:-

- (a) Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by

The method prescribed in Appendix 'A' of Chapter 4 (CPWD) shall be in accordance with Table 4.1.



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

TABLE 4.1
Graded Stone Aggregate or Gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of			
	40 mm	20 mm	16 mm	12.5 mm
80 mm	100	-	-	-
63 mm	-	-	-	-
40 mm	95 to 100	100	-	-
20 mm	30 to 70	95 to 100	100	100
16 mm	-	-	90 to 100	-
12.5 mm	-	-	-	90 to 100
10 mm	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10

- (b) Nominal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal size, the proportion of other sizes as determined by the method prescribed in Appendix 'A' of Chapter 4 shall be in accordance with Table 4.2.

TABLE 4.2
Single Sized (Ungraded) Stone Aggregate or Gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
40 mm	0-30	85-100	100	-	-	-
20 mm	0-5	0-20	85-100	100	-	-
16 mm	-	-	-	85-100	100	-
12.5 mm	-	-	-	-	85-100	100
10 mm	0-5	0-5	0-20	0-30	0-45	85-100
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

- (c) When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sized aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate as determined by method prescribed in Appendix 'A' of Chapter 4 shall be in accordance with Table 4.1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 4.3.

TABLE 4.3
Single Sized (Ungraded) Stone Aggregate or Gravel

Cement concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1:6:12	63	9	-	3	-	-
1:6:12	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
1:5:10	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
1:4:8	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5	-	-
1:3:6	40	-	4.5	1.5	-	-
1:3:6	20	-	-	4.5	-	1.5
1:2:4	40	-	2.5	1	-	1.5
1:2:4	20	-	-	3	-	1
1:2:4	12.5	-	-	-	3	1
1: 1 ¹ / ₂ :3	20	0	0	2	-	1

Note:

- (i) The proportions indicated in Table 4.3 above are by volume when considered necessary, these proportions may be varied marginally by Engineer-in-Charge after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the Engineer-in-Charge. If single size coarse aggregate are not premixed at site to obtain the graded coarse aggregate required for the mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.
- (ii) **Brick Aggregate:** Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in Table 4.4 when tested for sieve analysis for the method prescribed in Appendix 'A' of Chapter 4.0.

TABLE 4.4
Brick Aggregate

IS Sieve Designation	Percentage passing (by weight)
75 mm	100
37.5 mm	95-100
20.0 mm	45-100
4.75 mm	0.50

5.1.1.4

Stacking: Aggregate shall be stacked on a hard, dry and level patch of ground. When stack

Piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

5.1.1.5

Testing: Coarse aggregate shall be tested for the followings (as per IS 2386)

- Determination of particle size and shape (Appendix 'A' of Chapter 4)
- Estimation of organic impurities (as per IS 2386 - Part II)
- Surface moisture (Appendix 'B' of Chapter 4)
- Determination of 10% fine value (Appendix 'C' of Chapter 4)

Measurements: The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of



nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregate of nominal size below 40 mm.

5.1.2 Chemical Admixtures

When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS 9103 and as specified in Chapter 5 - R.C.C.

5.1.2.1

Admixtures may be any one of the following classes for use in concrete:-

- (a) Water Reducing Admixtures
- (b) Retarding Admixtures
- (c) Accelerating Admixtures.
- (d) Water Reducing and Retarding Admixtures.
- (e) Water Reducing and Accelerating Admixtures.
- (f) Permeability reducing (water proofing) Admixtures.

5.1.2.2

Liquid Admixtures: Admixtures introduced into the concrete as liquids generally fall into the following categories.

- (a) Air Entraining.
- (b) Water Reducing.
- (c) Water Reducing Retarders.
- (d) Retarders.
- (e) Water Reducing Accelerators.
- (f) Accelerators.

5.1.2.3 Dosage of these admixtures may vary according to manufacturer's specification.

5.1.2.4 Two or more admixtures may not be compatible in the same solution. It is therefore mandatory that when two admixtures manufactured by the same manufacturers is being used simultaneously, the manufacturer shall certify their compatibility. In case the two or more admixtures are produced by different manufacturers, then, before their use in concrete, test shall be performed by the manufacturer to establish their compatibility, all such test reports shall be furnished to the Engineer-in-Charge for his approval before their use in concrete.

5.1.2.5 Some admixture may be in the form of powder, particle or high concentration liquids which may require mixing with water prior to dosing. Under these conditions water in solution shall be considered as part of total water content in the batch in order to maintain the water-cement ratio



- 5.1.2.6** Admixture manufacturer's recommendation shall be carefully followed so as to ensure complete solution of the product or to prepare a standard solution of uniform strength for easier use.
- 5.1.2.7** Certain admixtures may contain significant amounts of finely divided insoluble materials or active ingredients which may or may not be readily soluble. It is essential for such suspension before actual batching. When relatively small amounts of powdered admixtures are to be used directly, these shall be pre-blended with cement.
- 5.1.2.8** Admixtures are sold under various trade names and may be in the form of liquids or powders. The proprietary name and the net quantity of content shall be clearly indicated in each package or container of admixtures. The admixtures shall be uniform within each batch and uniform between all batches
- 5.1.2.9** No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS 9103 and the test results are approved by the Engineer-in-Charge

5.2 CEMENT CONCRETE

5.2.1 Grades of Cement Concrete The concrete shall be in grade designated as under:

TABLE 4.5
Grades of Concrete

Group	Grade Designation	Specified characteristic compressive strength of 150 mm Cube at 28 Days in N/mm ²
(1)	(2)	(3)
Ordinary Concrete	M10	10
	M15	15
	M20	20
Standard Concrete	M25	25
	M30	30
	M35	35
	M40	40
	M45	45
	M50	50
	M55	55
High Strength Concrete	M60	60
	M65	65
	M70	70
	M75	75
	M80	80



Notes:

1. In the designation of concrete mix M refers to the mix and the number to the specified Compressive strength of 150 mm size cube at 28 days, expressed in N/mm².
2. For concrete of compressive strength greater than M55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

5.2.1.1 The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall.

TABLE 4.6

**Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal; Maximum Size
(Clause 5.2.1.1)**

Sl. No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m ³	Maximum Free Water Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m ³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	Mild	220	0.60	-	300	0.55	M20
(ii)	Moderate	240	0.60	M15	300	0.50	M25
(iii)	Severe	250	0.50	M20	320	0.45	M30
(iv)	Very Severe	260	0.45	M20	340	0.45	M35
(v)	Extreme	280	0.40	M25	360	0.40	M40

Notes:

1. Cement content prescribed in this Table is irrespective of the grades of cement. The additions such as fly or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio, if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.
2. Minimum grade for plain concrete under mild exposure condition is not specified.
3. The above minimum cement content and maximum water cement ratio apply only to 20 mm nominal maximum size aggregate. For other sizes of aggregate, these



should be changed as per Table 6 of IS 456. The minimum grade of concrete for plain and reinforced concrete shall be as per Table 4.6.

5.2.1.2 Concrete of grades lower than those given in Table 4.6 may be used for lean concrete, foundation for masonry walls or temporary reinforced concrete construction.

5.2.2 Workability of Concrete

5.2.2.1 The concrete mix proportion chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

<i>Placing Conditions</i>	<i>Degree of Workability</i>	<i>Slump (mm)</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
Blinding concrete: shallow sections: Pavements using pavers	Very low	See 4.2.2.2
Mass concrete: Lightly reinforced sections in slabs, beams, wall, columns, : floors	Low	25-75
Hand placed pavements: canal lining; Strip footing	Medium	50-100
Heavily reinforced sections in slabs, beams, walls, columns:		
Slip form work: Pumped concrete	Medium	75-100
Trench fill	High	100-150
Tremie concrete	Very High	See 4.2.2.3

Note:- For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used

5.2.2.2 In the ‘very low’ category of workability where strict control is necessary, for example, pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

5.2.2.3 In the ‘very high’ category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

5.2.3 Concrete Mix Proportioning



5.2.3.1 The determination of the proportion of cement, aggregate and water to attain the required strength shall be made as follows:

(a) *By designing the concrete mix:* such concrete shall be called ‘Design mix concrete’, for details reference may be made to RCC Chapter.

(b) *By adopting nominal concrete mix:* such concrete shall be called ‘Nominal mix concrete’. Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of Engineer-in-Charge, which, however, is likely to involve higher cement content.

5.2.3.2 Nominal Mix Concrete: Nominal Mix Concrete may be used for concrete of M20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table 4.7. The cement content of the mix specified in Table 4.7 for any nominal mix shall be proportionately increased if the quantity of water in the mix has to be increased to overcome the difficulty or placement and compaction, so that the water cement ratio as specified is not exceed.

TABLE 4.7
Proportions for Nominal Mix Concrete
(Clause 5.2.3.2)

Grade of Concrete	Total Quantity of Dry Aggregates by Mass per 50 kg of cement, to be taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, Kg. Max	Proportion of Fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, max Ltr.
(1)	(2)	(3)	(4)
M5	800	Generally 1:2 but subject to an upper limit of 1: 1 ½ and a lower limit of 1:2 ½	60
M7.5	625		45
M10	480		34
M15	330		32
M20	250		30

Note : - The proportion of the fine to coarse aggregate should be adjusted from upper limit progressively as the grading of fine aggregate becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Note : - Quantity of water required from durability point of view may be less than the value given above.

Example

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½, 1:2 and 1:2 ½ for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

5.2.4 Batching

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixed on any site or in any one plant. In



batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass: liquid admixture may however be measured in volume or mass: water shall be weighed or measured by volume in a calibrated tank (see also IS 4925).

Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926).

5.2.4.1 Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock-piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the specified grading is maintained.

5.2.4.2 The accuracy of the measuring equipment shall be within + 2 percent of the quantity of cement being measured and within + 3 percent of the quantity of aggregate, admixtures and water being measured.

5.2.4.3 Proportion/Type and grading of aggregates shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

5.2.4.4 Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bilking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-Charge to ensure that the specified grading is maintained.

5.2.4.5 It is important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the



aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass for aggregate due to variations in their moisture content, suitable adjustments in the masses of aggregates shall be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 4.8.

TABLE 4.8
Surface Water Carried by Aggregate
(Clause 5.2.4.5)

Sl No.	Aggregate	Approximate Quantity of Surface Water Percent by mass	l/m ³
(1)	(2)	(3)	(4)
(i)	Very wet sand	7.5	120
(ii)	Moderately wet sand	5.0	80
(iii)	Moist sand	2.5	40
(iv)	¹⁾ Moist gravel or crushed rock	1.25-2.5	20-40

¹⁾ Coarser the aggregate, less the water it will carry.

5.2.4.6 No substitutions in materials used on the work or alteration in the established proportions, except as permitted in 5.2.4.4 and 5.2.4.5 shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

5.2.5 Mixing

Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical breakdown of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the Engineer-in-Charge in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be 1 1/2 to 2 minutes, for hydrophobic cement it may be taken as 2 1/2 to 3 minutes.

5.2.5.1 Power Loader: Mixer will be fitted with a power loader complying with the following requirements.



- (a) The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note: In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

- (b) The minimum inside width of the feeding edge of the hopper shall be as specified below in Table

TABLE 4.9

<i>Nominal size of mixer (T, NT or R). litre</i>	<i>Minimum inside width of hopper feeding edge</i>
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

T = Tilting; NT = Non-tilting; R = Reverse

- (c) The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the centre line of the chute plate of the hopper when in discharge position, is at an angle of not less than 50° to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of centre line of the chute plate of the hopper when in discharge position, should be as larger as practicable, preferably not less than 40° to horizontal.

- (d) When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, these should be at least one and a half drums of rope on the drum.

(e) Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

(f) The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

(g) Safety device shall be provided to secure the hopper in raised position when not in use.

5.2.5.2 Mixing Efficiency: The mixer shall be tested under normal working conditions in accordance with the method specified in IS 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the



percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete. The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halves of the batch shall not be more than the following limits:

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

5.2.5.3 Machine Mixing: The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the Engineer-in-Charge. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed. The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed cleaned with water.

5.2.5.4 Hand Mixing: When hand mixing has been specifically permitted in exceptional circumstances by the Engineer-in-Charge in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by shovelling and turning till the coarse aggregate gets evenly distributed the cement sand mixture. Three quarters of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The



whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

5.2.5.5 Transportation and Handling: Concrete shall be transported from the mixer to the place of laying 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 to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

5.2.6 Placing

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains. As a general guidance, the maximum free fall of concrete may be taken as 1.5 metre.

5.2.7 Compaction

Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till dense concrete is obtained. The mechanical vibrators shall conform to IS 2505, IS 2506, IS 2514 and IS 4656. To prevent segregation, over vibration shall avoided. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

5.2.8 Construction Joints

Concreting shall be carried out continuously upto construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the Engineer-in-Charge. Number of such joints shall be kept minimum. Joints shall be kept as straight as possible. Construction joints should comply with IS 11817.

5.2.8.1 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, of workable consistency by using 2 kgs of cement per sqm shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete.

5.2.8.2 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 coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm 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.

5.2.9 Curing

Curing is the process of preventing loss of moisture from the concrete. The following methods shall be employed for effecting curing.

5.2.9.1 *Moist Curing* : Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

5.2.9.2 *Membrane Curing*: Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compound shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membrane such as polythene sheet covering the concrete surface may also be used to provide effective barrier against the evaporation.

5.2.9.3

Freshly laid concrete shall be protected from rain by suitable covering.

5.2.9.4 Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall

be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

5.2.10 Testing of Concrete

Testing of concrete shall be done as described in chapter of R.C.C.

5.2.11 Form Work

Form work shall be as specified in R.C.C. chapter and shall be paid for separately unless otherwise specified.

5.2.12 Finishes

Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

5.2.13 Durability of Concrete

A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service. The materials and mix proportions shall be such as to maintain its integrity and, if applicable, to protect reinforcement from corrosion.

The factors influencing durability include:

- (a) The environment;
- (b) The cover to embedded steel;
- (c) The type and quality of constituent materials;
- (d) The cement content and water/ cement ratio of the concrete;
- (e) Workmanship, to obtain full compaction and efficient curing; and
- (f) The shape and size of the member.

5.2.13.1 Requirements for Durability

5.2.13.1.1 General Environment: The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 4.9.

TABLE 4.9



Environmental Exposure Conditions

Sl. No	Environment	Exposure Conditions
(1)	(2)	(3)
(i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
(ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ ground water Concrete surfaces sheltered from saturated salt air in coastal area
(iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water. Concrete exposed to coastal environment.
(iv)	Very severe	Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive sub-soil/ ground water.
(v)	Extreme	Surface of members in tidal zone. Members in direct contact with liquid/ solid aggressive chemicals.

Note: For the purpose of determining exposure conditions, all places within a distance of 10 kms. of coastal line, sea front would be treated as coastal area.

5.2.13.1.2 Freezing and Thawing : Where freezing and thawing actions under wet conditions exist, enhanced durability can be obtained by the use of suitable air entraining admixtures. When concrete lower than grade M50 is used under these conditions, the mean total air content by volume of the fresh concrete at the time of delivery into the construction should be:

Nominal Maximum Size Aggregate (mm)	Entrained Air Percentage
20	5 ± 1
40	4 ± 1

5.2.13.1.3 Exposure to Sulphate Attack : For the very high sulphate concentration in Class 5 conditions given in Table 4.11, some form of lining such as polyethylene or polychloroprene sheet: or surface coating based on asphalt, chlorinated rubber, epoxy; or polyurethane materials should also be used to prevent access by the sulphate solution.

5.2.13.1.4 Chlorides in Concrete : The total amount of chlorides content (as Cl) in the concrete at the time of placing shall be as under :

CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Sl. No.	Type of Use of Concrete	Maximum Total Acid Soluble Chloride Content expressed as kg/ m ³ of Concrete
(1)	(2)	(3)
(i)	Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete	0.4
(ii)	Reinforced concrete or plain concrete containing embedded metal	0.6
(iii)	Concrete not containing embedded metal or any material requiring protection from chloride	3.0

5.2.13.1.5 Sulphates in Concrete: The total water-soluble sulphate content of the concrete mix, expressed as SO₃ should not exceed 4 per cent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix. The 4 per cent limit does not apply to concrete made with super sulphate cement complying with IS 6909.

Table 4.11

Requirements for concrete exposed to sulphate attack



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Sl No.	Class	Concentration of sulphates, Expressed as SO ₃ Concrete.			Type of Cement	Dense, Fully compacted made with 20 mm nominal maximum size Aggregates complying with IS 383	
		In Soil		In Ground Water (g/l)		Minimum Cement Content kg/m ³	Maximum Free Water- Cement Ratio
		Total SO ₃ (%)	SO ₃ in 2:1 (Water: Soil Extract) (g/l)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	1	Traces (<0.2)	Less than 1.0	Less than 0.3	Ordinary Portland cement or Portland slag cement or Portland pozzolana cement	280	0.55
(ii)	2	0.2 to 0.5	1.0 to 1.9	0.3 to 1.2	Ordinary Portland cement or Portland slag cement or Portland pozzolana cement	330	0.50
					Supersulphated cement or sulphate resisting Portland cement	310	0.50
(iii)	3	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	Supersulphated cement or sulphate resisting Portland cement	330	0.50
					Portland Pozzolana cement or Portland slag cement	350	0.45
(iv)	4	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	Supersulphated or sulphate resisting Portland cement	370	0.45
(v)	5	More than 2.0	More than 5.0	More than 5.0	Sulphate resisting Portland cement or supersulphated cement with protective coatings	400	0.40

Notes

1. Cement content given in this Table is irrespective of grades of cement.
2. Use of supersulphated cement is generally restricted where the prevailing temperature is above 40°C.
3. Supersulphated cement gives an acceptable life provided that the concrete is dense and prepared with a water-cement ratio of 0.4 or less, in mineral acids, down to pH 3.5.
4. The cement contents given in col. 7 of this Table are the minimum recommended. For SO₃ contents near the upper limit of any class, cement contents above these minimum are advised.
5. For severe conditions, such as thin sections under hydrostatic pressure on one side only and sections partly immersed, considerations should be given to a further reduction of water-cement ratio.
6. Portland slag cement conforming to IS 455 with slag content more than 50 per cent exhibits better sulphate resisting properties.
7. Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C3A content from 5 to 8 per cent shall be desirable to be used in concrete, instead of sulphate resisting cement. Alternatively, Portland slag cement conforming to IS 455 having more than 50 per cent slag or a blend of ordinary Portland cement and slag may be used provided sufficient information is available on performance of such blended cements in these conditions.



5.2.14 Measurements

5. 2.14.1 Dimensions of length, breadth and thickness shall be measured correct to nearest cm. except for the thickness of slab and partition which shall be measured to nearest 5 mm. Areas shall be worked out to nearest 0.01 sq.m and the cubic contents of consolidated concrete shall be worked out to nearest 0.01 cum. Any work done in excess over the specified dimension or sections shown in the drawing shall be ignored.

5. 2.14.2 Concrete work executed in the following conditions shall be measured separately:

- (a) Work in or under water
- (b) Work in liquid mud
- (c) Work in or under foul positions

5. 2.14.3 **Cast-in-situ concrete** and or precast concrete work shall be measured in stages described in the item of work, such as:

- (a) At or near the ground level
- (b) Upto specified floor level
- (c) Between two specified floor levels
- (d) Upto specified height above or depth below plinth level/ defined datum level.
- (e) Between tow specified heights or depths with reference to plinth/defined datum level.

level.

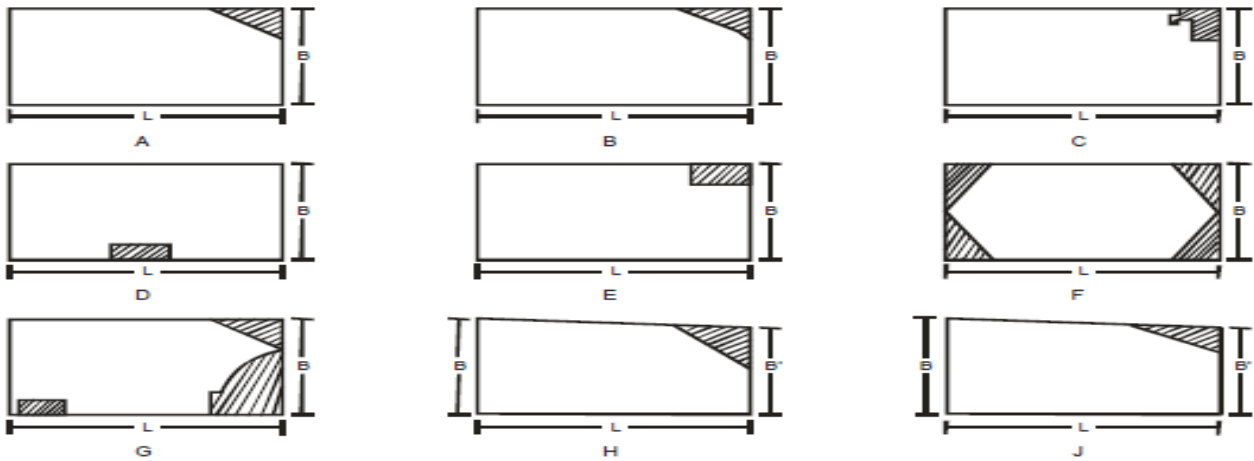
5. 2.14.4 No deduction shall be made for the following:

- (a) Ends of dissimilar materials for example beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sq cm in cross sections.
- (b) Opening upto 0.1 sq metre (1000 sq.cm)
- (c) Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq cm each in cross sectional areas.
- (d) Small voids such as shaded portions in Figure A to J below when these do not exceed 40 sq cm each in cross section.

Note: In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

Area of Fig. A to G shall be = L x B

Area of Fig. H & J shall be = $L \times \{\text{Average of } B \text{ and } B'\}$



5. 2.14.5 Cast-in-situ and precast concrete work shall be measured sperately.

5. 2.14.6 Cast-in-situ concrete shall be classified and measured as follows:

- (a) Foundation, footings, bases for columns
- (b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
- (c) Shelves
- (d) Slabs
- (e) Chajjas including portions bearing on the wall
- (f) Lintels, beams and bressummers
- (g) Columns, piers abutments, pillars, post and struts
- (h) Stair case including stringer beams but excluding landings.
- (i) Balustrades, newels and sailing
- (j) Spiral staircase (including landings)
- (k) Arches
- (l) Domes, vaults
- (m) Shell roof, arch ribs and folded plates
- (n) Chimneys and shaft.
- (o) Breast walls, retaining, walls, return walls
- (p) Concrete filling to precast components
- (q) Kerbs, steps and the like
- (r) String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like
- (s) Cornices and moulded windows sills.

(t) Louvers, fins, fascia.

5. 2.14.7 Precast cement concrete solid article shall be measured separately and shall include use of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement : 2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under:

<i>Classifications</i>	<i>Method of measurement</i>
(a) Wall panels	In square meters stating the thickness.
(b) String or lacing courses, coping, bed plates, plain windows sills, shelves, louvers, steps etc.	In cubic meters.
(c) Kerbs, edgings etc.	In cubic metres.
(d) Solid block work	In square metres stating the thickness or in cubic meters.
(e) Hollow block work	In square metres stating the thickness or in cubic metres.
(f) Light weight partitions	In square metres stating the partition's thickness.

5.2.15 Rate

The rate is inclusive of the cost of labour and materials involved in all the operations described above.

5.3 CEMENT- FLY ASH CONCRETE

5. 3.0 Fly ash concrete shall be prepared by mixing graded coarse aggregate of nominal size as specified with fine aggregate, ordinary Portland cement and fly ash in specified proportions with required quantity of water. The recommended composition of cement fly ash concrete are as under:



TABLE 4.12
Fly Ash Concrete Mixes

<i>Composition (Dry Volume)</i>	<i>Proportion (Dry Volume)</i>	<i>Compressive Strength at seven days</i>
<i>Lean Concrete (1:5:10)</i>		
Cement (Ordinary Portland)	1.0	28 kg/cm ²
Fly ash	2.5	
Sand	4.0	
Stone aggregate	11.0	
<i>Lean Concrete (1:4:8)</i>		
Cement (Ordinary Portland)	1.0	37 kg/cm ²
Fly ash	2.0	
Sand	3.5	
Stone aggregate	9.0	

Note: No fly ash is to be added to Portland Pozzolona cement in any case which itself contains fly ash.

5. 3.1 Proportioning

Proportioning shall be done by volume. Boxes of suitable size shall be used for measuring fly ash, sand and aggregate. The internal dimensions of the boxes shall be generally 35x25x40 cm. deep or as otherwise approved by the Engineer-in-charge. The unit of measurement of cement shall be a bag of 50 kg. And this shall be taken as 0.035 cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulkage shall be made as given in the chapter for mortar.

- 5. 3.2 Mixing shall be as specified in 5.2.5 except that the fly ash shall be placed in the hopper before cement in case of machine mixing.
- 5. 3.3 Placing and compaction shall be as specified in 5.2.6 and 5.2.7.
- 5. 3.4 Curing shall be as specified in 5.2.10.
- 5. 3.5 Form work shall be as specified in 5.2.12.
- 5. 3.6 Measurements shall be as specified in 5.2.15.
- 5. 3.7 **Rate**

Rate shall include the cost of materials and labour involved in all the operations described above.

5.4 DAMP PROOF COURSE



5.4.1 Cement Concrete Layer

This shall consist of cement concrete of specified proportions and thickness. The surface of brick or stone masonry work shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honeycombing. Continuity shall be maintained while laying the cement concrete layer and lying shall be terminated only at the predetermined location where damp proof course is to be discontinued. There shall be no construction joints in the Damp Proof Course.

5.4.2 Curing

Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

5.4.3 Application of Hot Bitumen

Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Bitumen of penetration A 90 or equivalent where used shall be heated to a temperature of $160^{\circ} \pm 5^{\circ}\text{C}$. The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere. It will be paid for separately.

5.4.4 Water Proofing Materials

Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer's specification stating the quantity of water proofing material in litres or kg per 50 kg or cement and will be paid for separately.

5.4.5 Measurements

The length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

5.4.6 Rate

The rate is inclusive of the cost of materials and labour involved in all the operations described above except for the applications of a coat of hot bitumen and addition of water proofing materials which shall be paid for separately, unless otherwise specified.



**DETERMINATION OF PARTICLE SIZE (appendix A)
(Clause 5.1.2.3 & 5.1.2.5)**

The apparatus, sample size and test procedure shall be same as specified in sub-head 'MORTARS'.

In order that the sieves shall not be overloaded, care must be taken to ensure that the maximum sieve loads shown in Table A-4.1 (below) are not exceeded at the completion of sieving.

TABLE A-4.1

I.S. Sieve Designation	Maximum weight for	
	45 cm dia sieve kg	30 cm dia sieve kg
45 mm	10	4.5
40 mm	8	3.5
31.5 mm or 22.1 mm	6	2.5
20 mm	4	2.0
16 mm or 12.5 mm	3	1.5
10 mm	2	1.0
5.6 mm	1.5	0.75
4.75 mm	1.0	0.50
3.35 mm	-	0.30

The sample weight taken will thus normally require several operations on each sieve. Each sieve should be taken separately over a clean tray or receiver until no more than a trace passes, but in any case for not less than two minutes. Materials should not be forced through the apertures but hand placing is permitted. A light brush should be used with fine sieves. The cumulative weight passing each sieve should be calculated as percentage of the total sample weight to the nearest whole number.

APPENDIX B

**TEST FOR SURFACE MOISTURE
(Clause 5.1.1.5)**

Take a sample of wet aggregate and weigh it (A). Then place it in a frying pan and gently apply heat, meanwhile stirring with a glass rod until the surface moisture disappears. This is apparent when the aggregate loses its shining wet appearance and becomes dull, or when it just attains a free funning condition. The saturated surface dry material is then weighed (B). Continue the heating thereafter until the moisture is evaporated and weigh the dry sample (C). The surface moisture is then calculated as follows:

$$\text{Surface moisture} = 100 \times A-B/C$$

It is expressed as a percentage of dry aggregate.

**DETERMINATION OF TEN PER CENT FINE VALUE
(Clause 5.1.1.5)**

Apparatus:

The apparatus for the standard test shall consist of the following:

(a) A 15 cm diameter open-ended steel cylinder, with plunger and base-plate, as shown in Fig. in the end of this appendix. The surfaces in contact with the aggregate shall be machined and case hardened or otherwise treated so as to have a diamond (VH) pyramid hardness number of not less than 650 VH.

(b) A straight metal tamping rod of circular cross-section 16 mm in diameter and 45 to 60 cm long, rounded at one end.



- (c) A balance of capacity 3 Kg, readable and accurate to one gram.
- (d) I.S. Sieve of sizes 12.5, 10 and 2.36 mm.
- (e) A compression testing machine capable of applying a load of 50 tonnes and which can be operated to give a uniform rate of loading so that the maximum load in any test is reached in 10 minutes. This load may vary from 0.5 to 50 tonnes.
- (f) For measuring the sample, a cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions:
Diameter 11.5 cm
Height 18.0 cm
- (g) Means of measuring the reduction in the distance between the plates of the testing machine to the nearest one millimetre during the test (for example, dial gauge).

Test Sample:

Material for the test shall consist of aggregate passing a 12.5 mm I.S. Sieve and retained on a 10 mm I.S. Sieve. The aggregate shall be tested in a surface dry condition. If dries by heating the period of drying shall not exceed four hours, the temperature shall be 100°C to 110°C and the aggregate shall be cooled to room temperature before testing. The quantity of aggregate shall be such that the depth of material in the cylinder, after tamping as described below, shall be 10 cm. The weight of material comprising the test sample shall be determined (weight A) and the same weight of sample shall be taken for the repeat test.

Note: About 6.5 kg of natural aggregate is required to provide the two test samples. Less of light weight aggregate is required. The measuring cylinder is filled in three layers of approximately equal depth with aggregate passing a 12.5 mm I.S. Sieve and retained on 10 mm I.S. Sieve. Each layer is subjected to 25 strokes from the tamping rod (16 mm dia and 45 to 60 cm long) rounded to one end, care being taken in case of weak materials not to break the particles. The surface of the aggregate shall be carefully levelled and the plunger inserted so that it rests horizontally on this surface.

Test Procedure:

The apparatus, with the test sample and plunger in position, shall then be placed in the compression testing machine. The load shall be applied at a uniform rate so as to cause a total penetration of a plunger in 10 minutes of about: 15.0 mm for rounded or partially rounded aggregates (for example uncrushed gravel) 20 mm for nominal crushed aggregate & 24 mm for honey combed aggregate (for example expanded shales and slags). These figures may be varied according to the extent of the rounding or honey combing. After reaching the required maximum penetration, the load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The fines passing the sieve shall be weighed, and this weight expressed as a



percentage of the weight of the test sample. Normally, this percentage will fall within the range 7.5 to 12.5, but if it does not, a further test shall be made at a load adjusted appropriately, to bring the percentage fines within the range of 7.5 to 12.5. A repeat test shall be made at the load that gives as percentage fines within the range 7.5 to 12.5. Calculations: The mean percentage fines from the two tests at this load shall be used in the following formula to calculate the load required to give 10 percentage fines.

$$\frac{14 \times X}{Y+4}$$

Load required for 10 percent fines =

Where X = Load in tonnes and

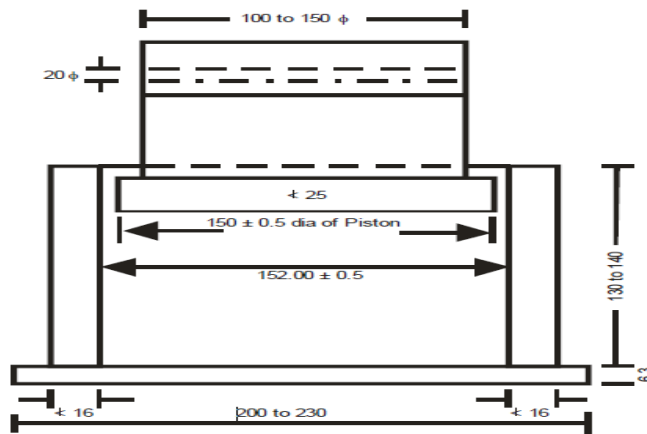
Y= mean percentage fines from two test at X tonnes load.

Reporting of Results:

The load required to produce 10 percent fines shall be reported to the nearest whole number for loads of 10 tonnes or more, the nearest 0.5 tonne for loads of less than 10 tonnes.

The value expressed to the nearest 0.5 tonne should be as follows:

- (a) For normal concrete, not less than 5 tonnes.
- (b) For wearing surfaces, not less than 10 tonnes.
- (c) For granolithic concrete, not less than 15 tonnes.



Drawing not to Scale
All dimensions in millimetres
Internal Diameter of Cylinder = 152.0± 0.5

Fig. C-4.1 : Apparatus for Determination of Ten per cent Fine Value

**SLUMP TEST
(Clause 5.2.2)**



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Apparatus: Mould shall consist of a metal frustum of cone having the following internal dimensions:

Bottom diameter.....	20 cm
Top diameter.....	10 cm
Height.....	30 cm

The mould shall be of a metal other than brass and aluminium of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used.

Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

Procedure: The internal surface of the mould shall be thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid and non-absorbent surface viz. levelled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of mould. Each layer shall be tamped with twenty five strikes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped through out its depth. After the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould is exactly filled. Any mortar which shall leak out between the mould and the base plate shall be cleaned away. The mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The moulded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.

The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

Result: The slump shall be recorded in terms of millimeters of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally give incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.



6. REINFORCED CEMENT CONCRETE WORK

6.0 GENERAL

Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

- (a) Form work (Centering and Shuttering)
- (b) Reinforcement
- (c) Concreting: (1– Cast-in-situ), (2 – Precast)

6.1 MATERIALS

6.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 mortars and chapter 04 concrete work as applicable.

6.1.2 Fly Ash admixed cement concrete (FACC) and fly ash Blended cements in Cement Concrete (PPCC) in RCC structures.

6.1.2.1 Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below :

6.1.2.2 *General*

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under :

(a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.

(b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of Concrete for certification of quality of concrete.

(ii) Minimum M -25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.



- (iii) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.
- (iv) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture. If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and /or PPC received from different sources shall be ensured by trials.
- (v) In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, flyash substitution/content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.
- (vi) Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

6.1.3 Steel for Reinforcement

6.1.3.1 The steel used for reinforcement shall be any of the following types:

- (a) Mild steel and medium tensile bars conforming to IS 432 (Part I)
- (b) High strength deformed steel bars conforming to IS 1786
- (c) Hard drawn steel wire fabric conforming to IS 1566
- (d) Structural steel conforming to Grade A of IS 2062
- (e) Thermo-mechanically treated (TMT) Bars.

6.1.3.2 Elongation percent on gauge length is $5.65 A$ where A is the cross sectional areas of the test piece.

6.1.3.3 Mild steel is not recommended for the use in structures located in earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.



6.1.3.4 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.

Nominal mass/weight : The tolerance on mass/ weight for round and square bars shall be the percentage given in Table 5.1 of the mass/ weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7.85 kg/ cm³ or 0.00785 kg/mm³.

TABLE 5.1
Tolerance on Nominal Mass

<i>Nominal size in mm</i>	<i>Tolerance on the Nominal Mass per cent</i>		
	<i>Batch</i>	<i>Individual sample +</i>	<i>Individual sample for coil (x)</i>
(a) Upto and including 10	± 7	-8	± 8
(b) Over 10, upto and including 16	± 5	-6	± 6
(c) Over 16	± 3	-4	± 4

+ for individual sample plus tolerance is not specified

(x) for coil batch tolerance is not applicable

Tolerance shall be determined in accordance with method given in IS 1786.

6.1.3.5 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.2.



TABLE 5.2

Sl. No	Property	Fe 415	Fe 415 D	Fe 500 D	Fe 550 D
(i)	0.2 Per cent Proof stress/ yield stress, Min, N/mm ²	415.0	415.0	500.0	550.0
(ii)	Elongation, per cent, Min. on gauge length $5.65 \sqrt{A}$, where A is the cross-sectional area of the test piece.	14.5	18.0	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 485.0 N/mm ²	12 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 500.0 N/mm ²	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 565.0 N/mm ²	8 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 600.0 N/mm ²
(iv)	Total elongation at maximum force, percent, Min on gauge length $5.65 \sqrt{A}$, where A is the cross-sectional area of the test piece.	-	5	5	5

Tests: Selection and preparation of Test sample. All the tests pieces shall be selected by the Engineer in- Charge or his authorized representative either-

(a) From cutting of bars

Or

(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it. In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative. The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation –

This shall be done as per IS 1608, read in conjunction with IS 226.

RE- test: This shall be done as per IS 1786.

Rebend test: This shall be done as per IS 1786.



6.1.3.6 Chemical composition of reinforcement bars shall be as per Table 5.3 as follows:-

TABLE 5.3

<i>Constituent</i>	<i>Maximum Per cent</i>			
	<i>Fe 415</i>	<i>Fe 415 D</i>	<i>Fe 500 D</i>	<i>Fe 550 D</i>
Carbon	0.30	0.25	0.25	0.25
Sulphur	0.060	0.045	0.040	0.040
Phosphorus	0.060	0.045	0.040	0.040
Sulphur and Phosphorus	0.110	0.085	0.075	0.075

6.1.3.7 Thermo Mechanically treated reinforcement bars:

(a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.

(b) The TMT bars are being produced under valid licence from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licences to various producers to produce TMT Bars.

(c) The TMT bars shall conform to IS 1786 pertaining to Fe 415 D or Fe 500 D or Fe grade of steel as specified.

(d) In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermomechanical treatment process of grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5. % and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

6.1.4 Stacking and Storage

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different



classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

6.1.5 Identification

Care shall also be taken to properly identify these bars at site. The staff shall be specially trained for looking for identification marks on these bars given by the manufacturers which are generally given colour code. It will be advisable to see that only one type/grade of bars are brought to site and used in the project after conducting tests for each lot.

6.2 FORM WORK (CENTRING & SHUTTERING)

6.2.1 Form Work

Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

6.2.2 Design & Tolerance in Construction

Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance as per the IS provisions

6.2.3 General Requirement

It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

6.2.3.1 Material for Form Work

(a) *Propping and Centering* : All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

6.2.3.2 (a) **Centering/Staging** : Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made from rolled structural steel sections.



- (b) In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.
- (c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

6.2.3.3 Shuttering: Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used or concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

- (a) *Runner Joists:* RSJ, MS Channel or any other suitable section of the required size shall be used as runners.
 - (b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.
 - (c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.

6.2.3.4 Form work shall be properly designed for self-weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 metres, the prop may be provided in multi-stages.

6.2.3.5 Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the Engineer-in-Charge, so as to offset the subsequent deflection, For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

6.2.3.6 Walls : The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. The two



shutters of the wall are to be kept in place by appropriate ties, braces and studs, some of the accessories used for wall form.

6.2.3.7 Removal of Form work (Stripping Time) : In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods:

Type of Form work	Minimum period Before Striking Form work for OPC 33 grade		Minimum period Before Striking Form work for OPC 43 grade		Minimum period Before Striking Form work for PPC	
	Before Striking	Form work for OPC 33 grade	Before Striking	Form work for OPC 43 grade	Before Striking	Form work for PPC
(a) Vertical form work to columns, walls, beams	16-24 h		16-24 h		24-36 h	

Type of Form work	Minimum period Before Striking Form work for OPC 33 grade		Minimum period Before Striking Form work for OPC 43 grade		Minimum period Before Striking Form work for PPC	
	Before Striking	Form work for OPC 33 grade	Before Striking	Form work for OPC 43 grade	Before Striking	Form work for PPC
(b) Soffit form work to slabs (Props to be refixed immediately after removal of formwork)	3 days		3 days		4 days	
(c) Soffit form work to beams (Props to be refixed immediately after removal of formwork)	7 days		7 days		10 days	
(d) Props to slabs:						
(1) Spanning upto 4.5m	7 days		7 days		10 days	
(2) Spanning over 4.5m	14 days		14 days		20 days	
(e) Props to beams and arches:						
(1) Spanning upto 6m	14 days		14 days		20 days	
(2) Spanning over 6m	21 days		21 days		30 days	

Note 1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally If Portland pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

Note 3: For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6: Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

6.2.3 Surface Treatment

6.2.4.1 Oiling the Surface : Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections. A typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5%pentachlorophenol conforming to IS 716 well



mixed to a viscosity of 70-80 centipoises. After 3-4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use. The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

6.2.4.2 The design of form work shall conform to sound Engineering practices and relevant IS codes.

6.2.4 Inspection of Form Work

The completed form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position. Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge. Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

6.2.5.1 Erection of Form Work (Centering and shuttering): Following points shall be borne in mind while checking during erection.

- (a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
- (b) Material used should be checked to ensure that, wrong items/ rejects are not used.
- (c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
 - (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
 - (ii) Sole plates shall be properly seated on their bearing pads or sleepers.
 - (iii) The bearing plates of steel props shall not be distorted.
 - (iv) The steel parts on the bearing members shall have adequate bearing areas.



- (d) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
- (e) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, overturning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
- (f) The stacked materials shall be placed as catered for, in the design.
- (g) When adjustable steel props are used. They should:
 - 1. be undamaged and not visibly bent.
 - 2. have the steel pins provided by the manufacturers for use.
 - 3. be restrained laterally near each end.
 - 4. have means for centralizing beams placed in the forkheads.
- (h) Screw adjustment of adjustable props shall not be over extended.
- (i) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/ clamped down after adjustment to prevent shifting.
- (j) No member shall be eccentric upon vertical member.
- (k) The number of nuts and bolts shall be adequate.
- (l) All provisions of the design and/or drawings shall be complied with.
- (m) Cantilever supports shall be adequate.
- (n) Props shall be directly under one another in multistage constructions as far as possible.
- (o) Guy ropes or stays shall be tensioned properly.
- (p) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.
- (q) Required camber shall be provided over long spans.
- (r) Supports shall be adequate, and in plumb within the specified tolerances.



6.2.5 Measurements

6.2.6.1 **General** : The form work shall include the following:

- (a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
- (b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
- (c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.
- (d) Working scaffolds, ladders, gangways, and similar items.
- (e) Filletting to form stop chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.
- (f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
- (g) Dressing with oil to prevent adhesion and
- (h) Raking or circular cutting

6.2.6.2 **Classification of Measurements**: Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following.

- (a) Foundations, footings, bases of columns etc. and for mass concrete
- (b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
- (c) Suspended floors, roofs, landings, shelves and their supports and balconies.
- (d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.
- (d) Columns, pillars, piers, abutments posts and struts.
- (e) Stairs (excluding landings) except spiral staircase.
- (f) Spiral staircases (including landings).

- (g) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates
- (h) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped
- (i) Chimneys and shafts.
- (j) Well steining.
- (k) Vertical and horizontal fins individually or forming box, louvers and bands, fascias and eaves board
- (l) Waffle or ribbed slabs.
- (m) Edges of slabs and breaks in floors and walls (to be measured in running metres where below 200 mm in width or thickness).
- (n) Cornices and mouldings.
- (o) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.
- (p) Chullah hoods, weather shades, chajjas, corbels etc. including edges and
- (q) Elevated water reservoirs.

6.2.6.3 Centering, and shuttering where exceeding 3.5 metre height in one floor shall be measured and paid for separately.

6.2.6.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

6.2.6.5 No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0.4 square metre. Nothing extra shall be paid for forming such openings.

6.2.6.6 Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well steining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.

6.2.6.7 Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However, there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

6.2.6 Rate

The rate of the form work includes the cost of labour and materials required for all the operations described above.

6.3 REINFORCEMENTS

6.3.1 General Requirements

Steel for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

6.3.1.1 *Assembly of Reinforcement:* Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer-in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 11/4 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

6.3.1.2 *Bonds and Hooks Forming End Anchorages:* Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.



(a) *U-Type Hook*

In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semi-circular hooks having clear diameter equal to four times the diameter of the bar.

Note: In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

(b) *Bends:* Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

6.3.1.3 Anchoring Bars in Tension: Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.

6.3.1.4 Anchoring Bars in Compression: The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

6.3.1.5 Binders, stirrups, links etc.: In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times and nominal size of bar.

6.3.2 Welding of Bars

Wherever facility for electric **arc welding** or **gas pressure welding** is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in- Charge. Welding shall be as per IS 2751 and 9417.

6.3.3 Placing in Position



6.3.3.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-Charge.

6.3.3.2 The bars shall be kept in correct position by the following methods:

(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.

(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 m or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them: or with block of cement mortar 1:2 (1 cement: 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.

(d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

6.3.3.3 ***Tolerance on Placing of Reinforcement*** : Unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:

Tolerance in spacing

(a) For effective depth, 200 mm or less +10 mm

(b) For effective depth, more than 200 mm + 15 mm

6.3.3.4 Bending at Construction Joints: Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameter for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

6.3.3.5 Cover : The minimum nominal cover to meet durability requirements shall be as under:-

<i>Exposure</i>	<i>Nominal Concrete cover in mm not less than</i>
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

- Notes :**
1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
 2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.
 3. For exposure condition 'severe' and 'very severe' reduction of 5 mm may be made, where concrete grade is M35 and above.
 4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

6.3.4 Measurement

Reinforcement including authorized spacer bars and lappages shall be measured in length of different diameter, as actually (not more than as specified in the drgs.) used in the work nearest to a centimetre and their weight calculated on the basis of standard weight given in Table 5.4 below. In case actual unit weight of the bars is less than standard unit weight, but within variation, in such cases weight of reinforcement shall be calculated on the basis of actual unit weight. Wastage and unauthorized overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement. Where tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the Engineer-in-Charge and measured separately and paid for.



TABLE 5.4
Cross Sections Area and Mass of Steel Bar

<i>Nominal Size mm</i>	<i>Cross sectional Area Sq.mm</i>	<i>Mass per metre Run Kg.</i>
6	28.3	0.222
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
20	314.3	2.47
25	491.1	3.85
28	615.8	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.86

Note: These are as per clause 6.2 of IS 1786.

6.3.5 Rate

The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking bending, binding, placing in position etc. as required or directed including tack welding on crossing of bars in lieu of binding with wires.

6.4 CONCRETING

6.4.0 The concrete shall be as specified under chapter 4 concrete work. The proportion by volume or by the weight of ingredients shall be as specified.

6.4.1 Consistency

The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated on or hand tamped, it shall be determined by slump test as prescribed in sub-head "concrete" under workability – requirement.

6.4.2 Placing of Concrete

6.4.2.1 Concreting shall be commenced only after Engineer-in-Charge has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shavings, saw dust, pieces of wood, or other foreign material and surfaces shall be treated

6.4.2.2 In case of concreting of slab and beams, wooden plank or cat walks of chequered MS plated or bamboo chalties or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to

convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

6.4.2.3 In case of columns and wall, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction shall be restricted to one metre per hour.

6.4.2.4 The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the Engineer-in-Charge. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 metres at a time.

6.4.2.5 During cold weather, concreting shall not be done when the temperature falls below 4.50C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

6.4.2.6 During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

6.4.3 Compaction

It shall be as specified in sub-head of Concrete Work of this specification.

6.4.3.1 Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations complying with IS 2505, IS 2506, IS 2514 and IS 4656. The Engineer-in-Charge may however relax this condition at his discretion for certain items depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation; such that de-aeration and effective compaction is attained at a rate



commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

6.4.3.2 Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibration. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. with 30 minutes of addition of water to the dry mixture.

6.4.4 Construction joints

6.4.4.1 Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown in structural drawing or as indicated in Fig. 5.26 or as directed by Engineer in-Charge. Number of such joints shall be kept to minimum. The joints shall be kept at places where the shear force is the minimum. These shall be straight and shall be at right angles to the direction of main reinforcement. Construction joints should comply with IS 11817.

6.4.4.2 In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

6.4.4.3 When stopping the concrete on a vertical plane in slabs and beams, and approved stop board shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined or feather joints shall not be permitted. Any concrete flowing through



the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

6.4.4.4 When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square metre shall then be applied on the roughened surface before fresh concrete is laid.

6.4.5 Expansion Joints

Expansion joints shall be provided as directed by Engineer-in-Charge, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running metre. The measurement shall be taken two places of decimal stating the depth and width of joint.

6.4.6 Curing

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the Engineer-in-Charge. After 24 hours of laying of concrete, the surface shall be cured by ponding with water for a minimum period of 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather condition.

6.4.7 Finishing

6.4.7.1 In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. **Sprinkling of dry cement while finishing shall not be resorted to.**

6.4.7.2 Immediately on removal of forms, the R.C.C. work shall be examined by the Engineer-in-Charge, before any defects are made good.



- (a) The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given in para 5.4.9.4 for visual inspection test.
- (b) Surface defects of minor nature may be accepted. On acceptance of such a work by the Engineer-in-Charge, the same shall be rectified as follows:
1. Surface defects which require repair when forms are removed, usually consist of bulged due to movement of forms, ridges at form joints, honey-combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly under cut to provide a key at the edge of the patch.
 2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.
 3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.
 4. Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.
 5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.
 5. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of



white Portland cement to the patching mortar, the exact quantity being determined by trial.

7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

(c) The exposed surface of R.C.C. work shall be plastered with cement mortar 1:3 (1 cement : 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure, shall be considered exposed surfaced for the purpose of this specification

Where such exposed surface exceeding 0.5 sqm in each location is not plastered with cement mortar 1:3 (1 cement : 3 fine sand) 6 mm thick, necessary deduction shall be made for plastering not done.

(d) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster. RCC work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6 mm.

(e) The surface of RCC slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

6.4.8 Strength of Concrete

The compressive strength on the work tests for different mixed shall be as given in Table 5.5 below:-



TABLE 5.5

Concrete Mix (Nominal Mix on Volume basis)	Compressive Strength in (Kg/ sq cm)	
	7 days'	28 days'
1:1:2	210	315
1:1.5:3	175	265
1:2:4	140	210

6.4.9 Testing of Concrete

6.4.9.0 Regular mandatory tests on the workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

- (a) Mandatory Lab, Test
- (b) Mandatory Field Test

Results of Mandatory Field Test will prevail over mandatory Lab. Test.

6.4.9.1 *Cube Test for Compressive Strength of Concrete - Mandatory Lab Test* : Mandatory tests shall be carried out as prescribed in Appendix A of Chapter 5.

6.4.9.2 *Additional Test* : Additional test, if required, shall be carried out as prescribed in Appendix B of Chapter 5.(CPWD)

6.4.9.3 *Slump Test* : This test shall be carried out as prescribed in sub-head 4 of concrete.

6.4.9.4 *Visual Inspection Test* : The concrete will be inspected after removal of the form work as described in para 6.4.7.2 The question of carrying out mandatory test or other tests described in Appendix A and B (para 6.4.9.1 and 6.4.9.2) will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected if:

- (i) It is porous or honeycombed as per para 6.4.7.2 (a).
- (ii) Its placing has been interrupted without providing a proper construction joint.



(iii) The reinforcement has been displaced beyond tolerance 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 at the risk and cost of the contractor.

6.4.10 Standard of Acceptance – for Nominal Mix

6.4.10.1 Mandatory Lab. Test : For concrete sampled and tested as prescribed in Appendix A of Chapter 5, the following requirement shall apply.

6.4.10.2 Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days.

6.4.10.3 7 days' Tests

Sampling: The average of the strength of three specimen shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than + 15% of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimen. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days' test shall have to be carried out.

Strength: If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength upto +15% then strength of the concrete shall be considered in order.

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days' test shall have to be carried out to determine the compressive strength of concrete cubes.

6.4.10.4 28 days' Test

- (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- (b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-Charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.



- (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
- (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge (see para 6.4.13.2).
- (e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests (See Appendix B of Chapter 5)(CPWD) to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

6.4.10.5 Acceptance Criteria of Field Test (Additional Test – Not Mandatory)

- (A) *Preparation of Standard Test Cubes for calibration of Rebound Hammer at site*
 - (a) In the beginning the standard test cubes of the specified mix shall be prepared by field units before undertaking any concrete work in each project.
 - (b) At least 18 standard cubes necessary for formation of one specimen of specified mix, shall be cast by site staff well in advance. From these 18 cubes any 3 cubes may be selected at random to be tested for crushing strength of 7 days. The crushing strength obtained should satisfy the specified strength for the mix as per specification or agreement. If the strength is satisfactory then the remaining cube will form the standard samples for calibration of rebound hammer. In case of failure, the site staff should totally reject the samples and remove them also and then make another set of samples by fresh mixing or alternatively, out of the remaining 15 cubes, 3 cubes will be tested on 28 days. If the 28 days' tests are found satisfactory then remaining 12 cubes will form the standard sample for calibration at 28 days' strength otherwise all samples shall be rejected and whole procedure repeated to form a fresh specimen. All the results shall be recorded in a register.
 - (c) No concreting will be allowed unless the standard specimen cubes are obtained. The criteria for acceptance and calibration of hammer will be 28 days' strength. The 7 days' strength is only to facilitate the work to start.



(d) No work (for the concrete cast between 8th and 28th day) shall be allowed to be paid unless 28 days' cube strength is obtained. For the concrete cast between 8th and 28th day, the decision to make the payment may be taken by the Engineer-in-charge on the basis of existing criteria. Concrete work will be rejected if 28 days' strength falls short as per acceptance criteria. No further work will be allowed till the acceptable standard cubes are obtained.

(e) *Frequency*: it will be once in each quarter or as per the direction and discretion of Engineer-in-Charge. Whenever the acceptance criteria is changed or concrete mix or type of cement is changed or Engineer-in-Charge feels it necessary for recorded reasons with the approval of the authority according to technical sanction, fresh specimen shall be prepared.

(B) Calibration of Hammer

(a) Simultaneously, same three cubes to be tested on 28 days as referred in para A (b) above shall be used to correlate the compressive strength of their concrete with rebound number as per procedure described in para 5.2 of the IS 13311 (Part 2) "Indian standard for non-destructive testing of concrete Method of test by rebound hammer which is given below in para B (b). The average of values of the rebound number (minimum readings) obtained in respect of same three cubes passing on 28 days' work test shall form the datum reference for remaining cubes for the strength of cubes.

(b) The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound hammer taken and then compressive strength determined as per IS 516. The fixed load required is of the order of 7 N/mm² when the impact energy of the hammer is about 2.2 NM. If the specimen are wet cured, they should be removed from wet storage & kept in the laboratory atmosphere for about 24 hours before testing. Only the vertical faces of the cubes as cast should be tested for rebound number. At least nine readings should be taken on each of the three vertical faces accessible in the compression testing machine when using rebound hammers. The points of impact in the specimen must not be nearer than 20 mm from the edge & should not be less than 20 mm from each other. The same points must not be impacted more than once.

(d) The rebound number of hammer will be determined on each of the remaining (18-3-3=12) cubes. Whenever the rebound number of hammer of any individual cube varies by more than +25% from the datum readings referred to in para B (a) above, that cube will be excluded and will not be considered for standard specimen cubes for calibration. It must be ensured that at least 8 cubes out of



12 that is 66.67% are within the permissible range of variation of rebound number i.e. +25% or otherwise whole procedure shall have to be repeated and fresh specimen prepared. These 8 cubes will form one standard sample in the beginning before commencement of work and shall be kept carefully for the visiting officers who will calibrate their hammers on these cubes.

- (e) This calibration will be done by field staff with their hammer and then chart of calibration giving the details of the average readings, date & month of casting, mix of the concrete etc. shall be prepared and signed by Engineer-in-Charge and will be duly preserved for future reference as and when required.

(C) Preservation of Cubes at site

Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the officers of QCTA/CTE or any other senior departmental officer, during their inspection of the work. They will calibrate their hammer on these cubes if required.

(D) Testing at Site

(D-1) Testing will be done generally by non-destructive methods like rebound hammers etc. Each field Division/ Sub Division/ Unit will purchase rebound hammers and keep them in working order at work site. The testing will be done only by hammers which are duly calibrated.

(D-2) The relative strength of actual field work will be tested with reference to strength of these standard cubes and calibration charts of a hammer for determining the rebound number on the field work. The hammer will be used as per manufacturer's guidelines at various locations chosen at random. The number of location/reading on each wall, beam or column etc. shall not be less than 12. All the readings should be within the +25% range of Values prescribed in calibration chart normally. However, reading indicating good strength will be when it is at per with calibrated value or between 100% & 125% and very good if more than 125% any value between 100% & 75% of calibrated value shall be considered satisfactory. Values from 75% to 50% shall be considered for payment at rates reduced on prorated basis. The concrete indicating rebound number less than 50% of calibrated value shall be rejected and not paid for.

(E) Acceptance of Field Tests and Strength



If the relative strength of actual field work is found satisfactory considering the calibration charts with reference to the standard cube test kept at site, the representative work will be considered satisfactory. If the work is considered below satisfactory, the same will be dealt as stated in para D-3 above.

(F) 7 days' Strength in Rare Cases only

Normally cube crushing strength on 28 days' test shall form the basis of acceptance. However in rare cases of time bound projects/ urgent repairs 7 days' cube test strength criteria may be adopted on similar lines using 7 days' standard test cubes and calibration graphs/ curves/ charts for 7 days' in lieu of 28 days' and testing work done at 7 days'.

(G) Precautions

(G-1) The testing shall be done generally as per guidelines of manufacture of the apparatus and strictly in accordance with the procedure laid down in clause 6 of IS 13311 (Part 2):

Indian Standard for Non-Destructive Testing of Concrete - Method of Test by Rebound Hammer.

(G-2) The rebound hammers are influenced by number of factor like type of cement aggregate, surface conditions, moisture content, age of concrete & extent of calibration of concrete etc. hence care shall be taken to compare the cement, aggregate etc. and tested under the similar surface conditions having more or less same moisture content and age.

However effect of age can be ignored for concrete between 3 days & 3 months old.

6.4.11 Measurements

6.4.11.1 Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm. The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic metre.

6.4.11.2 Reinforced cement concrete whether cast-in-situ or pre cast shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns and mass concrete etc. all work up to plinth level, column up to plinth level, plinth beams.

(b) Wall (any thickness) including attached pilasters, buttresses plinth and string course, fillets, column, pillars, piers, abutments, post and struts etc.



- (c) Suspended floors, roofs, landings and balconies.
- (d) Shelves
- (e) Chajjas

- (f) Lintel, beams and bressummers.
- (g) Columns, pillars, piers, abutments, posts and struts.

- (h) Stair-cases including waist or waist less slab but excluding landing except in (i) below.
 - (i) Spiral stair-case (including landing).
 - (j) Arches, arch ribs, domes and vaults.
 - (k) Chimneys and shafts.
 - (l) Well steining.
 - (m) Vertical and horizontal fins individually or forming box, louvers and facias.
 - (n) Kerbs, steps and the like.
 - (o) String courses, bands, coping, bed plates, anchor blocks, plain window sills and the like.
 - (p) Mouldings as in cornices, window sills etc.
 - (r) Shell, dome and folded plates.
 - (s) Extra for shuttering in circular work in plan.

6.4.11.3 Work under the following categories shall be measured separately.

- (a) Rafts, footings, bases of columns etc. and mass concrete.
- (b) All other items upto floor two level.
- (c) From floor two level to floor three level and so on.
- (d) R.C.C. above roof level shall be measured along with R.C.C. Work in floor just below.

6.4.11.4 No deduction shall be made for the following:



- (a) Ends of dis-similar materials (e.g. Joists, beams, post, griders, rafter, purlins, trusses, corbels steps etc.) upto 500 sq cm in cross-section.
- (b) Opening upto 0.1. sqm.

Note: In calculating area of openings upto 0.1 sqm the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.

- (c) The volume occupied by reinforcement.
- (d) The volume occupied by water pipes, conduits etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

6.4.11.5 Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

- (a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.
- (b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.
- (c) The columns measurements shall be taken through.
- (d) Chajjas along with its bearing on wall shall be measured in cubic metre nearest to two places of decimal. When chajjas is combined with lintel, slab or beam, the projecting portion shall be measured as chajjas, built in bearing shall be measured as per item of lintel, slab or beam in which chajja bears.
- (e) Where the band and lintels are of the same height and the band serves as lintel the portion of the band to be measured as lintel shall be for clear length of opening plus twice the overall depth of band.

6.4.12 Tolerances



Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C. members shall be as specified in the drawings by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the Engineer in- Charge after consultations with the Designer, if necessary. When tolerances in dimensions are permitted, following procedure for measurement shall apply.

- (a) If the actual dimension of R.C.C. members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurement.
- (b) If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.
- (c) If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.
- (d) For acceptance of RCC members whose dimensions are not exactly as per design dimensions, the decision of Engineer-in-Charge shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply.

6.4.13 Rate

6.4.13.1 The rate included the cost of materials and labour involved in all the operations described above except for the cost of centring and shuttering.

6.4.13.2 On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to specified compressive strength.

Example:

1. Average compressive strength in 80% of specified strength. Rate payable shall be 80% of agreement rate. 145 SUB HEAD 5.0 : REINFORCED CEMENT CONCRETE WORK.



2. In case average compressive strength is less than 70% of the specified strength, the work represented by the sample shall be rejected.

3. However, on the basis of mandatory field tests, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength shall be worked out as per para 6.4.10.5 (D-3) above. In addition, Engineer-in-charge may order for additional tests (see Appendix 'B' of chapter 5) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples had been used, can be retained on the basis of these tests. Engineer-in-Charge may take further remedial measured as necessary to retain the structure at the risk and cost of the contractor.

6.4.13.3 Where throating or plaster drip or moulding is not required to be provided in RCC chajjas, deduction for not providing throating or plaster drip or moulding shall be made from the item of R.C.C. in chajjas. The measurement for deduction item shall be made in running meters correct to a cm of the edge of chajja.

6.4.13.4 No extra payment for richer mix which projects into any member from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawings. The payment for work done under items of different mixed shall be limited strictly to what is indicated in the structural drawings.

6.5 ENCASING ROLLED STEEL SECTIONS

6.5.1 General Requirements

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

6.5.2 Wrapping

6.5.2.1 In case of columns, the wrapping shall be arranged to pass through the centre of the concrete covering. The wrapping of the entire length of the columns be carried out in stages and no stage shall cover more than 1.5 metre of height of columns. Successive wrappings shall be carried out only after the immediate



adjacent wrapping has been encased in concrete. The surface and edges of the flanges of the steel columns shall have a concrete cover of not less than 50mm. The wrappings of the successive stages shall be tied together.

6.5.2.2 In the case of beams and grillages, the wire mesh or expanded metal shall be wrapped round the lower flange of the beam and the wrapping shall be suspended by wire hangers 5 mm diameter placed at about 1.2 metres centres. The surfaces and edges of the steel sections shall have a concrete cover of not less than 50mm. The wrapping shall pass through the centre of the concrete covering at the edges and soffits of the flanges.

6.5.3 Form Work shall be as prescribed in 6.2.

6.5.4 Concreting

Concrete shall consist of a mix of 1:2:4 (1 cement : 2 coarse and : 4 graded stone aggregate of 12.5 mm nominal size) unless a richer mix is specified. The mix shall be poured solidly around the steel sections and around the wrapping by vibrating the concrete into position. Consistency of concrete, Placing of concrete and its compaction, curing, finishing and strength of concrete shall be as described in 6.4.

6.5.5 Measurements

The length shall be measured correct to one cm and other dimensions correct of 0.5 cm. The cement concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of plaster. No deduction shall be made for the volume of steel sections, expanded metal, mesh or any other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion only shall be deducted. Fabric reinforcement such as expanded metal shall be measured separately in square metres stating the mesh and size of strands. The description shall include the bending of the fabric as necessary, Racking or circular cutting and waste shall be included in the description.

6.5.6 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the cost of fabric reinforcement. The cost of providing and erecting steel section and wire hangers shall be paid for separately.

7. PITCHING

1.1 Pitching / Rivetment of slopes

7.1.1 **Description** - This work shall consist of covering the slopes of guide bunds, training works and road embankments with stone, shoulders, boulders, cement concrete blocks or stones in wire crates over a layer of granular material called filter. While river side slopes are given this protection against river action, the rear slopes, not subjected to direct attack of the river, may be protected against ordinary wave splashing by 0.3 – 0.6 metre thick cover of clayey or silty earth and turfed.

1.2 Pitching / Filter media

7.2.1 **Pitching** - The pitching shall be provided as indicated in the drawings. The thickness and the shape of stone pitching shall be shown on the drawing. The stone shall be sound, hard, durable and fairly regular in shape. Quarry stone should be used. Round boulders shall not be allowed. The stones subject to marked deterioration by water or weather shall not be accepted.

The size and weight of stone shall conform to clause 5.3.5.1 of IRC : 89(Annexure 2500-A.1). No stone, weighing less than 40 kg shall, however, be used. The sizes of spalls shall be a minimum of 25 mm and shall be suitable to fill the voids in the pitching.

Where the required size stones are not economically available, cement concrete blocks in M15 grade conforming to section 1700 or stones in wire crates may be used in place of isolated stones of equivalent weight. Cement concrete blocks will be preferred wherever practicable. Use of geo-synthetics has been dealt with in Section 700.

7.2.2 **Filter media** - The material for the filter shall consist of sand, gravel, stone or coarse sand. To prevent escape of the embankment material through the voids of the stone pitching / cement concrete blocks as well as to allow free movement of water without creating any uplift head on the pitching, one or more layers of graded materials, commonly known as a filter medium, shall be provided underneath the pitching.

7.2.3 The gradation of the filter material shall satisfy the following requirements:

Provision of a suitably designed filter is necessary under the slope pitching to prevent the escape of underlying embankment material through the voids of stone



pitching/cement concrete blocks when subjected to the attack of flowing water and wave action, etc. In order to achieve this requirement, the filter may be provided in one or more layers satisfying the following criteria:

D 15 (Filter)
 ----- < 5
 D 85 (Base)

D 15 (Filter)
 4 < ----- < 20
 D 15 (Base)

D 50 (Filter)
 ----- < 25
 D 50 (Base)

Notes:

- 1) Filter design may not be required if embankment consists of CH or Ch soils with liquid limit greater than 30, resistant to surface erosion. In this case, if a layer of material is used as bedding for pitching, it shall be well graded and its D 85 size shall be at least twice the maximum void size in pitching.
- 2) In the foregoing, D 15 means the size of that sieve which allows 15 per cent by weight of the filter material to pass through it and similar is the meaning of D 50 and D 85.
- 3) If more than one filter layer is required, the same requirement as above shall be followed for each layer. The finer filter shall be considered as base material for selection of coarser filter.
- 4) The filter shall be compacted to a firm condition. The thickness of filter is generally of the order of 200 mm to 300 mm. Where filter is provided in two layers, thickness of each layer shall be 150 mm.

7.2.4 Construction operations - Before laying the pitching, the sides of banks shall be trimmed to the required slope and profiles put up by means of line and pegs



at intervals of 3 metres to ensure regular straight work and a uniform slope throughout. Depressions shall be filled and thoroughly compacted.

The filter granular material shall be laid over the prepared base and suitably compacted to the thickness specified on the drawings. The lowest course of pitching shall be started from the toe wall and built up in courses upwards. The toe wall shall be in dry rubble masonry (uncoursed), in case of dry rubble pitching and shall be in nominal mix cement concrete (M 15) , in case of cement concrete block pitching. The stone pitching shall commence in a trench below the toe of the slope. Stone shall be placed by derrick or by hand to the required length, thickness and depth conforming to the drawings. Stones shall be set normal to the slope, and placed so that the largest dimension is perpendicular to the face of the slope, unless such dimension is greater than the specified thickness of pitching. The largest stones shall be placed in the bottom courses and for use as headers for subsequent courses.

In hand placed pitching, the stone of flat stratified nature should be placed with the principal bedding plane normal to the slope. The pattern of laying shall be such that the joints are broken and voids are minimum by packing with spalls, wherever necessary, and the top surface is as smooth as possible.

When two or more layers of stone must be laid to obtain the design thickness of pitching, dry masonry shall be used and stones shall be well bonded. To ensure regular and orderly disposition of the full intended quantity of stone as shown, template cross walls in dry masonry shall be built about a metre wide and to the full height of the specified thickness at suitable intervals and all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

Toe protection - In conformity with clause 5.3.7. of IRC : 89, a toe wall shall be provided at the junction of slope pitching and launching apron of a guide bund so as to protect the slope pitching from falling even when the apron is not laid at low water level. The toe wall shall be in dry rubble masonry (uncoursed) in case of dry rubble pitching or pitching / revetment with stones in wire crates and in nominal mix cement concrete (M 15) in case cement concrete blocks have been used in pitching. For protection of toes of bank slopes terminating either in short aprons at



bed levels or anchored in flooring / rocky bed, the provisions of clause 8.2.2 of IRC: 89 may be compiled with. The relevant specifications of the protective works for individual components will be followed.

8 WATER BOUND MACADAM SUB-BASE / BASE (for item number 18 and 19)

SPECIFICATIONS FOR WATER BOUND MACADAM SUB-BASE / BASE

1.1 Scope

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on a properly prepared subgrade/sub-base / base or existing pavement, as the case may be and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the engineer.

It is, however, not desirable to lay water bound macadam on an existing thin black topped surface without providing adequate drainage facility for water that would get accumulated at the interface of existing bituminous surface and water bound macadam.

1.2 Materials

8.2.1 Course aggregates - Coarse aggregates shall be either crushed or broken stone, crushed slag, over burnt (Jhama) brick aggregates or any other naturally occurring aggregates such as Kankar and Laterite of suitable quality. Materials other than crushed or broken stone and crushed slag shall be used in sub-base courses only. If crushed gravel/ shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 6. The type and size range of the aggregate shall be specified in the contract or shall be as specified by the engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part 5)- copy enclosed as Annexure.



8.2.2 Crushed or broken stone - The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and distinguished particles, dirt and other deleterious material.

Table 6 Physical requirements of coarse aggregates for water bound macadam for sub– base courses

Test	Test Method	Requirements
* Los Angeles Abrasion value or *Aggregate impact value	IS:2386 IS:2386 (Part-4) or IS;5640**	40 percent (Maxi.) 30 percent (Maxi.)
Combined Flakiness and Elongation indices (Total)***	IS:2386 (Part - 1)	30 percent (Maxi.)

* Aggregate may satisfy requirements of either of the two sets.

** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet condition in accordance with IS: 5640.

*** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

8.2.3 Crushed slag - Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 KN per m³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements

Chemical stability	To comply with requirements of appendix of BS : 1047
--------------------	--



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

	Sulphur content	Maximum 2 per cent
	Water absorption	Maximum 10 per cent

8.2.4 Over burnt brick aggregates - Brick aggregates shall be made from over burnt bricks or brick bats and be free from dust and other objectionable and deleterious materials.

8.2.5 Grading requirement of coarse aggregates - The coarse aggregates shall conform to one of the Gradings given in Table 7 as specified, provided; however, the use of Grading No. 1 shall be restricted to sub-base courses only.

Table 7, Grading requirements of coarse aggregates

Gradation	Size range	I.S. Sieve designation	Percent by weight passing
1	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2	63 to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

		22.4 mm	0-5
3	53 to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

Note: The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other gradings i.e., 2 & 3, it shall be 75 mm.

8.2.6 Screenings - Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

Screenings shall conform to the grading set forth in Table 8. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 9. The table also gives the quantities of materials (loose) required for 10 sq.m for sub-base / base compacted thickness of 100/75 mm. The use of screenings shall be omitted in the case of soft aggregates such as brick metal, Kankar, Laterites, etc. as they are likely to get crushed to a certain extent under rollers.

Table 8 Grading for screenings

Grading classification	Size of screenings	IS Sieve designation	Per cent by weight passing the IS sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 mcn	0-10



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 mcn	15-35

Table 9, Approximate quantities of coarse aggregates and screenings required for 100 / 75 mm compacted thickness of water bound macadam (Wbm) sub-base / base course for 10 sq.m area

Classification	Size Range	Compact thickness	Loose Qty.	Screenings			
				Stone screening		Crushable type such as moorum or gravel	
				Grading classification and size	For WBM sub-base/ base course (loose Qty)	Grading classification and size	Loose Qty.
Grading 1	90 mm to 45 mm	100 mm	1.21 to 1.43 m ³	Type A 13.2 mm	0.27 to 0.30 m ³	Not Uniform	0.30 to 0.32 m ³
Grading 2	63mm to 45 mm	75 mm	0.91 to 1.07m ³	Type A 13.2 mm	0.12 to 0.15 m ³	- do -	0.22 to 0.24 m ³



- do -	- do -	- do -	- do -	Type B 11.2 mm	0.20 to 0.22 m ³	- do -	- do -
Grading 3	53mm to 22.4 mm	75 mm	- do -	- do -	0.18 to 0.21 m ³	- do -	- do -

8.2.7 Binding material - Binding material to be used for water bound macadam as a filler material meant for preventing raveling, shall comprise of a suitable material approved by the engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part 5).

The quantity of binding material where it is to be used will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06 – 0.09 cu.m / 10sq.m and 0.08 – 0.10 cu.m/ 10 sq.m for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

8.3 Construction operations

8.3.1 Preparation of bases - The surface of the subgrade /sub-base/base to the specified lines and crossfall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base /base / surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course)

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the



existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one metre intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

8.3.2 Inverted choke - If water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on the prepared subgrade before application of the aggregates is taken up. In case of a fine sand or silty or clayey subgrade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of fine grained soil, the gradation of which will depend upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geo-synthetics performing functions of separation and drainage may be used over the prepared subgrade as directed by the engineer. Section 700 shall be applicable for use of geo-synthetics.

8.3.3 Spreading coarse aggregates - The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in clause 18.1.2.5. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings.



The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

8.4 Rolling - Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 KN capacity or tandem or vibratory rollers of 80 to 100 KN static weight. Type of roller to be used shall be approved by the engineer based on trial run. Except on super-elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. The edge/edges shall be compacted with roller running forward and backward. Roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired crossfall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates. It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses.

8.5 Application of screenings - After the coarse aggregate has been rolled to clause 18.1.3.4. Screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates.



The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate. The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and becoming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate. The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

- 8.6 Sprinkling of water and grouting** - After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

In case of lime treated soil sub-base, construction of water bound macadam on top of it can cause excessive water to flow down to the lime treated sub-base before it has picked up enough strength (is still "green") and thus cause damage to the sub-base layer. The laying of water bound macadam layer in such cases shall be done after the sub-base attains adequate strength, as directed by the engineer.

- 8.7 Application of binding material** - After the application of screenings in accordance with clauses 18.1.3.5. And 18.1.3.6. The binding material where it is required to be used (clause 18.1.2.7.) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding



material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

8.8 Setting and drying - After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface. The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

8.9 Surface finish and quality control work

The surface finish of construction shall conform to the requirements Control on the quality of materials and works shall be exercised by the engineer.

9.1 The water bound macadam work shall not be carried out when the atmospheric temperature is less than 0 deg. C. in the shade.

8.10 Reconstruction of defective macadam - The finished surface of water bound macadam shall conform to the tolerance of surface regularity. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to subgrade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. In no case shall depressions be filled up with screenings or binding material.

8.11 Arrangement for traffic - During the period of construction, the arrangement of traffic shall be done.

8.12 Measurements for payment - Water bound macadam shall be measured as finished work in position in cubic metres.

8.13 Rate - The contract unit rate for water bound macadam sub-base/base course shall be payable in full compensation for all components, including arrangement of water used in the work as approved by the engineer.



9. WET MIX MACADAM BASE

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-base as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as direction by the Engineer. The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm.

9.1 Materials

9.1.1 Aggregates

Physical requirements: Coarse aggregates shall be crushed stone. If crushed gravel is used, not less than 90 percent by weight of the gravel pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements as given below table.

TABLE: PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR BASE COURSES

	Test	Test Method	Requirements
1.	* Los Angeles abrasion value or	IS : 2386 (Part-4)	40 per cent (Max.)
	* Aggregate Impact value	IS : 2386 (Part-4) or IS : 5640	30 per cent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS : 2386 (Part-1)	30 per cent (Max.)**

* Aggregate may satisfy requirements of either of the two tests.

** To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated

particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part- 5).

Grading requirements: The aggregates shall conform to the grading given in Table below.

TABLE: GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

9.2 Construction Operations

9.2.1 **Preparation of base:** The surface of the sub-base to receive the wet mix macadam course shall be prepared to the specified lines and crossfall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course).

9.2.2 **Provision of lateral confinement of aggregates:** While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer.



9.2.3 **Preparation of mix:** Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

9.2.4 **Spreading of mix:** Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

- (i) Loading hoppers and suitable distribution mechanism
- (ii) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.
- (iii) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

9.2.5 **Compaction:** After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory



roller of minimum static weight of 80 to 100 kN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one- third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

9.2.6

Setting and drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

9.3 Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

9.4 Surface Finish and Quality Control of Work

Control on the quality of materials and surface finishing shall be as per direction of the Engineer.

9.5 Prime Coat Over Granular Base

This work shall consist of application of single coat of low viscosity liquid bituminous material to an absorbent granular surface preparatory to any superimposed bituminous treatment or construction.

9.5.1 Materials

The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:

- (i) Surfaces of low porosity; such as wet mix macadam and water bound macadam,
- (ii) Surfaces of medium porosity; such as cement stabilized soil base,
- (iii) Surfaces of high porosity; such as a gravel base.

The different ranges of viscosity requirements for the primers to be used for the different types of surfaces to be primed as classified are given in Table.

VISCOSITY REQUIREMENT AND QUANTITY OF BITUMINOUS PRIMER

Type of surface	Kinematic Viscosity of Primer at 60° C (Centistokes)	Quantity per 10 sq. m (Kg)
Low porosity	30-60	6 to 9
Medium porosity	70-140	9 to 12
High porosity	250-500	12 to 15

The bituminous primer shall be Medium Curing Cutback (MC) produced by fluxing, in an approved manner, bitumen of 80/100 penetration grade with kerosene. The cutback shall be free from water and shall not show any signs of separation prior to use. Slow setting Cationic emulsion as per IS: 8887 may also be used, but the particular grade to be used for the work shall be got approved by the Engineer.

Sampling and testing of bituminous primer shall be as per IS: 217; IS: 454 and



IS: 8887.

9.5.2 Weather and Seasonal Limitations

The bituminous primer shall not be applied on a wet surface or during dust storm or when the weather is foggy, rainy or windy. The prime coat for surface treatment should not be applied when the temperature in the shade is less than 10°C.

9.6 Construction

Equipment: The primer distributor shall be pneumatic tyred self-propelled pressure distributor equipped for spraying the material uniformly at the specified rates and temperatures. Spraying by manual methods may be allowed for small areas at the discretion of the Engineer. Power broom and/or blowers may be supplemented by hand brooms as directed by the Engineer.

Preparation of road surface: The surface to be primed shall be swept clean, free from dust and shall be dry. It shall be shaped to the specified grades and section. It shall also be free from ruts, any other irregularities and segregated materials. Minor depressions and potholes may be ignored until the surface is primed, after which they shall be patched with a suitable premix material prior to the surface treatment.

Application of bituminous primer: The bituminous primer shall be sprayed/distributed uniformly over the prepared dry surface using self-propelled sprayer equipped with self-heating arrangement, suitable pump, adequate capacity compressor and spraying bar with nozzles having constant volume or pressure system capable of supplying primer at specified rates and temperatures so as to provide a uniformly unbroken spread of primer. If the surface to be primed is so dry or dusty as to cause freckling of bituminous material, it shall be lightly and uniformly sprinkled with water immediately prior to priming; however, the bituminous material shall not be applied till such time as no surface water is visible. The primer shall be applied at the rate as specified in above Table.

Temperature of application of a primer need only be high enough to permit the primer to be effectively sprayed through the jets of the spray bar and to cover the granular base surface uniformly in the desired quantity.

The desirable range of temperatures at the time application of MC-30, MC-70 and MC-250 grades shall be 30 to 55⁰ C; 50 to 80⁰ C and 75 to 100⁰ C respectively. For a bituminous emulsion primer, the range of spraying temperature may be 20 to 60⁰ C.

Following the application of bituminous material, the surface shall be allowed to cure for at least 24 hours or for any other period so as to allow penetration



into the base course and aeration of volatiles from the primer material. If it is not absorbed within 24 hours after application, sand shall be spread over the surface to blot the excess primer. Care shall be taken to prevent over-priming; any pools of excess primer left on any part of the surface shall be swept out over the adjacent surface before spreading sand.

The primer coat shall be applied only on the topmost water bound macadam or any granular layer, over which the bituminous base course/wearing course, is to be laid.

Curing of primer and opening to traffic: It shall always be ensured that while opening to any kind of traffic, the primed surface is fully cured and is not sticky to avoid being picked up by traffic. Normally, the primed surface shall be allowed to cure for not less than 24 hours and during this period no traffic of any kind shall be permitted.

Laying of bituminous course over primed surface: Bituminous base course or wearing course shall be laid over the primed water bound macadam, wet mix macadam or any other granular base course, in the usual manner as per relevant Specification for the same including the requirement of tack coat as per above clauses.

9.7 Quality Control of Work

Control on the quality of materials and work shall be as per directions of the Engineer.

10 DENSE BITUMINOUS MACADAM

This work shall consist of construction in a single course of 50 to 100 mm thick base/binder course to the following Specifications on a previously prepared base.

10.1 Materials

10.1.1 **Bitumen:** The bitumen shall be paving bitumen of Grade VG-10, VG-20, VG-30, VG-40 as per Indian Standard Specifications for "Paving Bitumen" IS: 73-2006.

10.1.2 **Coarse aggregates:** The coarse aggregates shall consist of crushed stone, crushed gravel/shingle or other stones. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall be treated with antistripping



agents of approved quality in suitable doses. The aggregates shall satisfy the physical requirements as given below table.

TABLE: PHYSICAL REQUIREMENTS OF AGGREGATES FOR DENSE BITUMINOUS MACADAM

S.No	Test	Test Method	Requirement
1.	Los Angeles Abrasion Value *	IS: 2386 (Part-4)	40 per cent Maximum
2.	Aggregate Impact value *	IS: 2386 (Part-4)	30 per cent Maximum
3.	Flakiness and Elongation** Indices (Total)	IS: 2386 (Part-1)	30 per cent Maximum
4.	Coating and Stripping of Bitumen Aggregate Mixtures	AASHTO T 182	Minimum retained coating 95 per cent
5.	Soundness	IS: 2386 (Part-5)	12 per cent Maximum 18 per cent Maximum
	(i) Loss with Sodium Sulphate	5 cycles	
	(ii) Loss of Magnesium Sulphate	5 cycles	
6.	Water absorption	IS: 2386 (Part-3)	2 per cent Maximum

* Aggregates may satisfy requirements of either of the two tests.

** To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone

metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The portion of the total aggregate passing 4.75mm sieve shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part-37).

The plasticity index of the fraction passing the 425 micron sieve shall not exceed 4.

10.1.3 **Fine aggregates:** Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crusher-run screening, gravel, sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.



10.1.4 **Filler:** Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement as approved by the Engineer.

The filler shall be graded within the following limits:

IS Sieve	Per cent passing by weight
600 Micron	100
300 Micron	95 - 100
75 Micron	85 – 100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by mass of total aggregate of portland cement or hydrated lime shall be added and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Aggregate gradation: The combined coarse and fine aggregates and filler (when used) shall produce a mixture to conform to the grading set forth in Table below.

Table: AGGREGATE GRADATION FOR DENSE BITUMINOUS MACADAM

Sieve Designation	Percentage passing the sieve by weight
37.5 mm	100
26.5 mm	90-100
13.2 mm	56-80
4.75 mm	29-59
2.36 mm	19-45
300 micron	5-17
75 micron	1-7

The aggregate mix, as used in work, shall not vary from the low limit on one sieve to the high limit on the adjacent sieve but shall be well graded.

10.2 **Mix Design**

10.2.1 **Requirement of mix:** Apart from conformity with grading and quality requirements of individual ingredients, the mix shall meet the requirements set out in Table below.



Table: REQUIREMENTS OF DENSE BITUMINOUS MACADAM MIX

<i>S. No.</i>	<i>Description</i>	<i>Requirements</i>
1.	Marshall stability (ASTM Designation-D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb) minimum
2.	Marshall flow (mm)	2-4
3.	Per cent Air voids	3-5
4.	Minimum voids in mineral aggregates (VMA)	10 percent-12per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content percent by weight of total mix	Not less than 4.0%

10.2.2 Binder content: The binder content shall be so fixed as to achieve the requirements of the mix set out in the above Table. Marshall method for arriving at the binder content shall be adopted, replacing the aggregates retained on 26.5 mm sieve by the aggregates passing 26.5 mm sieve and retained on 22.4 mm sieve.

10.2.3 Job mix formula: The Contractor shall intimate to the Engineer in writing, atleast 20 days before the start of the work, the job mix formula proposed to be used by him for the work and shall give the following details:

- i) Source and location of all materials;
- ii) Proportions of all materials expressed as follows where each is applicable;
 - (a) Binder, as percentage by weight of total mix;
 - (b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler.
- iii) A single definite percentage passing each sieve for the mixed aggregate;
- iv) The results of tests enumerated in above Table as obtained by the Contractor;
- v) Test results of physical characteristics of aggregates to be used;



vi) Mixing temperature and compacting temperature.

While working out the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the former.

The approved job mix formula shall remain effective unless and until modified by the Engineer. Should a change in the source of materials be proposed, a new job mix formula shall be established and got approved from the Engineer before actually using the materials.

10.2.4 **Permissible variation from job mix formula:** It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in below Table.

TABLE: PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

S. No.	Description of Ingredients	Permissible variation by weight of total mix-in per cent
1.	Aggregate passing 13.2 mm sieve and larger sieves	± 8
2.	Aggregate passing 11.2 mm sieve and 5.6 mm sieve	± 7
3.	Aggregate passing 2.80 mm sieve and 1.40 mm sieve	± 6
4.	Aggregate passing 710 micron sieve and 355 micron sieve	± 5
5.	Aggregate passing 180 micron sieve	± 4
6.	Aggregate passing 90 micron sieve	± 2
7.	Binder	± 0.3
8.	Mixing temperature	± 10°C

10.3 **Construction Operations**

10.3.1 **Weather and seasonal limitations:** The work of laying shall not be taken up during rainy or foggy weather or when the base course is damp or wet, or during dust storm or when the atmospheric temperature in shade is 10°C or less.

10.3.2 **Preparation of base:** The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades



and cross sections as indicated in the drawings or as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used. A priming coat where needed, shall be applied as per direction of the Engineer.

10.3.3

Tack coat

The surface on which the tack coat is to be applied shall be cleaned of dust and any extraneous material before the application of the binder, by using a mechanical broom or any other approved equipment/method as specified by the Engineer.

Binder may be heated to the temperature appropriate to the grade of cutback used and approved by the Engineer and sprayed on the base at the rate specified in below Table. The normal range of spraying temperature for a bituminous emulsion shall be 20 ° C - 60 ° C and for a cutback 50 ° C – 80 ° C if RC-70/MC-70 grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer with self-heating arrangement and spraying bar with nozzles having constant volume or pressure system, capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface. After application and prior to succeeding construction allow the tack coat to cure, without being disturbed, until the water/cutter has completely evaporated, as determined by the Engineer.

TABLE: RATE OF APPLICATION OF TACK COAT

	Type Surface	Quantity of liquid Bituminous material in kg per 10 sq. m. area
i)	Normal bituminous surfaces	2.0 to 2.5
ii)	Dry and hungry bituminous surfaces	2.5 to 3.0
iii)	Granular surfaces treated with primer	2.5 to 3.0
iv)	Non bituminous surfaces	
	a) Granular base (not primed) b) Cement concrete pavement	3.5 to 4.0 3.0 to 3.5

Note:

There is no need to apply a tack coat on a freshly laid bituminous course if the subsequent bituminous course is overlaid the same day without opening it to traffic.



10.3.4 **Preparation of mix:** Dense Bituminous macadam mix shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates.

Hot mix plant shall be of suitable capacity preferably of batch mix type. Total system for crushing of stone aggregates and feeding of aggregate fractions in required proportions to achieve the desired mix, deployed by the Contractor must be capable of meeting the overall Specification requirements under stringent quality control. The plant shall have the following essential features:

General

- (a) The plant shall have coordinated set of essential units capable of producing uniform mix as per the job mix formula.

- Cold aggregate feed system with minimum 4 bins having belt conveyor arrangement for initial proportioning of aggregates from each bin in the required quantities. In order to have free flow of fines from the bin, it is advisable to have vibrator fitted on bin to intermittently shake it.

- (c) Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyer for measuring the flow of aggregates.

- (d) Dryer unit with burner capable of heating the aggregate to the required temperature without any visible unburnt fuel or carbon residue on the aggregate and reducing the moisture content of the aggregate to the specified minimum.

- (e) The plant shall be fitted with suitable type of thermometric instruments at appropriate places so as to indicate or record/register the temperature of heated aggregate, bitumen and mix.

- (f) Bitumen supply unit capable of heating, measuring/metering and spraying of bitumen at specified temperature with automatic synchronisation of bitumen and aggregate feed in the required proportion.

- (g) A filler system suitable to receive bagged or bulk supply of filler material and its incorporation to the mix in the correct quantity wherever required.

- (h) A suitable built-in dust control system for the dryer to contain/recycle permissible fines into the mix. It should be capable of preventing the exhaust of fine dust into atmosphere for environmental control wherever so specified by the Engineer.



- (i) The plant should have centralised control panel/cabin capable of presetting, controlling/synchronising all operations starting from feeding of cold aggregates to the discharge of the hot mix to ensure proper quality of mix. It should have indicators for any malfunctioning in the operation.
- (j) Every hot mix plant should be equipped with siren or horn so that the operator may use the same before starting the plant every time in the interest of safety of staff.

The temperature of binder at the time of mixing shall be in the range of 150°C to 163°C and that of the aggregate in the range of 155°C-163°C provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C.

Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly, and the discharge temperature of mix shall be between 130°C to 160 °C.

The mixture shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for transport shall be clean and be covered in transit if so directed by the Engineer. Any tipper causing excessive segregation of materials by its spring suspension or other contributing factors or that which shows undue delay shall be removed from the work unit such conditions are corrected.

10.3.5 Spreading: The mix transported from the hot mix plant to the site shall be spread by means of a self-propelled paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, lines and cross-section. However, in restricted locations and in narrow widths where the available equipment cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix. Similarly for smaller jobs, mechanical paver may be used with the approval of the Engineer.

The temperature of mix at the time of laying shall be in the range of 120⁰-160⁰ C.

Mixes with a temperature of less than 120⁰ C shall not be put into paver spreader. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal and transverse joints shall be offset by at least 250 mm from those in the lower courses and the joint on the top most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80°C laying of adjacent material.



10.3.6

Rolling: After spreading the mix by paver, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km/h, immediately following close to the paver. Generally the initial or breakdown rolling shall be done with 80-100 kN static weight smooth-wheeled roller. The intermediate rolling shall be done with 80-100 kN static weight vibratory roller or with a pneumatic tyred roller of 150-250 kN weight having a tyre pressure of at least 0.7 MPa. The finish rolling shall be done with 60-80 kN weight smooth wheeled tandem roller. All the compaction operations, i.e., breakdown rolling and intermediate rolling can be accomplished by using vibratory tandem roller of 80-100 kN static weight. During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good. The rollers shall not be permitted to stand on pavement which has not been fully compacted and where temperature is still more than 70°C. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the centre, except that on superelevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the mix and each pass of the roller shall overlap the preceding one by half the width of the rear wheel.

Rolling shall be continued till the density achieved is at least 98 per cent of that of laboratory Marshall specimen (compacted as defined in Table requirements of Dense Bituminous Macadam mix) and all roller marks are eliminated. Skin patching of an area that has been rolled will not be permitted. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100°C.

10.3.7

Opening to Traffic

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. The Dense Bituminous Macadam shall be provided with an appropriate wearing course as early as possible prior to regular opening to normal traffic and/or impending rain.



10.3.8 **Surface Finish and Quality Control of Work**

Control on the quality of materials & surface finishing shall be as per direction of the Engineer.

11 **BITUMINOUS CONCRETE**

11.1 This work shall consist of constructing in a single layer, bituminous concrete (asphaltic concrete) of thickness 25-100 mm on previously prepared bituminous course to the requirements of these Specifications.

Materials

11.1.1 **Bitumen:** The bitumen shall be paving bitumen of Grade VG-10, VG-20, VG-30, VG-40 as per Indian Standard Specifications for "Paving Bitumen" IS: 73-2006.

11.1.2 **Coarse aggregates:** The coarse aggregates shall consist of crushed stone, crushed gravel/shingle or other stones. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall be treated with antistripping agents of approved quality in suitable doses. The aggregates shall satisfy the physical requirements as indicated in clause 6.02.02.

If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The portion of the total aggregate passing 4.75mm sieve shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part-37).

The plasticity index of the fraction passing the 425 micron sieve shall not exceed 4.

11.1.3 **Fine aggregates:** Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crusher-run screening, gravel, sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

11.1.4 **Filler:** Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement as approved by the Engineer.



The filler shall be graded within the following limits:

IS Sieve	Per cent passing by weight
600 Micron	100
300 Micron	95 - 100
75 Micron	85 - 100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by mass of total aggregate of portland cement or hydrated lime shall be added and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

- 11.1.5 Aggregate gradation: The combined coarse and fine aggregates and filler (when used) shall produce a mixture to conform to the grading set forth in Table below.

Table: AGGREGATE GRADATION FOR BITUMINOUS CONCRETE

Sieve Designation	Percentage passing the sieve by weight
26.5 mm	100
19 mm	90 - 100
9.5 mm	56 - 80
4.75 mm	35 - 65
2.36 mm	23 - 49
300 micron	5 - 19
75 micron	2 - 8

The aggregate mix, as used in work, shall not vary from the low limit on one sieve to the high limit on the adjacent sieve but shall be well graded.

- 11.1.6 **Mix Design**

- 11.1.7 **Requirement of mix:** Apart from conformity with the grading and quality requirements of individual ingredients, the mix shall meet the requirements set forth in Table below.



TABLE: REQUIREMENTS OF BITUMINOUS CONCRETE MIX

S. No.	Description	Requirements
1.	Marshall stability (ASTM Designation: D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb) Minimum
2.	Marshall flow (mm)	2-4
3.	Per cent voids in mix	3-5
4.	Per cent voids in mineral aggregates (VMA)	Minimum 11-13 per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content, per cent by weight of total mix	Minimum 4.5
7.	Water Sensitivity (ASTM D1075) Loss of stability on immersion in water at 60° C	Min 75 per cent retained strength
8.	Swell Test (Asphalt Instt. MS-2, No. 2)	1.5 per cent Max

11.1.8 **Binder content:** The binder content shall be so fixed as to achieve the requirements of the mix set forth in above Table. Marshall method for arriving at the binder content shall be adopted.

11.1.9 **Job mix formula:** Clause 6.03.03 shall apply except that the requirement of Bituminous Concrete mix shall be as per above table.

11.1.10 **Permissible variations from the job mix formula:** The Contractor shall have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix. The permissible variations of individual percentages of various ingredients in the actual mix from the job mix formula may be within the limits as specified in clause 6.03.04.

11.2 Construction Operations

11.2.1 **Weather and seasonal limitations:** The work of laying shall not be taken up during rainy or foggy weather or when the base course is damp or wet, or during dust storm or when the atmospheric temperature in shade is 10°C or less.

11.2.2 **Preparation of base:** The base on which bituminous concrete is to be laid shall be prepared, shaped and conditioned to the specified levels, grade and crossfall (camber) as per drawing.

The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed by mechanical means or blown off



by compressed air. In portions where mechanical means cannot reach, other approved method shall be used.

- 11.2.3 **Tack coat:** A tack coat complying above shall be applied over the base.
- 11.2.4 **Preparation of mix:** Above Clause relating to preparation of mix shall apply.
- 11.2.5 **Spreading:** Above Clause relating to spreading of mix shall apply.
- 11.2.6 **Rolling:** Above Clause relating to rolling shall apply.
- 11.2.7 **Opening to Traffic**

Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.

Surface Finish and Quality Control of Work

Control on the quality of materials and surface finishing shall be as per direction of the Engineer.

12 GENERAL REQUIREMENTS FOR BITUMEN MACADAM & SEAL COAT

- 12.1 **Testing:** The contractor shall have a well equipped testing laboratory with a competent laboratory staff. Daily test (not less than two specimen per day) shall be made by them on the bituminous mixture produced to ensure compliance with these specification and copy of the test results duly signed by the competent authority shall be submitted to owner for record. Tests shall include water absorption, stability, filler content etc. The contractor shall give all facilities at all items to the owner or his representative to inspect the work or testing done by him. Generally the frequency of site test shall be carried out as follows:-

A) Borrow material

- a) Sand content (IS: 2720-part IV) -- 1 to 2 tests per 8000 cum of soil
- b) Plasticity test (IS: 2720-part V) -- 1 to 2 tests per 8000 cum of soil
- c) Density test (IS: 2720-part VII) -- 1 to 2 tests per 8000 cum of soil
- d) Moisture content test (IS: 2720-part II)—1 test per 250 cum of soil
- e) CBR test (IS: 2720-part XVI) -- 1test per 3000 cum of soil
- f) Compaction control (IS: 2720-part XXVIII) -- 1test per 1000 Sqm area

B) Water Bound Maccadam

- a) Aggregate impact value -- 1 test per 200 cbm of aggregate
- b) Grading -- 1 test per 100 cbm of aggregate



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

- c) Flakiness index -- 1 test per 200 cbm of aggregate
- d) Atterbergs limits -- 1 test per 25 cbm of binding material

C) Prime coat/Seal coat

- a) binder temperature -- at close intervals
- b) Rate of spread -- Two tests per day

D) Seal coat/Surface dressing

- a) Aggregate impact value -- 1 test/ 50 cbm of aggregate
- b) Flakiness index -- 1 test /50 cbm of aggregate
- c) Grading of aggregate -- 1 test /25 cbm of aggregate

E) Bituminous concrete

- a) Aggregate impact value, Flakiness index -- 1 test / 50-100 cbm of aggregate
- b) Density of compacted layer -- 1 test / 500 Sq.m area.

- 12.2 Weighing: Each lorry leaving the plant must be weighed on a weigh bridge in the presence of the representative of the Owner and a challan must be issued along with the lorry in duplicate showing the weight of the material loaded in the lorry. As and when required, the said lorries shall also be weighed at the Owners weigh bridge or any other weigh bridge approved by the owner to check the tonnage of the material stated on the challans. In case of short fall, the same shall be made good by the contractor without extra cost.
- 12.3 Testing Surface: The completed surface when ready for acceptance shall be thoroughly compacted, smooth, true to line, grade, camber and free from irregularities when tested by means of a straight edge of 3m long, laid on the finished surface parallel with the centre line of the road, the surface shall in no place vary more than 6mm from the working edge.
- 12.4 Maintenance: It will be binding on the contractor to maintain the road free of cost for a period of 5 (five) years from the date of completion of the work. Security deposit will be released as per clause 17 of general conditions of contract against a guarantee bond for the maintenance period of five years against the following defects.
- 12.5 The defects in the bituminous paving which the contractor may be called upon to rectify are of the following type
- a) Deformation of bituminous pavement resulting in waves or ruts
 - b) Cracking of bituminous pavement resulting in admission of water to the sub-grade and the deterioration of the bituminous pavement adjoining the cracks.

Tenderer's Signature with seal:
Date:



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

- c) Disintegration/Revealing of bitumen pavement resulting in the formation of pot holes.
- d) Polishing of the bitumen pavement under traffic resulting in a surface on which the vehicles are liable to skid.

12.6 Defects in areas in bitumen pavement under guarantee shall, when they exceed the limits specified below, be remedied immediately by the contractor. The limiting values of the defects shall be the following

- a) Deformation : 25mm in 3 m
- b) Cracks : 1500 mm in lengths and 3mm in width
- c) Disintegrated revealed patches: 2.00 sqm and/ or 12mm in depth.

12.7 IS / IRC CODES

IRC: 37	Guidelines for design of flexible pavements
IRC: 73	Geometric design of roads
IS – 73	Paving Bitumen
IS – 702	Industrial Bitumen
IS – 1201	Methods of testing tar and Bituminous materials

Tenderer's Signature with seal:
Date:



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Tenderer's Signature with seal:
Date:

SECTION – 9
Page 31 of 171
©2010 MECON LIMITED. All rights reserved

Page 108 of 118

MEC/23KM/T-17/10000018



10. PAINTING WITH ENAMEL PAINT

9.1 Enamel paint (conforming to is: 2933) of approved brand and manufacture and of the required colour shall be used.

For the under coat, the paint of same quality but of shade to suit that of the top coat shall be used.

9.2 Preparation of surface and application shall be as

9.2.1 **Preparation of Surface:** The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

9.2.2 **Application** - The specifications described shall hold good as far as applicable. The number of coats to be applied will be stipulated in the item. The painted surface shall present a uniform appearances and glossy finish, free from streaks, blisters etc.

9.3 **Commencing Work** - Painting shall not be started until the engineer has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work. The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the paint work being started.

9.4 **Brushes and containers** - After work, the brushes shall be completely cleaned of paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.



9.5 Measurements

9.5.1 The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

9.5.2 Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

9.5.3 Painting up to 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running meters and shall include cutting to line where so required.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. meters irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

9.5.4 In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Sl. No.	Description of work	How measured	Multiplying coefficients
1	2	3	4
I.	Wood work doors, windows etc.		
1	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2	Ledged and battened or ledged, battened and braced doors, windows etc.	Frame, edges chocks, cleats, etc. shall be deemed to be included in the item.	
3	Flush doors etc.	- do -	1.20 (for each side)
4	Part panelled and part glazed or gauzed doors, windows etc.	- do -	1.00 (for each side)



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

	(Excluding painting of wire gauze portion)		
5	Fully glazed or gauged doors, windows etc. (Excluding painting of wire gauze portion)	- do -	0.80 (for each side)
6	Fully venetianed or louvered doors,	- do -	1.80 (for each windows etc. side)
7	Trellis work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 (for painting all over)
8	Carved or enriched work	Measured flat	2 (for each side)
9	Weather boarding	Measured flat (not girthed supporting frame work shall not be measured separately)	1.20 (for each side)
10	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11	Boarding with cover fillets and	Measured flat (not girthed)	1.05 (for each match boarding side)
12	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)
II.	Steel Work Doors, Windows, etc.		



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

13	Plain sheeted steel doors or windows	Measured flat (not girthed including frame edges etc.)	1.10 (for each side)
14	Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)	- do -	0.50 (for each side)
	Partly panelled and partly glazed doors and windows (excluding painting of wire gauze portion)	- do -	0.80 (for each side)
16	Corrugated sheeted steel doors or windows	- do -	1.25 (for each side)
17	Collapsible gates	Measured flat	1.50 (for painting all over)
18	Rolling shutters of interlocked laths	Measured flat (size of opening) all over ; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
III.	General		
19	Expanded metal, hard drawn steel Wire fabric of approved quality, grill works and gratings in guard Bars, balustrades, railing partitions and MS bars in windows frames	Measured flat overall, no deduction shall be made for open spaces; supporting members shall not be measured separately.	1 (for paint all over)
	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel.	- do - (see note No. 12)	1 (for paint all over)



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

Corrugated iron sheeting in roofs, side cladding etc.	- do – Measured flat (not girthed)	1.14 (for each side)
AC semi-corrugated sheeting in roofs, side cladding etc.	- do -	1.20 (for each side)
AC semi-corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	- do -	1.10 (for each side)
Wire gauze shutters including painting of wire gauze.	- do-	1.00 (for each side)

Explanatory notes for Table 1:

- 1) Measurements for doors windows etc., shall be taken flat (and not girthed) over all including frames, where provided. Where frames are not provided, the shutter measurements shall be taken.
- 2) Where doors, windows, etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.
- 3) The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.
- 4) In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
- 5) When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer and measurement of this will be deemed to be included in the measurement of the face treated with that finish.
- 6) In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter



on the other face will be measured for the shutter only excluding the frame.

- 7) Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.
 - 8) Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
 - 9) Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings, etc.
 - 10) Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.
 - 11) The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.
 - 12) For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), up to the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.
- 10 Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.
- 11 For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas shall be measured in sq. meters and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

- 12 Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for those or for painting brackets, clamps etc.
- 13 Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.
- 14 Flag staffs, steel chimneys, aerial masts, spires and other each objects requiring special scaffolding shall be measured separately.
- 15 **Precautions** - All furnitures fixtures, glazing, floors, etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.
- 16 **Rate** - Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.



LIST OF APPROVED BRANDS AND MANUFACTURERS FOR MATERIALS USED

SL.NO.	DESCRIPTION OF EQUIPMENT	SUPPLIER / VENDOR NAME
1.	Cement	Ultratech, Birla Corp, ACC Limited, Ramco, Indorama, Andhra Cement, Grasim , India cement, Madras cement, Gujarat Ambuja Cements Ltd. Bharathi Cement, or Equivalent.
2.	Structural steel and reinforcement	SAIL, Tata Steel, Vizag, Jindal, or Equivalent.
3.	Anti-termite treatment	Chloropyriphous Chemical PECOPP, or Equivalent.
4.	Water proofing treatment	India water proofing, Likproof, Modern water proofing, or Equivalent.
5.	Pre-moulded Joint fillers	M/S STP or equivalent
6.	Paints & Distempers	Jenson & Nicholson, Berger, Asian, Nerolac or equivalent
7.	Expansion joint fibre boards	Shalitek, STP Ltd, Lloyd insulation, or Equivalent.
8.	Structural water proofing compound	Accoproof, Cico, Imperno, Fosroc, Kothari, or Equivalent.
9.	Concrete Admixtures	Structural water proofing Co., Fosroc chemicals, Sika., Sunanda speciality, or Equivalent.
10.	PVC cover blocks	Ishita Enterprises, or Equivalent.
11.	Non-shrink grout	'SHRINKOMP-30" of ACC', 'CONBEXTRA GPI' OF Fosroc Chemicals (India) Ltd, or Equivalent.
12.	Bonding coat	'Hack-Aid-Plast' of 'Polyalk EP' of Sunanda Speciality Coatings Pvt. Ltd., FOSROC, or Equivalent.
13.	Fly Ash Bricks	FLAG Bricks, or Equivalent.
14.	Waterproof Cement Paint	Supersnowcem, Nitcocem, Nitcote or equivalent



15.	Acrylic Emulsion Exterior Paint	Asian, Nerolac, ICI Dulux or equivalent
-----	---------------------------------	---

SCHEDULE OF QUANTITIES:

General Notes

1. The Schedule of Quantities shall be read in conjunction with the specifications, bid drawings and bid documents. CONTRACTOR shall not rely merely on the description given in the Schedule of Quantities.
2. Quantities of work indicated in the Schedule of Quantities are only approximate and are given to provide a common basis for bidding. The actual quantities of work shall be ordered by OWNER as shown on the final drawings released for construction. No claim shall be entertained from CONTRACTOR if the actual quantities or items of work differ from those indicated herein, except where stated otherwise. CONTRACTOR shall ascertain for himself the actual quantities of materials required before bidding. The OWNER reserves the right to modify any aspect of the scope of Tender for civil and structural works at any time during the course of work.
3. Quoted Prices shall be in Indian Rupees only.
4. Bids shall remain valid for acceptance for 3 (Three) months from the due date of receipt of Bids and during this period, no BIDDER shall be allowed to withdraw his Bid.
5. Lump Sum and Unit Prices shall be submitted for all Items and they shall be firm for the entire duration of the contract and any agreed extensions thereto. No escalation of prices will be applicable during the contract period and any agreed extensions thereto.
6. The quotation submitted by BIDDER shall be based on the approximate probable quantities of the several items of work which are furnished for BIDDER's convenience in the Schedule of Quantities. It must be clearly understood that the Contract is not a lump sum contract and that neither the approximate probable quantities nor the values of the individual items nor the aggregate value of the entire Bid shall form part of the contract and Owner does not in any way assure BIDDER or guarantee that work would correspond thereto.
7. The rates shall also be deemed to include any survey works and setting out that may be required to be carried out for laying out of all the works involved.



CONCRETE ROAD WORKS AT ETP AREA (VOLUME-2)

8. Nothing extra will be paid for any loss / damage of individual items of equipment during the course of the Work, however caused.
9. The quantities of work actually carried out (as evaluated from drawings and/or field measurements) against each item shall be measured and paid at the rates/prices finally agreed in the Schedule of Quantities where applicable or otherwise at such rates and prices as may be fixed within the terms of the Contract.
10. Where rates are called for executing works at different depths/heights or of different sizes, the rate given in the lower range shall always apply for a depth/height/size which defines the range.
11. The OWNER reserves the right to split the Contract. However, the rates and prices shall remain valid.
12. BIDDER shall be deemed to have allowed in his rates and prices for the provision, maintenance and final removal of all temporary works of whatsoever nature required for the proper execution of the works, except for those temporary works for which specific items have been provided in Schedule of Quantities. The prices inserted against these specific items of particular temporary works shall be deemed to have allowed for the provision, maintenance and final removal of those primary works. No further specific items of particular temporary works shall be measured and paid for separately.
13. Rates and amounts shall be written in ink and shall be entered in both figures and words. All erasures and corrections shall be signed by the BIDDER. Non-compliance of these conditions will render the Bid invalid.
14. Rates quoted shall remain firm for a variation of plus (+) or minus (-) 25% of the value of the work awarded.
15. Cost of erection bolts and weldment shall be deemed to have been included in the respective item rates. The weight of erection bolts and weldments shall not be considered in the weight of structural steel work for the purpose of payment.
16. No additional compensation is payable by OWNER for any expenses incurred by CONTRACTOR for travel etc. or for meetings / discussions with OWNER.

