

Name of Work : Construction Work of New Cross Drainage, Repairing of Cross Drainage , Structure & bridge repair Work & Other Misc. Work on Various Roads as & When required or in Emergency Under District (R & B) Division Junagadh Panchayat

SPECIFICATIONS OF MATERLAIS

M-1 Water

1.1 Water shall not be salty or brackish and shall be clean, **reasonably clear and free from objectionable** quantities of silt and traces of oil and injurious alkalies, salts, organic matter and other deleterious material which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-1978.

1.2. If required by Engineer-in-charge it shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in I.S. 269-1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 per cent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.

1.3. Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements which significantly affect the hydration reaction or otherwise interfere-with the hardening of concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.

1.4. Hard and bitter water shall not be used for curing.

1.5. Potable water will be generally found suitable for curing mortar or concrete. **M-2. Lime**

2. 1 Lime shall be hydraulic lime as per I.S. 712-1973. Necessary test shall be carried out as per I.S. 6932 (Part I to X), 1973.

2.2 The following field tests for times are to be carried out:

(1) A very rough idea can be formed about the type of lime by its visual examination i.e. fat lime bears pure white colour, lime in form of porous lumps of dirty white colour indicates quick lime, and solid lumps are unburnt lime stone.

(2) Acid tests for determining the carbonate content in lime. Excessive amount of impurities and rough determination of class of lime.

2.3 Storage shall comply with I.S. 712-1973. The slaked lime, if stored, shall be kept in a weather proof and damp-proof shed with impervious floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it. All lime that has been damaged in any way shall be rejected and all rejected materials shall be removed from site of work.

2.4 Field testing shall be done according to I.S. 1624- 1974 to show the acceptability of materials.

M-3. Cement

3.1 Cement shall be ordinary portland slag cement as per I.S. 269-1976 or Portland slag cement as per I.S. 455-1976.

M-4. White Cement

4.1 The white cement shall conform to I.S. 8041-1978.

M-5. Coloured Cement

5.1 Coloured cement shall be with white or gray portland cement as specified in the item of the work.

5.2. The pigments used for coloured cement shall be of approved quality and shall not exceed 10% of cement used in the Mix. The mixture of pigment shall be properly grounded to have a uniform colour and shade. The pigments shall have such properties to provide for durability under exposure to sunlight and weather.

5.3. The pigment shall have the property such that it is neither affected by the cement nor detrimental to it. **M-6. Sand**

6.1. Sand shall be natural sand, clean, well graded, hard strong durable and gritty particle free from injurious amounts of dust clay, kankar nodules, soft or flaky particles shale, alkali, salts organic matter, loam, mica or other deleterious substance and shall be got approved from the Engineer-in-charge. The sand shall not contain more than 8 percent of silt as determined by field test. If necessary the sand shall be washed to make it clean.

6.2. Coarse Sand:

The fineness modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse sand shall be as under.

L S. Sieve Designation	Percentage by Weight Passing sieve	I S. Sieve Designation	Percentage by Weight Passing through sieve
4.75 mm.	100	600 Micron	30-100
2.36 mm.	90 to 100	300 Micron	5-70
1.18 mm.	70-100	150 Micron	0-50

6.3. Fine Sand:

The fineness modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under:

L S. Sieve Designation	Percentage by Weight Passing sieve	I S. Sieve Designation	Percentage by Weight Passing through sieve
4.75 mm.	100	600 Micron	40-85
2.36 mm.	100	300 Micron	5-50
1.18 mm.	70-100	150 Micron	0-10

M-7. Stone Dust:

7. 1. This shall be obtained from crushing hard black trap or equivalent. it shall not contain 'more than 8%' silt as determined by field test with measuring cylinder. The method of determining silt contents- by field test is given as under:

7.2. A sample of stone dust to be tested shall be placed without. drying in 200 mm. measuring cylinder. The quantity of the sample shall be such, that it fills the cylinder upto 100 mm. mark. The clean water shall be added upto 150 mm. Mark, The mixture shall be stirred vigorously and the content allowed to settle for 3 hours.

7.3. The height of silt visible as settled layer above the stone dust shall be expressed as percentage of the height of the stone dust below. The stone dust containing more than 8% silt shall be washed so as to, bring the silt content within the allowable limit.

7.4. The fineness modulus of stone dust shall not be less than 1.80.

M-8. Stone Grit

8.1. Grit shall consist of crushed or broken stone and be hard strong, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless special stone of particular quarries is mentioned, grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer-in-charge. The grit shall have no deleterious reaction with cement.

8.2. The grit shall conform to the following gradation as per sieve analysis

L S. Sieve Designation	Percentage by Weight Passing sieve	I S. Sieve Designation	Percentage by Weight Passing through sieve
12.50 mm	100 %	4.75 mm	0-20 %
10.00 mm	80-100 %	2.36 mm	0-25 %

8.3. The crushing strength of grit will be such as to allow the concrete in which it is used to built up the specified strength of concrete.

8.4. The necessary tests for 'grit shall carried out as per the requirements of I.S. 2386 (Parts I to VII) 1963, as per instructions of the Engineer-in-charge. The necessity of test will be decided by the Engineer-in-charge.

M-9. Cinder:

9.1 Cinder is well burnt furnace residue which has been fused or sintered into lumps of varying sizes.

9.2. Cinder aggregates shall be well burnt furnace residue obtained from furnace using coal fuel only. It shall be sound clean free from clay, dirt, ash or other deleterious matter.

9.3. The average grading for cinder aggregates shall be as mentioned below:

L S. Sieve Designation	Percentage Passing	I S. Sieve Designation	Percentage Passing
20 mm	100	4.75 mm	70
10 mm	86	2.36 mm	52

M-10. Lime Mortar

10. 1. Lime shall conform to specification M-2. Water shall conform to specification M-1.

Sand shall conform to specification M-6.

10.2. Proportion of Mix:

10.2.1. Mortar shall consist of such proportions of slaked lime and sand as may be specified in the item. The slaked lime and sand be measured by volume. **10. 3. Preparation of mortar:** **10.3. 1.** Lime mortar shall be prepared by wet process as per I.S. 1625-1971. Power driven mill shall be used for preparation of lime mortar. The slaked lime shall be placed in the mill in an even layer and ground for the 180 revolutions with a sufficient water. Water shall be added as required during grinding (care being taken not to add more water) that will bring the mixed material to a consistency of stiff paste. Thoroughly wetted sand shall then be added evenly and the mixture ground for another 180 revolutions.

10.4. Storage

10.4. 1. Mortar shall always be kept damp, protected from sun and rain till used up, covering, it by tarpaulin or open sheds.

10.5. Use

10.5. 1. All mortar shall be used as soon as possible after grinding. It should be used on the day on which it is prepared. But in no case mortar made earlier than 36 hours shall be permitted for use.

M- 11. Cement Mortar

11. 1. Water shall conform to specification M71. Cement shall conform to specification M-3. Sand shall conform to

M-6. 11. 2. Proportion of Mix

11.2.1. Cement and sand shall be mixed to specified proportion, sand being measured by-measuring boxed.

The proportion of cement will be by volume on the basis of 50 Kg./Bag of cement being equal to 0.0342

Cu.m. The mortar may be hand mixed or machine mixed as directed.

11.3. Preparation of mortar

11.3.1 In hand mixed mortar cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogenous mixture of uniform colour is obtained. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar or mortar shall flow out. While mixing, the water shall be gradually added and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The water cement ratio shall be adopted as directed.

11.3.2 The mortar so prepared shall -be used, within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes.

M- 12. Stone Coares Aggregate for Nominal Mix Concrete

12. 1. Coarse aggregate shall be machine crushed stone of black trap or equivalent and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

12.2. The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement concrete and ordinary reinforced cement concrete shall generally be as per the table given below.

However in case (if reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6 mm. less than the cover, whichever is smaller.

TABLE

I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominalsize			I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominalsize		
	40 mm	20 mm	16 mm		40 mm	20 mm	16 mm
80 mm	-	-	-	12.5 mm	-	-	-
63 mm	100	-	-	10 mm	0.5	0.02	0.30
40 mm	85-100	100	-	4.75 mm	-	0.5	0.5
20 mm	0-20	85-100	100	2.35 mm	-	-	-
16 mm		-	85-100				

Note : This percentage may be varied some what by Engineer- in-charge when considered necessary for obtaining better density and strength of concrete.

12.3. The grading test shall be taken in the beginning and at the change of source of materials. The necessary test indicated in I.S. 383-19710 and I.S. 456-1978 shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If the aggregates are covered with dust, they shall be washed with water to make them clean.

M- 13. Black Trap or Equivalent Hard Stone Cores.

13.1. Aggregate For Design Mix Concrete : Coarse aggregate shall be of machine crushed stone of black trap or equivalent hard stone and be hard strong dense, durable clean and free from skin and coating likely to prevent proper adhesion of mortar.

13.2. The aggregates shall generally be cubical in shape, Unless special stones of particular quarries are mentioned, aggregates shall be machine crushed from the best, black trap or equivalent hard stones as approved. Aggregate shall have no deleterious reaction with cement.

13.3. The necessary tests indicated in I.S. 383-1970 and I.S. 456-1978 shall have to be carried out to ensure the acceptability of the material.

13.4. If aggregate is covered with dust it shall be washed with water, to make it clean.

M-14. Brick Bats Aggregate

14.1. Brick bat aggregate shall be broken from well burnt or slightly over burnt and dense brick. It shall be homogeneous in texture roughly cubical in shape, clean and free from dirt of any other foreign material. The brick bats shall be of 40 mm. to 50 mm. size unless otherwise specified in the item. The underburnt over burnt brick bats shall not be allowed.

14.2. The brick bats shall be measured by volume by suitable boxes or as directed.

M- 15. Brick

15. 1. The bricks shall be hand or machine moulded and made from suitable soils and kiln-burnt. They shall be free from crack and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour.

The bricks shall be moulded with a frog of 100 mm. x 40 mm. and 10 mm. to 20 mm. deep on one of its flat sides. The bricks shall not, break when thrown on the ground from a height of 600 mm.

15.2. The size of modular bricks shall be 190 mm. x 90 mm. x 90 mm.,

15.3. The size of the conventional bricks shall be as under
(9" X 4.3/8" X 2.3/4") 225 X 110 X 75 mm.

15.4. Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.

Length: $\pm 1/81$ " (3.0 mm.) Width: $\pm 1/1611$ (1.50 mm.) Height: $\pm 1/611$ (1.50 mm.)

15.5. The crushing strength of the bricks shall not be less than 35 Kg./Sq.Cm. The average water absorption shall not be more than 20 percent by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per I.S. 3495 (Part-I to IV) 1976.

M- 16 Stone

16.1. The stone shall be of the specified variety such as Granite / Trap Stone / Quartzite or any other type of good hard stones. The stones shall be obtained only from the approved quarry and shall be hard, sound, durable and free from defects like cavities, cracks, sand holes, flaws, injurious veins, patches of loose or soft materials etc. and weathered portions and other structural defects or imperfections tending to affect their soundness and strength. The stone with round surface shall not be used. The percentage of water absorption shall not be more than 5% of dry weight, when tested in accordance with I.S. 1134- 1974. The minimum crushing, strength of the stone shall be 200 Kg./Sq.Cm. unless otherwise specified.

16.2. The samples of the stone to be used, shall be got approved before the work is started.

16.3. The Khanki facing stone shall be dressed by chisel as specified in the item "or khanki facing in required shape and size. The face of stone shall be so dressed that the bushing, on the exposed face shall riot project by more than 40 mm. from the general wall surface and on face to be plastered it. shall not project by more than 19 mm. nor shall it have depressions more than 10.mm. from the average wall surface.

M- 17. Laterite Stone

17. 1. Laterite stone shall be obtained from the approved quarry. It shall be compacted in texture, sound, durable and free from soft patches. It shall have a minimum crushing strength of 100 Kg./Sq.Cm. in its dry condition. It shall not, absorb water more than 20% of its own weight when immersed for 24 hours in water. After quarrying the stone shall be allowed to weather for some time before using in work.

17.2. The stone shall be dressed into regular rectangular blocks so that all faces are free from waviness and unevenness, edges true and square.

17.3, Those types of stone in which white clay occure, should not be used.

1 7.4 Special corner stones shall be provided where so directed.

M- 18. Mild Steel Bars

18.1. Mild steel bars reinforcement for R.C.C. work shall conform to I.S. 432 (Part-11) 1966 and shall be of tested quality. It Shall also comply with relevant part. of I.S. 456- 1978.

18.2. All the reinforcement shall be clean arid free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing.

18.3. For the purpose of payment, the bar shall be measured correct upto 100 mm. length and weight payable worked out at the rate speciried below

1	6 mm	0.22 Kg/Rmt	8	20 mm	2.47 Kg/Rmt
2	8 mm	0.39 Kg/Rmt	9	22 mm	2.98 Kg/Rmt
3	10 mm	0.62 Kg/Rmt	10	25 mm	3.85 Kg/Rmt
4	12 mm	0.89 Kg/Rmt	11	28 mm	4.83 Kg/Rmt
5	14 mm	1.21 Kg/Rmt	12	32 mm	6.31 Kg/Rmt
6	16 mm	1.58 Kg/Rmt	13	36 mm	7.99 Kg/Rmt
7	18 mm	2.00 Kg/Rmt	14	40 mm	9.86 Kg/Rmt

M-19. High Yield Strength Steel Deformed Bars

19.1. High yield strength steel deformed bars be either cold twisted or hot rolled, shall conform to I.S. 11739-1966 and I.S. 11,39-1966 respectively.

19.2. Other provision and requirements shall conform to No. M-18 for Mild steel bars.

M-20 High Tensile Steel Wires

20.1. The high tensile wires for the use in priestesses concrete work shall conform to I.S. 2090-1962.

20.2. The !ensile strength of the high tensile steel bars shhiall be as specified in the Item. In absence of the given strength, the minimum Strength shall be taken as per para 6.1 of I.S. 1785-1962. Testing, shall be done per I.S. requirements.

20.3. The high tensile steel shall be free from loose mill scale, rust oil, grease, or any other harmful matter. Cleaning of steel bars may be carried out by immersion in vsolvent solution, wire brushing or passing through a pressure box containing carborundum.

20.4. The high tensile wire shall be obtained from manufactures in coil having diameter not less than 350 times the- diameter of wire its(-If so that wire springs back straight on being uncoiled.

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SPECIFICATIONS OF MATERLAIS (AS PER MORTH PROVISION)

GENERAL SPECIFICATION OF MATERIALS FOR INSTRUCTURES

as per Guidelines of the MORTH for road works

1001. GENERAL

Materials to be used in the work shall conform to the specifications mentioned on the drawings the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by, the Engineer.

1002. SOURCES OF MATERIAL

The Contractor shall notify, the Engineer of his proposed sources of materials prior to delivery. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.

1003. BRICKS

Burnt clay bricks shall conform to the requirements of IS:1077, except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

1004. STONES

Stones shall be of the type specified. It shall be hard, sound, and free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS:1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

1005. CAST IRON

Cast iron shall conform to IS:210. The grade number of the material shall not be less than 14.

1006. CEMENT

Cement to be used in the works shall be any of the following types with the prior approval of the Engineer :

- a) Ordinary Portland Cement, 33 Grade, conforming to IS:269.
- b) Rapid Hardening Portland Cement, conforming to IS:8041.
- c) Ordinary Portland Cement. 43 Grade, conforming to IS:81 12
- d) Ordinary Portland Cement. 53 Grade, conforming to IS:12269.
- c) Sulphate Resistant Portland Cement, conforming to IS:12330.

Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg/cu.m. of concrete.

Cement conforming to IS:8112 and IS:12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher constituent ratio of C3S/C2S, where C3S is Tri-calcium Silicate and C2S is Di-calcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength test% shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

Cement conforming to IS:12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS:456 are sulphate concentration in excess of 0.2 per cent in soil substrata or 300 ppm (0.03 per cent) in ground water. Tests to confirm actual

values of sulphate concentration 'are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS:12330 shall be carefully selected from strength considerations to ensure that the minimum required design, strength can be achieved without exceeding the maximum permissible cement content of 540 kg/ cu.m. of concrete.

Cement conforming to IS:8041 shall be used only for precast concrete products after specific approval of the Engineer.

Total chloride content in cement shall in no case exceed 0.05 per cent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO₃) shall in no case exceed 2.5 per cent and 3.0 per cent when tri-calcium aluminate per cent by mass is upto 5 or greater than 5 respectively.

1007. COARSE AGGREGATES

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or oilier approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, Parts I to VIII.

The contractor shall submit for the approval of the Engineer, the entire information indicated in Appendix A of IS:383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Section 1700.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 per Cent.

The coarse aggregate shall satisfy the following requirements of grading :

TABLE 1000-1 : REQUIREMENTS OF COARSE AGGREGATE

IS Sieve Size	Per cent by Weight passing the Sieve		
	40mm	20mm	12.5mm
63mm	100	-	-

40mm	95-100	100	-
20mm	30-70	95-100	100
12.5mm	-	-	90-100
10mm	10-35	25-55	40-85
4.75mm	0-5	0-10	0-10

1008. SAND/FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS: 2 116.

For plain and reinforced cement concrete (PCC and RCC') or prestressed concrete (PSQ works, Fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious material's in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorised sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts 1 to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS:383. The Fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

Sand/fine aggregate for structural concrete shall conform to the following grading requirements :

TABLE 1000-2

IS Sieve Size	Per cent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2-36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

1010. WATER

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values

- (a) To neutralise 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.
- (b) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.
- (c) The permissible limits for solids shall be as follows when tested in accordance with IS:3025 :

	Permissible (max)	Limits
Organic	200 mg/lit	
Inorganic	3000 mg/lit	
Sulphates (SO)	500 mg/lit	
Chlorides (Cl)	500 mg/lit*	
Suspended matter	2000 mg/lit	

*In case of structures of lengths 30m and below, the permissible limit of chlorides may be increased upto 1000 mg/lit

All samples of water (Including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein

- (d) The pH value shall not be less than 6.

1012. CONCRETE ADMIXTURES

1012.1. General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full fledged laboratory facilities for the manufacture and testing of concrete.

The contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer :

- (a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.

- (b) The chemical names of the main ingredients in the admixtures.
- (c) The chloride content, if any, expressed as a percentage by the weight of the admixture
- (d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.
- (e) Whether or not the admixture leads to the entrainment of air when used as per the manufacturers recommended dosage, and if so to what extent
- (f) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
- (g) There would be no increase in risk of corrosion of the reinforcement or other embedment as a result of using the admixture.

1012.2. Physical and Chemical Requirements

Admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied :

- (a) "Plasticizers" and "Super-Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".
- (b) Except where resistance to freezing and thawing and to disruptive action of deicing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS:1199 shall not be more than 2 per cent higher than that of the corresponding control mix and in any case not more than 3 per cent of the test mix.
- (c) The chloride content of the admixture shall not exceed 0.2 per cent when tested in accordance with IS:6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 shall also be observed.
- (d) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations in the same are indicated below:

- Dry Material Content : to be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.
- Ash content : to be within 1 per cent of the value stated by the manufacturer.

Relative Density (for liquid admixtures) : to be within 2 per cent of the value stated by the manufacturer.

(e) All tests relating to the concretes admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

1014. STORAGE OF MATERIALS

1014.1. General

All materials may be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and restorage of the materials. All such materials even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

1014.3. Aggregates

Aggregate stockpiles may be made on ground that is denuded or vegetation is hard and well drained. If necessary the ground shall be covered with 50 mm plank.

Coarse aggregates, unless otherwise agreed by the Engineer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

In the case of fine aggregates, these shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer.

1014.4. Cement

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and watertight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which has deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to the Employer.

The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of Cement and these records shall be available for inspection by the Engineer at all times.

The Contractor shall make a monthly, return to the Engineer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

1014.5. Reinforcement /Untensioned Steel

The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports, and shall be protected from mechanical injury and from deterioration by exposure.

1014.6. Prestressing Materials

All prestressing steel, sheathing, anchorages and sleeves or coupling must be protected during transportation, handling and storage. The prestressing steel, sheathing and other accessories must be stored under cover from rain or damp ground and protected from the ambient atmosphere if it is likely to be aggressive. Storage at site must be kept to the absolute minimum.

(a) Tendon : Wire, strand and bar from which tendons are to be fabricated shall be stored about 300mm above the ground in a suitably covered and closed space so as to avoid direct climatic influences and to protect them from splashes from any other materials and from the cutting operation of an oxy-acetylene torch or arc welding process in the vicinity. Under no circumstances, tendon material shall be subjected to any welding operation or on site heat treatment or metallic coating such as galvanising. Storage facilities and the procedures for transporting material into or out of store, shall be such that the material does not become kinked or notched. Wire or strand shall be stored in large diameter coils which enable the tendons to be laid out straight. As a guide, for wires above 5 mm dia, coils of about 2m dia without breaks or joints shall be obtained from manufacturer and stored. Protective wrapping for tendons shall be chemically neutral. All prestressing steel must be provided with temporary protection during storage.

(b) Anchorage Components : The handling and storing procedures shall maintain the anchorage components in a condition in which they can subsequently perform their function to an adequate degree. Components shall be handled and stored so that mechanical damage and detrimental corrosion are prevented. The corrosion of the gripping and securing system shall be prevented. The use of correctly formulated oils and greases or of other corrosion

preventing material is recommended where prolonged storage is required. Such protective material shall be guaranteed by the producer to be non-aggressive and non-degrading.

Prestressing steel shall be stored in a closed store having single door with double locking arrangements and no windows. Also the air inside the store shall be kept dry as far as possible by using various means to the satisfaction of the Engineer. Also instrument measuring the air humidity shall be installed inside the store. This is with a view to eliminating the possibility of initial rusting of prestressing steel during storage. The prestressing steel shall be coated with water solvable-grease. The prestressing steel should be absolutely clean and without any signs of rust.

All prestressing steel shall be stored at least 30 cm above ground level and it shall be invariably wrapped by protective cover of tar paper or polythene or any other approved material.

The Contractor should see that prestressing steel shall be used within 3 months of its manufacture. He should chalk out his programme in this respect precisely, so as to avoid initial corrosion before placing in position.

1014.7. Water

Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface, shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

1015. TESTS AND STANDARD OF ACCEPTANCE

All materials, even though stored in an approved manner shall be subjected to an acceptance test prior to their immediate use.

Independent testing of cement for every consignment shall be done by, the Contractor at site in the laboratory approved by the Engineer before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use. In case of imported cement, the same series of tests shall be carried out before acceptance.

1015.1. Testing and Approval of Material

The Contractor shall furnish test certificates from the manufacturer/ supplier of materials along with each batch of material(s) delivered to site.

The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of

contract and the relevant specifications. The testing of all the materials shall be carried out by the Engineer or his representative for, which the Contractor shall make all the necessary arrangements and bear the entire cost.

Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's cost at any recognised laboratory / testing establishments approved by the Engineer.

1015.2. Sampling of Materials

Samples provided to the Engineer or his representatives for their retention are to be in labelled boxes suitable for storage.

Samples required for approval and testing must be supplied well in advance by at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval. Delay to works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the works.

If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall be borne by the Contractor.

1015.3. Rejection of Materials not conforming to the Specifications

Any stock or hatch of material(s) of which sample(s) does not conform to the prescribed tests and quality shall be rejected by the Engineer or his representative and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modification.

1015.4. Testing and Approval of Plant and Equipment

All plants and equipment used for preparing, testing and production of materials for incorporation into the permanent works shall be in accordance with manufacturer's specifications and shall be got approved by the Engineer before use.

**Name of work :: Construction Work of New Cross Drainage, Repairing of Cross Drainage , Structure & bridge repair Work & Other Misc. Work on Various Roads as & When required or in Emergency Under District (R & B)
Division Junagadh Panchayat**

902. CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

902.1. General

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described herein-after:

902.2. Horizontal Alignment

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 10 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 25 mm.

902.3. Surface Levels

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in Table 900-1.

TABLE 900-T. TOLERANCES IN SURFACE LEVELS

1. Subgrade	+ 20 mm - 25mm
2. Sub-base + 10 mm	-20mm
(a) Flexible pavement	+ 6 mm
(b) Concrete pavement	-10mm
[Dry clean concrete or Rolled concrete]	
3. Base-course for flexible pavement	+6 mm
(a) Bituminous course	-6mm
(b) Other than bituminous	+10mm
(i) Machine laid	-10mm + 15 mm
(ii) Manually laid	-15 mm
4. Wearing course for flexible pavement	+ 6 mm
(a) Machine laid	- 6mm
(b) Manually kid	+ 10mm
	- 10mm
5. Cement concrete pavement	+ 5 mm -6mm*

* This may not exceed - 8 mm at 0 - 30 cm from the edges.

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on , a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall

be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

For checking the compliance with the above requirement for bituminous wearing courses and concrete pavements, measurements of the surface levels shall be taken on a grid of points spaced at 6.25 m along the length and at 0.5 m from the edges and at the centre of the pavement. In any length of pavement, compliance shall be deemed to be met for the final road surface, only if the tolerance given above is satisfied for any point on the surface.

902.4. Surface Regularity of Pavement Courses

The longitudinal profile shall be checked with a 3 metre long straight edge/moving straight-edge as desired by the Engineer at the middle of each traffic lane along a line parallel to the centre line of the road.

The maximum permitted number of surface irregularities shall be as per Table 900-2.

TABLE 900-2. MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES

Irregularity	Surfaces of carriageways paved shoulders				Surfaces of laybys, service areas and all bituminous base and courses			
	4 mm		7 mm		4 mm		7 mm	
Length(m)	300	75	300	75	300	75	300	75
National Highways/ Expressways	20	9	2	1	40	18	4	2
Roads of lower category*	40	18	4	2	60	27	6	3

•Category of each section of road as described in the Contract

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

for pavement surface (bituminous and cement concrete)	3 mm
for bituminous base courses	6 mm
for granular sub-base/ base courses	8 mm
for sub-bases under concrete pavements	10 mm
Quality Control for Road Works	

902.5. Rectification

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

(1) **Subgrade:** Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305.

(ii) **Granular Sub-base:** Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401.

(iii) **Lime/Cement Stabilized Soil Sub-base:** For lime/cement treated materials where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described herein below.

For cement treated material, when the time elapsed between detection of irregularity and the time of mixing of the material is less than 2 hours, the surface shall be scarified to a depth of 50 mm supplemented with freshly mixed materials as necessary and recompacted to the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to Specification. This shall also apply to lime treated material except that the time criterion shall be 3 hours instead of 2 hours.

(iv) **Water Bound Macadam/Wet Mix Macadam Sub-base/Base:** Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406.

(v) **Bituminous Constructions:** For bituminous construction oilier than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3-5 m in width.

- (vi) **Dry Lean Concrete Sub-base/Rolled Cement Concrete:** The defective length of the course shall be removed to full depth and replaced with material conforming to Clauses 601 or 603, as applicable. The area treated shall be at least 3 m long, not less than 1 lane wide and extend to the full depth. Before relaying the course, the disturbed subgrade or layer below shall be corrected by levelling, watering and compacting.
- (vii) **Cement concrete pavement:** The defective areas having surface irregularity exceeding 3 mm but not greater than 6 mm may be rectified by bump cutting or scrubbling or grinding using approved equipment. When required by the Engineer, areas which have been reduced in level by the above operation(s) shall be retextured in an approved manner either by cutting grooves (5 mm deep) or roughening the surface by hacking the surface. If high areas in excess 6 mm or low areas in excess of 3 mm occur, exceeding the permitted numbers and if the Contractor cannot rectify, the slab shall be demolished and reconstructed at the Contractor's expense and in no case the area removed shall be less than the full width of the lane in which the irregularity occurs and full length of the slab.

If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerances shall

112. ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

112.1. General

The Contractor shall at all times carry out work on the highway in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing highway, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the highway. The Contractor shall take prior approval of the Engineer regarding traffic arrangements during construction.

112.2. Passage of Traffic along a part of the Existing Carriageway under Improvement

For widening/strengthening existing carriageway where part width of the existing carriageway is proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consist of providing at least 150 mm thick granular base course covered with bituminous surface dressing in a width of at least 1.5 m and the surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the Engineer. The continuous length, in which such work shall be carried out, would be limited normally to 500 m at a place. However, where work is allowed by the Engineer in

longer stretches passing places at least 20 m long with additional paved width of 2.5 m shall be provided at every 0.5 km interval.

In case of widening existing two-lane to four-lane, the additional two lanes would be constructed first and the traffic diverted to it and only thereafter the required treatment to the existing carriageway would be carried out. However, in case where on the request of the Contractor, work on existing two-lane carriageway is allowed by the Engineer with traffic using part of the existing carriageway, stipulations as in Para above shall apply.

After obtaining permission of the Engineer, the treated shoulder shall be dismantled, the debris disposed of and the area cleared as per the direction of the Engineer.

112.3. Passage of Traffic along a Temporary Diversion

In stretches where it is not possible to pass the traffic on part width of the carriageway, a temporary diversion shall be constructed with 7 m carriageway and 2.5 m earthen shoulders on each side (total width of roadway 12 m) with the following provision for road crust in the 7 m width:

- (i) 200 mm (compacted) granular sub base;
- (ii) 225 mm (compacted) granular base course; and
- (iii) Premix carpet with Seal Coat/Mix Seal Surfacing.

The alignment and longitudinal section of diversion including junctions and temporary cross drainage provision shall be as approved by the Engineer.

112.4. Traffic Safety and Control

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of. Traffic approaching or passing through the section of the highway under improvement. Before taking up any construction, an agreed phased programme for the diversion of traffic on the highway shall be drawn up in consultation with the Engineer.

The barricades erected on either side of the carriageway/portion of the carriageway closed to traffic, shall be of strong design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriageway) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device to the directions of the Engineer. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs as approved by the Engineer shall be installed for the guidance of road users. On each approach, at least two signs shall be put up, one close to the point where transition of carriageway begins and the other 120m away. The signs shall be of approved design and of reflectory type, if so directed by the Engineer.

112.5. Maintenance of Diversions and Traffic Control Devices

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversions shall be maintained in a satisfactory condition till such time they are required as directed by the Engineer. The temporary travelled way shall be kept free of dust by frequent applications of water, if necessary.

901. GENERAL

901.1. All materials to be used, all methods adopted and all works performed shall be strictly in accordance with the requirements of these specifications. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out all required tests and Quality Control work per Specifications and/or as directed by the Engineer. The internal layout of the laboratory shall be as per Clause 121 and/or as directed by the Engineer. The list of equipment and the facilities to be provided shall be got approved from the Engineer in advance.

901.2. The Contractor's laboratory should be manned by a qualified Materials Engineer/Civil Engineer assisted by experienced technicians, and the set-up should be got approved by the Engineer.

901.3. The Contractor shall carry out quality control tests on the materials and work to the frequency stipulated in subsequent paragraphs. In the absence of clear indications about method and or frequency of tests for any item, the instructions of the Engineer shall be followed.

901.4. For satisfying himself about the quality of the materials and work, quality control tests will also be conducted by the Engineer (by himself, by his Quality Control Units or by any other agencies deemed fit by him), generally to the frequency set forth here in under. Additional tests may also, be conducted where, in the opinion of the Engineer, need for such tests exists.

901.5. The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests required by the Engineer from time to time. This may include provision of labour, attendants, assistance in packing and despatching and any other assistance considered necessary in connection with the tests.

901.6. For the work of embankment, subgrade and pavement, construction of subsequent layer of same or other material over the finished layer shall be done after obtaining permission from the Engineer. Similar permission from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

901.7. The Contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer during inspection. Works falling short of

quality shall be rectified/redone by the Contractor at Ws own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.

901.8. The cost of laboratory building including services, essential supplies like water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the Specification requirements shall be deemed to be incidental to the work and no extra payment shall be made for the same. If, however, there is a sep; rate item in the Bill of Quantities for setting up of a laboratory and installing testing equipment, such work shall be paid for separately.

901.9. For testing of samples of soils/soil mixes, granular materials, and mixes, bituminous materials and mixes, aggregates, cores etc., samples in the required quantity and form shall be supplied to the Engineer by the Contractor at his own cost.

901.10. For cement, bitumen, mild steel, and similar other materials where essential tests are to be carried out at the manufacturer's plants or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor. He shall also" furnish the test certificates to the Engineer.

901.11. For testing of cement concrete at site during construction, arrangements for supply of samples, sampling, testing and supply of test results shall be made by the Contractor as per the frequency and number of tests specified in the Handbook of Quality Control for Construction of Roads and Runways (IRC :SP 11) and relevant IS Codes or relevant clauses of these Specifications, the cost of which shall be borne by the Contractor.

901.12. The method of sampling and testing of materials shall be as required by the "Handbook of Quality Control for Construction of Roads and Runways" (IRC : SP: 11), and these MOST Specifications. Where they are contradicting, the provision in these Specifications shall be followed, Where they are silent, sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor.

901.13. The materials for embankment construction shall be got approved from the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contractor who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period.

Similarly, the supply of aggregates for construction of road pavement shall be from quarries approved by the Engineer. Responsibility for arranging uninterrupted supply of materials from the source shall be that of the Contractor.

901.14. Defective Materials

All materials which the Engineer/his representative has determined as not conforming to the requirements of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any order of-'he Engineer/his representative, given under this Clause, the Engineer/his representative shall

have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

901.15. Imported Materials

At the time of submission of tenders, the Contractor shall furnish a list of materials/finished products manufactured, produced or fabricated outside India which he proposes to use in the work. The Contractor shall not be entitled to extension of time for acts or events occurring outside India and it shall be the Contractor's responsibility to make timely delivery to the job site of all such materials obtained from outside India.

The materials imported from outside India shall conform to the relevant Specifications of the Contract. In case where materials/ finished products are not covered by the Specifications in the Contract, the details of Specifications proposed to be followed and the testing procedure as well as laboratories/ establishments where tests are to be carried out shall be specifically brought out and agreed to in the Contract.

The Contractor shall furnish to the Engineer a certificate of compliance of the tests carried out. In addition, certified mill test reports clearly identified to the lot of materials shall be furnished at the Contractor's cost.

Name of Work : Construction Work of New Cross Drainage, Repairing of Cross Drainage , Structure & bridge repair Work & Other Misc. Work on Various Roads as & When required or in Emergency Under District (R & B) Division Junagadh Panchayat

:: ITEMWISE SPECIFICATION FOR THIS WORK ::

Item No. 01 :: Job Work for Dismantling the existing Cross Drainage structure including removing and stacking the dismantled materials as and where directed (A) R. C. C. work, Brick masonry , UCR masonry, Pipe etc. Complete as per instruction of Engineer In Charge.

➤ **Scope**

This work shall consist of dismantling and removing existing culverts, bridges, pavements, kerbs and other structures like guard-rails, fences, utility services, manholes, catch basins, inlets etc. from the right of way which in the opinion of the Engineer interfere with the construction of road or are not suitable to remain in place, disposing of the surplus / unsuitable materials and backfilling to after the required compaction as directed by the Engineer.

Existing culverts, bridges, pavements and other structures which are within the highway and which are designed for removed shall be removed upto the limits and extent specified in the drawings or as indicated by the Engineer-in-charge.

Dismantling and removal operations shall be carried out with equipment and in such a manner as to leave undisturbed, adjacent pavement, structure and any other work to be left in place.

All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

➤ **Dismantling Culverts and Bridges**

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts/ bridges shall be entirely removed and other parts removed upto at least 600mm below the sub-grade, slope face or original ground level whichever is the lowest or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent materials, if required in connection with the dismantling of the structures, shall be incidental to this item.

Where existing culverts/ bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as are necessary and directed by the Engineer to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place so as to project into new work as dowels or ties are not be injured during removal of concrete.

Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes.

Steel structures shall unless otherwise provided be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the drawing or directed by the Engineer that the structure is to be removed in a condition suitable for re-erection, all members shall be match marked by the contractor with white lead paint before dismantling end pins, nuts, loose plates, etc. shall be similarly marked to indicate their proper location, all pins, pin holes and machined surface shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjaced members or packed in boxes.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber having salvage value as is designated by the Engineer.

➤ **Dismantling Pavements and Other structures**

In removing pavements, kerbs, gutters and other structures like guard rails, fences, manholes, catch basins, inlets etc. where portions of the existing construction are to be left in the finished work the same shall be removed to an existing joint or out and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

All concrete pavements, base course in carriageway and shoulders etc. designed for removal shall be broken to pieces whose volume shall not exceed 0.02 cubic metre and used with the approval of the Engineer or disposed of.

➤ **Back-filling**

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

➤ **Disposal of Materials**

All surplus materials shall be taken over by the Contractor which may either be re-used with the approval of the Engineer or disposed of with all lead and lifts.

➤ **Measurements for Payment**

The work of dismantling shall be paid for in units indicated below by taking measurements before and after, as applicable.

	(i)	Dismantling brick/stone masonry / concrete (Plain and reinforced)	Cubic Metre
Cubic Metre	(ii)	Dismantling flexible and cement concrete pavement	
Tonne	(iii)	Dismantling steel structure.	
Cubic Metre	(iv)	Dismantling timber structure	
Linear Metre	(v)	Dismantling pipes, guard rails, kerbs, gutters and fencing.	
No.	(vi)	Utility services	

➤ **Rate**

The contract unit rates for the various items of dismantling shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. The rates will include excavation and backfilling to the required compaction and for handling, giving credit towards salvage value disposing of the dismantled materials within all lead and lifts.

➤ Payment shall be made on **Job** basis.

Item No. 02 :: Excavation for foundation upto 1.5 m depth including sorting out and stacking of useful materials and disposing off the excavated stuff upto 50 Meter lead. (B) Dense or Hard soil

304.1 Scope

Excavation for structures shall consist of the removal of material for the construction of other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

304.2 Classification of Excavation

301.2.1. Classification : All materials involved in excavation shall be classified by the Engineer in the following manner:

(a) **Soil**

This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose murrum, a mixture of these and similar material which yields to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging equipment. Removal of gravel or any other modular material having dimension in any one direction not exceeding 75 mm shall be deemed to be covered under this category.

(b) **Ordinary Rock (not requiring blasting) this shall include:**

(i) Rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting;

- (ii) macadam surfaces such as water bound and bitumen bound; soling of roads, cement concrete pavement, coddle stone etc. compacted murrum or stabilized soil requiring use of pick axe or shovel or both.
 - (iii) lime concrete, stone masonry and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
 - (iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.
- (c) Hard Rock (requiring blasting)

This shall comprise:

 - (i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required;
 - (ii) reinforced cement concrete below ground level and in bridge / ROB / RUB / fly over piers and abutments,
 - (iii) boulders requiring blasting.
- (d) Hard Rock (using controlled blasting)

Hard rock requiring blasting as described under (c) but where controlled blasting is to be carried out in locations where built-up area, huts and are situated at within 200m of the blast site.
- (e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason like people living within 20m of blast sites etc. and excavation has to be carried out by chiselling, wedging or any other agreed method.
- (f) Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

304.3 Construction Operations

304.3.1 Setting Out

After the site has been cleared according to Clause 201, the limits of excavation shall be set out true to lines, curves and slopes, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete etc. required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

304.3.2 Excavation

Excavation shall be taken to the width of the lowest step of the footing including additional width as required for construction operation. The sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own cost shall put up necessary shoring; strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation.

Where blasting is to be resorted to, the same shall be carried out in accordance with Clause 302 and all precautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

304.3.3 Dewatering and Protection

Normally, open foundations shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, depression of water level by well-point system, cofferdams and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/ masonry against damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to the approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements for the quality and safety of the works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment's etc. inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete and for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

304.3.4 Preparation of Foundation

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete as per Clause 2104.1 at the cost of the Contractor. Ordinary filling shall not be permitted to bring the foundation to the design level as shown in the drawing.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 up to the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling up to this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving/casting of all piles forming the group. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

304.3.5 Slips and Slip-Outs

If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

304.3.6 Public Safety

Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS:3764.

304.3.7 Backfilling

Backfilling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thickness. The compaction shall be done with the help of suitable equipment such as trench compactor, mechanical tamper, rammer, plate vibrator etc. after necessary watering, so as to achieve the maximum dry density.

304.3.8 Disposal of Surplus Excavated Materials

All the excavated materials shall either be reused with the approval of the Engineer or disposed off with all loads and lifts as directed by Engineer in charge.

304.4 Measurements for Payment

Excavation for structures shall be measured in Cu.m for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer. Excavation over increased width, cutting of slopes, production/support to the existing structures shoring, shuttering and planking shall be deemed as incidental to the main work and shall not be measured and paid separately.

304.5 Rates

304.5.1 The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for:

- i. setting out;
- ii. transporting the excavated materials for use or disposal with all leads and lifts;
- iii. construction of necessary cofferdams, cribs/sheeting, shoring and bracing and their subsequent removal;
- iv. removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundations including trimming of bottoms of excavations;
- v. foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
- vi. backfilling, clearing up the site and disposal of all surplus material with all leads and lifts or as otherwise specified; and
- vii. all labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specifications.

304.5.2 The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work

Item No. 03 :: Providing and casting in situ Ordinary cement concrete M-150 for R.C.C. Raft and cut-off walls including necessary shuttering laying,vibrating, ramming and curing complete.

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement fine aggregate and coarse aggregates are specified by volume as given in table below for different four grades designated as ordinary M-100, M-150, M-200 and M-250.
2. In the designation of a concrete mix letter M refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes expressed in kg./cm.
3. The ordinary concrete mix shall generally be specified by volume for cement which normally comes in bags and is used by weight, volume shall be worked out taking 50 kg. of cement as 0.035 cubic metre in volume. While measuring aggregate by volume, shaking ramming or hammering shall not be done proportioning of sand be as per its dry volume. In case it is dam, allowance for bulking shall be made as per IS : 2386 (Part-III).
4. In gradients required for ordinary / concrete containing one 50 kg. bag of cement for different proportions of mix shall be as given in Table below.

TABLE

Grade of concrete	Mix by volume	Total quantity of dry aggregates by volume per 50 kg. cement to be taken as sum aggregate of the individual volumes of fine & coarse aggregates, maximum	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 kg. of cement max.
(1 cubic metre : 1000 Liters)				
1	2	3	4	5
Ordinary	Litres			Litres
M-100	1:3:6	300	General 1:2 for fine aggregate to Coarse aggregate by volume but subject to a upper limit of 1:1.1/2 & a lower limit of 1:3.	34
M-150	1:2:4	220		32
M-200	1:1.1/2:3	160		30
M-250	1:1:2	100		27

Note :- The proportion of the aggregates shall be adjusted from upper limit to lower limit progress grading of the final aggregate becomes finer and the maximum size of coarse aggregate becomes larger.

Example : For an average grading of fine aggregate (that is zone II of IS : 383 - 1963) the proportions 1:1 1/2, 1:2 and 1:3 for maximum size of aggregates 10mm, 20 mm and 40mm respectively (after carrying out sieve analysis).

Note:- A mix leaner than M-100 (1:3:6) may be used for non structural part, if provided in the contract. In such cases grading of aggregates shall be by volume. Other requirements for mixing, placing and curing shall be the same.

5. Following shall be the maximum nominal size of coarse aggregate for the different items of work.

Sr. No.	Item of construction	Maximum nominal size of coarse aggregate
i	R.C.C. well curb, R.C.C. well steining and R.C.C. Piles	40 mm
ii.	R.C.C. well steining	63 mm
ii	Well cap or pile cap, solid type piers, abutments and wing walls and their pier caps	40 mm
iii	R.C.C. works in cross girders, deck slab, wearing coat, kerb, light post, blast walls, approach slab etc. and hollow type piers, abutments, wing walls and their pier caps	20mm
iv	R.C.C. bearings	20 mm
v	For any other item of construction not covered by items (i) to (v) by drawing Engineer not	As specified on the drawing or as desired by the Engineer in charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of ribs of main beams, nominal maximum size of aggregate shall usually be restricted to 5 mm. less than the minimum lateral clear distance between the main bars or 5 mm. less than the minimum cover to the reinforcement whichever is the smaller.

6. Fine aggregate shall be clean, hard, coarse sand. It shall be free from dust and such other substances. The sand shall be got approved by the Engineer-in-charge.

7. All materials shall be stored as to prevent their deterioration or intrusion of their quality and fitness for the work. Any material which has deteriorated or has been

damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the work

8. Cement shall be store above the ground level in perfectly dry and watertight sheds and shall be stocked not more than eight bags high. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirements at site and should be cleaned at least once every 3 to 4 months. Cement more than 3 to 4 months old shall invariably be tested to ascertain that R satisfies the ascertain requirements. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of the fine or coarse aggregate shall be stored in separate stock piles sufficiently removed from each other to prevent intermixing the materials.
9. The water for mixing shall be portable water to the satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.
10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.
11. When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons, it shall be done on a smooth watertight platform large enough to allow efficient. Turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate. Which shall also be spread in a layer of uniform thickness on the mixing platform ? Dry coarse and fine aggregate and cement then shall be mixed thoroughly by turning over to get a mixture of uniform color. Enough water shall then be added gradually through a nose and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 percent above that specified.
12. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer-in-charge the first batch of concrete from the mixer shall contain only two third of normal quantity of course aggregate. Mixing plants shall be thoroughly cleaned before changing from one type of cement to another.
13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be so transported and placed that no

contamination, segregation or loss of its constituent material takes place. All from work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started with 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting then shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly designed agitators, operating continuously, when this time shall be within 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to by the Engineer-in-charge, concrete shall be disposed in horizontal layer to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.
15. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 metres. When trucking or chutes are used they shall be kept clean and used in such way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened swept clean, thoroughly wetted, and cleaned with a 13 mm. thick - layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushed, care being taken to avoid dislodgement of particulars of coarse aggregate. The surface shall then be thoroughly wetted. All free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this, surface shall not exceed 150 mm. in thickness and shall be well rammed against old work particular attention being given to corner and close spots.
16. All concrete shall be compacted to produce a dense homogenous mass with the assistance of Vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting Under water, where vibrators cannot be used Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event, of break downs.
17. Immediately after compaction concrete shall be protected against harmful effects of weather including rain, running water shocks, vibrations due to traffic, rapid temperature changes. Fast drying put process, it shall be covered with wet sacking Hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set. It shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation

concrete may be started after 48 hours of it's laying but the curing of concrete shall be continued for a minimum period of 14 days.

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Formwork shall however be delivered into following two district categories :-

- (1) Shuttering i.e. formwork required for forming the concrete
- (2) Scaffolding i.e. formwork required for supporting shuttering.

Forms for shuttering shall be constructed only, in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and reverts shall be counter-sunk and well ground to provide a smooth, plane surface.

19. Forms shall be mortar tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure especially in long spans to counteract the effects of any deflection. The framework shall be so fixed as to provide for such camber. Forms shall be as constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed. Chamfers or fillets of size 25 mm x 25 mm shall be provided at all angles of framework to avoid sharp corners.
20. The inside surface of forms shall except in the case of permanent formwork or where otherwise agreed to by the engineer-in-charge be coated with an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instruction and shall not be allowed to come into contact with any reinforcement of prestressing tendons and anchorage shall be applied strictly in accordance with the manufacturer's instruction and shall not be allowed to come into contact with any reinforcement of prestressing tendons and anchorage. Different release agents shall not be used in formwork of concrete which will be visible in the finished works.
21. Special measures shall be taken to ensure that the framework does not hinder the shrinkage of concrete because without these cracking could occur before the formwork is removed. Wherever applicable arrangement must be made to ensure that the formwork does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The formwork should take due account of the calculated amount of positive or negative camber so as to ensure the correct final

shape of the structures having regard to the deformation of false work, scaffolding or propping and the instantaneous deformation due to various causes affecting prestressed structures. Where there are re-entrant angles in the concrete section, the formwork should be removed at these sections as soon as possible after the concrete has set in order to avoid cracking due to shrinking of concrete. Formwork shall be tight enough to prevent any appreciable loss of cement during vibrations. Suitable tolerances should be provided in the formwork, immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of machinery materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formworks. Due consideration shall be given to local condition, Character of the structure, the weather and other condition that influence the setting of concrete the removal of the load supporting of soffit forms may commence when concrete has attained strength and of the materials used in the mix. Where field operations are controlled by the strength test of concrete, the removal of the load supporting of soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subject at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength test of concrete the vertical forms of beams, columns and walls may be removed after 2 days. The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to avoid any shock or vibrations. Supports shall be removed in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortars. No permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to reuse the framework it shall be cleaned and made good to the satisfaction of the Engineer-in-charge.
23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member and used for shuttering or any other purpose shall be cut inside the Cement Concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corner and other defects shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete with mortar or cement and fine aggregate mixed in the proportions used in the grade of concrete that is being

finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surface which has been pointed shall be kept moist for a period of 24 hours. If rock, pockets/honeycombs, in the opinion of the Engineer-in-charge are of such extent of and character as to affect materially or to endanger the life of the strength or the steel reinforcement he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and. methods of vibration of concrete shall be determined regular slump test. Following slump shall be adopted for different types of works.

	Type of Work	Slump where vibrator is used	Slump where vibrator is not used
1	Mass conc. In RCC, foundation footing and retaining walls	10 to 25 mm	80 mm
2	Beam slab and column with simply reinforced	25 to 40 mm	100 to 120 mm
3	Thin RCC section or congested steel	40 to 50 mm	125 to 150 mm

25. Works strength tests shall be made in accordance with IS : 516. Each test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and, cubes shall be made at the rate of one for every 5 cubic meter of concrete or a part thereof. However if concreting done in a day is than 15 cubic meter, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out when ever the quality and grading of materials is changed irrespective of the quantity of concrete poured, The number of specimens may be suitable increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.
26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength. 20 percent of the cubes cast each day may have values less than the specified strength provided the lowest value is not less than 85 percent of the specified strength.
27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in- charge. One carpenter with helper will invariably be kept throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position as not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi

or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Asstt. Engineer / Addl. Asstt. Engineer / Overseer or as instructed by the Engineer-in-charge. After removal of 'form work and suturing, the executive Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.
29. All necessary labour, materials, equipment etc. for sampling, preparing test cubes, curing etc. shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.
30. The unit rate for concrete shall include the cost of all materials, labour, tools and plant required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making fixing and removing of all centers and forms required for the work.
31. **The payment will be made on cumt. basis of the finished work.**

Item No. 04 :: Supplying and fixing reinforced concrete heavy duty non-pressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal diameters. (v) 900mm dia.

1. This shall consist of furnishing and installing reinforced cement concrete pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.
2. Reinforced concrete pipe shall be of **NP3 type** conforming to the requirements of IS : 458 and shall be of dia. as specified in the item. Each consignment of cement concrete pipes shall be inspected, if necessary and approved by the Engineer-in-charge either at the place of manufacture or at the site before their incorporation in the works.

NP3, NP2 and NP1 pipes are used for R.C.C. Pipes. Where the testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturer on company's letter head in the given' hereinafter from.

Production of such certificate will not however relieve the Contractor from his responsibility of supplying pipes of required standard and will have to bear the loss or damage caused to the work on account of defects found subsequently during execution. It will also be necessary to purchase these pipes from manufacturer having standard equipments for carrying out various tests as per IS : 458 at his factory.

Form of Certificate for NP-3, NP-2, NP-1 Pipes

We _____

Manufacturer or R.C.C. Pipes produce R.C.C. pipes as per the requirement of IS : 458 and also carry out the required test at our place, We have acquired equipments for carrying out test and are prepared to carry out tests at our factory sites. We have experience of manufacturing of pipes of years. The pipes supplied by us to M/S. _____.

Satisfy the requirement of IS:458.

Date: _____

Place:_____

Manufacturer's Sign _____

3. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to minimum of 900 mm. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at the cost of Contractor.
4. The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diameter of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 mm wide. The joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.
5. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.
6. The rate for the pipes shall include the cost of pipe including loading, unloading, handling, storing laying in position and joining complete.
7. The rate shall be for a unit of **one running meter**.

Item No. 05 :: Supplying and fixing reinforced concrete heavy duty non-pressure pipes with collars for culverts carrying heavy traffic as per IS 458 1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal diameters. (vii) 1200mm dia.

Specification as per Item No. 04. For NP-3 Dia. 1200mm dia.

Item No. 06 :: Providing and casting in situ controlled cement concrete M-200 for R.C.C. return as per drawings including centering shuttering ,scaffolding where necessary, laying vibrating, curing and finishing complete.(A) Height from 0.0 to 5.0 M. For wall.

**This item shall be carried out as per detailed specification of
Item No. [03] below in Design Mix Concrete M-200 grade
for R.C.C. return (A) Height from 0.0 to 5.0 M. (1) Piers (2)
Abutment (3) RCC return as directed including cost of shuttering,
scaffolding, laying, vibrating, curing and finishing as per design**

Item No. 07 :: Providing and laying in position FE 500D TMT bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawings for the following.(A) Piers (B) Abutments (C) R.C.C. Returns.

1601. DESCRIPTION

This work shall consist of furnishing and placing coated or uncoated mild steel or high strength deformed reinforcement bars (un tensioned) of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer.

1602. MATERIALS

Steel for reinforcement shall meet with the requirements of Section 1000.

Reinforcements may be either mild steel/medium tensile steel or high strength deformed bars. They may be uncoated or coated with epoxy or with approved protective coatings.

1603. PROTECTION OF REINFORCEMENT

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing, etc., as directed by the Engineer. Reinforcements shall be stored on blocks, racks or platforms and above the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.

Portions of uncoated reinforcing steel and dowels projecting from concrete, shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water to a consistency of thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coating on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

1604 BENDING OF REINFORCEMENT

Bar bending schedule shall be furnished by the Contractor and got approved by the Engineer before start of work.

Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

Bars shall not be bent or straightened in a manner that will damage the parent material or the coating.

Bars bent during transport or handling shall be straightened before being used on work and shall not be heated to facilitate straightening.

1600.5 PLACING OF REINFORCEMENT

- (a) The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcements and casting of concrete, which may result in rust formation on the surface, shall not be permitted.
- (b) Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.
- (c) Bars shall be kept in position usually by the following methods:
 - (i) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed

between the bars and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.

- (ii) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed upto a level just below their location.
 - (iii) Layers of reinforcements shall be separated by spacer bar at approximately one metre intervals. The minimum diameter of spacer bars shall be 12 nun or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.
 - (iv) Necessary stays, blocks, metal chairs, spacers, metal hangers, supporting wires etc, or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in its correct position.
 - (v) Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.
- (d) Bars coated with epoxy or any other approved protective coating shall be placed on supports that do not damage the coating. Supports shall be installed in a manner such that planes of weakness are not created in hardened concrete. The coated reinforcing steel shall be held in place by use of plastic or plastic coated binding wires especially manufactured for the purpose. Reference shall be made to Section 1000 for other requirements.
- (e) Placing and fixing of reinforcement shall be inspected and approved by the Engineer before concrete is deposited.

1606. BAR SPLICES

1606.1. Lapping

All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, will be permitted without approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other, and shall be kept apart by 25 mm or 1 I/. . times the maximum size of coarse aggregate, whichever is greater. If this is not feasible, overlapping bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points, along the span where stresses are low.

1606.2. Welding

1606.2.1. Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

1606.2.2. While welding may be permitted for mild steel reinforcing bars conforming to IS: 432, welding of deformed bars conforming to IS: 1786 shall in general be prohibited. Welding may be permitted in case of bars of other than S, 240 grade including special welding grade of S 415 grade bars conforming to IS: 1786, for which necessary chemical analysis has been secured and the carbon equivalent (CE) calculated from the chemical composition using the formula

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mg+V}{5} + \frac{Ni+Cu}{15}$$

is 0.4 or less.

1606.2.3. The method of welding shall conform to IS:2751 and 15:9417 and to any supplemental specifications to the satisfaction of the Engineer.

Welding may be carried out by metal arc welding process. Oxy- acetylene welding shall not be permissible. Any other process may be used subject to the approval of the Engineer and necessary additional requirements to ensure satisfactory joint performance. Precautions on over heating, choice of electrode, selection of correct

current in arc welding etc., should be strictly observed.

All bars shall be butt welded except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or Double- V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used.

Welded joints shall be located well away from bends and not less than twice the bar diameter away from a bend.

Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators, welding procedure are adequate to produce and maintain uniform quality at par with that attainable in shop welding to the satisfaction of the Engineer.

Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 2751. Inspection of welds shall conform to IS: 822 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.

Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding. When welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding. Only competent and experienced welders shall be employed on the work with the approval of the Engineer. No welding shall be done on coated bars.

M.S. electrodes used for welding shall conform to IS: 814.

1606.2.4. Welded joints shall preferably be located at points where steel will not be subject to more than 75 per cent of the maximum permissible stresses and welds so staggered that at anyone section, not more than 20 per cent of the bars are welded.

1606.2.5. Welded pieces of reinforcement shall be tested, Specimens shall be taken from the site and the number and frequency of tests shall be as directed by the

Engineer.

1606.3. Mechanical Coupling of Bars

Bars may be joined with approved patented mechanical devices as indicated on the drawing or as approved by the Engineer e.g. by special grade steel sleeves swagged on to bars in end to end contact or by screwed couplers. In case such devices are permitted by the Engineer, they shall develop at least 125 per cent of the characteristic strength of the reinforcement bar.

1607. TESTING AND ACCEPTANCE

The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.

The fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted by the Engineer.

Manufacture's test certificate regarding compliance with the Indian Standard for each lot of steel shall be obtained and submitted to the Engineer. If required by the Engineer, the Contractor shall carry out confirmatory tests in the presence a person authorized by the Engineer. Cost of these tests shall be borne by the Contractor. The sampling and testing procedure shall be as laid down in IS 1786. If any test piece selected from a lot fails, no retesting shall be done and lot shall be rejected.

1608. MEASUREMENTS FOR PAYMENT

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS: 1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

1609. RATE

The contract unit rate for coated/uncoated reinforcement shall cover the cost of

material, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings as per these specifications and as directed by the Engineer, including all labour, equipment, supplies, incidentals, sampling, testing and supervision.

The unit late for coated reinforcement shall be deemed to also include cost of all material, labour, tools and plant, royalty, transportation and expertise required to carry out the work. . The rate shall also cover sampling, testing and supervision required for the work.

Unit rate for payment of this item shall be per 1-M.T. of complete item.

Item No. 08 :: Filling around the pipes with murrum including dressing , tampering etc. complete.

Area around pipes shall be filled with murrum immediately after the pipes have been laid and the joining material has hardened. The material shall be clean, free from boulders large roots, excessive amount of sods or other vegetable matter, and lumps and shall be approved by the Engineer-in charge. Filling up to 0.3 metre above the top of the pipe shall be carefully done and the soil thoroughly rammed, temped or vibrated in layers of not exceeding 150 mm. particular care being taken to thoroughly consolidate the materials under the launches of the pipe. Filling shall be carried out simultaneously on both sides of the pipes in such a manner that unequal pressures do not occur. In case of high embankments after filling up to the top in the above said manner a loose fill of a depth equal to external diameter of the pipe shall be placed over the pipe before further layer are added and compacted. Materials shall be filled in pharas 3m. x 1.5. m x 0.5 m size and shall be measured in Cu.M.

Unit rate includes cost of materials and spreading including labour and tools needed for the above operations.

Payment shall be paid on Cum basis.

Item No. 09 :: Construction of granular sub-base 200mm thick layer by providing machine crushed B.T. material satisfying MORT&H specification (Fifth revision) of grading III including spreading in uniform layer with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC and compacting with vibratory roller to achieve the desired density etc. complete.

401 GRANULAR SUB-BASE

401.1 Scope

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

402 Materials

401.2.1 The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the gradings given in Table 400-1 and physical requirements given in Table 400-2. Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

401.2.2 If the water absorption of the aggregates determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregates shall be tested for Wet Aggregate Impact Value (AIV) (IS:5640). Soft aggregates like Kankar, brick ballast and laterite shall also be tested for Wet AIV (IS:5640).

Table 400-1: Grading for Granular Sub-Base Materials

IS Sieve	Percent by Weight Passing the IS Sieve					
Designation	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	1100	-
53.0 mm	80-100	100	100	100	80-100	100

26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	-	-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-
0.425 mm	10-15	10-15	-	-	0-5	0-8
0.075 mm	<5	<5	<5	<5	-	0-3

Table 400-2: Physical Requirements for Materials for Granular Sub-base

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

401.2 Construction Operations

401.2.1 Preparation of Sub-grade

Immediately prior to the laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

401.3.2 Spreading and Compacting

The sub-base material of the grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer.

Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 percent below the optimum moisture content.

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer, up to 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall or on super-elevation. For carriageway having cross fall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks, or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

401.4 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

401.5 Arrangements for Traffic

During the period of construction, arrangements for the traffic shall be provided and maintained in accordance with Clause 112.

401.6 Measurements for Payment

Granular sub-base shall be measured as finished work in position in cubic metres.

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

401.7 Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

- i. making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- ii. supplying all materials to be incorporated in the work including all royalties, fees, rents where applicable with all leads and lifts;
- iii. all labour, tools, equipment, and incidentals to complete the work to the Specifications;
- iv. carrying out the work in part widths of road where directed; and carrying out the required tests for quality control.

Item No. 10 :: Painting Two Coats on New Concrete Surfaces (Painting two coats after filling the surface with synthetic enamel paint in all shades on new plastered concrete surfaces)

1.0. Materials

The synthetic enamel paint shall conform to M-44 B.

2.0. Workmanship

2.1. General : The materials required for work of painting work shall be obtained directly from approved manufactures or approved dealer and brought to the site in maker's drums; kegs. etc. with seal unbroken.

2.1.2. All materials not in actual use shall be kept properly protected, lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become state or flat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in smaller container. No left over paint shall be put back into stock tins. When not in use the containers shall be kept properly closed.

2.1.3. If for any reasons, things is necessary, the brand of thinner recommended by the manufacturer shall be used.

2.1.4. The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No painting on exterior or other exposed part o the work shall be carried out in wet, damp or otherwise unfavorable weather and all the surfaces shall be thoroughly dry before painting work is started.

2.2. Application of paint:

2.2.1. Brushing operations are to be adjusted to the spreading capacity advised by the manufacture of particular paint. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles to the same. In this process,

no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

- 2.2.2. Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand-paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved from Engineer-in-charge before next coat is started.
- 2.2.3. Each coat the last shall be lightly rubbed down with sand paper of fine pumice stone and cleaned of dust before the next coat is applied. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.
- 2.2.4. Special care shall be taken while painting over bolts, nuts, rivets, overlaps etc. approved best quality brushes shall be used.

3.0. Mode of measurements and payment

- 3.1. The new concrete surface shall be measured under this item.
- 3.2. All the work shall be measured net in the decimal system, as executed subject to the following limits unless otherwise stated hereinafter.
 - (a) Dimensions shall be measured to the nearest 0.01 meter.
 - (b) Areas shall be worked out to the nearest 0.01 sq. meter.
- 3.3. No deductions shall be made for openings not exceeding 0.5 sq. mt. each and no addition shall be made for painting to beddings, moldings, edges, jambs, soffits, sills etc. of such opening.
- 3.4. In case of fabricated structural steel and iron work, priming coat of paint shall be included with fabrication. In case of trusses if measured in sq. m. compound girders, stanchions, lattices, grader and similar work, actual area shall be measured in sq. m. and no extra shall be paid for painting on bolts heads, nuts, washers etc. No addition shall be made to the weight calculated for the purpose of measurements of steel and iron works for paint applied on shop or at site.
- 3.5. The different surfaces shall be grouped into one general item, areas of uneven surfaces being converted into equivalent plain areas in accordance with the table given as per Annexure-II for payment.
- 3.6. The rate shall be for a unit of One sq. meter.

Item No. 11 :: Providing & laying weep hole in Abutments, and returns by using A.C. pipe of 100mm including laying in proper grede and jointing the completed as per detailed specification.

The weep holes in the masonry and returns shall be provided of the [A.C. / P.V.C. pipes](#) of 100 mm dia. The pipe shall be fixed of suitable length & in full thickness of the masonry / concrete work. Necessary C.I. grating shall be provided on back side of abutment & returns on the inlet of opening of weep holes.

Materials the [A.C. / P.V.C. pipes](#) of 100mm dia.

The Asbestos cement pipe of diameters specified in description of the item shall conform to I.S. 1626-1900. The interior of pipe shall have a smooth finish, regular surface & regular internal diameter.

The tolerance in all dimensions shall be as per IS 1926-Part-I 1980.

The grating shall be of [C.I.](#) 100 mm. dia. & per IRC specification.

The weep holes shall be provided 1 meter C/C shall be placed in staggered. After laying weep holes, it shall be clear of earth and other materials from its complete length.

The rate shall be paid on [Number](#) basis.

Item No. 12 :: Excavation for foundation in sand, gravel, clay soft soils and murrum etc. including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed.(A) Depth up to 3.0 M. and lead upto 100 m for 10 Cum.

The work shall be executed as per specification of **Item No. 2** except the work is for **excavation for foundation in sand, gravel, clay soft soils and murrum etc. including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed. (A) Depth up to 3.0 M. and lead upto 100 m for 10 Cum**

Item No. 13 :: Providing and laying controlled cement concrete M.150 for curing complete excluding cost of formwork and reinforcement for reinforced concrete work in (A) Foundations, footings, Base of columns and Mass concrete

This item shall be carried out as per detailed specification of Item No. [06] below in Design Mix Concrete M-150 grade for R.C.C. return (A) Foundations, footings, Base of columns and Mass concrete as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 14 :: Providing and Casting in situ controlled Cement Concrete M-200 for R.C.C. Raft and cutt-off walls including necessary shuttering laying, vibrating, ramming and curing complete.

This item shall be carried out as per detailed specification of Item No. [06] below in Design Mix Concrete M-200 grade for R.C.C. Raft and cutt-off walls as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 15 :: Providing and casting in situ controlled cement concrete M-200 for R.C.C. return as per drawings including centering shuttering, scaffolding where necessary, laying vibrating, curing and finishing complete. (A) Height from 0.0 to 5.0 M. (1) Piers (2) Abutmen (3) RCC return

This item shall be carried out as per detailed specification of Item No. [06] below in Design Mix Concrete M-200 grade for R.C.C. return (A) Height from 0.0 to 5.0 M. (1) Piers (2) Abutment (3) RCC return as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 16 :: Providing and casting in situ controlled cement concrete M-200 for R.C.C. work in superstructure including centering, ramming vibrating curing and finishing complete. (A) T-Beam and Deck slab type of superstructure (I) Deck slab

This item shall be carried out as per detailed specification of Item No. [06] below in Design Mix Concrete M-200 grade for R.C.C. return (A) T-Beam and Deck slab type of super structure (I) Deck slab as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 17 :: Providing and casting in situ ordinary cement concrete concrete M-200 for approach slab including formwork curing and finishing complete.

**This item shall be carried out as per detailed specification of
Item No. [06] below in Design Mix Concrete M-200 grade
for R.C.C. return (A) approach slab as directed including cost of
shuttering, scaffoldign, laying, vibrating, curing and finishing as per
design**

Item No. 18 :: Providing and laying - Fitter Media 600mm thick directed at the back of abutments, returns and wing walls as per detailed specifications.

1. Well graded pebbled or metal of 40 mm to 63 mm. size shall be used. The grading and tolerances of metal of pebbles shall be as under :-

Sr. No.	No. of Size Range	Sieve designation	Percentage by weight passing through the
1	63 mm. to 40 mm	90 mm.	100-00
		63 mm.	85-100
		50 mm.	35-70
		40 mm.	00-15
		20 mm.	00-05

The size shall be 40 mm. to 63 mm. where in tolerance limit for over size shall be upto 15% and that for lower size should be upto 15% and below 20 mm. it shall be allowable upto 5%. The filter Materials shall be tightly placed to a thickness of not less than 600 mm. and provided over the entire surface behind abutments, wings or return walls to the full height.

2. Materials shall be first stacked in boxed of 2 m. 1.1/2 m. x 0.5 m. size on fairly level ground and measured.
3. The measurement for payment shall be made on Sq.m. basis of Specified Thickness.
4. The unit rate includes the cost of materials, scaffolding labour and tools to complete the work.

2504.2.2 Filter Medium

The material for the filter shall consist of coarse sand, gravel or stone. One or more layers of graded materials, to act as a filter medium, shall be provided underneath the pitching, to prevent loss of the embankment material and build up of uplift head on the pitching.

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

$$\frac{D_{15} \text{ of Filter}}{D_{85} \text{ of Base Material}} < 5$$

$$4 > \frac{D_{15} \text{ of Filter}}{D_{15} \text{ of Base Material}} < 20$$

Notes $\frac{D_{50} \text{ of Filter Material}}{D_{50} \text{ of Base Material}} < 25$

1. Filter design may not be required if embankment consists of CH or CL 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, D15 means the size of that sieve which allows 15 percent by weight of the filter material to pass through it and similar is the meaning of D 50 and D 85 (15 being replaced with 50 and 85 respectively).
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 600 mm.

Item No. 19 :: Providing uncoursed rubble stone masonry in Cement Mortar 1:5 for flooring including curring pointing in Cement Mortar 1:3 on exposed faces complete.

1. Stone shall be hard, sound free from cracks decay and weathering and shall be freshly quarried from approved quarry. Stone with round surface shall not be use. The Stones when immersed in water for 24 hours shall not absorb water by more than 5 per cent of their cry weight when tested in accordance with IS: 1125. The length of stone shall not exceed three times its height and the breadth on base shall not be greater than three fourth of the thickness of wall not less than 15 cm. Minimum crushing strength of stone shall not be less than 105 kg/sq.cm.
2. Cement and sand shall be mixed in proportion as a specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall than be added and the mortar mixed to produce workable consistency.
3. The mixing shall be done intimately, on a clean water tight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then after addition of water the mortar shall be mixed for at least two minutes. In case cement mortar has stiffened because of evaporation of water, the same shall be retempered by adding water as frequently as needed to restore the requisite consistency but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

4. Dressing of stone shall conform to the general requirements for dressing of stone covered in IS : 1129. Stone shall be sufficiently wetted before laying to prevent absorption of water from mortar. The bed which is to receive the stones shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and in vertical joints and settled carefully in place with a wooden mallet immediately on placement so that it is solidly bedded in before the same has set. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. Whenever foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. Vertical joints shall be staggered as far as possible. Sufficient transverse bond shall be provided by the use of bond stones extending from the front to the back of the masonry. In case of thick walls bond stones shall overlap each other in their arrangement. Bell shaped bond stones or headers shall not be used.
5. At all angular junction stones at each alternate course shall be well bonded into the respective course of the adjacent wall. All connected masonry in structure shall be carried up at one uniform level throughout as far as possible, but when breaks are unavoidable, the masonry shall be raked in sufficient long steps to facilitate jointing of new work with old. The stepping of running shall not be more than 450 with the horizontal. Wing walls, abutments and piers, etc. shall be carried up truly plumb or to the specified batter. Face work and hearting shall be brought up evenly. The top of each course, however, shall not be levelled up by use of flat chips.
6. Stones shall be hammer dressed on the face, the sides and beds to enable it to come in proximity with the neighbouring stone. The bushing on the face shall be more than 4 cm on exposed face. Chips and spalls of stones may be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones to bring these up to the level of face stones. Use

- of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 per cent of the quantity of stone masonry.
7. The hearting or interior filling wall face shall consist of rubble stone, not less than 15 cm. in any direction carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid early level with facing and backing. Through bond stones shall be provided in masonry upto 60 cm. thickness and in case of masonry above 60 cm thickness a set of two or more bond stones overlapping each other at least by 15 cm shall be provided in a line from face to back. In case of highly absorbant types of stones (porous limestone and sand stones, etc.) the bond stone shall extend only about two third into the wall, as through stone in such cases may give rise to penetration of dampness and therefore, for all thickness of such masonry a set of two or more bond stones overlapping each other by at least 15 cm. shall be provided for every 0.50 square metres of the masonry surface. Bond stone shall be stacked separately and marked to distinguish from other stones. Masonry work shall be started after sufficient number of bond stones are collected on site as directed by the Engineer-in-charge. Vertical bond stones shall be inserted at the rate of one per 3 sq.mt. and shall be staggered.
 8. The quoins shall be laid header and stretcher alternately. Every stone shall be fitted to the adjacent stones so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible and to avoid long vertical lines of joints.
 9. The face joints shall be more than 20 mm. thick but be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar.
 10. Green work shall be protected from by suitable covering. Masonry work in cement or composite mortar shall be kept moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day. During hot weather all finished or partly completed work shall be covered or wetted in such manner as to prevent rapid drying. The raking of joints, where necessary shall be done at the end of day's work when mortar is green.

11. The scaffolding shall be sound and strong to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the screw backs or arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good.
12. When fresh masonry is to be placed against existing surface of structure, these shall be cleaned of all loose material, roughed and wetted as directed by the Engineer-in-charge as to effect a good bond with the new work.
13. Stone masonry shall be measured in cubic meters.
14. The unit rate for stone masonry work shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the work.
15. For a surface which is to be subsequently pointed, the joints shall be squarely raked out to a depth of 15 mm. while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.
16. Cement and sand shall be mixed in proportions as specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.
17. The mixing shall be done intimately by hand-mixing, on a clean water tight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed for at least two minutes after addition of water. in case of cement mortar, that has stiffened because of evaporation of water the same shall be re-tempered by adding water as frequently as needed to restore to requisite consistency but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.
18. For pointing, the mortar shall be filled and pressed into the raked out joints before giving the required finish. The pointing shall then be proper type given on the drawings. If type of pointing is not mentioned on the drawing the same shall be

ruled pointing. For ruled pointing after the mortar has been filled and pressed into the joints and finished off level with the edges, it shall while still green be ruled along the centre with a half round tool of such width as may be specified by the Engineer-in-charge, The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar.

19. Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period it shall be suitably protected from all damages.
20. Stage scaffolding shall be approved for the work. This shall be independent of the structure.
21. The work of pointing shall be measured in **cubic metres** of the surface treated.
22. The rate for pointing shall include erecting and removal of scaffolding all labour, materials and equipment incidental to complete tie pointing, rising out joints, cleaning, wetting filling mortar, trowelling, pointing and watering.

Item No. 20 :: Providing and laying rubble for Flexible apron (each stone weighting not less than 40Kg.) including and packing and filling in the interestices with quarry-spalls.

1. The work shall consist of laying boulders directly on the prepared surface for protection against scour.
2. The stones used in apron shall be sound, hard, durable & fairly regularly in shape. Stone subject to marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be levelled and prepared for the length and width as shown on the drawings. The size of stone shall be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40 Kg. The specific gravity of stone shall be as igh as possible and it shall not be less than 2.50. To ensure regular and orderly disposition of the full intended quantity of stone in the apron. template cross walls in dry masonry shall be built about a metre wide and to the full weight of the specified thickness of the apron at intervals of 30 metres and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.
3. Payment shall be made on Cu.m. basis of chata. The materials shall have to be stacked at site before laying. Preparation of base for laying bedding shall be deemed incidental to the work nothing shall deducted for voids.
4. The rate shall include cost of materials, labour & tools to complete the job.
5. Payment shall be made on **Cu.m.** basis.

Item No. 21 :: Providing and casting in situ controlled cement concrete M-200 for average 75 mm thick wearing coat laid as directed including tamping, vibrating, finishing, curing and filling in joints with bitumen complete.

602 CEMENT CONCRETE PAVEMENT

602.1 Scope

602.1.1 The work shall consist of construction of un-reinforced, dowel jointed, plain cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer.

602.1.2 The design parameters, viz., thickness of pavement slab, grade of concrete, joint details etc. shall be as stipulated in the drawings.

602.2 Materials

602.2.1 Source of Materials

The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work in trial length. If the Contractor subsequently proposes to obtain materials from a different source during the execution of main work, he shall notify the Engineer, with relevant test data, for his approval, at least 45 days before such materials are to be used.

602.2.2 Cement

Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but preference shall be to use at least the 43 grade or higher.

S.No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade.	IS:8112
ii)	Ordinary Portland Cement 53 Grade	IS:12269
iii)	Portlant slag cement	IS:455
iv)	Portland Pozzolana Cement	IS:1489-Part I

If the soil around concrete pavement has soluble salts like sulphates in excess of 0.5 percent, the cement used shall be sulphate resistant and shall conform to IS:12330.

Cement to be used may preferably be obtained in bulk form. If cement in paper bags is proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and. dispose them off suitably. No paper pieces shall enter the concrete mix. Bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test.

Fly-ash upto 20 percent by weight of cementitious material may be used in Ordinary Portland- Cement 43 and 53 Grade as part replacement of cement provided uniform blending with cement is ensured. The fly ash shall conform to IS:3812 (Part I).

Site mixing of fly ash shall be permitted only after ensuring availability of the equipments at site for uniform blending through a specific mechanised facility with automated process control like batch mix plants conforming to IS:4925 and IS-4926. Site mixing will not be allowed otherwise.

The Portland Pozzolana Cement produced in factory as per IS:1489-Part I shall not have fly-ash content more than 20 percent by weight of cementitious material. Certificate from the manufacturer to this effect shall be produced before use.

602.2.3 Chemical Admixtures

Admixtures conforming to IS:9103 and IS:6925 shall be permitted to improve workability of the concrete and/or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used, must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in the trial length paving. If air entraining admixture is used, the total quantity of air shall be 5 ± 1.5 percent for 31.5 mm maximum nominal size aggregate (in air-entrained concrete as a percentage of the volume of the mix).

602.2.4 Silica Fumes

Silica fume conforming to a standard approved by the Engineer may be used as an admixture in the proportion of 3 to 10 percent of cement. Silica fume shall comply with the requirements given in IS:15388-2003, IS:456-2000, IRC:SP:76 and IRC:44-2008.

602.2.5 Fibres

Fibres may be used subject to the provision in the design/approval by the Engineer to reduce the shrinkage cracking and post-cracking. The fibres may be steel fibre as per IRC:SP:46 or polymeric Synthetic fibres within the following range of specifications:

Effective Diameter	10 micron - 100 micron
Length	6-48 mm
Specific gravity	more than 1.0
Suggested dosage	0.6-2.0 kg/cu.m (0.2 - 0.6% by weight of cement in mix) Usage will be regulated as stipulated in IRC:44/IS:456
Water absorption	less than 0.45 percent
Melting point of this fibre shall not be less than 160°C.	
The aspect ratio generally varies from 200 to 2000	

These synthetic fibres will have good alkali and UV light resistance

When fibres are used, the mix shall be so designed that the slump of concrete at paving site is 25±15 mm.

602.2.6 Aggregates

602.2.6.1 Aggregates for pavement concrete shall be natural material complying with IS:383 but with a Los Angeles Abrasion Test value not exceeding 35 percent. The limits of deleterious materials shall not exceed the requirements set out in Table 600-2.

Table 600-2 : Permissible Limits of Deleterious Substances in Fine and Coarse Aggregates

S No	Deleterious substances	Method of tests	Fine aggregate percentage by Weight (Max.)		Coarse Aggregate Percentage by Weight (Max)	
			Uncrushed	Crushed	Uncrushed	Crushed
1	Coal and lignite	IS :2386 (Part II)- 1963	1.0	1.0	1.0	1.0
2	Clay Lumps	Do	1.0	1.0	1.0	1.0
3	Material finer than 75 IS Sieve	IS :2386 (Part II)	3.0	8.0	3.0	3.0
4	Soft fragments	IS :2386 (Part II)	-	-	3.0	-
5	Shale	IS :2386 (Part II)	1.0	-	-	-
6	Total percentages of al deleterious materials (except mica) including SI No. (i) to (V) for col 4,6 and 7 SI No (i) and (II) for Col 5 Only		5.0	2.0	5.0	5.0

* Crushed aggregate at least one face fractured

Note: The presence of mica in the fine aggregate has been found to reduce considerably the durability and compressive strength of concrete and further investigations are underway to determine the extent of the deleterious effect of mica. It is advisable,

therefore, to investigate the mica content of fine aggregate and make suitable allowances for the possible reduction in the strength of concrete or mortar; in cases where the stretch of the project road passes through micaceous belt.

The aggregates shall be free from chart, flint, chalcedony or other silica in a form that can react with the alkalies in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 percent by weight and the total sulphate content expressed as sulphuric anhydride (SO₃) shall not exceed 0.25 percent by weight. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for atleast 72 hours before batching, as directed by the Engineer.

602.2.6.2 Coarse Aggregates

Coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 31.5 mm for pavement concrete. No aggregate which has water absorption more than 2 percent shall be used in the concrete mix. The aggregates shall be tested for soundness in accordance with IS:2386 (Part-5). After 5 cycles of testing, the loss shall not be more than 12 percent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used. The Los Angeles Abrasion value shall not exceed 35. The combined flakiness and elongation index of aggregate shall not be more than 35 percent.

602.2.6.3 Fine Aggregates

The fine aggregates shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS:383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregates shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37).

602.2.6.4 Combined Gradation of Fine and Coarse Aggregates

The combined gradation of fine and coarse aggregates shall be as per Table 600-3.

Table 600-3 : Aggregate Gradation for Pavement Quality Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
31.5 mm	100
26.5 mm	85-95
19.0 mm	68-88
9.5 mm	45-65
4.75 mm	30-55
600 micron	8-30
150 micron	5-15
75 micron	0-5

602.2.7 Water

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS:456.

602.2.8 Steel for Dowels and Tie Bars

Steel shall conform to the requirements of IS:432 and IS:1786 as relevant. The dowel bars shall conform to IS:432 of Grade I. Tie bars shall be either High yield Strength Deformed bars conforming to IS-1786 and grade of Fe 500D or plain bars conforming to IS-432 of Grade I. The steel shall be coated with epoxy paint for protection against corrosion.

602.2.9 Joint Filler Board

Synthetic Joint filler board for expansion joints shall be used only at abutting structures like bridges and shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS: 1838, with a compressibility more than 25 percent. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. If two pieces are joined to make up full width, the joint shall be taped such that no slurry escapes through the joint. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

602.2.10 Joint Sealing Compound

The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide/polyurethane/silicone type having flexibility, resistance to age hardening and durability as per IRC:57. Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies with the relevant standard mentioned below. The samples shall meet the requirements as mentioned in IRC:57.

If sealant is of hot poured type, it shall conform to hot applied sealant : IS:1834 or ASTM : 3406-95, as applicable Cold poured sealants shall be one of the following :

- | | | |
|------|--------------|--------------------------------------|
| i) | polysulphide | IS:11433 (Part I), BS:5212 (Part II) |
| ii) | polyurethane | BS:5212 |
| iii) | silicone | ASTM 5893-04 |

602.2.11 Preformed Seals

The pre-formed joint sealing material shall be a vulcanized elastomeric compound using polychloroprene (Neoprene) as the base polymer.

The joint seal shall conform to requirements of ASTM D 2628 as given in Table 600-4.

Table 600-4 : Requirement of Preformed Seals as per ASTM D 2628

Sr No	Description	Requirements	ASTM Test methods
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1	Tensile strength, min	13.8 MPa	D 412
2	Elongation at break	Min.250 %	D 412
3	Hardness, Type A durometer	55+/- points	D 2240
4	Oven aging, 70 h at 100°C Tensile strength loss	20 % max	D 573
5	Elongation loss	20 % max	
6	Hardness Change Type A durometer	0 to +10 points	D 471
7	Oil Swell, ASTM Oil 3,70 h at 100°C Weight change	45% max	D 1149
8	Ozone resistance 20 percent strain, 300 pphm in air, 70 h at 40°C	No cracks	D 2240
9	Low temperature stiffening, 7 days at -10°C Hardness Change type A durometer	0 to +15 points	
10	Low temperature recovery, 22h at -10°C deflection	88 % min	D 2628
11	Low temperature recovery, 22h at -29°C deflection	83 % min	D 2628
12	Low temperature recovery, 70h at -100°C, 50% deflection	85 % min	D 2628
13	Compression, deflection, at 80% of normal width min	613 N/m	D 2628

602.2.12 Storage of Materials

All materials shall be stored in accordance with the provisions of Clause 1014 of the specifications. All efforts shall be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work. The platform where aggregates are stock piled shall be paved and elevated from the ground atleast by 150 mm. The area shall have slope to drain off rain water. The storage space must also permit easy inspection, removal and storage of the materials. Aggregates of different sizes shall be stored in partitioned stack-yards. All such materials even though stored in approved godowns must be subjected to acceptance test as per Clause 903 of these Specifications prior to their use.

602.3 Proportioning of Concrete

602.3.1 After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer vide Clause 602.3.4. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on laboratory trial mixes using the approved materials and methods as per IRC:44 or IS:10262. The target mean strength for the design mix shall be determined as indicated in Clause 602.3.3.1. The mix design shall be based on the flexural strength of concrete.

602.3.2 Cement Content

When Ordinary Portland Cement (OPC) is used the quantity of cement shall not be less than **450 kg/cu.m**. In case fly ash grade I (as per IS:3812) is blended at site as part replacement of cement, the quantity of fly ash shall be upto 20 percent by weight of cementitious material and the quantity of OPC in such a blend shall not be less than **360 kg/cu.m**. The minimum of OPC content, in case ground granulated blast furnace slag cement blended, shall also not be less than 310 kg/m³. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary by the contractor at his own cost.

602.3.3 Concrete Strength

602.3.3.1 The characteristic flexural strength of concrete shall not be less than 4.5 MPa unless specified otherwise. Target mean flexural strength for mix design shall be more than $4.5 \text{ MPa} + 1.65s$, where s is standard deviation of flexural strength derived by conducting test on minimum 30 beams. While designing the mix in the laboratory, correlation between flexural and compressive strengths of concrete shall be established on the basis of at least thirty tests on specimens. However, quality control in the field shall be exercised on the basis of flexural strength. It may, however, be ensured that the materials and mix proportions remain substantially unaltered during the daily concrete production. The water content shall be the minimum required to provide the agreed workability for full compaction of the concrete to the required density as determined by the trial mixes or as approved by the Engineer and the maximum free water cement ratio shall be 0.45 when only OPC is used and 0.50 when blended cement (Portland Pozzolana Cement or Portland Slag Cement or OPC blended with fly ash or Ground Granulated Blast Furnance Slag, at site) is used.

602.3.3.2 The ratio between the 7 and 28 day strength shall be established for the mix to be used in the slab in advance, by testing pairs of beams and cubes at each stage on at least six batches of trial mix. The average strength of the 7 day cured specimens shall be divided by the average strength of the 28 day specimens for each batch, and the ratio 'R' shall be determined. The ratio 'R' shall be expressed to three decimal places.

If during the construction of the trial length or during some normal working, the average value of any four consecutive 7 day test results falls below the required 7 day strength as derived from the value of 'R' then the cement content of the concrete shall, without extra payment, be increased by 5 percent by weight or by an amount agreed by the Engineer. The increased cement content shall be maintained at least until the four corresponding 28 day strengths have been assessed for in conformity with the requirements as per Clause 602.3.3.1. Whenever the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

602.3.4 Workability

602.3.4.1 The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum

workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer. The control of workability in the field shall be exercised by the slump test as per IS:1199.

602.3.4.2 The workability requirement at the batching and mixing plant and paving site shall be established by slump tests carried during trial paving. These requirements shall be established from season to season and also when the lead from batching and mixing plant site to the paving site changes. The workability shall be established for the type of paving equipment available. A slump value in the range of 25 ± 15 mm is reasonable for paving works but this may be modified depending upon the site requirement and got approved by the Engineer. These tests shall be carried out on every tipping truck/dumper at batching and mixing plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate tipping trucks or as per the instructions of the Engineer.

602.3.5 Design Mix

602.3.5.1 The Contractor shall carry out laboratory trials of design mix with the materials from the approved sources to be used as per IRC:44. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. They shall be repeated, if necessary, until the proportions, that will produce a concrete which complies in all respects with these Specifications, and conform to the requirements of the design/drawings.

602.3.5.2 The proportions determined as a result of the laboratory trial mixes may be adjusted, if necessary, during the construction of the trial length. Thereafter, neither the materials nor the mix proportions shall be varied in any way except with the written approval of the Engineer.

602.3.5.3 Any change in the source of materials or mix proportions proposed by the Contractor, during the course of work shall be assessed by making laboratory trial mixes and the construction of a further trial length of length not less than 50 m unless approval is given by the Engineer for minor adjustments like compensation for moisture content in aggregates or minor fluctuations in the grading of aggregate.

602.4 Sub-base

The cement concrete pavement shall be laid over the sub-base constructed in accordance with the relevant drawings and Specifications. It shall be ensured that the sub-base is not damaged before laying the concrete pavement. If the dry lean concrete sub-base is found damaged at some places or it has cracks wider than 10 mm, it shall be repaired with fine cement concrete (aggregate size 10 mm and down) or bituminous concrete before laying separation membrane layer.

602.5 Separation Membrane

As separation membrane shall be used between the concrete slab and the sub-base. Separation membrane shall be impermeable PVC sheet 125 micron thick transparent or white in colour laid flat with minimum creases. Before placing the separation membrane,

the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheathing shall be replaced at the Contractor's cost. The separation membrane may be nailed to the lower layer with concrete nails. The separation membrane shall be omitted when two layers of wax-based curing compound is used.

602.6 Joints

602.6.1 The locations and type of joints shall be as shown in the drawing. Joints shall be constructed depending upon their functional requirement. The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It shall be ensured that the required depth of cut is made from edge-to-edge of the pavement. Transverse and longitudinal joints in the pavement and Dry Lean Concrete sub-base shall be staggered so that they are not coincident vertically and are at least 800 to 1000 mm and 300 to 400 mm apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and crew members without damaging the texture of the pavement.

Sawing operation could start as early as 4-8 hours after laying of concrete pavement but not later than 8 to 12 hours depending upon the ambient temperature, wind velocity, relative humidity and required maturity of concrete achieved for this purpose.

When the kerb is cast integrally with the main pavement, slab, the joint cutting shall also be extended to the kerb.

Where the use of maturity meter is specified, sawing should not be initiated when the compressive strength of the concrete is less than 2 MPa and should be completed before it attains the compressive strength of 7 MPa.

602.6.2 Transverse Joints

602.6.2.1 Transverse joints shall be contraction, construction and expansion joints constructed at the spacing described in the drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints.

- i) Deviations of the performed filler board (IS:1838) in the case of expansion joints from the intended line of the joint shall not be greater than ± 10 mm.
- ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.
- iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.
- iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 602.10.

602.6.2.2 Contraction Joints

The contraction joints shall be placed transversely at pre-specified locations as per drawings/ design using dowel bars. These joints shall be cut as soon as the concrete has

undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab.

Contraction joints shall consist of a mechanical sawn joint groove, 3 to 5 mm wide and one fourth to one-third depth of the slab ± 5 mm or as stipulated in the drawings and dowel bars complying with Clause 602.6.5.

Contraction joint shall be widened subsequently to accommodate the sealant as per Clause 602.10, to dimensions shown on drawings or as per IRC:57.

602.6.2.3 Expansion Joints

The expansion joint shall consist of a joint filler board complying with Clause 602.2.9 and dowel bars complying with Clause 602.6.5 and as detailed in the drawings. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given in Clause 602.6.2.1. The adjacent slabs shall be completely separated from each other by the joint filler board.

602.6.3 Transverse Construction Joint

Transverse construction joint shall be placed whenever concreting is completed after a day's work or is suspended for more than 30 minutes. These joints shall be provided at location of contraction joints using dowel bars. If sufficient concrete has not been mixed to form a slab extending upto a contraction joint, and if an interruption occurs, the concrete placed shall be removed upto the last preceding joint and disposed of. At all construction joints, steel bulk heads shall be used to retain the concrete. The surface of the concrete laid subsequently shall conform to the grade and cross sections of the previously laid pavement. When positioning of bulk head/stop-end is not possible, concreting to an additional 1 or 2 m length may be carried out to enable the movement of joint cutting machine so that joint grooves may be cut and the extra 1 or 2 m length is cut out and removed subsequently after concrete has hardened.

After minimum 14 days of curing, in case OPC cement is used and 16 days of curing when flyash or blended cement is used, the construction joint shall be widened to accommodate the sealant as per Clause 602.10 to dimensions shown on drawing or as per IRC:57.

602.6.4 Longitudinal Joint

602.6.4.1 The longitudinal joints shall be constructed by forming or by sawing as per details of the joints shown in the drawing. Sawed longitudinal joints shall be constructed when the concrete pavement placement width exceeds 4.5 m. The groove may be cut after the final set of the concrete. Joints should be sawn to at least one-third the depth of the slab ± 5 mm as indicated in the drawing. The joint shall be widened subsequently to dimensions shown on the drawings.

Where adjacent lanes of pavement are constructed separately using slip form pavers or side forms, the tie bars may be bent at right angles against the vertical face/ side of the first lane constructed and straightened before placing concrete in the adjacent lane. Broken or damaged tie bars shall be repaired or replaced as required.

The groove for sealant shall be cut in the pavement lane placed later.

602.6.4.2 Tie Bars

Tie bars shall be provided at the longitudinal joints as per dimensions and spacing shown in the drawing and in accordance with Clause 602.6.6. The direction of the tie bars at curves shall be radial in the direction of the radius.

602.6.5 Dowel Bars

602.6.5.1 Dowel bars shall be mild steel rounds in accordance with Clause 602.2.8 with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale. They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. Any protrusions shall be removed by grinding the ends of the dowel bars. The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.

602.6.5.2 Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of ± 20 mm, and centered equally about intended lines of the joint within a tolerance of ± 25 mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given here-in-under, the compliance of which shall be checked as per Clause 602.11.7.

- i) For bars supported on cradles prior to the laying of the slab:
 - a) All bars in a joint shall be within ± 2 mm per 300 mm length of bar
 - b) 2/3rd of the number of bars shall be within ± 3 mm per 500 mm length of bar
 - c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane
 - d) Cradles supporting dowel bar shall not extend across the line of joint i.e. no steel bar of the cradle assembly shall be continuous across the joint.
- ii) For all bars inserted after laying of the slab except those inserted by a Dowel Bar Insertor the tolerance for alignment may be twice as indicated in (i) above.

The transverse joints at curves shall be radial in the direction of the radius.

602.6.5.3 Dowel bars; supported on cradles in assemblies, when subject to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and in both directions horizontally) shall conform to be within the limits given in Clause 602.6.5.2.

602.6.5.4 The assembly of dowel bars and supporting cradles, including the joint filler board in the case of expansion joints, shall have the following degree of rigidity when fixed in position:

- i) For expansion joints, the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 kN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300 mm from either end of any length of filler board, if a continuous fixing is used. The residual deflection after load shall be not more than 3 mm.
- ii) The fixings for joint assembly shall not fail under 1.3 kN load and shall fail before the load reaches 2.6 kN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.
- iii) Fixings shall be deemed to fail when there is displacement of the assemblies by more than 3 mm with any form of fixing, under the test load. The displacement shall be measured at the nearest part of the assembly to the centre of the bar or timber packing.

602.6.5.5

Dowel bars in the contraction joints, construction joints and expansion joints shall be covered by a thin plastic sheath. The thickness of the sheath shall not exceed 0.5 mm and shall be tightly fitted on the bar for at least two-thirds of the length from one end for dowel bars in contraction/construction joints and half toe length plus 50 mm for expansion joints. The sheathed bar shall comply with the following pull out tests:

Four bars shall be taken at random from stock and without any special preparation shall be covered by sheaths as required in this Clause. The ends, if the dowel bars which have been sheathed shall be cast centrally into concrete specimens' 150 mm x 150 mm x 600 mm, made of the same mix proportions to be used in the payment, but with a maximum nominal aggregate size of 20 mm and cured in accordance with IS:516. At 7 days a tensile load shall be applied to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall not be greater than 0.14 MPa.

602.6.5.6 For expansion joints, a closely fitted W cap 100 mm long consisting of water proofed cardboard or an approved synthetic material like PVC or GI pipe shall be placed over the sheathed end of each dowel bar. An expansion space (about 25 mm) at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of cement slurry into the annular space between the sheathing and dowel bar shall be taped around its mouth

602.6.6 Tie Bars

602.6.6.1 Tie bars in longitudinal joints shall be deformed steel bars of strength 500 MPa complying with IS:1786 and in accordance with the requirements given in this Clause. The bars shall be free from oil, dirt, loose rust and scale.

602.6.6.2 Tie bars projecting across the longitudinal joint shall be protected from corrosion for 75 mm on each side of the joint by a protective coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used. In the case of coastal region and high rainfall areas, tie bars shall be epoxy coated in their full length as per IS:13620.

602.6.6.3 Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of the slab. Alternatively, tie bars at longitudinal joints may be mechanically or manually inserted into the plastic concrete from above by vibration using a method which ensures correct placements of the bars and recompaction of the concrete around the tie bars.

602.6.6.4 Tie bars shall be positioned to remain in the middle from the top or within the upper middle third of the slab depth as indicated in the drawings and approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30 mm below the joint groove. Spacing of tie bars on curves of radius less than 360 m shall not be less than 350 mm.

602.6.6.5 To check the position of the tie bars, one metre length, 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes). The pit shall be refilled with the fresh concrete of same mix after checking.

602.7 Weather and Seasonal Limitations

602.7.1 Concreting during Monsoon Months

Concreting should be avoided during rainy season. However, when concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other waterproof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purposes shall be adequately protected. Any concrete damaged by rain shall be removed and replaced. If the damage is limited to texture, it shall be retextured in accordance with the directions of the Engineer.

602.7.2 Temperature Limitation

No concreting shall be done when the temperature of the concrete reaching the paving site is above 30°C. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc., tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of. When the ambient temperature is more than 35°C, no concreting shall be permitted. The ice flakes should not be manufactured from chlorinated water. Generally the rate of evaporation of water shall not exceed 1 kg/sqm/hour as per IRC:15.

No concreting shall be done when the concrete temperature is below 5°C and the temperature is further falling.

602.8 Fixed Form Paving

602.8.1 Side Forms and Rails

These shall be provided in case of fixed form paving. All side forms shall be of mild steel of depth equal to the thickness of pavement or slightly less to accommodate the surface irregularity of the sub-base. The forms can be placed in series of steel packing plates or shims to take care of irregularity of sub-base. They shall be sufficiently robust and rigid to support the weight and pressure caused by a paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms. The forms and rails shall be firmly secured in position by not less than 3 stakes/pins for every 3 m length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3 m and when in place shall not settle in excess of 1.5 mm in 3 m while paving is being done. Forms shall be cleaned and oiled immediately before each use. The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances ± 10 mm and ± 3 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected by the Engineer for his approval 12 hours before construction of the slab and shall not be removed until at least 12 hours afterwards. No concreting shall commence till formwork has been approved by the Engineer.

602.8.2 At all times sufficient forms shall be used and set to the required alignment for at least 300 m length of pavement immediately in advance of the paving operations, or the anticipated length of pavement to be laid within the next 24 hours whichever is more.

602.8.3 Slip Form Paving

602.8.3.1 Use of Guidewires

Where slip form paving is proposed, a guidewire shall be provided along both sides of the slab. Each guidewire shall be at a constant height above and parallel to the required edges of the slab as described in the contract drawing within a vertical tolerance of ± 3 mm. Additionally, one of the wires shall be kept at a constant horizontal distance from the required edge of the pavement as indicated in the contract drawing within a lateral tolerance of ± 10 mm.

602.8.3.2 The guidewires shall be supported on stakes 5-6 m apart by connectors capable of fine horizontal and vertical adjustment. The guidewire shall be tensioned on the stakes so that a 500 gm weight shall produce a deflection of not more than 20 mm when suspended at the mid point between any pair of stakes. The ends of the guidewires shall be anchored to fixing point or winch and not on the stakes. On the curves, the stakes shall be fixed at not more than 3 m centre-to-centre.

602.8.3.3 The stakes shall be positioned and hammered into the ground and the connectors will be maintained at their correct height and alignment from 12 hours on the day before concreting takes place till after finishing of texturing and spraying of curing compound on the concrete.

However, the guidewire shall be erected and tensioned on the connectors at any section for at least 2 hours before concreting that section.

602.8.3.4 The Contractor shall submit to the Engineer for his approval of line and level, the stakes and connectors which are ready for use in the length of road to be constructed next day. Such approval shall be obtained atleast 12 hours before commencement of paving operation. Any deficiencies noted by the Engineer shall be rectified by the Contractor who shall then re-apply for approval of the affected stakes. Work shall not proceed until the Engineer has given his approval. It shall be ensured that the stakes and guidewires are not affected by the construction equipment when concreting is in progress.

602.9 Construction

602.9.1 General

A systems approach may be adopted for construction of the pavement, and the Method Statement for carrying out the work, detailing all the activities, indication of time-cycle, equipment, personnel etc., shall be got approved from the Engineer before the commencement of the work. This shall include the type, capacity and make of the batching and mixing plant besides the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving rate of atleast 500 m in one day. The paving speed of slip-form paver shall not be less than 1.0 m per minute. The concreting should proceed continuously without stops and starts.

602.9.2 Batching and Mixing

Batching and mixing of the concrete shall be done at a central or RMC Concrete batching and mixing plant with automatic controls, located at a suitable place which takes into account sufficient space for stockpiling of cement, aggregates and stationary water tanks. This shall be located at an approved distance, duly considering the properties of the mix and the transporting arrangements available with the Contractor.

602.9.3 Equipment for Proportioning of Materials and Paving

602.9.3.1 Proportioning of materials shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates. Water shall be measured by volume. Specified percentage of plasticizer in volume will be added by weight of cement. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design, the grading of aggregates shall be controlled by appropriate blending

techniques. The capacity of batching and mixing plant shall be at least 25 percent higher than the proposed capacity of the laying/paving equipment.

602.9.3.2 Batching Plant and Equipment :

- 1) General : The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregates and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. There shall be a separate bin for flyash, if this additive is specified. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned. A continuous type of mixing plant can also be used provided the ingredients are weighed through electronic sensors before feeding.
- 2) Automatic weighing devices : Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells. The weighing devices shall have an accuracy within $\pm 1\%$ in respect of quantity of cement, admixtures and water and $\pm 2\%$ in respect of aggregates and the accuracy shall be checked at least once a month.
- 3) Mixer : Mixers shall be pan type, reversible type or any other mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mix, without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed in 90 seconds or as per the manufacturer's recommendation. The mixer shall be equipped with a suitable non-resettable batch counter which shall correctly indicate the number of batches mixed.

The mixer shall be cleaned at suitable intervals. The pick-up and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 20 mm wear from new conditions. Drilled holes of 5 mm diameter near each end and at midpoint of each blade are

recommended. Batching Plant shall be calibrated in the beginning and thereafter at suitable interval not exceeding 1 month.

- 4) Control cabin : An air-conditioned centralized computer control cabin shall be provided for automatic operation of the equipment.
- 5) The design features of the batching plant should be such that it can be shifted quickly.

602.9.3.3 Paving Equipment

The concrete shall be placed with an approved fixed form or slip form paver with independent units designed to (i) spread, (ii) consolidate, screed and float-finish, (iii) texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous pavement in conformity with the plans and Specifications. The paver shall be equipped with electronic sensor controls to control the line and grade from either one side or both sides of the machine.

Vibrators shall operate at a frequency of 8000-10000 impulses per minute under load at a maximum spacing of 600 mm. The variable vibration setting shall be provided in the machine.

602.9.3.4 Concrete Saw

The Contractor shall provide adequate number of concrete saws with sufficient number of diamond-edge saw blades. The saw machine shall be either electric or petrol/diesel driven type. A water tank with flexible hose and pump shall be made available for this activity on priority basis. The Contractor shall have at least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

602.9.4 Hauling and Placing of Concrete

602.9.4.1 Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of tipping trucks or transit mixers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Covers shall be used for protection of concrete against the weather. While loading the concrete truck shall be moved back and forth under the discharge chute to prevent segregation. The tipping trucks shall be capable of maintaining the mixed concrete in a homogeneous state and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that the paving is done in an uninterrupted manner with a uniform speed throughout the day's work. Tipping-trucks shall be washed at a regular frequency as prescribed by the Engineer to ensure that no left-over mix of previous loading remains stuck.

602.9.4.2 Placing of Concrete

The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C and

30°C. When the time between mixing and laying exceed these values, the concrete shall be rejected and removed from the site. Tipping trucks delivering concrete shall normally not run on plastic sheathing nor shall they run on completed slabs until after 28 days of placing the concrete.

The placing of concrete in front of the PQC paver should preferably be from the side placer to avoid damage to DLC by concrete tipping trucks. In case of unavoidable situation, truck supplying concrete to the paver may be allowed to ply on the DLC with the approval of the Engineer. The paver shall be capable of paving the carriageway as shown in the drawings, in a single pass and lift.

602.9.4.3 Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 602.8. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per the relevant Clauses of these Specifications. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the concrete in the pavement.

602.9.4.4 In areas inaccessible to paving equipment, the pavement shall be constructed using, side forms, as per Clause 602.9.7.

602.9.4.5 In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

602.9.4.6 The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer when it shall be applied as a mist by means of approved equipment.

602.9.4.7 If considered necessary by the Engineer, the paving machines shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.

602.9.4.8 While the concrete is still plastic, its surface shall be textured by brush or tines as per the instructions of the engineer in compliance with Clause 602.9.11.. The surface and edges of the slab shall be cured by the application of a sprayed liquid curing membrane in compliance with Clause 602.9.12. After the surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chainage at every 100 m interval by embossing.

602.9.4.9 As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of 1:1:2, cement :sand : coarse agg. (10 mm down) with water cement ratio not more than 0.4 under the supervision of the Engineer.

602.9.4.10 If the requirement of Clause 902.4. for surface regularity fails to be achieved on two consecutive working days, then normal working shall cease until the, cause of the excessive irregularity has been identified and remedied.

602.9.5 Construction by Slip Form Paver

602.9.5.1 The slip form paving train shall consist of a power machine which spreads compacts and finishes the concrete in a continuous operation. The slip form paving machine shall compact the concrete by internal vibration and shape it between the side forms with either a conforming plate or by vibrating and oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off

plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or crossfall.

602.9.5.2 The level of the conforming plate and finishing beams shall be controlled automatically from the guide wires installed as per Clause 602.8 by sensors attached at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

602.9.5.3 Slip-form paving machines shall have vibrators of variable output, with a maximum energy output of not less than 2.5 KW per metre width of slab per 300 mm depth of slab for a laying speed upto 1.5 m per minute. The machines shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations. Normal paving speed shall be maintained as per Clause 602.9.1.

602.9.5.4 If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements of Clause 902.3, the work shall be stopped until such time as the Contractor can demonstrate his ability to slip form the edges to the required levels. The deficient edge shall be temporarily supported by a side form and the thickness deficiency shall be made good by adding fresh concrete to the newly formed edge and compacting.

602.9.5.5 Slip-form pavers with adequate width to pave the entire carriageway width in one go shall be employed unless specified in the Contract. In situations where full-width paving is not possible, paving in part widths may be permitted by the Engineer. Paving in part will be avoided, except in unavoidable circumstances. In case of part width paving, care shall be taken to ensure that while laying the next lane, bond between the remaining half length of tie bar or subsequently inserted tie bars and the newly laid concrete is adequately developed. Care shall be taken to avoid damage to the previous lane.

602.9.5.6 In case paving in separate lanes is allowed, work on the adjacent lane shall be permitted when the previously paved lane is cured for at least 14 days and is in a position to bear the weight of paving machine. When the wheels or crawler tracks are to ply on the already paved surface, necessary precautions shall be taken by placing protective pads of rubber or similar material so that texture is not damaged. The wheel or track shall be reasonably away from the edge to avoid damage to the previously laid slab.

602.9.5.7 Tube Floating

Upon the instructions of the Engineer, Contractor shall scrape the concrete surface when in plastic state with a 3 m long tube float fixed with a long and stable handle before texturing. Tube float shall be of an alloy steel tube of 50 to 60 mm diameter with a long and stable handle. The length of tube float shall preferably be longer than half the length of slab i.e., half the distance between two transverse contraction joints. This operation shall be done to minimise surface irregularity caused due to varied causes like frequent stoppages of work, surface deformation due to plastic flow etc. The tube, float shall be placed at the centre of the slab parallel to longitudinal joint and pulled slowly and uniformly towards the edges. After the use of float tube, it shall be frequently cleaned before further use. The slurry removed shall be discarded. This activity shall be advanced laterally by providing an overlap of half the length of tube float. The removal of the cement slurry from the surface shall be sufficient enough such that the texture is formed on a firm surface and is more durable. This operation, however, shall be carried out after removing bleeding water.

602.9.6 Construction by Fixed Form Paver

602.9.6.1 The fixed form paving train shall consist of separate powered machines which spread, compact and finish the concrete in a continuous operation.

602.9.6.2 The concrete shall be discharged without segregation into a hopper spreader which is equipped with means for controlling its rate of deposition on to the sub-base. The spreader shall be operated to strike off concrete upto a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of spreader shall strike off the concrete to the surcharge adequate to ensure that the vibratory compactor thoroughly compacts the layer. If necessary, poker vibrators shall be used adjacent to the side forms and edges of the previously constructed slab. The vibratory compactor shall be set to strike off the surface slightly high so that it is cut down to the required level by the oscillating beam. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or crossfall. The final finisher shall be able to finish the surface to the required level and smoothness as specified, care being taken to avoid bringing up of excessive mortar to the surface by over working.

Tremix Process :- Surplus water from the concrete is removed immediately after placing and vibration, reducing the water : cement ratio to an optimum level. This is done using

the Vacuum Equipment comprising of Suction Mat Top Cover, Filter pads and Vacuum Pump. The process starts immediately after surface vibration

Filter pads are placed on the fresh concrete leaving about 4 inches of fresh concrete exposed on all sides. The Top Cover is then placed on the filter pads and rolled out till it covers the strips of exposed concrete on all sides. The Top Cover is then connected to the vacuum pump through a suction hose and the pump is started Vacuum is immediately created between the filter pads and the top cover. A tmospheric pressure compresses the concrete and the surplus water is squeezed out. This process lowers the water content in the concrete by 15-25 % The dewatering operation takes approx. 1.5 - 2 minutes per centimeter thickness of the floor. The dewatered concrete is compacted and dried to such an extent that it is possible to walk on it without leaving any foot prints. This is the indication of concrete being properly dewatered and ready for finishing. The finishing operations - Floating & Trowelling take place right after dewatering. Floating operation is done with Floating disc. This ensures after mixing of sand & cement particles, further compaction and closing the pores on the surface. Floating operation generates skid-free finish. Trowelling is done with Trowelling blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish. Repeated passes with disc and blades improve the wear resistance substantially.

602.9.7 Semi-mechanised Construction

Areas in which hand-guided methods of construction become indispensable shall be got approved by the Engineer in writing in advance. Such work may be permitted only in restricted areas in small lengths. Work shall be carried out by skilled personnel as per methods approved by the Engineer. The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength, of concrete and all other quality control measures shall be the same as in the case of machine laid work. Guidelines on the use of plants, equipment, tools, hauling of mix, compaction floating, straight edging, texturing, edging etc. shall be as per IRC:15.

602.9.8 Transition Slabs

At the interface of rigid and flexible pavement, at least 3 m long reinforced buried slab shall be provided to give a long lasting joint at the interface. The details shall be as given in IRC:15.

602.9.9 Anchor Beam and Terminal Slab Beam Adjoining Bridge Structures

RCC anchor beams shall be provided in the terminal slab adjoining bridge structures as per drawings and IRC:15.

602.9.10 The Treatment of Concrete Pavement on Culverts

The concrete pavement shall be taken over the culverts. At both ends of the culvert slab, a contraction joint shall be. provided in the concrete pavement. Nominal reinforcement of 10 mm dia bars at 150 mm spacing in both directions shall be provided at 50 mm below the top of the slab. The reinforcement shall be stopped 50 mm short of the contraction joint. Such reinforcement shall also be provided in the next slab panel on either side.

602.9.11 Surface Texture

602.9.11.1 Tining

After final floating and finishing of the slab and before application of the liquid curing membrane, the surface of concrete slabs shall be textured either in the transverse direction (i.e., at right angles to the longitudinal axis of the road) or in longitudinal direction (i.e., parallel to the centreline of the roadway). The texturing shall be done by tining the finished concrete surface by using rectangular steel tines. A beam or a bridge mounted with steel tines shall be equipped and operated with automatic sensing and control devices from main paver or

auxiliary unit. The tining unit shall have facility for adjustment of the download pressure on the tines as necessary to produce the desired finish. The tining rakes shall be cleaned often to remove snots of slurry. The tines shall be inspected daily and all the damaged and bent tines shall be replaced before commencing texturing. Tined grooves shall be 3 mm wide and 3 to 4 mm deep. Before commencing texturing, the bleeding water, if any, shall be removed and texturing shall be done on a firm surface. The measurement of texture depth shall be done as per Clause 602.12.

- a) Transverse tining : When the texturing is specified in transverse direction, a beam of at least 3 m length mounted with tines shall be moved in transverse direction to produce the texture. The grooves produced shall be at random spacing of grooves but uniform in width and depth. The spacing shall conform to a pattern shown below:

Random spacing in mm

10	14	16	11	10	13	15	16	11	10	21
13	10									

The above pattern shall be repeated. Texturing shall be done at the right time such that the grooves after forming shall not close and they shall not get roughened. Swerving of groove patterns will not be permitted. The completed textured surface shall be uniform in appearance.

- b) Longitudinal tining : Longitudinal tining shall be done, if specified in the Contract. The texturing bridge shall be wide enough to cover the entire width of the carriageway but within 75 mm from the pavement edge. The centre to centre spacing between the tines shall be 18 to 21 mm. The width of tine texture shall be 3 mm and depth shall be 3 to 4 mm.

602.9.11.2 Brush Texturing

Alternatively on the instructions of the Engineer, the brush texturing shall be applied. The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but wider brushes normally of 3 m length are preferred. The brush shall be made of 32 gauge tape wires grouped together in tufts placed at 10 mm centres. The tufts shall contain an average of 14 wires and initially be 100 mm long. The brush shall have two rows of tufts. The rows shall be 20 mm apart and

the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down to 90 mm long.

The texture depth shall be determined by the Sand Patch Test as described in the Clause 602.12. This test shall be performed at least once for each day's paving and wherever the Engineer considers it necessary at times after construction as under:

Five individual measurements of the texture depth shall be taken at least 2 m apart anywhere along a diagonal line across a lane width between points 50 m apart along the pavement. No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

Texture depths shall not be less than the minimum required depth when measurements are taken as given in Table 600-5 nor greater than an average of 1.25 mm.

Table 600-5 : Texture Depth

Time of Test		Number of Measurements	Required Texture Depth (MM)	
			Specified Value	Tolerance
1	Between 24 hours and 7 days after the construction of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	± 0.25
2	Not later than 6 weeks before the road is opened to traffic	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over the length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

602.9.12 Curing

602.9.12.1 Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminized reflective curing compound which hardens into an impervious film or membrane with the help of mechanical sprayer.

602.9.12.2 The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks of application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying. The curing compound shall be sprayed in two applications to ensure uniform spread.

Curing compounds shall contain sufficient flake aluminum in finely divided dispersion to produce a complete coverage of the sprayed surface with -a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index not less than 90 percent in accordance with BS Specification No. 7542 or as per ASTM C-309-81 Type 2.

602.9.12.3 In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents mounted on mobile trusses as described in Clause 602.7.2, during adverse weather conditions as directed by the Engineer. After three hours, the pavement shall be covered by moist hessian laid in two layers and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

602.9.12.4 The Contractor shall be liable at his cost to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint as per procedure in IRC:SP:83.

602.10 Preparation and Sealing of Joint Grooves

602.10.1 General

All joints shall be sealed using sealants described in Clause 602.2.10.

602.10.2 Preparation of Joint Grooves for Sealing

602.10.2.1 Grooves are saw cut in the first instance just to provide minimum width (3-5 mm) to facilitate development of crack at joint locations, as shown in the drawing. Subsequently before sealing, grooves are widened by sawing as per the dimensions in the drawing. Dimension of the grooves shall be controlled by depth/width gauge.

602.10.2.2 If rough arrises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle upto 10° from the perpendicular to the surface, the overhanging edge of the groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degree, the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects upto a maximum width, including any chamfer, of 20 mm for transverse joints and 10 mm for longitudinal joints. If the spalling cannot be so eliminated then the arrises shall be repaired by an approved thin bonded arrises repair using cementitious/epoxy mortar materials.

602.10.2.3 All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. The Engineer shall instruct cleaning by pressurized water jets. Depending upon the requirement of the sealant manufacturer, the sides of the grooves shall be sand blasted to increase the bondage between sealant and concrete.

602.10.2.4 The groove shall be cleaned and dried at the time of priming and sealing. If sand blasting is recommended by the supplier, the same shall be carried out.

602.10.2.5 Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint where hot poured sealant is used. When cold poured sealant is used a debonding tape of 1.0-2.0 mm thickness and 6 to 8 mm width shall be inserted to plug the groove so that the sealant does not enter in the initially cut groove.

602.10.3 Sealing with Sealants

602.10.3.1 When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with his instructions.

The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed, is below 7°C.

602.10.3.2 If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified- by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturer's recommendations and reheated material shall not be used. The Movement Accomodation Factor of the sealant shall be more than 10 percent.

602.10.3.3 Cold applied sealants with chemical formulation like polysulphide/ polyurethane/ silicone as per IRC:57 shall be used These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accomodation Factor shall be more than 25 percent.

602.10.3.4 The-sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the Contractor in consultation with the Engineer, shall establish the right temperature and time for applying, the sealant. Thermometer shall be hung on a pole at the site for facilitating control during the sealing operation.

602.10.3.5 Sealant shall be applied, slightly to a lower level than the slab with a tolerance of 3 ± 1 mm.

602.10.3.6 During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapours or by the sealing process. The sealant after pouring, shall be allowed to cure for 7 days or for a period as per instructions of manufacturers.

602.11 Trial Length

602.11.1 The trial shall be constructed at least one month in advance of the proposed start of concrete paving work. At least one month prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a detailed method statement giving description of the proposed materials, plant, equipment and construction methods. All the major equipments like paving train, batching plant, tipping trucks etc., proposed in the construction are to be approved by the Engineer before their procurement. No trials of new materials, plant, equipment or construction methods, nor any development of them shall be permitted either during the construction of trial length or in any subsequent paving work, unless they form part of further trials. The trial lengths shall be constructed away from the carriageway.

602.11.2 The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab., at least 100 m long for mechanised construction and at least 50 m long for hand guided methods. The width of the trial section shall be the full carriageway width as shown in the drawings. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

602.11.3 The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 50 m constructed each day for mechanised construction and a minimum of 25 m on each day for hand guided construction. The trial length shall be constructed at a paving rate which is proposed for the main work.

602.11.4 Transverse joints including expansion joint and longitudinal joint that are proposed in the main work shall be constructed and assessed in the trial length.

602.11.5 The trial length shall comply with the Specifications in all respects including the test requirement of Table 900-6 with the following additions.

602.11.5.1 Surface Levels and' Regularity

- a) In checking for compliance with Clause 902.3 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.
- b) The maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 902.4. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length

602.11.5.2 Joints

- a) Alignment of dowel bars shall be inspected in any two consecutive transverse joints in a trial length construction by removing the fresh concrete in a width

of 0.5 m on either side of the joint. The joint pit shall be refilled with freshly prepared concrete, after inspection. Alternatively, it can be tested by suitable device like MIT SCAN with the permission of the Engineer. If the position or alignment of the dowel bars at one of these joints does not comply with the requirements and if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected, then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly joints may be constructed at more frequent joint intervals than the normal spacing required in trial slabs.

- b) If there are deficiencies in the first expansion joint that is constructed as a trial, the next expansion joint shall be a trial joint. Should this also be deficient, further trial of expansion joints shall be made as part of the trial length which shall not form part of the permanent works, unless agreed by the Engineer.

602.11.5.3 Density

In-situ density in trial length shall be assessed as described in Clause 903.5.2.2 from at least 3 cores drilled from each part of the trial length when the concrete is not less than 7 days old. Should any of the cores show honey-combing in the concrete, the trial length shall be rejected and the construction in the main carriageway shall not be permitted until further trials have shown that modification has been made which would result in adequate compaction.

602.11.5.4 Strength

Minimum of thirty (30) beams for flexural strength and thirty (30) cubes for compressive strength shall be prepared from the concrete delivered in front of the paving plant. Each pair of beams and cubes shall be from the same location/batch but different sets of beams and cubes shall be from different locations/batches. Compressive and flexural strength shall be tested after 28 days water curing in the laboratory.

At the age of 28 days, thirty (30) cores with diameter 150 mm shall be cut from the pavement slab when the thickness of concrete pavement is more than 300 mm. In case the concrete pavement thickness is less than 300 mm, the dia of core shall be 100 mm. The cores shall be suitably cut at both ends to provide a specimen of plain surface on both ends. The dia to height ratio of core shall be 1 to 2. For cylindrical specimen of PQC of dia 150 mm, the variation in dia shall be ± 0.5 mm, a tolerance on height shall be ± 1 mm for a specimen of height 300 mm or more. For cylindrical specimen of dia 100 mm, the variation in dia shall be ± 0.3 mm, and a tolerance on height shall be ± 1 mm for a specimen height of 200 mm. The compressive strength test shall be conducted as per IS:516. Concrete in the member represented by a core test shall be considered acceptable, if the average equivalent cube strength of the cores is equal to at least 85 percent of the

cube strength (characteristic strength) of the grade of the concrete specified for the corresponding age of 28 days and no individual core has a strength less than 75 percent.

202.11.6 Approval and Acceptance

602.11.6.1 Approval of the materials, plant, equipment and construction methods shall be given when the trial length complies with the Specifications. The Contractor shall not proceed with normal working until the trial length has been approved. If the Engineer does not notify the Contractor of any deficiencies in any trial length within 7 days after the completion of that trial length, the Contractor may assume that the trial length, and the materials, plant, equipment and construction methods adopted are acceptable, provided that the 28 days strength of cubes and cores extracted from trial length meet the requirement of the specified strength.

602.11.6.2 When approval has been given, the materials, plant, equipment and construction methods shall not thereafter be changed, except for normal adjustments and maintenance of plant, without the approval of the Engineer. Any changes in materials, plant, equipment, and construction methods shall entitle the Engineer to require the Contractor to lay a further trial length as described in this Clause to demonstrate that the changes will not adversely affect the permanent works.

602.11.6.3 Trial lengths which do not comply with the Specifications, with the exception of areas which are deficient only in surface texture and which can be remedied in accordance with Clause 602.9.11.6 shall be removed immediately upon notification of deficiencies by the Engineer and the Contractor shall construct a further trial length.

602.11.7 Inspection of Dowel Bars

602.11.7.1 Compliance with Clause 602.6.5. for the position and alignment of dowel bars at contraction and expansion joints shall be checked by measurements relative to the side forms or guide wires.

602.11.7.2 When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall be exposed sufficiently in the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of days work

by extending slab length by 2 m. After sawing the transverse joint groove, the extended 2 m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances. This joint shall be treated as construction joint. The position of dowel bars in any type of transverse joint i.e, contraction, construction or expansion can alternatively be tested by suitable device like MIT SCAN with the permission of the Engineer.

602.11.7.3 If the position and alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only one joint of the three is

defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved.

602.11.7.4 After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with epoxy mortar. Plastic sheath as per Clause 602.6.5.5 shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 602.10.

602.11.8 Inspection of Tie Bars

To check the position of the tie bars, one metre length 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes of its laying). The pit shall be refilled with the fresh concrete of same mix after checking.

602.12 Measurement of Texture Depth - Sand Patch Method

602.12.1 The following Apparatus shall be used:

- i) A cylindrical container of 25 ml internal capacity;
- ii) A flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, next to one face, the reverse face being provided with a handle;
- iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

602.12.2 Method

The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder. The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that

the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks.

602.12.3 The diameter of the patch shall be measured to the nearest 5 mm. The texture depth of concrete surface shall be calculated from $31000/(D \times D)$ mm where D is the diameter of the patch in mm.

602.12.4 Measurement of Texture Depth - Tining

602.12.4.1 The following apparatus shall be used

- i) Tire Tread Depth Gauge

A stainless steel tire tread depth gauge with graduations with least count of 1.0 mm.

The gauge end may be modified to measure depth of tine texture.

- ii) A stainless steel caliper to measure spacing of tines. If necessary the caliper may be modified to measure the spacing and width of tine texture. The gauge shall be used after making necessary calibration.
- iii) Wire brush
- iv) Corborundum stone
- v) Steel straight edge to remove snots etc. sticking to the surface. The straight edge may be of 6 x 25 x 300 mm size.

602.12.4.2 Test Section

A unit of testing shall be 75 m per lane. If the length of construction is less than 75 m it shall be taken as one unit.

602.12.4.3 Test Procedure

In each 75 m section, along the diagonal line, 10 points shall be selected for making checks of depth, width and spacing of tine grooves. The surface where tests are to be conducted shall be cleared carefully with a wire brush or a steel straight edge or using a corborundum plate to remove any upward projection of concrete. When the base plate of the gauge is in contact with the concrete surface, the gauge shall be pressed to the bottom of groove and the depth shall be measured and recorded at this location. At the same location, the spacing of tines shall be measured to verify whether the pattern recommended in Clause 602.9.11.1 is complied or not.

The average of depth and width at 10 locations shall be calculated and recorded to the nearest 1 mm. The spacing of spectrum measured at 10 locations shall be recorded separately.

602.12.5 The average depth shall be 3 to 4 mm. When the depth is less than 2.5 mm and in excess of 4.5 mm, the Contractor shall stop concreting till he corrects his tine brush or replaces it. The sensors associated with work shall be again calibrated to achieve the required texture. The textured groove less than 2.5 mm shall be re-grooved using concrete saw at the cost of Contractor. Variation in texture width in the range of 3+1 mm and 3 - 0.5 mm will be acceptable. If the variation of width is in excess of this range, the Contractor shall stop work and correct the brush and technique. When the spacing of spectrum is not satisfactory, the Contractor shall replace the entire brush.

602.13 Opening to Traffic

No vehicular traffic shall be allowed to ply on the finished surface of a concrete pavement within a period of 28 days of its construction and until the joints are permanently sealed and cured. The road may be opened to regular traffic after completion of the curing period of 28 days and after sealing of joints is completed including the construction of shoulder, with the written permission of the Engineer.

602.14 Acceptance Criteria in Quality and Distress

- i) Tolerances for Surface Regularity, Level, Thickness and Strength: The tolerances for surface regularity, level, thickness and strength shall conform

to the requirements given in Clause 903.5. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900 as shown under

903.5.2 Pavement Concrete

903.5.2.1 Sampling and Testing of Beam and Cube Specimens At least three beams and three cube specimens, one set of three each for 7 day and 28 day strength tests shall be cast for every 150 cu.m (or part thereof) of concrete placed during construction. On each day's work, not less than three pairs of beams and cubes shall be made for each type of mix from the concrete delivered to the paving plant. Each pair shall be from a different delivery of concrete and tested at a place to be designated by the Engineer in accordance with the testing procedure as outlined in Clause 602.3.3. Groups of four consecutive results from single specimens tested at 28 days shall be used for assessing the strength for compliance with the strength requirements. The specimens shall be transported in an approved manner to prevent sudden impact causing fractures or damage to the specimen. The flexural strength test results shall prevail over compressive strength tests for compliance.

903.5.2.2 A quality control chart indicating the strength values of individual specimens shall be maintained for continuous quality assurance. Where the requirements are not met with, or where the quality of the concrete or its compaction is suspect, the actual strength of the concrete in the slab shall be ascertained by carrying out tests on cores cut at the rate of 2 cores for every 150 cu.m of concrete. The average of the results of crushing strength tests on these cores shall not be less than 0.8 x 0.85 times the corresponding characteristic compressive strength of cubes, where the height to diameter ratio of the cores is two. Where height to diameter ratio is not two, necessary corrections shall be made in calculating the crushing strength of cubes in the following manner.

The crushing strengths of cylinders with height to diameter ratios between 1 and 2 may be corrected to correspond to a standard cylinder of height to diameter ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11n + 0.78$$

where f = correction factor and

n = height to diameter ratio

The corrected test results shall be analysed for conformity with the specification requirements for cube samples. Where the core tests are satisfactory, they shall have precedence for assessing concrete quality over the results of moulded specimens. The diameter of cores shall not be less than 150 mm.

If, however, the tests on cores also confirm that the concrete is not satisfying the strength requirements, then the concrete corresponding to the area from which the cores were cut should be replaced, i.e., at least over an area extending between two transverse joints where the defects could be isolated or over larger area, if necessary, as assessed by additional cores and their test results. The equivalent flexural strength at 28 days shall be estimated in accordance with Clause 602.3.3.2.

In order to ensure that the specified minimum strength at 28 days is attained in 1 in 20 of all test beams, the mix shall be proportioned to give an average strength at 28 days exceeding the specified strength by 1.65 times the standard deviation calculated first from the flexural strengths of test beams made from the trial mix and subsequently from the accumulating result of flexural strengths of job control test beams. shall be re-calculated from the test results obtained after any change in the source or quality of materials and the mix shall be adjusted as necessary to comply with the requirements. An individual 28 day test strength below the specified strength shall not be evidence for condemnation of the concrete concerned if the average 28 day strength of this beam plus the preceding 5 and succeeding 4 beams exceeds the specified strength by 1.65 times the standard deviation and provided that there is no other evidence that the concrete mix concerned is substandard.

Beams shall be made each day in pairs at intervals, each pair being from a different batch of concrete. At the start of the work, and until such time as the Engineer may order a reduction in the number of beams required, at least six pairs of beams and cubes shall be made each day, one of each pair for testing at 28 days for determination of minimum permissible flexural strength and the other for testing at an early age for the Engineer to assess the quality of the mix. When the first thirty number of 28-day results are available, and for so long as the Engineer is satisfied with the quality of the mix, he may reduce the number of beams and cubes required.

During the course of construction, when the source of any material is to be changed, or if there is any variation in the quality of the materials furnished, additional tests and necessary adjustments in the mix shall be made as required to obtain the specified strength.

The flexural strengths obtained on beams tested before 28 days shall be used in conjunction with a correlation between them and the 28 day flexural strengths to detect any deterioration in the quality of the concrete being produced. Any such deterioration shall be remedied without awaiting the 28 day strengths but the earlier strengths shall not constitute sole evidence of non-compliance of the concrete from which they were taken.

Concrete shall be deemed not to comply with the Specification when more than one test beam in a batch has a 28 day strength less than the specified strength and the average 28 day flexural strength of the batch of beams is less than the specified strength plus 1.65 times the standard deviation of the batch.

Should the concrete fail to comply with the Specification for strength as described above, the Contractor may, all at his own expense, elect to cut cores from the suspect concrete as the Engineer shall direct. From the relation between cube strength and flexural strength, the core strength shall be converted to flexural strength.

The equivalent flexural strength at 28 days shall be the estimated in-situ strength multiplied by 100 and divided by the age-strength relation obtained from Table 900-5.

Any concrete that fails to meet the strength specification shall be removed and replaced at Contractor's expense.

Table 900-5 : Age-Strength Relation of Concrete (Related to 100 percent at 28 Days)

Days	0	2	4	6	8
0	-	41.0	60.0	71.0	77.50
10	81.5	85.0	87.5	90.0	92.0
20	94.0	96.0	97.50	98.5	100.0
30	101.0	102.0	103.50	104.5	105.5
40	106.5	107.0	108.0	109.5	110.0
50	110.5	111.0	112.0	112.5	113.0
60	114.0	114.5	115.0	115.5	116.0
70	116.5	117.0	117.5	118.0	118.5
80	119.0	119.5	119.5	120.0	120.5
90	121.0	121.5	122.0	122.0	122.5
100	123.5	123.5	123.5	124.0	124.5
110	125.0	125.0	125.5	125.5	126.0
120	126.0	126.0	127.0	127.0	127.5
130	127.5	128.0	128.5	128.5	129.0
140	129.0	129.5	129.5	130.0	130.0
150	130.5	130.5	131.0	131.0	131.5
160	131.5	131.5	132.0	132.0	132.5
170	132.5	132.5	133.0	133.0	133.5
180	133.5	134.0	134.0	134.5	134.5
190	135.0	135.0	135.0	135.5	135.5
200	135.5	135.5	136.0	136.0	136.5

210	136.5	136.5	137.0	137.0	137.0
220	137.0	137.5	137.5	137.5	138.0
230	138.0	138.5	138.5	138.5	138.5
240	139.0	139.0	139.0	139.5	139.5
250	139.5	140.0	140.0	140.0	140.0
260	140.5	140.5	140.5	140.5	141.0
270	141.0	141.0	141.5	141.5	141.5
280	142.0	142.0	142.0	142.0	142.0
290	142.5	142.5	142.5	142.5	142.5
300	143.0	143.0	143.0	143.0	143.5
310	143.5	143.5	144.0	144.0	144.0
320	144.0	144.5	144.5	144.5	144.5
330	144.5	145.0	145.0	145.0	145.0
340	145.0	145.5	145.5	145.5	145.5
350	146.0	146.0	146.0	146.0	146.0
360	146.0	146.0	146.5	146.5	146.5

903.5.2.3 In-situ Density

The density of the compacted concrete shall be such that the total air voids are not more than 3 percent. The air voids shall be derived from the difference between the theoretical maximum dry density of the concrete calculated from the specific gravity of the constituents of the concrete mix and the average value of three direct density measurements made on cores at least 150 mm diameter. Three cores shall be taken from trial lengths and in first two km length of the pavement, while the slab is being constructed during normal working. The proportions of the mix and the vibratory effort imparted i.e. the frequency and magnitude of vibration shall be adjusted to achieve the maximum density.

All cores taken for density measurement in the trial section shall also be checked for thickness. The same cores shall be made use of for determining in-situ strength. In case of doubt, additional cores may be ordered by the Engineer and taken at locations decided by him to check the density of concrete slab or the position of dowel/tie bars without any compensation being paid for the same.

In calculation of the density, allowance shall be made for any steel in cores.

Cores removed from the main carriageway shall be reinstated with compacted concrete with mix proportions of 1 part of Portland cement : 2 parts of fine aggregate:2 parts of 10 mm nominal size single sized coarse aggregate by weight. Before filling the fine mix, the

sides shall be hacked and cleaned with water. Thereafter cement-sand slurry shall be applied to the sides just prior to filling the concrete mix.

903.5.2.4 Thickness

Thickness shall be controlled by taking levels as indicated in Clause 902.3. Thickness of the slab at any point checked as mentioned above shall be within a tolerance of -5 mm to + 10 mm of the specified thickness as per Drawing. Thickness deficiency more than 5 mm may be accepted and paid for at a reduced rate given in Clause 602.16.3. In no case, however, thickness deficiency shall be more than 10 mm.

903.5.2.5 Summary of Control Tests

Table 900-6 gives a summary of frequency of testing of pavement concrete.

Table 900-6: Frequency of Quality Control Tests for Pavement Concrete

1)	i) Levels, alignment and texture		Clause 902.3
	i) Width of pavement and position of paving edges		Clause 902.2
	iii) Pavement thickness		Clause 902.3 and Clause 903.5.2.4
	iv) Alignment of joints, widths, depth of dowel grooves		To be checked @ one joint per 400 m length or a day's work
	v) Surface regularity both transversely and longitudinally		Once a day or one day's work without disturbing the curing
	vi) Alignment of dowel bars and their accuracy/tie bars		To be checked in trial length as per Clause 602.6.5.2 and once on every 2 km.
	vii) Texture depth		Clause 602.12
2)	Quality of materials and concrete shall be as under :		
	1) Cement Physical and Chemical Tests		IS:269 IS:455 IS:1489 IS:8112 IS:12269 Once for each source of supply and occasionally when called for in case of long/ improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer
	2) Coarse and Fine Aggregate	i) Gradation	IS:2386 One test for every day's work of each fraction of coarse aggregate and fine aggregate,

				initially; (may be relaxed later at the discretion of the Engineer)
		ii) Deleterious constituents	IS:2386 (Pt.2)	--do--
		iii) Water absorption	IS:2386 (Pt.3)	Regularly as required subject to a minimum of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.
	3) Coarse Aggregate	i) Los Angeles Abrasion value or Aggregate Impact test	IS:2386 (Pt.4)	Once for each source of supply and subsequently on monthly basis
		ii) Soundness	IS:2386 (Pt.5)	Before approving the aggregates and every month subsequently.
		iii) Alkali aggregate reactivity	IS:2386 (Pt.7) IS:456	--do--
	4) Water	Chemical Test	IS:2386	Once for approval of source of supply. subsequently only in case of doubt
	5) Concrete	i) Strength of Concrete	IS:516	2 cubes and 2 beams per 150 cu.m or part thereof (one for 7 day and other for 28 day strength) or minimum 6 cubes and 6 beams per day's work whichever is more
		ii) Core strength on hardened concrete	IS:516	As per the requirement of the Engineer, only in case of doubt.

		iii) Workability of fresh concrete-Slump Test	IS:1199	One test per each dumper load at both Batching plant site and paving site initially when work starts. Subsequently sampling may be done from alternate dumper.
		iv) Thickness determination		From the level data of concrete pavement surface and sub-base at grid points of 5/6.25 m x 3.5 m
		v) Thickness measurement for trial length		3 cores per trial length
		vi) Verification of level of string line in the case of slip form paving and steel forms in the case of fixed form paving		String line or steel forms shall be checked for level at an interval of 5.0 m or 6.25 m. The level tolerance allowed shall be 12 mm. These shall be got approved 1-2 hours before the commencement of the concreting activity.

- ii) Tolerances in Distress : The acceptance criteria with regard to the types of distresses in rigid pavement shall be as per IRC:SP-83. "Guidelines for Maintenance, Repair and Rehabilitation of Cement Concrete Pavements". The cracks (of severity rating not more than 2) which may appear during construction or before completion of Defect Liability Period shall be acceptable with suggested treatments as given in IRC:SP-83.

Cement Concrete Pavement slabs having cracks of severity rating more than 2 i.e. cracks of width more than 0.5 mm for single discrete cracks, multiple and transverse cracks and cracks of width more than 3 mm in case of longitudinal cracks and of depth more than half of the Concrete pavement slabs, shall be removed and replaced as per IRC : SP -83

602.15 Measurements for Payment

602.15.1 Cement Concrete pavement shall be measured as a finished work in **cubic meters** of concrete placed based on the net plan area and thickness as measured in accordance with Clause 602.15.2.

602.15.2 The finished thickness of concrete for payment on volume basis shall be computed in the manner described in Clause 113.3 with the following modifications:

- i) The levels shall be taken before and after construction at grid points 5m centre to centre longitudinally in straight as well as at curves.
- ii) A day's work is considered as a 'lot' for calculating the average thickness of the slab. In calculating the average thickness, individual measurements which are in excess of the specified thickness by more than 10 mm shall be considered as the specified thickness plus 10 mm.

602.15.3 Individual areas deficient by more than 10mm shall be verified by the Engineer by ordering core cutting and if in his opinion the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans.

602.16 **Rate**

602.16.1 The Contract unit rate for the construction of the cement concrete pavement shall be payment in full for carrying out the operations required for the different items of the work as per these Specifications including full compensation for all labour, tools, plant, equipment, providing all materials i.e. aggregates, dowel bars, tie bars, PVC membrane, cement, stabilizers (lime, cements or any other stabilizers approved by the Engineer), storing, mixing, transportation, placing, compacting, finishing, curing, testing, all royalties, fees, rents where necessary, all leads and lifts and incidentals to complete the work as per specifications.

The unit rate shall all include the full costs of construction, expansion, contraction and longitudinal joints including joint filler, sealant, primer, debonding strip and all other operations for completing the work. The construction and testing of trial length shall be included in the contract unit rate for the pavement and shall not be paid separately.

602.16.2 Where the average thickness for the lot is deficient by the extent shown in Table 600-6, payment for cement concrete pavement shall be made at a price determined by adjusting the contract unit price as per Table 600-6

Table 600-6 : Payment Adjustment or Deficiency in Thickness

Deficiency in the Average Thickness of Day's Unit Price	Percent of Contract Payable
Work Up to 5mm	100
6-10 mm	87

602.16.3 No additional payment shall be made for the extra thickness of the slab than shown on the drawings.

Item No. 22 :: Providing and placing in position FE 550D bar reinforcement for following items including cutting bending hooking and tying complete as per detailed drawing. For well :- curb, staining, cap and RCC Raft.

Specification as per Item No. 07.

Item No. 23 :: Providing and laying in position FE 550D TMT bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawings for the following. (A) Piers (B) Abutments (C) R.C.C. Returns

Specification as per Item No. 07.

Item No. 24 :: Providing and placing in position FE 550D TMT. Bar reinforcement including, cutting, bending hooking and tying complete as per detailed drawings. (I) Solid Slab. (II) Deck Slab.

Specification as per Item No. 07.

Item No. 25 :: Providing and fixing in position FE 500D TMT bar reinforcement including cutting, bending and tying complete as per detailed drawings. (A) R.C.C. Kerb. (B) R.C.C. Footpath. (C) R.C.C. Approach slab. (D) Wearing Coat.

Specification as per Item No. 07.

Item No. 26 :: Providing and fixing premoulded compressible filler board in black colour confirming to MoRT&H Specifications (Clause 1015), having minimum density 95kg/cum. non-staining with less than 1% water absorption & compression recovery of 93% minimum as per specification for 20 mm wide expansion joint including cutting to required size and shape at all levels etc. complete as directed.

➤ **Material**

1. Sil flax (Capcel HD 100)

Sil flax (Capcel HD 100) shall be of approved quality and brand (The Supreme Industries Limited or equivalent) water absorption shall be 0.080 Max Compaction deflection & recovery % with weathering shall be 93% compaction deflection & recovery 100% without weathering shall be 100% thickness of board shall be 20mm with appropriate size.

2. Premoulded compressible filler board

Premoulded compressible filler board shall be approved quality and brand (The Supreme Industries Limited or equivalent).

➤ **Workmanship**

Preparation of Surface

Surface shall be cleaned by washing with water and all dirt, dust and loosed material shall be removed and surface shall be toughly cleaned olded compressible filler board shall be laid as specified by the manufacturer and as directed by Engineer in charge.

➤ **Mode of Measurement and Payment**

The unit rate of pre-moulded compressible filler board shall include the cost of all materials, cost of labour, cost of all necessary materials, transporting charges for fixing boards in wall at the place shown in drawing and as instructed by Engineer in charge, all tools and plant required for assembling and fixing in position, finishing as per direction of the Engineer in charge, and all other incidental expenses for preparing expansion joint of specified size to complete the joint structure or its components as shown on the drawings and according to these specifications. They shall also include the cost of making, fixing and making walls good by plaster etc. as required.

The pre-moulded compressible filler board shall be measured for its breadth and height or length limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one Square meter.

The payment will be made on square meter basis of the finished work.

The rate shall be for a unit of one **Square meter**.

Item No. 27 :: Providing and applying the elastomeric joint sealant two component, high performance polysulfide formulation conforming to BS:4254 and ASTM C 920 having weathering resistance to ultra-violet rays and shall exhibit shore A hardness of 25 and have movement accommodation factor 25% including using of compatible primer of approved standard etc. complete. For 20 mm thick joint

General

This work shall consist of providing and applying elastomeric joint sealant two component high performance polysulfide formulation conforming to BS:4254 and ASTM C920 having weathering resistance to ultraviolet rays and shall exhibit shore A hardness of 25 and have movement accommodation factor 25% and specification and dimensions shown on the drawings and conforming to these specifications or as approved by the Engineer in charge.

- 1.0. Elastomeric joint sealant shall be constructed according to the details shown on the drawings. The position of all bolts cast and holes drilled in plates shall be accurately determined from templates.
- 2.0. **20mm thick** joint sealant provided in the elastomeric joint sealant shall conform to the relevant IS specification and shall be accurately shaped to the section of concrete beam & slab. Positive methods shall be employed in placing the assemblies, to keep them in correct position during the placing of concrete. Care shall be taken to avoid impairment of the clearance in any manner. The material used for filling elastomeric joint shall be silicon sealant water proofing rubberized adhesive as specified on the drawings. It shall conform to the requirement of IS : 1838 & shall be got approved from the Engineer-in-charge. The joint filler shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided. After providing expansion joint the open face of beam / column shall be covered with 15 cm. wide & 8 mm thick Bison panel as per design.
3. The elastomeric joint sealant shall be measured in running meters.
4. The rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as shown on the drawings.

MODE OF MEASUREMENT & PAYMENT :

- 3.1.** The unit rate of elastomeric joint sealant shall include the cost of all materials, tools and plant required for lifting to required height with all lead and lift, placing & fixing in position including providing necessary reinforcement, all required specials and jointing material as per direction of the Engineer-in-charge and all other incidental expenses for producing elastomeric joint sealant work of specified size to complete the structure or its components as shown on the drawings and according to these specifications.
- 3.2.** The elastomeric joint sealant work shall be measured for its length limiting to specified capacity to those specified on plan or as directed. The rate shall be for a unit of one **Running** meter.
- 3.3.** The payment will be made on **Running meter** basis of the finished work as directed above.

Item No. 28 :: Providing and fixing 25 mm diameter backup rod having minimum density 22 kg per cum (ASTMD - 3575) & compression strength of 0.40 kg per sqm (ASTM - 5249) and finishing with polysulphide sealant etc. complete.
For 20 mm wide expansion joint.

General

This work shall consist of providing and fixing 25 mm diameter backup rod having minimum density 22 kg per cum (ASTMD - 3575) & compression strength of 0.40 kg per sqm (ASTM - 5249) and finishing with polysulphide sealant and dimensions shown on the drawings and conforming to these specifications or as approved by the Engineer in charge.

- 1.0. Expansion joint shall be constructed according to the details shown on the drawings. The position of all bolts cast and holes drilled in plates shall be accurately determined from templates.
- 2.0. 20 mm wide expansion joints shall conform to the relevant IS specification and shall be accurately shaped to the plate soldered on strip at intervals of about 30 cm. Care shall be taken to avoid impairment of the clearance in any manner. The material used for fixing expansion joint shall be silicon sealant water proofing rubberized adhesive as specified on the drawings. It shall conform to the requirement of IS : 1838 & shall be got approved from the Engineer-in-charge. The joint filler shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided.
3. The expansion joints shall be measured in running meters.
4. The rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as shown on the drawings.

MODE OF MEASUREMENT & PAYMENT :

- 3.1. The unit rate of expansion joint shall include the cost of all materials, tools and plant required for lifting to required height with all lead and lift, placing & fixing in position including providing necessary reinforcement, all required specials and jointing material as per direction of the Engineer-in-charge and all other incidental expenses for producing expansion joint work of specified size to

complete the structure or its components as shown on the drawings and according to these specifications.

- 3.2.** The expansion joint work shall be measured for its length limiting to specified capacity to those specified on plan or as directed. The rate shall be for a unit of one **Running** meter.
- 3.3.** The payment will be made on **Running meter** basis of the finished work as directed above.

Item No. 29 :: Providing P.V.C. 100 mm diameter water spouts including necessary iron gratings as per drawings.

2705 DRAINAGE SPOUTS

Drainage along longitudinal direction shall be ensured by sufficient number of drainage fixtures embedded in the deck slab. The spouts shall be of not less than 100 mm in diameter and shall be of corrosive resistant material such as galvanised steel with suitable cleanout fixtures. The spacing of drainage spouts shall not exceed 10 m. The discharge from drainage spout shall be kept away from the deck structure by means of suitable down pipes upto 500 mm above High Flood Level. In case of viaducts in urban areas, the drainage spouts should be connected with suitably located runners and down pipes to discharge the surface run-off into drains provided at ground level.

2705.1 Fabrication

The drainage assembly shall be fabricated to the dimensions shown on the drawings. All materials shall be corrosion resistant. Steel components shall be of mild steel conforming to IS:226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanised.

2705.2 Placement

The galvanised assembly shall be given two coats of bituminous paint before placement. The whole assembly shall be placed in true position, lines and levels as shown on the drawings with necessary cutouts in the shuttering for deck slab and held in place firmly. Where the reinforcements of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the cut out.

2705.3 Finishing

After setting of the deck slab concrete, the shrinkage cracks around the assembly shall be sealed with polysulphide sealant or bituminous sealant as per 18:1834 and the excess sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be provided to cover at least 50 mm on the wearing coat surface all round the drainage assembly.

2708 MEASUREMENTS FOR PAYMENT

Drainage / water spouts shall be measured in numbers.

2709 RATE

The contract unit rate for drainage spout shall include the cost of all labour, material, tools and plant required for completing the work as per these specifications. It shall also include the cost of providing runners and down pipes with all fixtures upto 500 mm above high flood level or up to the drains at ground, as applicable or as shown on the drawings.

Item No. 30 :: Providing & laying weep hole in Abutments, and returns by using A.C. pipe of 100mm including laying in proper grade and jointing the completed as per detailed specification.

Specification as per Item No. 11.

Item No. 31 :: Earthwork for embankment including breaking clods, dressing with all lead and lift and including watering rolling and consolidation of subgrade in layers at O.M.C. to required dry density including filling the depression which occur during the process using power roller 8T to 10T .(E) From Borrow area within 3.0KM. lead

305 EMBANKMENT CONSTRUCTION

305.1 General:

305.1.1 Description:

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, sub grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

305.2 Materials and General Requirements.

305.2.1 Physical requirements :

305.2.1.1 The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, murrum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment sub grade.

The following types of material shall be considered unsuitable for embankment:

- (a) Materials from swamps, marshes and bogs;
- (b) Peat, log, stump and perishable material; and soil that classifies as OL, OI, OH or Pt in accordance with IS:1498;
- (c) Materials susceptible to spontaneous combustion;
- (d) Materials in a frozen condition;
- (e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- (f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage, properties ("free swelling index" exceeding 50 percent when tested as per IS:2720-Part 40) shall not be used as a fill material. Where an expansive clay with acceptable "free swelling index" value is used as a fill material, sub grade and top 500mm portion of the embankment just below sub grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO₃) per liter when tested in accordance with BS:1377 Part-3, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance

described in the Contract), permanent works constructed out of concrete, cement bound materials or other cementations materials.

Materials with a total sulphate content (expressed as SO_3) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377, Part 3 shall not be deposited within 500 mm or other distances described in the contract, of metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm when being placed in the embankment and 50 mm when placed in the sub grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

305.2.1.5 Ordinarily, only the materials satisfying the density requirements given in Table 300-1 shall be employed for the construction of the embankment and the sub grade.

TABLE 300-1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS

S.No.	Type of work	Maximum laboratory dry unit weight when tested as per IS:2720(Part 8)
1.	Embankments upto 3 metres height, not subjected to extensive flooding.	Not less than 15.2 kN/cu.m.
2.	Embankments exceeding 3 metres height or embankments of any height subject to long periods of inundation.	Not less than 16.0 kN/cu.m.
3.	Subgrade and earthen shoulders/ Verges/backfill	Not less than 17.5 kN/cu.m.

Notes: (1) This Table is not applicable for lightweight fill materials e.g. cinder, fly ash etc.

(2) The materials to be used in sub grade shall be non-expensive and shall satisfy design CBR at the specified dry density and moisture content. In case the available materials fail to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer shall be followed.

305.2.1.6 The materials to be used in sub grade shall conform to the design CBR value at the specified dry density and moisture content of the test specimen. In case the

available materials fails to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Association Committee shall be followed.

305.2.1.7 The materials to be used in high embankment construction shall satisfy the specified requirements of strength parameters.

305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the sub grade and the embankment portion just below the sub grade.

305.2.2.2 Borrow materials:

The arrangement for the source of supply of the materials for embankment and sub grade and compliance with the guidelines, and environmental requirements, in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width of a minimum of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or sitting of temporary buildings or structures.

305.2.2.3 Fly-Ash

User of fly-ash shall conform to the Ministry of Environment and Forest guidelines. Where fly-ash is used the embankment construction shall conform to the physical and chemical properties and requirements of IRC:SP:38-2001, “Guidelines for Use of Flyash in Road Construction”. The term fly-ash shall cover all types of coal ash such as ponds ash, bottom ash or mound ash.

Embankment constructed out of fly ash shall be properly designed to ensure stability and protection against erosion in accordance with IRC guidelines. A suitable thick cover may preferably be provided at intervening layers of pond as for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500mm.

305.2.2.4 Compaction Requirements

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub grade material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the sub grade.

TABLE 300-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE.

Type of work/material		Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)
1.	Sub grade and earthen shoulders	Not less than 97%
2.	Embankment	Not less than 95%
3.	Expansive Clays	
	a) Sub grade and 500mm.portion Just below the sub grade.	Not allowed.
	b) Remaining portion of embankment	Not less than 90-95%

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval :

- (i) The values of maximum dry density and optimum content obtained in accordance with IS:2720 (Part 8), appropriate for each of the fill materials he intends to use.
- (ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

The maximum dry density and optimum moisture content approved by the Engineer, it shall form the basis for compaction.

305.3 Construction Operations :

305.3.1 Setting Out

After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to be desired density and the position specified and conforms to the specified side slopes.

305.3.2 Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair./restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, Clause 305.4.6 shall apply.

305.3.3 Stripping and Storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

305.3.4 Compacting ground supporting embankment/Sub grade:

Where necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling in accordance with Clause 305.3.5 and 305.3.6 so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the sub grade level (top of the sub grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 300-2, the ground shall be loosened up to a level 0.5m below the sub grade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to achieve dry density not less than 97 percent relative compaction as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation (500mm portion just below the sub-grade) shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, atleast 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

305.3.5 Spreading material in layers and bringing to appropriate moisture content

305.3.5.1 The embankment and sub grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250mm when vibratory roller / vibratory soil compactor is used and not more than 200 mm when 80-100 kN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by balding, dicing or barrowing until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content can not be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS:2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS:2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the sub grade.

305.3.5.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cutting, another fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

305.3.6 Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheeled roller, self propelled single drum vibratory roller, tandem vibratory roller, pneumatic type roller, pad foot roller etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 kN static weight or heavy pneumatic type roller of adequate capacity capable of achieving the required compaction. The contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trails. The procedure to be adopted for these site trials shall be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankments / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage

The surface of the embankment/subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

305.3.8 Repairing of damages caused by rain/spillage of water :

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6 If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9 Finishing operations:

Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, cross sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 301.3.2 and 305.3.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moisture slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the top soil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4 Construction of Embankment and subgrade under special conditions.

305.4.1 Earthwork for widening existing road embankment :

When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal , continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers/plate compactors/power rammers or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2 Earthwork for embankment and subgrade to be placed against sloping ground

Where an embankment /subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1 before placing the embankment/subgrade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings, before the fill is placed against sloping ground.

Where the contract requires construction of transverse subsurface drain at the cut-fill interface, work on the same shall be carried out to Clause 309 in proper sequence with the embankment and subgrade work as approved by the Engineer.

305.4.3 Earthwork over existing road surface:-

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:-

- (i) If the existing road surface is of granular or bituminous type and lies within 1 m of the new formation levels, it shall be scarified to a depth of 50mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.
- (ii) If the existing road surface is of bituminous type or cement concrete type and lies within 1 m of the new formation level, the bituminous or cement concrete layer shall be removed completely.
- (iii) If the level difference between the existing road surface and the new formation level is more than 1 m. the existing surface shall be roughened after ensuring that the minimum thickness of 500mm of subgrade is available.

305.4.4 Embankment and subgrade around structures :-

To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC: 78. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2504 unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5 Construction of embankment over ground incapable of supporting construction equipment.

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract, will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6 Embankment construction under water and Water logged areas

305.4.6.1 Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS:1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75mm. The material should be non-

plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

305.4.6.2 Embankment construction in waterlogged and Marshy Areas :

The work shall be done as per IRC:34.

305.4.7 Earthwork for high embankment :-

The material for high embankment construction shall conform to Clause 302.2.1.7. In the case of high embankments (more than 6 m), the Contractor shall normally use fly ash in conformity with Clause 305.2.1.1 or the material from the approved borrow area.

Where provided, stage construction of embankment and controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging fill results the Contractor shall bring the resultant level upto formation level with acceptable materials for use in fill.

305.4.8 Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

305.5 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however be made good by the Contractor at his own expense as directed by the Engineer.

305.6 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on remoulded samples, compacted to the field density at the field moisture content and tested for soaked / unsoaked condition as specified in the contract.

305.8 Measurements for Payment

305.8.1 Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals given in Sub-section 113.3 after completion of clearing and grubbing and after completion of embankment / sub-grade. The volume of earthwork in cubic metres by the method of average end areas.

305.8.2 The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cu.m. of compacted fill and all bulking or shrinkage shall be ignored.

305.8.3 The embankment constructed with fly ash will be measured in cum, separately for the fly ash portions and for the soil cover and intervening layers of soil, unless otherwise specified in the contract.

305.8.4 Construction of embankment under water shall be measured in cu.m.

305.8.5 Construction of high embankment with specified material and in specified manner shall be measured in cu.m.

305.8.6 Stripping including storing and reapplication of topsoil shall be measured in cu.m.

305.8.7 Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cu.m.

305.8.8 Removal of unsuitable material at embankment/subgrade foundation and replacement with suitable material shall be measured in Cu.m.

305.8.9 Scarifying existing granular/bituminous road surface shall be measured in Square metres.

305.8.10 Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6.

305.8.11 Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cu.m.

305.9 RATES:

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for :

- (i) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided other wise in the contract.
- (ii) Setting out;
- (iii) Compacting ground supporting embankment/subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;
- (iv) Scarifying or cutting continuous horizontal benches 300mm wide on side slopes of existing embankment and subgrade as applicable;
- (v) Cost of watering or drying of material in borrow areas and/or embankment and subgrade during construction as required;
- (vi) Spreading in layers, bringing to appropriate moisture content and compacting to specification requirements;
- (vii) Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;
- (viii) Restricted working at sites of structures;
- (ix) Working on narrow width of embankment and subgrade,
- (x) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the contractor.
- (xi) All labour, material, tools, equipment and incidentals necessary to complete the work to the Specifications;
- (xii) Dewatering, and
- (xiii) Keeping the embankment/completed formation free of water as per Clause 311.
- (xiv) Transporting unsuitable excavated material for disposal with all leads and lifts.

305.9.2 Clause 301.9.5 shall apply as regards Contract unit rates for items of stripping and storing top soil and of reapplication of topsoil.

305.9.3. Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and recompacting the embankment / subgrade foundation.

- 305.9.4.** Clauses 309.1.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.
- 305.9.5.** The Contract unit rate for scarifying existing granular/bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals, necessary to complete the work. This will also comprise of handling, giving credit towards salvage value and disposal of the dismantled materials with all leads and lifts or as otherwise specified.
- 305.9.6.** Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.
- 305.9.7.** The Contract unit rate for providing and laying filter material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.8.** The Contract unit rate for providing and compacting backfill material behind abutments and retaining walls shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.9.** Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.
- 305.9.10.** Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

Measurement shall be taken and paid in Cu.m.

Item No. 32 :: Providing and laying Pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications A) Stone/Boulder.

2504. PITCHING / REVETMENT ON SLOPES

2504.1. Description

The work shall consist of covering the river side slopes of guide bunds, training works and road embankments with stone, boulders, cement concrete blocks or stones in wire crates over a layer of granular material which will act as a filter. The rear slopes, not subjected to direct attack of the river, may be protected by 300 mm - 600 mm thick cover of clayey or silty earth and turfing.

2504.2 Pitching and Filter Medium

2504.2.1 Pitching

The pitching shall be provided with stones of thickness and shape as indicated on the drawings.

The stones shall be obtained from quarries and shall be sound, hard, durable and fairly regular in shape. Round boulders shall not be allowed. Stones showing 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. No stone, shall weigh less than 40 kg. The size of spalls shall be a minimum of 25 mm and shall be suitable to fill the voids in the pitching.

Where the stones of required size are not economically available, cement concrete blocks in minimum M 15 grade concrete conforming to Section 1700 of these Specifications or stones in wire crates, shall be used .

Geosynthetics, if used in pitching, shall conform to Section 700 of these Specifications.

2504.2.2 Filter Medium

The material for the filter shall consist of coarse sand, gravel or stone. One or more layers of graded materials, to act as a filter medium, shall be provided underneath the pitching, to prevent loss of the embankment material and build up of uplift head on the pitching.

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

$$\frac{D_{15}(\text{Filter})}{D_{85}(\text{Base})} < 5$$

$$4 < \frac{D_{15}(\text{Filter})}{D_{15}(\text{Base})} < 20$$

Notes:

- (i) Filler 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.
- (ii) 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 (15 being replaced with 50 and 85 respectively)..
- (iii) 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.
- (iv) The filler shall be compacted to a firm condition. The thickness of filler is generally of the order of 200 mm to 300 mm. where filler is provided in two layers, thickness of each layer shall be 150 mm.

2504.3. 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 filler granular material shall be laid over the prepared base and suitably compacted to the thickness specified on the drawings by means of suitable equipment.

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) conforming to Clause 1405.3, in case of dry rubble pitching and shall be in nominal mix cement concrete (M-15) conforming to Clause 1704.3 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 subsequence 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 full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size and wedged in with hammers to ensure tight packing.

When two or more layers of stones 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.

2504.4. 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} conforming to Clause 1405.3 in case of dry rubble pitching or pitching/ revetment with stones in wire crates and in nominal mix cement concrete (M-15) conforming to Clause 1704.3 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 complied with.

2509. MEASUREMENTS FOR PAYMENT

The earth work in construction of embankment for guide bund shall be measured in cubic metres unless otherwise specified.

The filter and stone pitching shall be measured separately in cubic metres unless otherwise specified.

Rubble stone / cement concrete blocks, flooring and cement concrete bedding shall be measured in cubic metres for each class of material. Preparation of base for laying the flooring shall be deemed incidental to the work.

For laying apron, excavation upto an average depth of 150 mm shall be deemed to be included in the main item and shall not be measured separately unless otherwise

specified. Excavation more than 150 mm shall be measured in cubic metres as given in Clause 300.

2510. RATE

The contract unit rate for one cubic metre of filter or stone/cement concrete block pitching on slopes shall include the cost of preparing the bases, putting to the profiles, laying and compacting the filter and stone pitching of dry rubble/cement concrete block rivetment for embankment slopes to the specified thickness, lines, curves, slopes and levels and all labour and materials as well as tools and plant required for the work.

The contract unit rate for rubble stone/cement concrete block flooring shall include the cost of all material, labour and tools and plant for completing the work as per these specifications.

Item No. 33 :: Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification.

The material for the filter shall consist of sand, gravel, stone or coarse sand. To prevent escape of the embankments 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.

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 :

$$\frac{D_{15}(\text{Filter})}{D_{85}(\text{Base})} < 5$$
$$4 < \frac{D_{15}(\text{Filter})}{D_{15}(\text{Base})} < 20$$
$$\frac{D_{50}(\text{Filter})}{D_{50}(\text{Base})} < 25$$

- Notes : 1. Filter design may not be required of 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.

2504.3. 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) conforming to Clause 1405.3, in case of dry rubble pitching and shall be in nominal mix cement concrete (M 15) conforming to Clause 1704.3 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 full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size and wedged in with hammers to ensure tight packing.

When two or more layers of stones 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 galling even when the apron is not laid at low water level. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Clause 1405.3 in case of dry rubble pitching or pitching / revetment with stones in wire crates and in nominal mix cement concrete (M 15) conforming to Clause 1704.3 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 complied with. The relevant specifications of the protective works for individual components will be followed.

TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

MEASUREMENTS FOR PAYMENT

The protection works shall be measured as set forth below. If directed by the Engineer for measurement, the materials may have to be stacked at site before laying and nothing extra will be paid to the Contractor for this stacking.

The filter underneath stone pitching shall be measured separately in **cubic** metres unless otherwise specified.

Preparation of base for laying the flooring shall be deemed incidental to the work.

RATE

The contract unit rate for one **cubic meter** of **filter material underneath stone pitching** on slopes shall include the cost of preparing the bases, putting to the profiles, laying and compacting the filter and stone pitching of dry rubble/cement concrete block revetment for embankment slopes to the specified thickness, lines, curves, slopes and levels and all labour and materials as well as tools and plant required for the work.

The contract unit rate for filter material underneath stone pitching shall include the cost of all material, labour and tools and plant for completing the work as per these specifications.

Item No. 34 :: Hazard Marker Sign :-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 90x30 cms. rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D 4956 and latest M.O.S.T. Specifications; 1.8mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with bestquality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC blockof size 45 x 45 x 60 Cms. for each leg.including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor.

(A) Class-C Type-11 Retro Reflective sheeting.

The sign board shall conform to IRC-67-1977 and ninth schedule of the motor vehicle Act. It shall be providing and fixed as directed by the Engineer in charge.

1.2 Traffic Signs having retro-reflective sheeting :

1.2.1 General Requirements :

The retro-reflective sheetings used on the sign shall consist of white or coloured sheeting having a smooth outer surface which has the property of retro reflective over its entire surface. It shall be weather resistance and show colour fastness. It shall be new and unused and shall shown no evidence of cracking scaling pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained form a reputed laboratory by the manufacture of the sheeting. The reflective sheeting shall be either or Engineering Grade material with enclosed lens or of high intensity grade with encapsulated lens/ micro prismatic type. The type of sheeting to be used would depend upon the type functional hierchy and importance of the road.

1.2.2 High Intensity Grade Sheeting :

1.2.2.1 Encapsulated Lens Type :

This sheeting shall be of encapsulated lens type consisting of spherical glass lens elements, adhered to a synthetic resin and encapsulated by a flexible, transparent water proof plastic having a smooth surface. The retro reflective surface after cleaning with

soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E:810) as indicated in Table 800-1.

TABLE 800-1

**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR
HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX SQUARE
METRE).**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+ 30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90% of the values of retro reflectance indicated in Table 800-1. At the end of 10 years, the sheeting shall retain at least 75% of its original retro-reflectance.

1.3.2 Engineering Grade Sheeting :

This sheeting shall be of enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical, resulting in a non-exposed lens optical reflecting systems. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard E-810) as indicated in Table 800-2.

TABLE 800-2

**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR
ENGINEERING GRADE SHEETING (CANDELAS PER LUX SQUARE
METRE).**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+ 30	30	22	7.0	3.5	6.0	1.7

0.5	-4	30	25	13.5	14.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

1.1.2.3 When totally wet, the sheeting shall not show less than 90% of the values of retro-reflectance indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50% of its original retro reflective.

1.1.3 **Messages / Borders :** The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs. Screen-printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.

1.1.4 For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 800-1(a), 800-1(b) and 800-2 as applicable.

1.1.5 Cut out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per Clause 801.3.2 of 801.3.3 as applicable) except those in black which shall be of non-reflective sheeting.

1.1.6 **Colour :** Unless otherwise specified, the general colour scheme shall be as stipulated in IS:5 "Colour for Ready Mixed Paints".

Blue	IS	Colour No.166 : French Blue
Red	IS	Colour No.537 : Signal Red
Green	IS	Colour No.284 : India Green
Orange	IS	Colour No.591 : Deep Orange

The colours shall be durable and uniform in acceptable but when viewed in day light or under normal headlights at night.

1.1.7 **Adhesives :** The sheeting shall either have a pressure sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The sheeting shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant

surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

1.1.8 Refurbishment: Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminium backing pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for type of material used for the sign and should thoroughly bond with that material.

Alternatively, the aluminium blank shall be recycled to a finished condition and new sheeting's put on in an approved manner.

1.1.9 Fabrication :

1.1.9.1 Surface to be reflectorised shall be prepared to receive the retro-reflective sheeting. The smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

1.1.9.2 Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure sensitive adhesive shall be overlapped not less than 5 mm. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

1.1.10 Warranty Durability : For each lot of sheetings procured, the contractor shall obtain from the manufacturer a 10 years warranty for satisfactory field performance including stipulated retro-reflectance of the sheetings of high intensity grade and a 5 years warranty for the engineering grade and submit the same to the Engineer. In

addition, a 10 years and a five years warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut-out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and passed on to the Engineer. The contractor / supplier shall also furnish a certification that the signs and materials supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty.

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values Tables 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH weatherometer AASHTO Designation M 268).

1.2 Installation :

1.2.1 Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanised iron (G.I.). Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

1.2.2 All components of signs and supports, other than the reflective portion and G.I. Posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

1.2.3 The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case or reinforced concrete or G.I. Posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

1.3 Measurements for Payment :

The measurement for standard cautionary, mandatory and information sign shall be in number of different types of signs supplied and fixed as per above details and specifications. Direction and place identification signs, also shall be measured in numbers of different type of sign supplied and fixed.

1.4 **Rate :**

The contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

➤ *SPECIAL TERMS AND CONDITIONS OF CONTRACT FOR SIGN BOARDS*

- 1 **Warranty certificate for 10 years for respective grades of signs from the sheeting manufacturer should be attached with the bid.**
- 2 **A certificate of authorization from the sheeting manufacturer shall be submitted with the bid.**
- 3 **The responsibility for handling, upkeep and safety of the boards lies with the contractor until the completion of work and final payment are released.**
- 4 **The contract is valid for three months from the date of work order. The required quantity has to be supplied and fixed as and when intimated by the Division.**
- 5 **The measurement for payment will be done only after fulfilling condition up to the satisfaction of Executive Engineer. The 100% quantity of supply and fixing will be checked by Deputy Executive Engineer and at least 10% quantity of supply and fixing will be checked by the Executive Engineer to ensure quality and workmanship, before passing for payments.**

The contractor will have to ensure how he is going to arrange repair or replacement of defective boards after intimation from the Division.

Item No. 35 :: Providing Yellow and Black Patta (three coat) including distempeing (Three coats) with oil bound distemper of approved brand and manufacture and of required shade on wall surfaces to give an even shade, over and including a priming coat with distemper primer of approved brand and manufacture after thoroughly brushing the surface free from mortar dropping and other foreign matter and also including preparing the surface even and sand papered smooth as per instruction of Engineer Incharge.

1.0. Materials

- 1.1.** Oil bound washable distemper and primer shall be of approved brand and manufacture. The distemper shall be of required colour and shade and the same shall conform to I.S. : 428-1969. The shade shall be approved by Engineer in charge.

2.0. Workmanship

The Yellow and Black Patta (three coat) including distempering shall be carried out [on wall surfaces](#) to give an even shade.

2.1. Scaffolding

Where scaffolding is required, it shall be erected in such a way that as far as possible no pail of scaffolding shall rest against the surface to be distempered. A properly secured and well tied suspended platform (Joola) may be used for distempering. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the walls and floors. For distempering to ceiling, proper stage scaffolding shall be erected where necessary.

2.2. Preparation of surface :

- 2.2.1.** The undecorated surface to be distempered shall be thoroughly brushed from dust, dirt, grease, mortar dropping and other foreign matter and sand papered smooth. New plaster surface shall be allowed to dry for at least 2 months before applications of distemper.
- 2.2.2.** All unnecessary nails shall be removed. Pitting in plaster shall be made good with plaster again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed. The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with I.S; 2395 (Part 01) 1966. Before applying distempering, any unevenness shall be

made good by applying putty made of plaster of paris mixed with water on entire surface including filling up the undulation and then sand papering the same after it is dry.

2.3. Priming coat :

2.3.1. A priming coat of alkali resistance primer of approved manufacture and shade shall be applied over the papered surface in case of new work on undecorated surface. If the distemper priming is done after the wall surface dries completely, the alkali resistance primer shall be applied.

2.3.2. Application of primer shall be done as under: The primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours before oil bound distemper or paint is applied.

2.3.3. Oil bound distemper is not recommended to be applied within six months of the completion of wall plaster.

2.4. Preparation of oil bound distemper :

2.4.1. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer only. Sufficient quantity of distemper required for a day's work shall be prepared.

2.5. Application of Distemper coat:

2.5.1. For undecorated surfaces, after the primer coat is dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out priming coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed immediately by vertical strokes which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit proper drying of the preceding coat. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc.

2.5.2. Sufficient quantity of distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be striated in any room which cannot be completed on the same day.

2.5.3. 15 cm. double bristled distemper brush shall be used. After day's work brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

2.6. Protective measurements : The surfaces of doors, windows, floors, articles of furniture etc. and such other parts of the buildings as are not to be distempered shall be protected from being splashed upon. Such surfaces shall be cleaned of distemper splashes if any.

3.0. Mode of measurements and payment

3.1. Priming coat of alkali resistance primer, scraping of surface spoiled by struck roots, removal of oil and grease spots, treatment for infraction of effloresces., mould moss, fungi, algae and lichen and patch repairs to plaster shall be included in this item for which nothing extra shall be paid.

3.2. All the work shall be measured net in the decimal system as in place subject to the following limits unless otherwise stated hereinafter:

(a) Dimensions shall be measured to the nearest 0.01 m.

(b) Area in individual items shall be worked out to the nearest 0.01 sq. m. All work shall be made for ends of joints, beams, posts etc., and openings, not exceeding 0.5 sq.mt. each and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings not for finish around ends of joints, beams, posts etc.

3.3. Deductions of opening exceeding 0.5 sq.m. but not exceeding 3 sq. m. each shall be made as follows and net addition shall be made for reveals, jambs, soffits etc. of these openings :

(a) When both the faces of wall are provided with same finish, deductions shall be made for one face only.

(b) When each face of wall is provided with different finish, deduction shall be made for that side of frame for doors, windows etc. on which width of reveals is

less than that of the other side but no deduction shall be made on the other side. Where the width of reveals on the both the faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of finish.

(c) When only one face of wall is treated and the other face is not treated, full deductions shall be made if the width of the reveal on treated side is less than that on untreated side but if the width of the reveal is equal or more than that on untreated side neither deductions nor additions to be made for reveals, jambs, soffits, sills etc.

- 3.4.** In case of opening of area exceeding 3 sq. m. each deduction shall be made for openings but jambs, sills and soffits shall be measured.
- 3.5.** No deductions shall be made for attachments such as casings, conduits, pipes, electric wiring and the like.
- 3.6.** Item includes removing nails, making good holes, patches with materials similar in composition of distemper.
- 3.7.** The extra rate shall be paid for carrying out distempering work on ceiling/sloping roofs over and above.
- 3.8.** The rate includes cost of all materials, labours, scaffolding, protective measures etc. involved in all the operations described above. This shall also include conveyance, delivery, handling, unloading, storing work etc.
- 3.9.** The rate shall be for a unit of one sq. meter.

Item No. 36 :: Excavation for foundation upto 1.5 m depth including sorting out and stacking of useful materials and disposing off the excavated stuff upto 50 Meter lead.(A) Loose or soft soil.

Specification as per Item No. 02.

Item No. 37 :: Providing and casting in situ controlled cement concrete M-250 for R.C.C. return as per drawings including centering shuttering ,scaffolding where necessary, laying vibrating, curing and finishing complete.(A) Height from 0.0 to 5.0 M. For wall

**This item shall be carried out as per detailed specification of
Item No. [06] below in Design Mix Concrete M-250 grade
for R.C.C. return (A) Height from 0.0 to 5.0 M. (1) Piers (2)
Abutment (3) RCC return as directed including cost of shuttering,
scaffolding, laying, vibrating, curing and finishing as per design**

Item No. 38 :: Tubular Steel Railing on Medium Weight steel channel (ISMC series) 100 mm x 50 mm (Providing, fixing and erecting 50 mm dia steel pipe railing in 3 rows duly painted on medium weight steel channels (ISMC series) 100 mm x 50 mm, 1.2 metres high above ground, 2 m centre to centre, complete as per approved drawings).

This work shall be includes finishing, fabricating, galvanizing, transporting steel.

GENERAL

General requirements relating to the material shall conform to the specifications of I.S. 1367 and I.S. 1364.

Finished material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish.

All material shall conform to I.S. 1367 & 1364.

Fabrication

All work shall be in accordance with the drawing and as per director of Engineer-in-charge.

All welding shall be done with the prior approval of the Engineer and the workmanship shall conform to the specification of I.S. 823 or the relevant Indian Standard as appropriate.

The compact sheet metal beam rail & members to be galvanized hot dip process.

All fitting shall conform to I.S. 1367 and I.S. 1364.

The [steel pipe railing](#) to be fixed on vertical part with a spacer of channel section 100 mm x 50 mm and 330 mm long.

The [steel pipe railing](#) shall be fixed 50 mm above row level fixed on ISMC series channel vertical post 100 mm x 50 mm spacer 2 m center to center 1.20m high 1.1 m below ground or low level.

The mode of measurements shall be in **Rmt** with whole work including all material and labour works with all necessary machinery & equipments.

Item No. 40 :: "THRIE" : Metal Beam Crash Barrier with base plate Providing and erecting a "Thrie" W - metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 85 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2 m centre to centre. The vertical post fixing at site shall be on Base Plate of Size 240 x 320 x 16 mm thick with 6 Nos 20 mm dia 4.6 grade

anchor bolt upto minimum depth of 200 mm & ISMC Vertical Post shall be fixed with base plate with 12 mm thick stiffener plate of 100 x 80 mm & This base shall be casted in M25 grade Cement concrete of size 35 x 35 x 12 cms. for each post including necessary fabrication work etc. complete. All steel parts and fittings to be galvanised by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical Post with a spacer of channel section 150 x 75 x 5 mm, 550 mm long complete as per Morth Specification clause 810 including butt welding to all nuts & bolts etc. complete as per instruction of Engineer In Charge. Also red colour strip of size 100 x 300 mm shall be fixed on vertical front side of each post for better night visibility. The end barrier treatment shall be done as per IS Standard 119 : 2015.

2703.1. General

- a) Bridge railing/crash barrier includes the portion of the structure erected on and above the kerb.
- b) Railings/crash barrier shall not be constructed until the centering false work for the span has been released and the span is self-supporting.
- c) For concrete with steel reinforcement, specifications for the items of controlled concrete and reinforcement mentioned under relevant sections of these specifications shall be applicable.
- d) The railing/crash barrier shall be carefully erected true to line and grade posts shall be vertical with a tolerance not exceeding 6mm in 3m. The pockets left for posts shall be filled with non shrink mortar.
- e) The type of railing/crash barrier to be constructed shall be as shown on the drawings and shall conform to IRC:6 and IRC:5. 15.4.5. Crash barriers shall provide a smooth and continuous face on the traffic side and shall be suitably extended into the approaches. Exposed rail ends, posts and sharp changes in the geometry of the railings shall be avoided. Suitable reflective (luminous) devices shall be provided on the traffic face of the barrier at intervals to ensure adequate visibility during night and foggy conditions.
- f) Care shall be exercised in assembling expansion joints in the railings to ensure that they function properly.
- g) The bridge railings shall be amenable to quick repairs.
- h) Warrants: The longitudinal roadside barriers are basically meant to shield two types of roadside hazards i.e. embankments and roadside obstacles and also for preventing the vehicles veering off the sharp curves. Therefore, all embankments with height 3 m or more shall have safety barriers at the edge of formation, with delineating reflectors fitted on them.

Normally on shoulder side the lateral distance of at least 0.75 to 1.0 m width

from edge of paved portion (i.e. carriageway + paved shoulder) should be available without any obstacles. Wherever a permanent object cannot be removed for some reasons, provision of tandems viz. W-beam metal crash barriers and hazard markers with reflectors must be made. Further, frangible lighting columns and sign posts need to be used for minimizing the severity in case of collision.

Irrespective of type of barrier being used, the slope in front of W-beam or wire rope or rigid barrier shall be near to flat gradient so that safety barrier perform best when impacted by a vehicle and the slope of ground in front of barrier shall not be steeper than 10:1.

Some of the commonly encountered roadside obstacles are bridge piers, abutments and railing ends, roadside rock mass, culverts, pipes and headwalls, cut slopes, retaining walls, lighting supports, traffic signs and signal supports, trees and utility poles.

Bridge rail / crash angles, transiting and end treatment.

Traffic crash barrier is toe warrants. For an approach barrier to a bridge. The criteria for clear total requirements given in figure shall be apply. The crash barrier shall be provided where transition sanction between approach barrier and bridge railing / barrier. If the end of approach barrier terminate within clear tone, a crash worthy end treatment is also warranted.

The end of the road side barrier can batter dues if hit, therefore it should farm an integral part of crash barrier end treatment should have spear vault or roll, a vehicle for head on as angled impacts.

The end treatment on approach shall be modified eccentric loader terminal (MELT) as shown in fig.-13 and departure sides shall be trailing terminal (TT) arrangement shown in.

Placement of crash barrier on road edge barrier.

As far as possible, crash barrier should be placed at a distance 2.5 m of the carriage way (Travelled way) for range & continues stretches. The distance between barrier & hazard should not be less than destruction of barrier by on impact by full size vehicle.

In cash of embankments a minimum distance of 60 cm should be maintained between barrier and start of embankments - slope or hazard to in reverse for vehicle dropping.

When the kerb exists on the edge of road and on closed proximity of travelled way, weather and shoulders or median edge line a distance of 100 mm shall be maintained between vertical frames the kerb & W-beam force. The steel barrier shall be placed in such a way so as not to be collided by vehicle directly fig. 17.

The material of metal railing/crash barrier shall be handled and stored with care, so that it remains clean and free from damage. Railing/crash barrier materials shall be stored above the ground on platforms, skids, or other supports and kept free from grease, dirt and other contaminants.

Any material which is lost, stolen or damaged after delivery shall be replaced or repaired

by the Contractor. Methods of repair shall not damage the material or protective coating.

2703.2. Metal Railings/Crash barrier

Materials, fabrication, transportation, erection and painting for bridge railings shall conform to the requirements of section 810.

All complete steel rail elements, pipe terminal sections, posts, bolts, nuts, hardware and other steel fitting shall be galvanised or painted with an approved paint.

If galvanised, all elements of the railing shall be free from abrasions, rough or sharp edges, and not be kinked, twisted or bent. If straightening is necessary, it shall be done by methods approved by the Engineer.

Damaged galvanised surfaces, edges of holes and ends of steel railing cut after galvanising shall be cleaned and re-galvanised.

The railing/crash barrier shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

Unless otherwise specified on the drawings, metal railing/crash barrier shall be given one shop coat of paint and three coats of paint after erection if sections are not galvanised.

Railings/crash barrier shall not follow any irregularity in the alignment of the deck. When shown on the drawings, the rail elements shall be curved before erection.

1.0 The work shall consist of furnishing and erection of metal safety barrier of dimensions and at locations as shown on the drawing, 'or' as directed by the Engineer-in-charge.

2.0 Materials

2.1 Metal beam rail shall be corrugated sheet of galvanized iron of the class, type section and thickness and shall be provided in one row as indicated in the item and shown on plan. Railing post shall be of steel section 150 mm x 75 mm x 5 mm. All complete steel rail elements, terminal sections, bolts, nuts, hardware and other fittings shall be galvanized. All elements of the railing shall be free from abrasion, rough or sharp edges and shall not be kinked twisted or bent, and shall confirm to the confirming to IS 2062 IS:1367 and IS:1364.

2.2 All steel members shall be galvanized with coating thickness not less than 550 gm/m² (gsm). galvanizing shall be as per MORTH specification. fasteners/bolts shall be of grade 4.6 and diameter 16mm dome head bolts. W-beam metal crash barrier shall confirm to MORTH specification. MORTH specification for metal crash barrier shall be applicable.

2.3 3mm ACM type reflector, 100 mm wide and 4.50 m long, type 4 class-B, High intensity grade sheeting as per IRC 67-2012 including labour.

- 2.4 Anchor bolts shall be of minimum grade 4.6 and manufactured by Hilti or equivalent confirming to IS 1367 and IS 1364.

3.0 Construction Operation :

- 3.1 Removing / Dismantling existing Parapet wall / Pipe Railing/crash barrier followed must by these *specification*.

- 3.1 Installation of posts :

3.1.0. Workmanship

- 3.1.1. The concrete base shall be cleared with relevant detailed specification.

- 3.2 Base plate shall be fixed with anchor bolts in existing concrete as shown in drawing or as per manufacture guidelines minimum depth of 200mm for solid slab and for T beam girder slab base plate on top and bottom of slab shall be provided.

- 3.2.1 The Pit shall be back filled with M-25 as shown on drawing or as directed.

- 3.3 While fixing steel post shall be embedded in concrete at 1.5 mt C/C with necessary base plate and anchor bolts using epoxy chemical. The line and grade of railing shall be true to that shown on the plan. The railing shall be carefully adjusted to fixing in place to ensure proper matching at abutting joints and correct alignments and caber throughout their length. Holes for field connection shall be drilled with the railing in place in the structure at proper grade and alignment. Placement / fixing crash barrier in accordance with guidelines specified in IRC 119, 2015.

- 3.4 Railing steel post shall be given one coat of primer and two coats of paint on structural steel after erection if the sections are not galvanized. Any part of assembly below ground shall be painted with two coats of red lead paint.

4.0 Erection:

- 4.1 All ground rail anchors shall be set and attachment made and placed as indicated in the item and shown on the plan or as directed by the Engineer-in-charge.

- 4.2 All railings shall be erected, drawn and adjusted so that the longitudinal tension will be uniform throughout the entire length of the rail.

- 4.3 The post shall be vertical with a tolerance not exceeding 6 mm in a length of 3 meter. The railing barrier shall be erected true to line and grade.

5.0 Measurement for payment :

- 5.1 "Thrie" Metal beam crash barrier will be measured and paid by **liner meter** of completed length as per plans and accepted in place.

- 5.2 No measurement for payment shall be made for excavation, back filling with concrete etc. performed in connection with this construction.

- 5.3 The contract unit rate shall include full compensation for furnishing of labour, material, tools, equipment's works involved in constructing the "THRIE" Metal beam crash barrier complete in place in all respect as per these specification.

Item No. 41 :: Gabian Structure for Retaining Earth (Providing and construction of a gabain structure for retaining earth with segments of wire crates of size 7 m x 3 m x 0.6 m each divided into 1.5 m compartments by cross netting, made from 4 mm galvanised steel wire @ 32 kg per 10 sqm having minimum tensile strength of 300 Mpa conforming to IS:280 and galvanizing coating conforming to IS:4826, woven into mesh with double twist, mesh size not exceeding 100 x 100 mm, filled with boulders with least dimension of 200 mm, all loose ends to be tied with 4 mm galvanised steel wire).

1.0 Description

This work shall consist of furnishing, assembling, and filling mechanically woven double twist hexagonal wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are mainly in accordance with International Standards EN 10223 & EN 10244.

2.0 Material

2.1 Mechanically Woven Wire Mesh Gabions

2.1.1 Wire

All tests on the mesh wire, lacing wire and selvedge wire must be performed prior to manufacturing the mesh.

Tensile strength: The wire used for the manufacture of mesh shall have a tensile strength minimum 380-550 N/mm² in accordance with EN 10223-3.

Elongation: Elongation shall not be less than 10%, in accordance with EN 10223-3. Test must be carried out on a sample at least 25 cm long.

2.1.2 Galmac Coating: Minimum quantities of Galmac (Zn 90% + 10% Al) shown at Table 2 should meet the requirements of EN 10244-2 (Table 2 and Class A).

2.1.2.1 Adhesion of Galmac coating: The adhesion of the Galmaccoating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers in accordance with EN 10244.

2.1.3 PVC (Polyvinyl Chloride) Coating

The technical characteristics and the resistance of the PVC to ageing shall meet the relevant standards. All tests on the PVC must be performed prior to manufacturing the mesh

PVC coating thickness: Nominal – 0.5 mm, Minimum – 0.38 mm;

Specific weight: 1.3 kg/dm³ – 1.35 kg/dm³ in accordance with ISO 1183.

Hardness: between 50 and 60 Shore D, according to ISO 868.

Tensile strength: Higher than 21 MPa, according to ISO 527

Elongation at break : Not less than 200% in accordance with ISO 527.

UV Stabilized

2.1.4 Galmac + PVC coated Wire Mesh dimensions

Mesh Wire: Diameter – Inner diameter shall be 3.0mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4mm. **ID/OD 3.0/4.0mm.**

Selvedge Wire: Diameter –Inner diameter shall be 3.4mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4.4mm. **ID/OD 3.4/4.4 mm.**

Mesh Opening: Nominal Dimension D =100mm, as per Fig. 2.

2.1.5 Lacing wire and internal stiffeners for gabions

Lacing wire: Diameter – Inner diameter shall be 2.2mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 3.2 mm. **ID/OD 2.2/3.2mm**

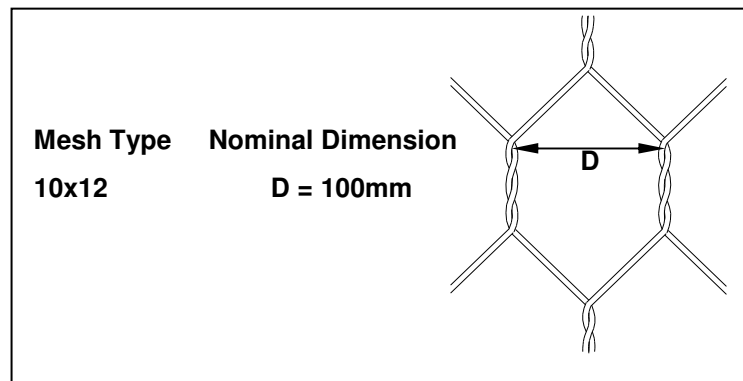
Stiffener wire: Diameter -Inner diameter shall be 3.0mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4.0mm. **ID/OD 3.0/4.0 mm**

Table 1: Wire mesh (10x12 mesh type):

Mesh type	“D”(mm)	Galmac+PVC coated		
		Diameter of wire (Inner/Outer wire)		
		Mesh wire(mm)	Selvedge wire (mm)	Lacing wire(mm)
10X12	100mm	3.0/4.0	3.4/4.4	2.2/3.2

Tolerances in Mesh Opening size “D”: - 4% and +16%

Figure 2-Mesh Type



2.1.6 Tolerances

Wire: Wire diameter tolerance and minimum Galmac coating requirement is given in the following table 2. Wire tolerances (Table 2) shall be in accordance with EN 10218-2.

Gabions: $\pm 5\%$ in all dimensions (length, breadth and height) shall be allowed as tolerance for Gabion units.

Mesh opening: Tolerances on the hexagonal, double twisted wire mesh, opening shall not exceed -4% to $+16\%$ on the nominal dimension D values (see Fig.2).

Table 2-Standard Mesh wire Properties

<i>Internal Wire Dia mm</i>	<i>2.2</i>	<i>2.7</i>	<i>3.0/4.0</i>
<i>Wire Tolerance(\pm)mm</i>	<i>0.06</i>	<i>0.06</i>	<i>0.07</i>
<i>Minimum Qty of Galmac(gm/m²)</i>	<i>230</i>	<i>245</i>	<i>265</i>

2.1.7 Standard Sizes

Standard sizes (Length x Breadth x Height) of gabions are 4m x 1m x 1m, 3m x 1m x 1m, 2m x 1m x 1m, 1.5m x 1m x 1m, 4m x 1m x 0.5m, 3m x 1m x 0.5m and 2m x 1m x 0.5m.

2.2 Fabrication

Gabions shall be manufactured with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. The lid may be a separate piece made of the same type mesh as the basket. All perimeter edges of the mesh forming the basket and top, or lid, shall be mechanically selvage with wire having a larger diameter.

Gabion is divided into cells by means of diaphragms positioned at approximately 1m centres. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

Table 3 - Typical Gabion sizes (10 x 12 -mesh type)

Length, m	Width, m	Height, m	Number of Diaphragms
4.0	1.0	1.0	3
3.0	1.0	1.0	2
2.0	1.0	1.0	1
1.5	1.0	1.0	0
4.0	1.0	0.5	3
3.0	1.0	0.5	2
2.0	1.0	0.5	1

2.3 Rock

The rock for gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 0.15 m and 0.25 m. The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface. The size shall be such that a minimum of three layers of rock must be achieved when filling the gabions of 1m thick. The stone for filling the gabion shall weigh 30 to 50 kg.

3 Construction Requirements

Gabion filling and lacing and erection at site should be strictly as per the instruction of approved (by engineer) manufacturer's instructions as per the site specific requirements. The manufacturer should satisfy the eligibility criteria outlined in Clause 7.

3.1 Assembly

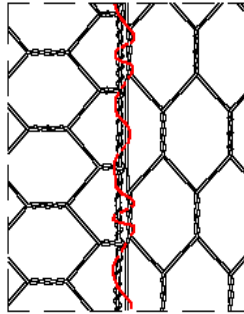
Gabions are supplied folded flat and packed in bundles. Larger units may be supplied in rolls. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are satisfactorily aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire as described in Section 2.1.5.

The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting the lacing wire to the wire mesh (Figure 3). Proceed to lace

with alternating double and single loops through every mesh opening, pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting.

Figure 3

Lacing wire



3.2 Installation

After initial assembly, the gabions are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Section 3.1. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 3.1.

3.3 Filling

Gabions shall be filled with rock as specified in Section 2.3. During the filling operation some manual stone placement is required to minimize voids. The exposed faces of vertical structures may be carefully hand placed to give a neat, flat, and compact appearance.

The cells shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding (0.30 m) higher than the adjoining cell. It is also recommended to slightly overfill the baskets to allow for settlement of the rock. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions.

3.3.1 1m High Gabions

1meter high gabions shall be filled in three layers, 300 mm at a time. Connecting wires shall be installed after the placement of each layer, that is, at 300 mm high.

3.3.2 0.5m High Gabions

0.5 meter high gabions do not require connecting wires unless the baskets are used to build vertical structures. In some cases, these units shall be filled in two layers 250mm at a time. Connecting wires shall be installed after the placement of the first layer, which is at 250mm high.

3.4 Internal Connecting Wires

Internal connecting wires should be used when a structure requires layers of gabions to be stacked on top of each other. Internal Connecting Wires shall connect the exposed face of a cell to the opposite side of the cell. An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed. Lacing wire or prefabricated internal connecting wires may be used.

3.5 Lid Closing

Once the gabion baskets are completely full, the lids will be pulled tight until the lid meets the perimeter edges of the basket. The lid must then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in Section 3.1.

3.6 Mesh cutting and folding

Where shown on the drawings or otherwise directed by the engineer, the gabions shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

3.7 Filling of Gabion with Rubble with use of planks or boats or barge in deep water near and surrounding pier location

4.0 Method of Measurement

The payment quantities for excavation shall be determined by the outside limits of the gabion structure. Quantities will be determined from cross sections and the linear distance, and paid for under the appropriate bid items. **The rate include the charges of boats, planks or barge for transporting gabions with filling of Rubble.**

The quantity to be paid for “In place gabions” shall be the **cubic meter of gabions of irrespective sizes**. Project conditions and material availability will determine the actual size of gabions to be used.

Excavated material beyond the limits of the gabions shall be backfilled with gravel, crushed rock or other material approved by the engineer.

5.0 Basis of Payment

Accepted gabions will be paid for at the unit price for each pay item included in the contract.

6.0 Testing and Acceptance criteria

The material should get approval from the client before the actual supply start. The manufacturer of the Gabion facing unit should provide “Manufacturers Test Certificate’ and Quality Conformity Certificate for the material with every lot/shipment. Tensile strength test and zinc coating test on basic wire shall be done on one sample per every **5000** numbers of units supplied.

6.1 PVC Coating Thickness: The thickness of the PVC coating shall be determined on a randomly chosen individual piece of wire removed from the coil at 3 places 1 metre apart.

Measure with a micrometer the diameter of the galvanized steel wire with PVC coating. Determine the thickness of the PVC coating by stripping the PVC coating from the wire and measure the reduced diameter with a micrometer. The thickness of the coating is the difference between the diameter of the galvanized steel wire with PVC coating and the measured diameter of the galvanized steel wire divided by two. The thickness values should be as per clause 2.1.3. While removing the PVC coating by stripping, take care not to remove any of the metallic surface.

6.2 PVC Coating – Resistance to Sodium chloride solution:

Apparatus: Chamber or room where the temperature is between 5oC and 30oC, Weighing balance accurate to within 0.1 mg, Test tube.

Reagents – Saturated Sodium Chloride solution

Preparation of test specimen – Bend a 200 mm long piece of PVC coated wire into a U – shaped that it can fit in to the test tube.

Procedure – Weigh the test specimen and put it in the test tube. Fill the test tube with the sodium chloride solution such that the ends are 5 mm above the solution. After at least 60 hours remove the test specimen from the solution, wash it, dry it and reweigh it. There shall be no loss of mass.

7.0 Eligibility of Manufacturer

The flow chart of quality procedures adopted in the plant should be submitted to the client for getting the source approval.

Manufacturer shall have experience in supplying, designing and providing Technical support for Gabions for Retaining earth / Scour Protection / Erosion Control. The manufacturer shall have in-house design facilities to provide site specific design. They shall also give the required technical assistance at site. The manufacturer shall produce an authentic documentary evidence to prove minimum 5 year experience for supplying, designing and providing technical assistance at site for Retaining Wall works for a minimum quantity of 5,000 Cum.

Item No. 42 :: Gabian Structure for Erosion Control, River Training Works and Protection works (Providing and constructing gabain structures for erosion control, river training works and protection works with wire crates of size 2 m x 1 m x 0.3 m each divided into 1m compartments by cross netting, made from 4 mm galvanised steel wire @ 32 kg per 10 sqm having minimum tensile strength of 300 Mpa conforming to IS:280 and galvanizing coating conforming to IS:4826, woven into mesh with double twist, mesh size not exceeding 100 mm x 100 mm, filled with boulders with least dimension of 200 mm, all loose ends to be securely tied with 4 mm galvanised steel wire.)

3.0 Description

This work shall consist of furnishing, assembling, and filling mechanically woven double twist hexagonal wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are mainly in accordance with International Standards EN 10223 & EN 10244.

4.0 Material

4.1 Mechanically Woven Wire Mesh Gabions

2.1.1 Wire

All tests on the mesh wire, lacing wire and selvedge wire must be performed prior to manufacturing the mesh.

Tensile strength: The wire used for the manufacture of mesh shall have a tensile strength minimum 380-550 N/mm² in accordance with EN 10223-3.

Elongation: Elongation shall not be less than 10%, in accordance with EN 10223-3. Test must be carried out on a sample at least 25 cm long.

2.1.3 Galmac Coating: Minimum quantities of Galmac (Zn 90% + 10% Al) shown at Table 2 should meet the requirements of EN 10244-2 (Table 2 and Class A).

2.1.3.1 Adhesion of Galmac coating: The adhesion of the Galmaccoating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers in accordance with EN 10244.

2.1.3 PVC (Polyvinyl Chloride) Coating

The technical characteristics and the resistance of the PVC to ageing shall meet the relevant standards. All tests on the PVC must be performed prior to manufacturing the mesh

PVC coating thickness: Nominal – 0.5 mm, Minimum – 0.38 mm;

Specific weight: 1.3 kg/dm³ – 1.35 kg/dm³ in accordance with ISO 1183.

Hardness: between 50 and 60 Shore D, according to ISO 868.

Tensile strength: Higher than 21 MPa, according to ISO 527

Elongation at break : Not less than 200% in accordance with ISO 527.

UV Stabilized

2.1.4 Galmac + PVC coated Wire Mesh dimensions

Mesh Wire: Diameter – Inner diameter shall be 3.0mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4mm. **ID/OD 3.0/4.0mm.**

Selvedge Wire: Diameter –Inner diameter shall be 3.4mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4.4mm. **ID/OD 3.4/4.4 mm.**

Mesh Opening: Nominal Dimension D =100mm, as per Fig. 2.

2.1.5 Lacing wire and internal stiffeners for gabions

Lacing wire: Diameter – Inner diameter shall be 2.2mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 3.2 mm. **ID/OD 2.2/3.2mm**

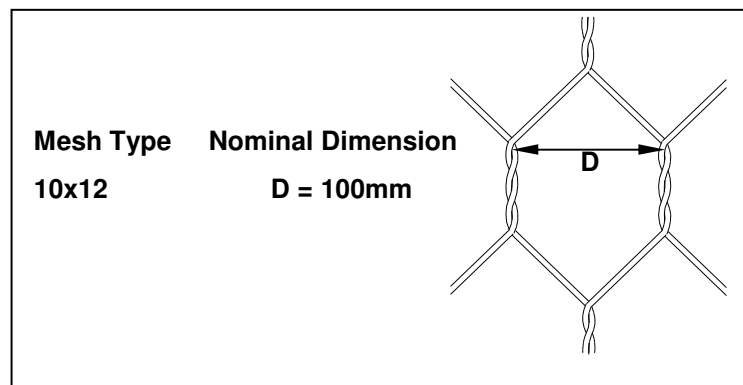
Stiffener wire: Diameter -Inner diameter shall be 3.0mm for the Galmac coated wire and when measured with PVC coating the outer diameter shall be 4.0mm. **ID/OD 3.0/4.0 mm**

Table 1: Wire mesh (10x12 mesh type):

Mesh type	“D”(mm)	Galmac+PVC coated		
		Diameter of wire (Inner/Outer wire)		
		Mesh wire(mm)	Selvedge wire (mm)	Lacing wire(mm)
10X12	100mm	3.0/4.0	3.4/4.4	2.2/3.2

Tolerances in Mesh Opening size “D”: - 4% and +16%

Figure 2-Mesh Type



2.1.6 Tolerances

Wire: Wire diameter tolerance and minimum Galmac coating requirement is given in the following table 2. Wire tolerances (Table 2) shall be in accordance with EN 10218-2.

Gabions: $\pm 5\%$ in all dimensions (length, breadth and height) shall be allowed as tolerance for Gabion units.

Mesh opening: Tolerances on the hexagonal, double twisted wire mesh, opening shall not exceed -4% to $+16\%$ on the nominal dimension D values (see Fig.2).

Table 2-Standard Mesh wire Properties

<i>Internal Wire Dia mm</i>	<i>2.2</i>	<i>2.7</i>	<i>3.0/4.0</i>
<i>Wire Tolerance(\pm)mm</i>	<i>0.06</i>	<i>0.06</i>	<i>0.07</i>
<i>Minimum Qty of Galmac(gm/m²)</i>	<i>230</i>	<i>245</i>	<i>265</i>

2.1.7 Standard Sizes

Standard sizes (Length x Breadth x Height) of gabions are 4mx1mx1m, 3mx1mx1m, 2mx1mx1m, 1.5mx1mx1m, 4mx1mx0.5m, 3mx1mx0.5m and 2mx1mx0.5m.

2.2 Fabrication

Gabions shall be manufactured with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. The lid may be a separate piece made of the same type mesh as the basket. All perimeter edges of the mesh forming the basket and top, or lid, shall be mechanically selvedge with wire having a larger diameter.

Gabion is divided into cells by means of diaphragms positioned at approximately 1m centres. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

Table 3 - Typical Gabion sizes (10 X 12 -mesh type)

Length, m	Width, m	Height, m	Number of Diaphragms
4.0	1.0	1.0	3
3.0	1.0	1.0	2
2.0	1.0	1.0	1

1.5	1.0	1.0	0
4.0	1.0	0.5	3
3.0	1.0	0.5	2
2.0	1.0	0.5	1

2.3 Rock

The rock for gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 0.15 m and 0.25 m. The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface. The size shall be such that a minimum of three layers of rock must be achieved when filling the gabions of 1m thick. The stone for filling the gabion shall weigh 30 to 50 kg.

3 Construction Requirements

Gabion filling and lacing and erection at site should be strictly as per the instruction of approved (by engineer) manufacturer's instructions as per the site specific requirements. The manufacturer should satisfy the eligibility criteria outlined in Clause 7.

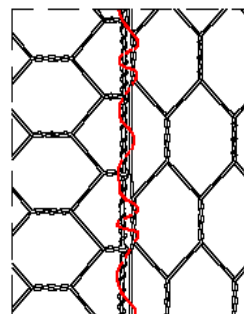
3.1 Assembly

Gabions are supplied folded flat and packed in bundles. Larger units may be supplied in rolls. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are satisfactorily aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire as described in Section 2.1.5.

The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting the lacing wire to the wire mesh (Figure 3). Proceed to lace with alternating double and single loops through every mesh opening, pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting.

Lacing wire

Figure 3



3.2 Installation

After initial assembly, the gabions are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Section 3.1. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 3.1.

3.3 Filling

Gabions shall be filled with rock as specified in Section 2.3. During the filling operation some manual stone placement is required to minimize voids. The exposed faces of vertical structures may be carefully hand placed to give a neat, flat, and compact appearance.

The cells shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding (0.30 m) higher than the adjoining cell. It is also recommended to slightly overfill the baskets to allow for settlement of the rock. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions.

3.3.1 1m High Gabions

1meter high gabions shall be filled in three layers, 300 mm at a time. Connecting wires shall be installed after the placement of each layer, that is, at 300 mm high.

3.3.2 0.5m High Gabions

0.5 meter high gabions do not require connecting wires unless the baskets are used to build vertical structures. In some cases, these units shall be filled in two layers 250mm at a time. Connecting wires shall be installed after the placement of the first layer, which is at 250mm high.

3.4 Internal Connecting Wires

Internal connecting wires should be used when a structure requires layers of gabions to be stacked on top of each other. Internal Connecting Wires shall connect the exposed face of a cell to the opposite side of the cell. An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed. Lacing wire or prefabricated internal connecting wires may be used.

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3.6 Mesh cutting and folding

Where shown on the drawings or otherwise directed by the engineer, the gabions shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

3.7 Filling of Gabion with Rubble with use of planks or boats or barge in deep water near and surrounding pier location

4.0 Method of Measurement

The payment quantities for excavation shall be determined by the outside limits of the gabion structure. Quantities will be determined from cross sections and the linear distance, and paid for under the appropriate bid items. **The rate includes the charges of boats, planks or barge for transporting gabions with filling of Rubble.**

The quantity to be paid for “In place gabions” shall be the **cubic meter of gabions of irrespective sizes**. Project conditions and material availability will determine the actual size of gabions to be used.

Excavated material beyond the limits of the gabions shall be backfilled with gravel, crushed rock or other material approved by the engineer.

5.0 Basis of Payment

Accepted gabions will be paid for at the unit price for each pay item included in the contract.

6.0 Testing and Acceptance criteria

The material should get approval from the client before the actual supply start. The manufacturer of the Gabion facing unit should provide “Manufacturers Test Certificate”

and Quality Conformity Certificate for the material with every lot/shipment. Tensile strength test and zinc coating test on basic wire shall be done on one sample per every 5000 numbers of units supplied.

6.1 PVC Coating Thickness: The thickness of the PVC coating shall be determined on a randomly chosen individual piece of wire removed from the coil at 3 places 1 metre apart.

Measure with a micrometer the diameter of the galvanized steel wire with PVC coating. Determine the thickness of the PVC coating by stripping the PVC coating from the wire and measure the reduced diameter with a micrometer. The thickness of the coating is the difference between the diameter of the galvanized steel wire with PVC coating and the measured diameter of the galvanized steel wire divided by two. The thickness values should be as per clause 2.1.3. While removing the PVC coating by stripping, take care not to remove any of the metallic surface.

6.2 PVC Coating – Resistance to Sodium chloride solution:

Apparatus: Chamber or room where the temperature is between 5oC and 30oC, Weighing balance accurate to within 0.1 mg, Test tube.

Reagents – Saturated Sodium Chloride solution

Preparation of test specimen – Bend a 200 mm long piece of PVC coated wire into a U – shaped that it can fit in to the test tube.

Procedure – Weigh the test specimen and put it in the test tube. Fill the test tube with the sodium chloride solution such that the ends are 5 mm above the solution. After at least 60 hours remove the test specimen from the solution, wash it, dry it and reweigh it. There shall be no loss of mass.

7.0 Eligibility of Manufacturer

The flow chart of quality procedures adopted in the plant should be submitted to the client for getting the source approval.

Manufacturer shall have experience in supplying, designing and providing Technical support for Gabions for Retaining walls / Scour Protection / Erosion Control. The manufacturer shall have in-house design facilities to provide site specific design. They shall also give the required technical assistance at site. The manufacturer shall produce an authentic documentary evidence to prove minimum 5 year experience for supplying, designing and providing technical assistance at site for Retaining Wall works for a minimum quantity of 5,000 Cum.

Item No. 43 :: Grouting with C.M. 1:4 in Pitching as per drawing or as per instruction of Engineer In Charge.

1.0 MATERIAL

The non shrink grout and Acrylic Polymer putty shall be of good quality & make and as approved by the Engineer in charge.

The sample shall have to be approved by the Engineer in charge before execution on site.

2.0 Workmanship

The grouting with C.M. 1:4 in pitching as per drawing or as per instruction of Engineer in charge.

The crack shall be made dust free by blowing compressed air and then washing with water.

The cracked surface shall be washed and saturated with water by pumping from top most pitching and downwards complete as per the instructions and directed by the Engineer in charge.

The grouting shall be done as directed and as per the approved design and drawings supplied by the Engineer in charge.

3.0. Mode of measurements and payment

3.1. The rate shall include all material, labour and all operations above etc. required for satisfactory completion of this item.

Quantity of grout material for payment purpose shall be taken on the basis of actual quantity consumed. (rates are excluding injection grouting material).

3.2. The rate shall be for a unit of **Cum.**

Item No. 44 :: Jacketing : - Providing and casting in situ design mix concrete M.25 mix for 23 cm thick jacketing consisting 16 mm dia 200mm c/c both ways , 16 dia pin @ 400mm c/c vertically & 800mm c/c horizontally with base supported with 300 x 450 mm beam reinforced with main 6 No. 16 mm dia. bar and stirrups 8 mm dia. 150 mm c/c etc. complete including drilling holes in the pier, providing steel bars for connecting existing pier to jacketing and filling the holes with rich mortar including shuttering, scaffolding wherever necessary, laying, vibrating curing and finishing etc. complete.

1.0 MATERIAL

- 1.1.** Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Grit shall conform to M-8. Coarse aggregate shall conform M-12.

2.0 Workmanship

The lapping or welding of the existing reinforcement shall be done as per site condition and as per structural engineer's guide line.

The jacketing shall be of existing piers and abutments with 23 cm thick layer of concrete with M-25 concrete including shuttering, scaffolding, vibrating, curing and reinforcement as directed by the Engineer in charge.

The jacketing shall be done as directed and as per the approved design and detailed drawings including drilling holes in the pier, providing steel TMT Fe-500D bars for connecting existing pier to jacketing and filling the holes with rich mortar as directed by the Engineer in charge.

3.0. Mode of measurements and payment

- 3.1.** The rate includes cost of all materials, tools etc. required for satisfactory completion of this item but excluding of labour cost and steel reinforcement.
- 3.2.** The rate shall be for a unit of **one square meter.**

Item No. 45 :: Epoxy bonding of new concrete to old concrete.

Epoxy Bonding coat of approved adhesive on chipped portion of RCC of approved quality & standard make shall be applied new concrete to old concrete and as direction of engineer in charge etc. complete.

Providing and applying single component, SBR Polymer @ 10% of cement weight, modified cementitious bond coat @ 2.2 kg cement per sqm of surface area mixed with specific proportion of approved polymer with SBR in 2 or 3 or 4 layers upto 50mm overall thickness or as directed, after applying bonding coat if required as per manufacturer's specification, before the bonding agent becomes tack free, initially by hand and finally finishing the same with trowel carefully compacting the same around the rebar and finishing to bring it in line with existing concrete surface on the columns, slabs, beam etc. where the thickness of application is less than 50 mm in patches as per specification. wherever total thickness of repair is exceeding 50 mm, use of 10/ 6 mm down size aggregate may be required or as per manufacturer's specification or as directed by engineer in charge. Item rate is inclusive of materials all labour, tools and tackles, scaffolding and transportation etc. complete as per specification and as directed by Engineer in-charge.

➤ **Methodology :-**

Repairing Damaged Portion with Repair Mortarfortified with SBR.

Procedure and application

Fresh mortar shall be applied while the epoxy bond coat is still tacky and well within setting period. If adhesive cured to the extent of loosing its tack or has set before mortar is applied. The same shall be removed or slightly abraded and another coat of bond coat shall to be applied by the contractor at his own cost. Freshly placed mortar shall be thoroughly consolidated to ensure full bonding of the fresh mortar with the parent concrete. If there is a failure of bond of fresh mortar / plaster with parent concrete surface and it sounds hollow on tapping, the repair work shall be dismantled and redone by the contractor at his own cost and to the entire satisfaction of the Engineer-in-charge and as per instructions of Engineer in charge.

➤ **Mode of Measurement & Payment:**

Quantity of SBR actually consumed shall be measured for payment purpose and as directed by engineer in charge.

1. The measurement shall be in Sq.mt.
2. The rate includes all materials, labour, equipment, plant, transportation, scaffolding etc. to execute this item.

Item No. 46 :: Guniting concrete surface with cement mortar applied with compressor after cleaning surface and spraying with epoxy complete as per Technical specification

2807.1. The gunite is a mixture of cement, sand and water. It comprises 100 parts by weight of cement, 300 parts by weight quartz sand, 35-50 parts by weight water and 2 parts by weight approved quick setting compound. In general, dry mix shotcrete shall be used.

2807.2. Ordinary portland cement conforming to IS:269 shall be used in guniting.

2807.3. Sand for guniting shall comply with the requirements stipulated in IS: 383. In general, sand should neither be too coarse to increase the rebound nor too fine to increase the slump. Sand should preferably have a moisture content between 3 to 6 per cent.

The grading of sand shall lie within the limits given below :

IS sieve designation	Percent passing the sieve
4.75 mm	95-100
2.36 mm	65-90
1.18 mm	45-75
600 microns	30-50
300 microns	10-22
150 microns	2-8

2807.4. For thick sections it may be advantageous to incorporate coarse aggregate in the mix provided guniting equipment is available. Coarse aggregate, when used, shall conform to grading given in Table I of IS: 9012. The percentage of coarse aggregate may normally be kept as 20 to 40 per cent of the total aggregate and the mix shall be suitably designed.

2807.5. Water/cement ratio for guniting shall fall within the range 0.35 to 0.50 by mass, wet enough to reduce the rebound. Drying shrinkage may be between 0.06 per cent to 0.10 per cent. The quick setting compound shall be added at the nozzle with water just before guniting.

2807.6. Workmanship

The cement and sand shall be batched and mixed and conveyed through a hose pipe with the help of compressed air. A separate line shall bring the water under pressure. The cement, sand and water mix shall be passed through and intimately mixed in a special manifold and then projected at high velocity to the surface being repaired. The density of gunite shall not be less than 2000 kg/cu. m. The strength of gunite shall not be less than 25 MPa. For effective guniting, the nozzle shall be kept 60 to 150 cm away from the surface, preferably normal to that surface. While enclosing reinforcement bars during repairs the nozzle shall be held closer at a slight angle and the mix shall be wetter than the normal.

2807.7. Test panels simulating actual field conditions shall be fabricated for conducting pre-construction testing. The procedure for testing the cubes or cylinders taken from the panels stipulated in Clause 6 of IS : 9012 shall be followed.

2807.8. It should be ensured from tests that a strength of about 25 MPa at 28 days is available for the mortar/concrete mix.

2807.9. The defective concrete shall be cut out to the full depth till sound concrete surface is reached. Under no circumstances should the thickness of concrete to be removed be less than clear cover to the main reinforcement. No square shoulders shall be left at the perimeter of the cut-off portion and all edges shall be tapered. Thereafter, all loose and foreign materials should be removed and the surface be sand-blasted to make it rough to receive shotcrete after applying a coat of bonding epoxy as per recommendation of the manufacturer @ 1.0 kg per 1.5 sq. m. of surface area.

2807.10. The exposed reinforcement shall be thoroughly cleaned free of rust, scales etc. by wire brushing. Wherever the reinforcements have been corroded, the same shall be removed and replaced by additional reinforcement. Before application of gunite, a coat of neat cement slurry should be applied on the surface of the reinforcement.

2807.11. Sufficient clearance shall be provided around the reinforcement to permit encasement with sound gunite. Care shall be taken to avoid sand pockets behind the reinforcement.

2807.12. A thickness of 25 to 40 mm of gunite can normally be deposited in one operation. If, for some reason, the total thickness is to be built up in successive operations, the previous layer should be allowed to set but not become hard before the application of the subsequent layer. It would always be necessary to apply guniting on a damp concrete surface.

2807.13. Where required, welded wire fabrics 5 cm x 5 cm x No. 10 gauge shall be provided in the first layer of guniting. The fabric shall be tied properly. In case the damage to the concrete member is too deep, the specifications for guniting as well as requirement of placement of wire mesh has to be decided as per field conditions.

2807.14. The stipulations given in IS: 9012 regarding application of gunite should be followed so as to keep the rebound to the minimum. The quality of guniting and workmanship shall be such that the percentage of rebound mentioned in IS: 9012 can be adhered to. In no circumstances shall the rebound material re-used in the work.

2807.15. It would be desirable that green gunite is moistened for at least 7 days. Guniting work shall not be done during windy or rainy conditions.

2811. TESTS AND STANDARDS FOR ACCEPTANCE

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

2812. MEASUREMENT FOR PAYMENT

a) Measurement for guniting / shotcreting and epoxy mortar shall be per **square metre** of surface area of application.

2813. RATE

The contract unit rate for guniting /shotcreting including epoxy required shall include cost of all materials, labour, tools and plant, placing in position, testing, curing, surface preparation and other incidental expenses including the provision of nipples for the satisfactory completion of the work as per these specifications.

Item No. 47 :: Providing and inserting nipples with approved fixing compound after drilling holes for grouting as per Technical specifications including subsequent cutting/removal and sealing of the hole as necessary of nipples after completion of grouting with Cement/Epoxy.

Scope: The clause of the specification covers the sealing of grout through nipples.

Material: The nipple should be of 12mm dia of approved quality.

Process: The nipple should be fixed in concrete with approved cement, fixing compound and consumables. The drilling should be made in proper manner for fixing the nipples.

Mode of measurement: The measurement shall be made for in “**Each**”

Rates : -

The rate includes the charges of centering, scaffolding, labour charges for hammering and chiseling etc. complete. The work shall be carried out as per instruction of Engineer in charge

Item No. 48 :: Sealing of crack / porous concrete with Epoxy Grout by injection through nipples complete as per clause 2803.1.

2803. SEALING OF CRACKS BY INJECTION OF EPOXY GROUT

General

The work of epoxy adhesive utilising the structural concrete bonding process shall conform to these specifications.

The Contractor shall furnish detailed methodology of construction including sources of supply of material, tools, equipment and appliances to be used on work, details of personnel and supervision.

Personnel

The Contractor's personnel shall be qualified and experienced in epoxy injection process.

Material

The material for injection shall be suitable two-component low viscosity epoxy resin, having the required characteristics of bonding with concrete and resistance to moisture penetration. Epoxy mortar or polysulphide resin may be used for sealing the surface.

The material for epoxy injection shall conform to the following :

- 1) The mixing ratio of resin and hardener shall generally be between 1 to 1 and 2 to 1 by volume subject to manufacturer's recommendations.
- 2) Neither the mixed epoxy adhesives nor their individual components shall contain solvents and thinners.
- 3) The components shall be free of lumps or foreign material. The viscosity of the individual components shall not change more than ± 15 per cent when kept in closed containers at 25 degrees Celsius after two weeks.

4) Consistency requirement

	Standard Version cps	Low Viscosity Version cps
Viscosity of mixed adhesive at 25 degrees Celsius	(200 – 300)	(100 – 190)
5) Pot life of mixed adhesive at 25 degrees Celsius	1 hour \pm 15 minutes*	
6) Set time of mixed adhesive	3 to 6 hours	

at 25 degrees Celsius	
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* In the case of two component injection system where resin and hardener get mixed at point of injection pot life at 25 degrees Celsius shall be not greater than 15 min \pm 10 minutes.

Equipment for Injection

The equipment shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at nozzle. The pumps shall be generally electrically powered and shall provide in-line metering and mixing. The tolerance on mix ratio shall be 5 per cent by volume. The injection equipment shall have automatic pressure control capable of discharging mixed adhesive at any pre-set pressure within the prescribed limits and shall be additionally equipped with a manual pressure control.

The injection equipment with sensors on both the components A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

If considered appropriate, suitable compressed air operated epoxy injection gun can be used with prior approval of the Engineer for manual injection of mix when resin and hardener had been mixed in a separate unit.

Preparation

Surfaces adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil efflorescence or other foreign matter by brushing /water jetting /sand blasting. Acids and corrosives shall not be permitted for cleaning.

Entry ports shall be provided along the crack at intervals of not more than the thickness of concrete at the location.

Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces.

Before proceeding with the injection, the surface seal material must gain adequate strength with respect to concrete of the member/injection pressure.

Epoxy injection

Injection of epoxy adhesive shall begin at lowest entry port and continue until there is an appearance of epoxy adhesive at the next entry port adjacent to the entry port being pumped.

When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped and entry port shall be sealed. Thereafter, epoxy injection shall be transferred to next adjacent port where epoxy adhesive has appeared.

Epoxy adhesive injection shall be performed continuously until cracks are completely filled.

If port to port travel of epoxy adhesive is not indicated, the work shall immediately be stopped. In case the volume of the injected material exceeds 2 litres for a particular entry port, the work shall be stopped and the specifications may be reviewed.

Precautions for Application

- a) Unless otherwise specified, components A and B, i.e., resin and hardener shall be at a temperature between 10 degrees Celsius and 35 degrees Celsius at the time of mixing.
- b) Temperature of structural member during epoxy injection shall be between 10 degrees Celsius and 35 degrees Celsius unless otherwise specified.
- c) Immediately prior to use, each component shall be thoroughly mixed with a clean paddle. The paddle shall be of a type that does not induce air into the material. Separate clean paddle must be used for each component.
- d) Any heating of the adhesive components shall be done by application of indirect heat in case the work is to be done in cold climate.
- e) Just before use, the two components shall be thoroughly mixed in the ratios specified by the manufacturer. The length of mixing time shall be in strict accordance with manufacturer's recommendations. When mixed, all adhesives with different coloured components shall have a uniform colour without streaks.
- f) The use of solvents and thinners will not be permitted except for cleaning of equipment.

Measurement for Payment :-

- The contract unit rate for sealing of cracks and injection of cement grout shall include cost of all materials, labour, tools and plant, placing in position, testing, curing, scaffolding and other incidental expenses for the satisfactory completion of the work as per this specification.

Measurement for sealing of cracks and injection shall be made by weight of epoxy consumed in **Kg.** epoxy grouting.

Item No. 49 :: Chipping & removing the debonded/ delaminated/ loose/ disintegrated concrete at the places and in the manner and upto the depth and in regular shape as advised by the Engineer in charge without damaging the reinforcement/ RCC with the help of chisel and light hammering or equivalent equipments. Cleaning the surface with wire brushes making the surface free from dust, oil and all impurities etc. as directed by Engineer Incharge.

(Actual consumed bag shall be measured for payment.)

Patch repair to damaged concrete up to average 50 mm depth (by using ready to use patch repair mortar of best standard approved brand as per data sheet) and as per the work methodology and specifications & cost of all material, labour, machinery, equipment, taking necessary safety measures for all floors as directed and approved by EIC.

General

This specification covers the repair of leached, honey combed and spalled concrete and patched sports of existing concrete by polymer modified cementitious (PMC mortar / concrete).

Materials

Portland cement conforming to IS:8112 shall be used for production of PMC mortar. Prepackaged repair mortar of equivalent quality of any brand may be used if approved by the Engineer in charge.

➤ **Mortar Modifier :**

Mortar modifier shall be Nitobond SBR of Fosroc or approved equivalent. The mortar modifier shall be styrene butadiene emulsion specially designed for use as a gauging liquid for cementitious 1:3 (1 cement : 3 sand) mortar by minimum 80% and flexural strength should be improved by minimum 15%. The mechanical properties of typical 1:3 (1 cement : 3 sand) mortar shall be tested as per BS-6319 at 28 days air cured.

➤ **Sand :**

The sand to be used for making the PMC mortar shall be of Zone-II as per IS-383. The sand to be used must satisfy the limits of deleterious materials and requirements of soundness as given in Clause 3.2.1 and clause 3.6 of IS:383. Confirmation tests shall be conducted by the contractor and sample of approved sand deposited with the Engineer in charge. For consistent performance the use of clean and dry sand is essential. Where wet sand is to be used for any reason, moisture content for sand shall be determined at site laboratory and mixing water quantity shall be adjusted accordingly.

➤ **Reinforcement Primer :**

The primer shall be Nitozinc primer a two pack zinc rich liquid packed and supplied and ready to use. An unbroken 40 microns thick coating shall be capable of providing "active" galvanic protection and of avoiding the generation of incipient anodes in the immediately adjacent locations. It

shall be a suitable viscosity to enable the coating to penetrate imperfections and pits within surface of corrosion damaged steel bars. The formulation of primer shall be such that drying proceeds after 20 to 40 minutes at 35 degree C or after 30 minutes to one coat at 20 degree C. The primer should conform to the requirement of BS-4652:1971.

Reinforcement

All exposed reinforcement shall be cleaned in accordance with the following :

- a. Where exposed reinforcement is sound and does not show any signs of heavy corrosion or pitting other than typical rusting, it shall be mechanically cleaned to remove rust and loose mill-scales. It is always preferable to clean the steel to a bright condition.
- b. Where exposed reinforcement shows signs of heavy corrosion / deterioration it shall be cleaned by sand blasting or by proprietary rust removing compound if permitted by Engineer-in-charge and then treated as given in subsequent para of this specification.

➤ **Constructions for PMC Material System**

➤ **Primer slurry**

PMC repair mortar

Cement	:	50 Kg.
Nitobond SBR	:	5.0 Liters
Zone II sand	:	150 Kg.
W/C Ratio	:	0.35

➤ **Mixing of materials**

The mixing of materials in proportions indicated above shall be carried out using forced action mixer or with slow speed drive mixer (400-500 rpm) fitted with a spiral paddle. Remixing and re-tempering shall not be permitted. The mix ready to use mortar shall not contain lumps of any type and shall be uniform in colour. In order to obtain a smooth consistency the cement should be blended slowly into the liquids. Stir frequently during use to offset settlement.

Removing debonded / delaminated / loose / disintegrated concrete should be removed with the help of portable electrical tools or chisels and hammer and wire brushes, so as to expose sound concrete surface. Shapes of patches should be made regular to the extent feasible (sharp corners should be avoided). Reinforcement should be thoroughly cleaned by use of wire brushes or any other mechanical means. Reinforcement should be then applied with suitable protective coating of Zinc rich primer of reputed manufacturers like FOSROC, SIKA or BERGER. Thereafter bond coat comprising of latex and cement mixed in proportions recommended by reputed manufacturers of polymer i.e. Fosroc, Sika, BASF should be applied Polymer acrylic can be used for this purpose. While bond coat is tacky, the broken portion should be made

good by applying with polymer : cement : sand should be 0.1:1:3. Broken portion should be made good in layers of about 15 to 20mm each or as feasible at site. Polymer mortar should be cured with water for minimum 7 days. Alternatively curing compound of reputed manufacturers or polymer : cement slurry can be applied in suitable proportions to act as curing layer as it is difficult to cure small patches. The work is execute for all pier, abutment, pier cap, abutment cap deck slab girder structure were required.

The necessary working platform shall be of M.S. shall be providing for working and as well as for supervision.

The work shall be carried out as directed by Engineer in charge.

Payment shall be based on **per 25 Kg. bag** of finished polymer mortar surface area.

The Rate includes all required working M.S. platform, scaffolding of M.S. pipe / girder / channel and M.S. plates all materials, labours, tools, plants, equipments, welding, fabricating, curing etc. for satisfactory completion of item as directed by Engineer in charge.

Item No. 50 :: Repair of RCC Railing (Carrying out repair of RCC M30 railing to bring it to the original shape.)

1.0 MATERIALS

- (a) The materials shall be used as per the general specification.
- (b) The material shall be used as per description of item given and as directed by the Engineer in charge.

2. WORKMANSHIP

- (a) Workmanship shall be as per description given above and to the satisfaction of the Engineer in charge.

3. MODE OF MEASUREMENT

- (a) The rate shall be includes cost of all materials and labour required for satisfactory of this item as described above.
- (b) The work shall be measured for the finished work.
- (c) The Rate shall be for unit of **Rmt.**

Item No. 51 :: Repair of steel Railing (Repair of steel railing to bring it to the original shape)

1.0 MATERIALS

- (a) The materials shall be used as per the general specification.
- (b) The material shall be used as per description of item given and as directed by the Engineer in charge.

2. WORKMANSHIP

- (a) Workmanship shall be as per description given above and to the satisfaction of the Engineer in charge.

3. MODE OF MEASUREMENT

- (a) The rate shall be includes cost of all materials and labour required for satisfactory of this item as described above.
- (b) The work shall be measured for the finished work.
- (c) The Rate shall be for unit of **Rmt.**

Item No. 52 :: Providing and laying rubble for apron (each stone weighting notless than 40Kg.) including and packing and filing in the interesticeswith quarry-spalls.

1. The work shall consist of laying boulders directly on the prepared surface for protection against scour.
2. The stones used in apron shall be sound, hard, durable & fairly regularly in shape. Stone subject to marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be levelled and prepared for the length and width as shown on the drawings. The size of stone shall be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40 Kg. The specific gravity of stone shall be as igh as possible and it shall not be less than 2.50. To ensure regular and orderly disposition of the full intended quantity of stone in the apron. template cross walls in dry masonry shall be built about a metre wide and to the full weight of the specified thickness of the apron at intervals of 30 metres and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.
3. Payment shall be made on Cu.m. basis of chata. The materials shall have to be stacked at site before laying. Preparation of base for laying bedding shall be deemed incidental to the work nothing shall deducted for voids.
4. The rate shall include cost of materials, labour & tools to complete the job.
5. Payment shall be made on **Cu.m.** basis.

Item No. 53 :: Construction of precast RCC railing of M30 Grade, aggregate size not exceeding 12 mm, true to line and grade, tolerance of vertical RCC post not to exceed 1 in 500, centre to centre spacing between vertical post not to exceed 2000 mm, leaving adequate space between vertical post for expansion, complete as per approved drawings and technical specifications.

The item shall be carried out for **precast RCC railing of M-30 grade** as directed.

The relevant specification of general technical specification booklet as follows :

cement concrete M-30 grade : Cement concrete M-30 grade as per **Item No. 6.**

Reinforcement (TMT) : Item No. 7

Filter Material : Kapachi : M-13
Sand : M-6

Item shall be carried out to full satisfaction of Engineer in charge.

MODE OF MEASUREMENT & PAYMENT

The item shall be measured and paid for **meter**.

Item No. 54 :: Providing G.I. 100 mm diameter water spouts including necessary iron gratings as per drawings.

2705 DRAINAGE SPOUTS

Drainage along longitudinal direction shall be ensured by sufficient number of drainage fixtures embedded in the deck slab. The spouts shall be of not less than 100 mm in diameter and shall be of corrosion resistant material such as galvanised steel with suitable cleanout fixtures. The spacing of drainage spouts shall not exceed 10 m. The discharge from drainage spout shall be kept away from the deck structure by means of suitable down pipes upto 500 mm above High Flood Level. In case of viaducts in urban areas, the drainage spouts should be connected with suitably located runners and down pipes to discharge the surface run-off into drains provided at ground level.

2705.1 Fabrication

The drainage assembly shall be fabricated to the dimensions shown on the drawings. All materials shall be corrosion resistant. Steel components shall be of mild steel conforming to IS:226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanised.

2705.2 Placement

The galvanised assembly shall be given two coats of bituminous paint before placement. The whole assembly shall be placed in true position, lines and levels as shown on the drawings with necessary cutouts in the shuttering for deck slab and held in place firmly. Where the reinforcements of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the cut out.

2705.3 Finishing

After setting of the deck slab concrete, the shrinkage cracks around the assembly shall be sealed with polysulphide sealant or bituminous sealant as per 18:1834 and the excess sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be provided to cover at least 50 mm on the wearing coat surface all round the drainage assembly.

2708 MEASUREMENTS FOR PAYMENT

Drainage / water spouts shall be measured in numbers.

2709 RATE

The contract unit rate for drainage spout shall include the cost of all labour, material, tools and plant required for completing the work as per these specifications. It shall also include the cost of providing runners and down pipes with all fixtures upto 500 mm above high flood level or up to the drains at ground, as applicable or as shown on the drawings.

Item No. 55 :: Removal of existing cement concrete wearing coat including its disposal complete as per Technical specification without causing any detrimental effect to any part of the bridge structure and removal of dismantled material with all lifts and lead upto 1000m(Thickness 75 mm).

1. Commencement of Dismantling

Before commencing dismantling, the nature and condition of concrete, the condition and position of reinforcement should be ascertained. The contractor shall familiarise himself with the structural design and ensure that the overall stability of the bridge is not affected.

2. Dismantling of existing wearing coat shall be carried out using milling machine. Care should be taken to avoid any damage to the existing structure including reinforcement or prestressing anchorages for cables, if any, located in the deck slab. The milling machine blade shall be so adjusted that cuts the existing bituminous wearing coat only and open the below concrete coat clearly without damaging it.

The milled material shall be disposed up to all lead and lift as directed by engineer in charge.

3. Precautions during Dismantling Work

For general guidelines, reference may be made to Section 100.

Dismantling work shall not be carried out at night, or during storm or heavy rain. A warning device shall be installed in the area to be used to warn the workers in case of mishap/emergency.

Safety helmets conforming to IS: 2925 shall be used by the workmen engaged in dismantling work. The sheds and tool boxes should be located away from the work site. Goggles preferably made up of celluloids and gas masks shall be worn at the time of dismantling, especially where tools like jack hammers are deployed to protect eyes from injuries from flying pieces, dirt, dust etc. Leather or rubber gloves shall be worn by the workers during the demolition of RCC work. Screens made up of G.I. sheets shall be placed wherever necessary to prevent the flying pieces from injuring the workers.

Water should be sprayed to reduce the dust while removing concrete wearing course with jack hammer. No work shall be taken up under the span when dismantling work is in progress.

2812. MEASUREMENT FOR PAYMENT

Dismantling of existing cement concrete wearing coat shall be measured in **square metre** of area of wearing course dismantled.

2813. RATE

The contract unit rate for dismantling of existing cement concrete wearing coat shall include cost of all materials, labour, tools and plant, traffic management, signages, safety precautions and other incidental expenses including satisfactory completion of the work as per these specifications.

Item No. 56 :: Applying epoxy mortar over leached, honey combed and spalled concrete surface and exposed steel reinforcement complete as per Technical specification.

2804. EPOXY MORTAR FOR REPLACEMENT OF SPALLED CONCRETE

2804.1. Material

2804.1.1. Formulation

The epoxy resins for use in the mortar shall be obtained from a reputed manufacturer and the mortar shall be prepared in conformity with the manufacturer's recommendations.

They shall generally conform to the following :

Pot life	:	90 minutes at 25 degrees Celsius
		60 minutes at 30 degrees Celsius
		45 minutes at 35 degrees Celsius
Bond strength	:	12 MPa
Tensile strength	:	16 MPa

The contractor shall carry out tests on the samples made out or requirements indicated above.

The sand content in the mortar shall be in accordance with the desired consistency.

2804.2. Proportioning and Mixing

The resin and hardener shall be mixed before adding the dry filler. The mixed ready to use mortar should not contain lumps of unwetted filler and should be uniform in colour. For a total weight of 1 kg or less, hand mixing will be sufficient. For quantities in excess of 1 kg, the component shall be mixed for 3 minutes with a slow speed –400 – 600 rpm – electric drill with a jiffy mixer. The stirrer shall be moved up and down and along the sides until an even streak free colour is obtained. Whipping in an excessive amount of air shall be avoided. If no power is available, a flat putty knife may be used to reach into the corners of the can and hand mixing done for at least 5 minutes.

2804.3. Surface Preparation

Surface upon which epoxy is to be placed shall be free of rust, grease, oil, paint, loose material, unsound concrete, dust or any other deleterious material.

Since cured epoxy does not provide adequate bond with any material, all overlay, whether epoxy or cement based, shall be done within pot life of the base epoxy layer.

2804.4. Contaminants, such as oil, grease, tar, asphalt, paint, wax, curing compounds or surface impregnants like linseed oil or silicones, including laitance and weak or loose concrete shall be removed. When bonding to asphalt, the surface should be roughened so that clean aggregate is exposed. Epoxy bonding agents shall not be applied when it rains, or in standing water. The surface must be dry.

Two general methods of surface preparation shall be followed :

- a) Mechanical that includes grinding, grit blasting, water blasting and scarification.
- b) Chemical that includes acid etching with 15 per cent by weight of hydrochloric solution, followed by repeated flushing with high pressure stream of water.

2804.5. Application

Epoxy primer coat shall be applied with the help of stiff nylon bristle brushes or hard rubber rollers or spray gun depending upon the nature of surface and extent of work area. As far as possible, the coating shall be uniformly thick.

Before the primer coat is fully cured, epoxy mortar shall be applied by means of trowels and floats. The interval between the application of primer coat and epoxy mortar shall be approximately 15 /30 minutes depending upon the ambient temperature.

Seal Coat shall be applied after 24 hours curing, after mild roughening of the surface of the mortar.

2804.6. Coverage

The coverage of resin mix would depend on the system of resin used. However, as a general guideline the coverage area shall be as under:

- a) **Primer coat:** One kg of resin – hardener mix covers an area of 3-6 square metres per coat depending on the finish of the concrete.
- b) **Epoxy mortar.** One square metre of surface requires approximately 20-24 kg of epoxy mortar when laid to a thickness of 10 mm.
- c) **Seal coat:** 4 to 6 square metres per kg of mix depending on the temperature of application.

2804.7. Cleaning and Maintenance of Equipment

Tools and equipment are best cleaned immediately after use since the removal using a scraper and remainder washed away completely using solvents such as toluene, xylene or acetone. Equipments used for epoxy shall always be cleaned before it hardens. Solvents used for this purpose may be Methyl Chloride (non-flammable). Cured epoxies may be removed using Methylene Chloride.

2804.8. Testing

Epoxy used for making mortar shall conform to all requirements and testing procedures as laid down in Clause 2803.9.

2804.9. Handling precautions

Epoxy resins can cause irritation of skin in sensitive persons if incorrectly handled. The resin and hardener should be allowed to come into direct contact with skin. The most effective protection is achieved by wearing rubber or polythene gloves.

2804.10. Personnel and Environment Safety

Any skin contact with epoxy materials, solvents and epoxy strippers should be avoided. Epoxy resins and particularly epoxy hardeners (B Component) may cause a rash on the skin. The official toxicity classification on the container labels may be looked for before starting work.

Rubber gloves, with a cloth liner and protective clothing shall be worn. Barrier creams are recommended but are not substitutes for protective clothing. Eyes shall be protected where splashing could occur while spraying or mixing. Good ventilation shall be ensured and inhalation of vapours avoided. If materials are sprayed, a respirator shall be used.

If skin contact occurs, it shall be immediately washed with a cleaner, followed by soap and water. Should eye contact occur, it shall be flushed immediately with plenty of water for 15 minutes and a doctor called for.

If contact occurs with the clothing, it shall be immediately changed to prevent further skin contact, and if the contact occurs with components A or B, the clothing shall be thrown away. Hardened epoxy is not harmful but will break the clothing.

All emptied, used buckets, rags and containers shall be removed from site. These shall be stored in waste disposal bags and suitably disposed.

➤ Mode of Measurement & Payment :-

Payment shall be measured and paid for a unit of **Sq.m.**

Item No. 57 :: Replacement of Expansion Joints complete as per drawings.

2607.1. Components

Strip seal expansion joint shall comprise the following items:

Edge beams - This special claw leg profiled member shall be of extruded rolled steel section combining good weld ability with notch toughness.

Strip seal - This shall be of chloroprene with high tear strength, insensitive to oil, gasoline, and ozone. It shall have high resistance to aging. This component, provided to ensure water tightness, shall have bulbous shape of the pan of the seal which is inserted into the groove, provided in the edge beam. The seal should be vulcanized in single operation for minimum full length of joint.

Rigid Anchorage - This shall be welded to the edge beam at staggered distance.

Anchor loops - This shall be made of weld able steel connecting the rigid anchorage with, deck reinforcement

2607.2. Material

Edge beams of this special section are at present being directly imported in India.

The steel shall conform to steel grade Rst 37-2 of German Standard or equivalent.

Chloroprene of strip seal shall conform to clause 915.1 of RC:83 (Pan II). The properties of chloroprene shall conform to Table 2600-1.

Anchorage steel shall conform to IS:2061.

Anchor loop shall conform to IS:2062.

TABLE 2600-1. STRIP SEAL ELEMENT SPECIFICATION

Sealing element is made of chloroprene and must be a extruded section. The working movement range of the sealing element shall be at least 80 mm with a maximum of 100 mm at right angles to the joint and ± 40 mm parallel to the joint

PROPERTY	SPECIFIED VALUE
Hardness	63 \pm 5 Shore A
Tensile Strength	Min 11 MPa
Elongation at fracture	Min 350 per cent
Tear Propagation Strength	
Longitudinal	Mm 10 N/mm
Transverse	Min 10 N/mm

Shock Elasticity	Min 25 per cent
Abrasion	Min 220 mm ³
Residual Compressive Strain (22 h/70 deg C/30 per cent strain)	Max 28 per cent
Ageing in hot air (14 days/70 deg C)	Max +5 Shore A
Change in hardness	Max -20 per cent
Change in tensile strength	Max -20 per cent
Change in elongation at fracture	
Ageing in ozone (24 h/50pphm/25 deg C/20 per cent strain)	No cracks
Swelling behavior in Oil (116 h/25 per cent Q ASTM Oil no.	
Volume Change	Max 5 per cent
Change in hardness	Max 10 Shore A
ASTM Oil no.3	
Volume Change	Max 25 per cent
Change in hardness	Max 20 Shore A
Cold Hardening Point	Min -35 deg C

26073. Fabrication (Pre-installation)

Rolled steel profiles for edge beams shall be long enough to cater for a 2-lane carriageway. These shall be cut to size of actual requirements by means of a metre box saw. Alignment of the cut-to-size steel profiles shall then be made in accordance with the actual bridge cross-section on work tablet. For this purpose, the contour of bridge cross-section shall be sketched onto these tables. After the steel profiles are aligned, they will be chucked to the tables by means of screw clamps and tacked by arc welding.

Anchor plates shall be cut to the required size by gas cutting. These shall be welded to the edge beams.

Anchor loops shall be bent to the required shape and welded to anchor plates.

The finally assembled joints shall then be clamped and transported to the work site.

2607.4. Handling and Storage

For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together. The manufacturer shall supply either directly to the Engineer or to the Bridge Contractor all the materials of strip seal joints including sealants and all other accessories for the effective installation of the jointing.

Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding by the Contractor to prevent damage. Any damage occurring after delivery shall be made good at the Bridge Contractor's expense to the satisfaction of the Engineer.

2607.5. Installation

2607.5.1. The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is likely to be installed, the gap dimension shall be preset.

2607.5.2. Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.

2607.5.3. The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be tight.

2607.5.4. Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

2607.5.5. The joint shall be lowered in a pre-determined position. Following placement, of the joint in the prepared recess, the joint shall be levelled and finally aligned and the anchor loops on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the

auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

2607.5.6. High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case not less than M 35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets still in place shall be removed.

2607.5.7. Rolled up neoprene strip seal shall be cut into the required length and inserted between the edge beams by using a crow bar pushing the bulb of the seal into the steel grooves of the edge beams. A landing to a bead shall be formed in the thickened end of the edges of the seal which would force the thickened end against the steel beam due to wedge effect when the strip seal is buttoned in place.

2607.5.8. As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.

2607.5.9. The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

Acceptance Test

All steel elements shall be finished with conform corrosion protection system.

For neoprene seal, the acceptance test shall conform to the requirement stipulated in Table 2600-1. It shall also be stretch tested. If a manufacturer is to supply this type of joint, they will have to produce a test certificate accordingly conducted in a recognised laboratory, in India or abroad.

In view of the importance of the built up edge beam*, special investigation of fatigue strength of this section with anchorages to withstand 2×10^6 load change cycles

without showing signs of damage, will be required. The supplier shall have to produce a test certificate in this regard, conducted in a recognised laboratory, in India or abroad.

The manufacturer shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic bating.

The manufacturer shall satisfy the Engineer that water tightness test for the type of joint has been carried out in a recognised laboratory to check the water tightness trader a water pressure of 4 bars.

As strip seal type of joint if specialised in nature generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of this type of joint.

2608. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

2609. MEASUREMENTS FOR PAYMENT

The expansion joint shall be measured in **running metres**. For filled joints, the rate per running metre shall include the cost of sealant for the depth provided in this drawing.

2610. RATE

The contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as per these specifications in the case of Bridge Contractor supplying the expansion joint. If the manufacturer supplies the expansion joint directly to the Engineer, the cost of installation, handling and fixing shall be borne by the Bridge Contractor.

Item No. 74 :: Clearing and grubbing road land including uprooting rank vegetation grass bushes, shrubs ,sapling and trees girth up to 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials (C) By mechanical means in area of light jungle.

201. **CLEARING AND GRUBING**

201.1. **Scope**

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil etc. to an average depth of 150mm in thickness, which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials with all lead and lift. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these specifications.

201.2. **Preservation of Property/Amenities**

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own cost, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306 (as per Page No. 77 in MORTH specification booklet). Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials etc. and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3 (as per Page No. 78 in MORTH specification booklet).

201.3. **Methods, Tools and Equipments**

Only such methods, tools and equipment as are approved by the Engineer and which will not affect any property to be preserved shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., failing within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres shall be suitably treated.

201.4. **Disposal of Materials**

All materials arising from clearing and grubbing operations shall be taken over and shall be disposed of by the Contractor at suitable disposal sites with all lead and lift. The disposal shall be in accordance with local, State and Central regulations.

201.5. **Measurements for Payment**

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of [Hectares](#). Cutting of trees upto 300mm in girth and removal of their stumps, including removal of stumps upto 300mm in girth left over after trees have been cut by any other agency and trimming of branches of trees extending above the roadway and back filling to the required compaction shall be considered incidental to the clearing and grubbing operations. Clearing and grubbing of borrow areas shall be deemed to have been included in the

rates quoted for the embankment construction item and no separate payment shall be made for the same.

Ground levels shall be taken prior to and after clearing and grubbing. Levels taken prior to clearing and grubbing shall be the base level and will be accordingly used for assessing the depth of clearing and grubbing and computation of quantity of any unsuitable material which is required to be removed. The levels taken subsequent to clearing and grubbing shall be the base level for computation of earthwork for embankment.

Cutting of trees, excluding removal of stumps and roots of trees of girth above 300 mm shall be measured in terms of number according to the girth sizes given below:-

- i) Above 300 mm to 600 mm
- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

Removal of stumps and roots including back filling with suitable material to required compaction shall be a separate item and shall be measured in terms of number according to the sizes given below:-

- i) Above 300 mm to 600 mm
- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

For this purpose of cutting of trees and removal of roots and stumps, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

201.6. **Rates**

206.6.1 The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to

complete the work. These will also include removal of stumps of trees less than 300mm girth excavation and back-filling to required density, where necessary and handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads. Clearing and grubbing done in excess of 150 mm by the Contractor shall be made good by the Contractor at his own cost as per Clause 301.3.3 to the satisfaction of the Engineer prior to taking up earthwork. Where clearing and grubbing is to be done to a level beyond 150 mm, due to site considerations, as directed by the Engineer, the extra quantity shall be measured and paid separately.

201.6.2 The Contract unit rate for cutting trees of girth above 300 mm shall include handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.3 The Contract unit rate for removal of stumps and roots of trees girth above 300 mm shall include excavation and backfilling with suitable material to required compaction, handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.4 The Contract unit rate is deemed to include credit towards value of usable materials, salvage value of unusable material and off-set price of cut trees and stumps belonging to the forest Department. The off-set price of cut trees and stumps belonging to the Forest Department shall be deducted from the amount due to the Contractor and deposited with the State Forest Department. In case the cut trees and stumps are required to be deposited with the Forest Department the Contractor shall do so and no deduction towards the off-set price shall be effected. The offset price shall be as per guidelines I estimates of the state Forest Department.

201.6.5 Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

Item No. 75 :: Box cutting the road to proper slope and camber for making a base for road work including removing the excavated stuff and (Refilling same) depositing on road in layer wise, side slope as directed up to all lead etc. complete.including disposed the surplus soil as and where directed with all lead and lift without any extra cost etc. comp.

The sub grade / sub base / base to receive the water bound macadam course shall be prepared to the specified grade and camber and made of dust and other extraneous materials. Any nets of soft places shall be corrected in on approved manner and rolled until firm.

Cutting shall be paid on cross section area as established by the longitudinal level and cross sections for this purpose. The work shall be started after the initial longitudinal section of the ground and cross sections are taken and recorded.

The final surface shall confirm to proper profile, camber and super elevation etc. as directed by the Engineer. The earthwork shall be paid on sectional measurements, cross sectional etc. taken.

No allowance or payments shall be made for materials excavated prior to the taking of level by the Engineer.

The rate is inclusive of cutting in all soil and murrum including removal of all shrubs, jungle cutting, cutting stuff in slopes, side drain bank etc. complete.

This item also includes the clearing the sides and demarking the line as per requirement and cutting out the existing tress on the road side, not extra payment will be paid for.

At the time of preparing final bill, the road formation in embankment and cutting shall have be perfect condition true to grade, camber and side slope duly dressed and damages due to rain cuts etc. during entire working period shall have to be done by the contractor.

The work taken in length shall be completed in all respects viz. width, grades, camber, side drains, side slopes etc. and measurements for incomplete work shall not be taken otherwise.

1.0 Mode of Measurement & Payment :

The unit rate box cutting shall include the cost of all materials, tools and plant required for excavation in all type of soils in grade and camber, line and levels and

finishing as per direction of the Engineer-in-charge, excavation and all other incidental expenses for producing item of box cutting of specified breadth and depth and grade to complete the item or its components as shown on the drawings and according to these specifications.

The box cutting shall be measured for its cross section area and compacting volumes in cubic metres by the method of average areas.

The rate will be made on **Cubic Meter** basis of the finished work.

Item No. 76 :: Construction of granular sub-base 200mm thick layer by providing machine crushed B.T. material satisfying MORT&H specification (Fifth revision) of grading III including spreading in uniform layer with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC and compacting with vibratory roller to achieve the desired density etc. complete.

Scope:-

This work shall consist of laying and compacting natural locally available granular material on prepared subgrade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

Materials:-

The material to be used for the work shall be granular sub base in single layer as per gradation made of natural locally available material in proper proportion and approved by engineer in charge as directed (having C.B.R. not less than 25%).

While the gradings in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53mm and 9.5 mm, the corresponding gradings for the coarse graded materials for each of the three maximum particle sizes are given at Table 400-2. The grading to be adopted for a project shall be as specified in the Contract.

Physical requirements :-

The materials shall have a 10 percent lines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS:812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3), if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading-II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

TABLE 400-1. GRADING FOR CLOSE GRADED GRANULAR SUB-BASE MATERIALS.

IS Sieve Designation	Per cent by weight passing the IS Sieve -----
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	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	80-100	100	-
26.5 mm	55-90	70-100	100
9.5 mm	35-65	50-80	65-95
4.75 mm	25-55	40-65	50-80
2.36 mm	20-40	30-50	40-65
0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

TABLE 400-2, GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Percent by weight passing the IS Sieve -----		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	< 10	<10	<10
CBR Value (Minimum)	30	25	20

Note:-The material passing 425 micron (0.425 mm) sieve for all the three grading when tested according to IS: 2720(Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

Strength of sub-base:-

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remolded at field dry density and moisture content and any other tests for the "Quality" of materials, as may be necessary.

Construction Operations:

Preparation of subgrade:-

Immediately prior to laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

Spreading and compacting:

The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super elevation and shall commence at the edges and progress towards the center for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (Camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km. Per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

Surface Finish and Quality Control of Work:-

The surface finish of construction shall conform to the requirements of Clause 902.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

Arrangements for Traffic :-

During the period of construction, arrangement of traffic shall be maintained in accordance with clause 112.

Measurements for payment:-

During granular materials sub-base shall be measured as finished work in position in **cubic metres**.

The protection of edges of granular materials sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

RATE:-

The contract unit rate for granular materials sub-base shall be payment in full for carrying out the required operations including full compensation for

- (i) making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) all labour, tools, equipment and incidentals to complete the work to the specifications;
- (iv) carrying out the work in part widths of road where directed; and carrying out the required tests for quality control.

Item No. 77 :: Graded II Granular sub base (GSB)

Providing & Laying of Compacted closed graded Granular Sub base(GSB) in single layer of graded granular material consisting of only black trap crushed stone aggregate as per grading-IV given table 400-1 of the specification MORT & H and compacted to the required density with vibratory roller with plain drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight in all seasons as per MORT&H, maintaining the required slope & grade during the operation as approved by the engineer in charge & watering to the proper moisture content and sprinkled with the help of truck mounted water tank fitted with suitable arrangements (Fully saturated having CBR value not less than 30).

Scope:-

This work shall consist of laying and compacting natural locally available granular material on prepared subgrade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

Materials:-

The material to be used for the work shall be granular sub base in single layer as per gradation made of natural locally available material in proper proportion and approved by engineer in charge as directed (having C.B.R. not less than 25%).

While the gradings in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53mm and 9.5 mm, the corresponding gradings for the coarse graded materials for each of the three maximum particle sizes are given at Table 400-2. The grading to be adopted for a project shall be as specified in the Contract.

Physical requirements :-

The materials shall have a 10 percent lines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS:812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3), if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading-II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

TABLE 400-1. GRADING FOR CLOSE GRADED GRANULAR SUB-BASE MATERIALS.

IS Sieve Designation	Per cent by weight passing the IS Sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	80-100	100	-
26.5 mm	55-90	70-100	100
9.5 mm	35-65	50-80	65-95
4.75 mm	25-55	40-65	50-80
2.36 mm	20-40	30-50	40-65
0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

TABLE 400-2, GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Percent by weight passing the IS Sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	< 10	<10	<10
CBR Value (Minimum)	30	25	20

Note:-The material passing 425 micron (0.425 mm) sieve for all the three grading when tested according to IS: 2720(Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

Strength of sub-base:-

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remolded at field dry density and moisture content and any other tests for the "Quality" of materials, as may be necessary.

Construction Operations:

Preparation of subgrade:-

Immediately prior to laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

Spreading and compacting:

The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super elevation and shall commence at the edges and progress towards the center for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (Camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km. Per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

Surface Finish and Quality Control of Work:-

The surface finish of construction shall conform to the requirements of Clause 902.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

Arrangements for Traffic :-

During the period of construction, arrangement of traffic shall be maintained in accordance with clause 112.

Measurements for payment:-

During granular materials sub-base shall be measured as finished work in position in **cubic metres**.

The protection of edges of granular materials sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

RATE:-

The contract unit rate for granular materials sub-base shall be payment in full for carrying out the required operations including full compensation for

- (i) making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) all labour, tools, equipment and incidentals to complete the work to the specifications;
- (iv) carrying out the work in part widths of road where directed; and

carrying out the required tests for quality control.

Item No. 78 :: Supplying and fixing reinforced concrete heavy duty non-pressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal diameters. (iii) 600mm dia.

Specification as per Item No. 04. For NP-3 Dia. 600mm dia.

Item No. 79 :: Providing and Spraying Prime Coat with Bitumen emulsion S S-1 @ 7.50 Kg / 10 SqM including Cost of asphalt

502. PRIME COAT OVER GRANULAR BASE

502.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

502.2. Materials

502.2.1. Primer: 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 stabilised soil base,
- (iii) Surfaces of high porosity; such as a gravel base.

502.2.2. Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table 500-1.

TABLE 500-1 VISCOSITY REQUIREMENT AND QUANTITY OF LIQUID BITUMINOUS PRIMER

Type of surface	Kinematics Viscosity of Primer at 60°C (Centistokes)	Quantity of Liquid Bituminous Material 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

502.2.3. Choice of primer: The primer shall be bitumen emulsion, complying with IS 8887 (slow setting) of a type and grade as specified in the Contract or as directed by the

Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

502.3. Weather and Seasonal Limitations

Bituminous primer shall not be applied to a wet surface (see 502.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

502.4. Construction

502.4.1. Equipment: The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas, inaccessible to the distributor or in narrow strips shall be sprayed with a pressure hand sprayer or as directed by the Engineer.

502.4.2. Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8 and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

502.4.3. Application of bituminous primer : The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. Where a geosynthetic is proposed for use, the requirements of Clauses 703.3.2 and 703.4 shall apply. The bituminous primer shall be sprayed uniformly in accordance with Clause 501. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

502.4.4. Curing of primer and opening to traffic: A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

502.4.5. Tack coat: Over the primed surface, a tack coat should be applied in accordance with Clause 503.

502.5. Quality Control of Work

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

502.6. Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

502.7. Measurement for Payment

Prime coat shall be measured in terms of surface area of application in **Square metres**.

502.8. Rate

The contract unit rate for prime coat with adjustments as described in Clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of **7.50 kg per 10 square meter**, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

Item No. 80 :: Providing and laying 20mm thick Mix Seal Surface with tack coat @ 2.0 kg/10 sqm using B.T. chips as per M.O.R.T. & H. gradation type A and specification with VG-30 for mixing @ 51.00 Kg / M.T. i.e. 5.1 % of total weight of mix using including heating and mixing the aggregate and asphalt in continuous of drum mix plant and hot laid process spreading the same by paver finisher and consolidation with roller as per M.O.R.T. & H. specification to achieve desire density, including providing all materials equipments, tools and plants, fire wood, oil, kerosene, labour charges etc. complete using contractor's own machinery, drum mix plant and paver finisher etc. complete.

512.1. Scope

512.1.1. This work shall consist of the preparation, laying and compaction of a close graded premix surfacing material of **20 mm thickness** composed of graded aggregates premixed with a bituminous binder on a previously prepared surface in accordance with the requirements of these Specifications, to serve as a wearing course.

512.1.2. Close graded premix surfacing shall be of Type A or Type B as specified in the Contract documents.

512.2. Materials

512.2.1. Binder : The binder shall be bitumen of a suitable **viscosity grade VG-30** as specified in the Contract, or as directed by the Engineer, and satisfying the requirements of IS: 73.

Viscosity Grade (VG) Bitumen Specification as per IS 73 : 2006

Characteristics	VG - 10	VG-20	VG-30	VG-40
Absolute Viscosity 60°C, poises, min	800	1600	2400	3200
Kinematics Viscosity 135°C CSI, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, % min	99.0	99.0	99.0	99.0
Penetration at 25°C	80-100	60-80	50-70	40-60
Softening point, C min	40	45	47	50
Test on residue from thin film oven test / RTFOT:				
(A) Viscosity ration at 60°C, max	4.0	4.0	4.0	4.0
(B) Ductility at 25°C, cm, min after thin film over test	75	50	40	25

512.2.2. Coarse aggregates : **504.2.2.1.** The 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. If crushed shingle/gravel 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 preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall preferably be treated with anti-stripping agents of approved quality in suitable dose as per *Appendix-5*. The aggregates shall satisfy the physical requirements set forth in Table 500-3.

**TABLE 500-3. PHYSICAL REQUIREMENTS OF AGGREGATES FOR
BITUMINOUS MACADAM**

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

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

Note : If crushed slag is used, Clause 404.2.3 shall apply.

512.2.3. Fine aggregates : The fine aggregates shall consist of crushed rock quarry sands, natural gravel / sand or a mixture of both. These shall be clean, hard, durable, un-coated, mineral particles, dry and free from injurious, soft or flaky particles and organic or deleterious substances.

512.2.4. Aggregate gradation.: The coarse and fine aggregates shall be so graded or combined as to conform to one or the other grading shown in Table 500-26, as specified in the contract.

TABLE 500-26. AGGREGATE GRADATION

IS Sieve Designation (mm)	Cumulative per cent by weight of Total aggregate passing	
	Type A	Type B
13.2 mm	-	100
11.2 mm	100	88-
100		
5.6 mm	52 - 88	31 -
52		
2.8 mm	14 - 38	5 - 27
0.090 mm	0 - 5	0- 5

512.2.5. Proportioning of materials: The total quantity of aggregates used for Type A or B close-graded premix surfacing shall be 0.27 cubic metre per 10 square metre area. The quantity of binder used for premixing in terms of straight-run bitumen shall be 22.0 kg and 19.40 kg per 10 Square metre area for Type A and Type B surfacing respectively.

512.3. Construction Operations

501.5.1. Weather and seasonal limitations: Laying shall be suspended while free standing water is present on the surface to be covered or during rain, fog and dust storms. After rain, the bituminous surface, prime or tack coat, be blown off with a high pressure air jet to remove excess moisture or the surface left to dry before laying shall start Laying of bituminous mixtures shall not be carried out when the air temperature at the surface on which it is to be laid is below 10⁰C or when the wind speed at any temperature exceeds 40 km/h at 2m height unless specifically approved by the Engineer.

501.5.2. Cleaning of surface: The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom or any other approved equipment / method as specified in the contract. The use of a high

pressure air jet from a compressor to remove dust or loose matter shall be available fall time on the site, unless otherwise specified in the Contract.

501.53. Spreading: Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver and its of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and levelled with suitable hand tools by experienced staff, and compacted to the satisfaction of the Engineer.

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint. The remainder of the pavement up to the joint and the corresponding area beyond it shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material with a temperature greater than 145⁰C shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.

Hand placing of pre-mixed bituminous materials shall only be permitted in the following circumstances:

- (i) For laying regulating courses of irregular shape and varying thickness.
- (ii) In confined spaces where it is impracticable for a paver to operate.
- (iii) For footways.
- (iv) At the approaches to expansion joints at bridges, viaducts or other structures.
- (v) For laying mastic asphalt in accordance with Clause 515.
- (vi) For filling of potholes.
- (vii) Where directed by the Engineer.

Manual spreading of pre-mixed wearing course material or the addition of such material by hand spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:

- (i) At the edges of the layers of material and at gullies and manholes.
- (ii) At the approaches to expansion joints at bridges, viaducts or other structures.
- (iii) As directed by the Engineer.

501.5.4. Cleanliness and overlaying: Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the Contractor shall make it good to the satisfaction of the Engineer, in compliance with Clause 501.8.

Binder course material shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the Contract, for more than three consecutive days after being laid. The Engineer may extend this period, by the minimum amount of time necessary, because of weather conditions or for any other reason. If the surface of the base course is subjected to traffic, or not covered within three days, a tack coat shall be applied, as directed by the Engineer.

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. Excessive traffic speeds should not be permitted.

512.7. Measurements for Payment

Close graded premix surfacing, Type A or B shall be measured as finished work, for the area specified to be covered, in square metres at a specified thickness. The area will be the net area covered, and all allowances for wastage and cutting of joints shall be deemed to be included in the rate.

The measurement shall be all measures for finished work on weight base in **Metric Tonne**.

512.8. Rate

The contract unit rate for close graded premix surfacing, Type A or B shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2. (i) to (xi).

501.8.8.2. Rate for premixed bituminous material:

The contract unit rate for premixed bituminous material shall be payment in full for carrying out the required operations including full compensation for, but not necessarily limited to:

- (i) Making arrangements for traffic to Clause 112 except for initial ant to verge. shoulders and construction of diversions;
- (ii) Preparation of the surface to receive the material.
- (iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lift.
- (iv) Mixing, transporting, laying and compacting the mix, as specified.
- (v) All labour, tools, equipment, plant including installation of [drum](#) mix plant power supply units and all machinery, incidental to complete the work to these Specifications;
- (vi) Carrying out the work in part widths of the road where directed;
- (vii) Carrying out all tests for control of quality and
- (viii) The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and payment will be adjusted accordingly.
- (ix) The rates for premixed material are to include for all wastage in cutting of joints etc.
- (x) The rates are to include for all necessary testing, mix design, transporting and testing of samples, and cores. If there is not a project specific laboratory, the Contractor must arrange to carry out all necessary testing at an outside Laboratory, approved by the Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.
- (xi) The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed to be included in the Contractor's rates for the material.

Item No. 81 :: Earthwork for embankment including breaking clods, dressing with all lead and lift and including watering rolling and consolidation of subgrade in layers at O.M.C. to required dry density including filling the depression which occur during the process using power roller 8T to 10T .(E) From Borrow area within 3.0KM. lead

305 EMBANKMENT CONSTRUCTION

305.1 General:

305.1.1 Description:

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, sub grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

305.2 Materials and General Requirements.

305.2.1 Physical requirements :

305.2.1.1 The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, murrum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment sub grade.

The following types of material shall be considered unsuitable for embankment:

- (g) Materials from swamps, marshes and bogs;
- (h) Peat, log, stump and perishable material; and soil that classifies as OL, OI, OH or Pt in accordance with IS:1498;
- (i) Materials susceptible to spontaneous combustion;
- (j) Materials in a frozen condition;
- (k) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- (l) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage, properties ("free swelling index" exceeding 50 percent when tested as per IS:2720-Part 40) shall not be used as a fill material. Where an expansive clay with acceptable "free swelling index" value is used as a fill material, sub grade and top 500mm portion of the embankment just below sub grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO₃) per liter when tested in accordance with BS:1377 Part-3, but

using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract), permanent works constructed out of concrete, cement bound materials or other cementations materials.

Materials with a total sulphate content (expressed as SO₃) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377, Part 3 shall not be deposited within 500 mm or other distances described in the contract, of metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm when being placed in the embankment and 50 mm when placed in the sub grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

305.2.1.5 Ordinarily, only the materials satisfying the density requirements given in Table 300-1 shall be employed for the construction of the embankment and the sub grade.

TABLE 300-1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS

S.No.	Type of work	Maximum laboratory dry unit weight when tested as per IS:2720(Part 8)
1.	Embankments upto 3 metres height, not subjected to extensive flooding.	Not less than 15.2 kN/cu.m.
2.	Embankments exceeding 3 metres height or embankments of any height subject to long periods of inundation.	Not less than 16.0 kN/cu.m.
4.	Subgrade and earthen shoulders/ Verges/backfill	Not less than 17.5 kN/cu.m.

Notes: (1) This Table is not applicable for lightweight fill materials e.g. cinder, fly ash etc.

(3) The materials to be used in sub grade shall be non-expensive and shall satisfy design CBR at the specified dry density and moisture content. In case the available materials fail to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer shall be followed.

305.2.1.6 The materials to be used in sub grade shall conform to the design CBR value at the specified dry density and moisture content of the test specimen. In case the available materials fails to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Association Committee shall be followed.

305.2.1.7 The materials to be used in high embankment construction shall satisfy the specified requirements of strength parameters.

305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the sub grade and the embankment portion just below the sub grade.

305.2.2.2 **Borrow materials:**

The arrangement for the source of supply of the materials for embankment and sub grade and compliance with the guidelines, and environmental requirements, in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width of a minimum of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or sitting of temporary buildings or structures.

305.2.2.3 Fly-Ash

User of fly-ash shall conform to the Ministry of Environment and Forest guidelines. Where fly-ash is used the embankment construction shall conform to the physical and chemical properties and requirements of IRC:SP:38-2001, “Guidelines for Use of Flyash in Road Construction”. The term fly-ash shall cover all types of coal ash such as ponds ash, bottom ash or mound ash.

Embankment constructed out of fly ash shall be properly designed to ensure stability and protection against erosion in accordance with IRC guidelines. A suitable thick cover may preferably be provided at intervening layers of pond ash for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500mm.

305.2.2.4 Compaction Requirements

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub grade material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the sub grade.

TABLE 300-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE.

Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)
1. Sub grade and earthen shoulders	Not less than 97%
2. Embankment	Not less than 95%
3. Expansive Clays	
a) Sub grade and 500mm. portion Just below the sub grade.	Not allowed.
b) Remaining portion of embankment	Not less than 90-95%

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval :

- (i) The values of maximum dry density and optimum content obtained in accordance with IS:2720 (Part 8), appropriate for each of the fill materials he intends to use.
- (ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

The maximum dry density and optimum moisture content approved by the Engineer, it shall form the basis for compaction.

305.3 Construction Operations :

305.3.1 Setting Out

After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to be desired density and the position specified and conforms to the specified side slopes.

305.3.2 Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair./restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, Clause 305.4.6 shall apply.

305.3.3 Stripping and Storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

305.3.4 Compacting ground supporting embankment/Sub grade:

Where necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling in accordance with Clause 305.3.5 and 305.3.6 so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the sub grade level (top of the sub grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 300-2, the ground shall be loosened up to a level 0.5m below the sub grade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to achieve dry density not less than 97 percent relative compaction as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation (500mm portion just below the sub-grade) shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, atleast 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

305.3.5 Spreading material in layers and bringing to appropriate moisture content

305.3.5.1 The embankment and sub grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250mm when vibratory roller / vibratory soil compactor is used and not more than 200 mm when 80-100 kN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by balding, dicing or barrowing until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content can not be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS:2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS:2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the sub grade.

305.3.5.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cutting, another fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

305.3.6 Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheeled roller, self propelled single drum vibratory roller, tandem vibratory roller, pneumatic type roller, pad foot roller etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 kN static weight or heavy pneumatic type roller of adequate capacity capable of achieving the required compaction. The contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trails. The procedure to be adopted for these site trials shall be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankments / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage

The surface of the embankment/subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

305.3.8 Repairing of damages caused by rain/spillage of water :

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6 If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9 Finishing operations:

Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, cross sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 301.3.2 and 305.3.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moisture slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the top soil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4 Construction of Embankment and subgrade under special conditions.

305.4.1 Earthwork for widening existing road embankment :

When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal , continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers/plate compactors/power rammers or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2 Earthwork for embankment and subgrade to be placed against sloping ground

Where an embankment /subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1 before placing the embankment/subgrade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings, before the fill is placed against sloping ground.

Where the contract requires construction of transverse subsurface drain at the cut-fill interface, work on the same shall be carried out to Clause 309 in proper sequence with the embankment and subgrade work as approved by the Engineer.

305.4.3 Earthwork over existing road surface:-

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:-

- (iv) If the existing road surface is of granular or bituminous type and lies within 1 m of the new formation levels, it shall be scarified to a depth of 50mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.
- (v) If the existing road surface is of bituminous type or cement concrete type and lies within 1 m of the new formation level, the bituminous or cement concrete layer shall be removed completely.
- (vi) If the level difference between the existing road surface and the new formation level is more than 1 m. the existing surface shall be roughened after ensuring that the minimum thickness of 500mm of subgrade is available.

305.4.4 Embankment and subgrade around structures :-

To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC: 78. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2504 unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5 Construction of embankment over ground incapable of supporting construction equipment.

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract, will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6 Embankment construction under water and Water logged areas

305.4.6.1 Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS:1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75mm. The material should be non-

plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

305.4.6.2 Embankment construction in waterlogged and Marshy Areas :

The work shall be done as per IRC:34.

305.4.7 Earthwork for high embankment :-

The material for high embankment construction shall conform to Clause 302.2.1.7. In the case of high embankments (more than 6 m), the Contractor shall normally use fly ash in conformity with Clause 305.2.1.1 or the material from the approved borrow area.

Where provided, stage construction of embankment and controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging fill results the Contractor shall bring the resultant level upto formation level with acceptable materials for use in fill.

305.4.8 Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

305.5 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however be made good by the Contractor at his own expense as directed by the Engineer.

305.6 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on remoulded samples, compacted to the field density at the field moisture content and tested for soaked / unsoaked condition as specified in the contract.

305.8 Measurements for Payment

305.8.1 Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals given in Sub-section 113.3 after completion of clearing and grubbing and after completion of embankment / sub-grade. The volume of earthwork in cubic metres by the method of average end areas.

305.8.2 The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cu.m. of compacted fill and all bulking or shrinkage shall be ignored.

305.8.3 The embankment constructed with fly ash will be measured in cum, separately for the fly ash portions and for the soil cover and intervening layers of soil, unless otherwise specified in the contract.

305.8.4 Construction of embankment under water shall be measured in cu.m.

305.8.5 Construction of high embankment with specified material and in specified manner shall be measured in cu.m.

305.8.6 Stripping including storing and reapplication of topsoil shall be measured in cu.m.

305.8.7 Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cu.m.

305.8.8 Removal of unsuitable material at embankment/subgrade foundation and replacement with suitable material shall be measured in Cu.m.

305.8.9 Scarifying existing granular/bituminous road surface shall be measured in Square metres.

305.8.10 Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6.

305.8.11 Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cu.m.

305.9 RATES:

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for :

- (xv) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided other wise in the contract.
- (xvi) Setting out;
- (xvii) Compacting ground supporting embankment/subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;
- (xviii) Scarifying or cutting continuous horizontal benches 300mm wide on side slopes of existing embankment and subgrade as applicable;
- (xix) Cost of watering or drying of material in borrow areas and/or embankment and subgrade during construction as required;
- (xx) Spreading in layers, bringing to appropriate moisture content and compacting to specification requirements;
- (xxi) Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;
- (xxii) Restricted working at sites of structures;
- (xxiii) Working on narrow width of embankment and subgrade,
- (xxiv) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the contractor.
- (xxv) All labour, material, tools, equipment and incidentals necessary to complete the work to the Specifications;
- (xxvi) Dewatering, and
- (xxvii) Keeping the embankment/completed formation free of water as per Clause 311.
- (xxviii)Transporting unsuitable excavated material for disposal with all leads and lifts.

305.9.2 Clause 301.9.5 shall apply as regards Contract unit rates for items of stripping and storing top soil and of reapplication of topsoil.

305.9.3. Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and recompacting the embankment / subgrade foundation.

- 305.9.4.** Clauses 309.1.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.
- 305.9.5.** The Contract unit rate for scarifying existing granular/bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals, necessary to complete the work. This will also comprise of handling, giving credit towards salvage value and disposal of the dismantled materials with all leads and lifts or as otherwise specified.
- 305.9.6.** Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.
- 305.9.7.** The Contract unit rate for providing and laying filter material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.8.** The Contract unit rate for providing and compacting backfill material behind abutments and retaining walls shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.9.** Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.
- 305.9.10.** Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

Measurement shall be taken and paid in Cu.m.

Item No. 82 :: Regulatory / Mandatory Sign :-Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 60 cms. Dia Circle as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with bestquality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC blockof size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor.

(B) Class-B Type-4 Retro Reflective sheeting.

This item shall be carried out for REGULATORY Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 83 :: Cautionary Warning Sign :-Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 90 x 90 x 90 cms. equilateral triangle as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D- 4956 and latest M.O.S.T. Specifications; 3.6mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC blockof size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (B) Class-B Type-4 Retro Reflective sheeting

This item shall be carried out for CAUTIONARY WARNING Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 84 :: Hazard Marker Sign :-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 90x30 cms. rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 1.8mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with bestquality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor.

(B) Class-B Type-4 Retro Reflective sheeting

This item shall be carried out for HAZARD MARKER Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 85 :: Diversion Ahead Sign :-Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 180x60 cms. rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retroreflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications ; 3.1 mtr long stand post (2 Nos.) of Iron Angle 50 x 50 x 5mm / 50NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (B) Class-B Type-4 Retro Reflective sheeting

This item shall be carried out for DIVERSION AHEAD Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 86 :: Chevron sign:-Providing and fixing sign boards made out of 1.5mm aluminium sheet/3mm ACP (Aluminum composite Panel); size 60x50cm rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching, coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3 mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35x35x3mm; painted with bestquality epoxy coatings in black and white bends, the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-B Type-4 Retro Reflective sheeting

This item shall be carried out for CHEVRON Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 87 :: Around the Island / Road Direction Sign (Big) :-Providing andfixing sign boards made out of 2mm aluminium sheet / 4mm ACP(Aluminum composite Panel); size 180x60 cms. as per design ofIRC-67-2012. Pre treated with phosphating process & acidetching; coated with one coat of epoxy primer and two coats ofbest quality epoxy paint ; reflectorised with High IntensityPrismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.3 mtr long stand post ofIron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required andframe fabricated from suitable size iron angle of 35 x 35 x 3mm;painted with bestquality epoxy coatings in black and white bends.The details of symbol for each board shall be as per theinstruction of engineer in charge. The fixing at site shall be in1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg includingexcavation, curing etc.complete under the supervision ofengineer in charge. A warranty for 7 years for the Retro reflectivesheeting from original manufacturer & a certified copy of 3 yearoutdoor exposure test report from third party test lab for theproduct offered shall be submitted by contractor. (B) Class-B Type-4 Retro Reflective sheeting

This item shall be carried out for ROAD DIRECTION Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 88 :: Men at work (Heavy) sign :-Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 120cm x 90cm as per design of IRC-67-2012. Pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with High Intensity Prismatic Grade retroreflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.6 mtr long stand post (2 Nos.) of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 50x50x5mm; painted with best quality epoxy coatings in black and white bands. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 years for the Retroreflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (B) Class-B Type-4 Retro Reflective sheeting.

This item shall be carried out for MEN AT WORK Sign boards as per Detailed Specification of Item No. 34 as above except the size of the board shall be 90 x 90 x 90 cms. equilateral triangle as per Design and shall be fixed on C.C. Block of 45x45x60cm.s as above.

Item No. 89 :: Cat Eye/ Road Stud/RPM: Supplying Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with Micro prismatic lens (No Glass bead lens) capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORTH Circular No RW/NH/33023/10-97 DO Dt 11.06. 1997. The height, width and length shall not exceed 20 mm, 130 mm and 130 mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35 +/- 5 degree. The body of the marker should having finger grip for easy and accurate placement and application with epoxy/bituminous Adhesive as recommended by the manufacturer of the marker. The color of the marker should be as per the IRC 35-2015 and as directed by Engineer-in-charge.

1.0 General

The colour, configuration, size and location of **Molded Twin Shanks Raised Pavement Markers** for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC:35-2015 or as shown on the drawings or as directed by the Engineer.

The **Molded Twin Shanks Raised Pavement Markers** shall be reflectorised as shown on the drawings or as directed by the Engineer. It shall be of retro-reflectorised type and made of polycarbonate and ABS moulded body and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORTH Circular No RW/NH/33023/10-97 – DO III Dt. 11.06.1997.

In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

1.2 Materials :

The various materials and fabrication of the **Molded Twin Shanks Raised Pavement Markers** shall conform to the following requirements.

The adhesive materials shall be of standard quality and it shall be high resistance quality against heavy moving vehicles.

The materials shall be used for the body of the **Molded Twin Shanks Raised Pavement Markers** is of high density PVC materials.

The dimensions and size of the **Molded Twin Shanks Raised Pavement Markers** shall be as per IS standard. The retro-reflective sheeting used on the **Molded Twin Shanks Raised Pavement Markers** shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro reflection over its entire surface. It shall be weather resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

High intensity grade sheetings : This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H).

TABLE 800.1

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING

[CANDEL AS PER LUX PER SQUARE METRE]

Observa- tion (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+ 30	150	100	60	25	1.1
0.5	- 4	95	62	30	15	7.5

0.5	+ 30	65	45	25	10	5.0
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When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-1. At the end of 7 years, the sheeting shall retain at least 75 percent of its original retro-reflectance.

Engineer grade sheetings : This sheeting shall be of enclosed lens type consisting of micro prismatic lens elements embedded beneath the surface of a smooth, flexible, transparent, water proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H) as indicated in Table 800.2.

TABLE 800.2
ACCEPTABLE MINIMUM CO-EFFICIENT OF
RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING
[CANDEL AS PER LUX PER SQUARE METRE]

Observa- tion (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+ 30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	4.5	7.5	2.0
0.5	+ 30	15	13	4.0	2.2	3.0	0.8

When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

1.3 Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values (Table 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

1.4 INSTALLATION:

The [Molded Twin Shanks Raised Pavement Markers](#) shall be installed directly on road surface, after cleaning completely by removing all dust and other foreign materials from the surface of the road.

1.5 MEASUREMENT FOR PAYMENT :

The measurement of [Molded Twin Shanks Raised Pavement Markers](#) shall be in numbers, these shall be measured in **No.**

1.6 RATE :

The Contract unit rate shall be payment in full for the cost of making [Molded Twin Shanks Raised Pavement Markers](#) including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

Item No. 90 :: Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds as per IRC:35-2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta /bump patta lane/center line/ edge line/cut patta. The white color marking should provide liminance coefficinet on cemend road shall be min 130 mcd/m2/lux and Asphalt road shall be min 100 mcd/m2/lux during the servíce life during the day time. The marking should meet the performance crterla for night time reflectivity, wet reflectivity and skld resistance as mentioned in the section-15 of IRC 35-2015.warty for retro retlecinty shall be two years.Warranty for retro reflectivity shall be for two year.

803.4 Hot Applied Thermoplastic Road Marking

803.4.1 Thermoplastic Material

803.4.1.1 General

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

803.4.1.2 Requirements :

- I. Composition: The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 800-9.

Table 800-9 : Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30 - 40	30 - 40
Titanium dioxide	10.0 min.	–
Calcium Carbonate and I nert Fillers	42.0max.	See Note Below
Yellow pigments	–	See Note Below

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

- II. Properties: The properties of thermoplastic material, when tested in accordance with ASTM 036/BS-3262-(Part I), shall be as below:

a. Luminance:

White: Daylight luminance at 45°-65 percent min. as per AASHTO M249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M249

b. Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

c. Skid resistance: not less than 45 as per BS:6044.

d. Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

e. Softening point: $102.5^{\circ}\text{C} \pm 9.5^{\circ}\text{C}$ as per ASTM D 36.

f. Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249

III. Storage life : The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/ Contractor.

IV. Reflectorisation : Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.2.

V. Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1) The name, trade mark or other means of identification of manufacturer

2) Batch number

3) Date of manufacture

4) Colour (white or yellow)

5) Maximum application temperature and maximum safe heating temperature.

VI. Sampling and Testing : The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

803.4.2 Reflectorizing Glass Beads

803.4.2.1 General

This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.6.4.

803.4.2.2 The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in Clause 803.4.2.3.

803.4.2.3 Specific Requirements

- a) Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

TABLE 800-10: GRADATION REQUIREMENT FOR GLASS BEADS

Sieve size	Percent Retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 micron	-	5 to 20
425 micron	65 to 95	-
300 micron	-	30 to 75
180 micron	0 to 10	10 to 30
Below 180 Micron		00 to 15

- b) **Roundness** : The glass beads shall have a minimum of 70 percent true spires.
- c) **Refractive index** : The glass beads shall have a minimum refractive index of 1.50.
- d) **Free flowing properties** : The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paints striping. They shall pass the free flow test.

803.4.2.4 Test Methods

The specific requirements shall be tested with the following methods:

- i. Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The

glass spheres shall be free of lumps and clusters and shall flow freely through the funnel.

- ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).
- iii. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

803.4.3 Application Properties of Thermoplastic Material

803.4.3.1 The thermoplastic material shall readily get screeded/extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

803.4.3.2 The material upon heating to application temperatures shall not exude fumes which are toxic, obnoxious or injurious to persons or property.

803.4.4 Preparation

- i. The material shall be melted in accordance with the manufacturer's instructions in a heater with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

803.5 Reflectorised Paint

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used shall conform to the requirements of Clause 803.4.2.

803.6 Application

803.6.1 Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the

Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

803.6.2 Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

803.6.3 The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

803.6.4 The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

803.6.5 The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS:3262 (Part 3).

803.6.6 The markings shall be done to accuracy within the tolerances given below:

- i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.
- ii. The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by more than 20 mm
- iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.

- iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Engineer, the ratio of the lengths of the Painted sections shall remain the same.

803.6.7 Properties of Finished Road Markings

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

- a. The stripe shall not be slippery when wet.
- b. The marking shall not lift from the pavement in freezing weather.
- c. After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60°C.
- d. The marking shall not deteriorate by contact with sodium chloride calcium chloride or oil dripping from traffic.
- e. The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f. The colour of yellow marking shall conform to IS Colour No. 356 as given in IS:164

803.6.8 Measurements for Payment

803.6.8.1 The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

803.6.8.2 In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

803.6.9 Rate

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work.

1.7 SPECIAL TERMS AND CONDITIONS FOR THERMOPLAST PAINT WORK:

- (1) Agency should carry out the such type of work by only of thermoplastic paint laying machine (power driven only) with temperature controller and automatic mixing arrangement of glass beads in required proportion.
- (2) After completion of the laying of thermoplastic paint work, four years guarantee for durability and reflectivity as per M.O.R.T.H. specification for road and bridge works clause 803 should be given by the bidder in the writing.
- (3) Guarantee security deposit shall be retained @ 10% of the cost of the item of thermoplast paint from the R.A. bills, which will be released after expiry of guarantee period.
- (4) Agency who carry out the such type of work shall have an experience of carrying out similar type of work.
- (5) Test certificates as per M.O.R.T.H. specification for road and bridge works clause 803.3.2.2 (vi) should be furnished of reputed laboratory before.

Item No. 91 :: Demolation and disposal of unserviceable materials with all lead & lift.
(ii) Un reinforced cement concrete.

Specification as per Item No. 01

Item No. 92 :: Excavation in large boulders and soft rock by welding including shoring, strutting and dewatering as necessary and disposing of the excavated stuff as directed.

Specification as per Item No. 02.

Item No. 93 :: Providing and filling in foundation with ordinary cement concrete M-100 mix and providing necessary vertical pin headers including formwork, vibrating, ramming and curing complete.

<p>This item shall be carried out as per detailed specification of Item No. [03] below in Design Mix Concrete M-100 grade for R.C.C. as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design</p>

Item No. 94 :: Providing and fixing mild steel dowel bars of minimum 32mm dia. for anchoring by drilling holes in foundation strata including necessary bending, hooking of dowel bars and grouting the holes complete as per detailed drawing and as directed.

1. For **mild steel** specifications for MS reinforcement as per **Item No. 7** shall be apply.
2. The dowel bars shall be provided and anchored in pier caps / abutment caps and super structure as per detailed drawings for free ends and fixed ends. G.I. pipes and other, materials such as mastic asphalt as directed by Engineer-in-charge or as per drawing shall be provided G. I. pipes shall as approved by Engineer-in-charge.
3. The payment shall be made per **running meter** of dowel bars in anchored condition
4. Unit rate shall include cost of all materials, labour and equipments to complete the Job

Item No. 95 :: Providing and casting in-situ ordinary cement concrete M-200 mix and providing necessary pin headers including shuttering, scaffolding laying vibrating, curing and finishing complete without V-grooves.

This item shall be carried out as per detailed specification of Item No. [03] below in Design Mix Concrete M-200 grade for R.C.C. as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 96 :: Providing and casting in situ controlled cement concrete M-250 for RCC work in pier caps / Abutment caps & Dirt wall including ordinary cement concrete M-250 bed block or pedestal of required size below bearings as per detailed drawings centering, shuttering, scaffolding wherever necessary laying, vibrating, curing and finishing complete.

This item shall be carried out as per detailed specification of Item No. [03] below in Design Mix Concrete M-250 grade for R.C.C. as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 97 :: Providing and casting in situ controlled cement concrete M-300 for R.C.C. solid slab including centering, scaffolding, curing and finishing complete.

This item shall be carried out as per detailed specification of Item No. [03] below in Design Mix Concrete M-300 grade for R.C.C. Solid slab as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 98 :: Providing and casting in situ controlled cement concrete M-300 for RCC Crash Barrier including curing and finishing complete.

This item shall be carried out as per detailed specification of Item No. [03] below in Design Mix Concrete M-300 grade for R.C.C. Crash Barrier as directed including cost of shuttering, scaffolding, laying, vibrating, curing and finishing as per design

Item No. 99 :: Providing and filling in foundation with ordinary cement concrete M-150 mix and providing necessary vertical pin headers including formwork, vibrating, ramming and curing complete.

**This item shall be carried out as per detailed specification of
Item No. [03] below in Design Mix Concrete M-150 grade
for R.C.C. as directed including cost of shuttering, scaffoldign, laying,
vibrating, curing and finishing as per design**

Item No. 100 :: Providing and casting in situ controlle cement concrete M - 300 for average 75mm. thick Wearing coat laid as directed including tamping, vibrating, finishing, curing, and filling in joints with bitumen complete.

**This item shall be carried out as per detailed specification of
Item No. [03] below in Design Mix Concrete M-300 grade
for R.C.C. as directed including cost of shuttering, scaffoldign, laying,
vibrating, curing and finishing as per design**

Item No. 101 :: Providing and casting in - situ controlle cement concrete M-300 for approach slab.

**This item shall be carried out as per detailed specification of
Item No. [03] below in Design Mix Concrete M-300 grade
for R.C.C. Approach slab as directed including cost of shuttering,
scaffoldign, laying, vibrating, curing and finishing as per design**

Item No. 102 :: Providing and fixing in position mild steel 32 mm dowel bars in pier caps for anchorage in fix end as per detailed drawing including cutting , bending & welding complete.

1. For **mild steel** specifications for MS reinforcement as per **Item No. 7** shall be apply.
2. The dowel bars shall be provided and anchored in pier caps / abutment caps and super structure as per detailed drawings for free ends and fixed ends. G.I. pipes and other, materials such as mastic asphalt as directed by Engineer-in-charge or as per drawing shall be provided G. I. pipes shall as approved by Engineer-in-charge.
3. The payment shall be made per **running meter** of dowel bars in anchored condition
4. Unit rate shall include cost of all materials, labour and equipments to complete the Job

Item No. 103 :: Providing and fixing in position mild steel 32 mm dowel bars in pier caps for anchorage in free end as per detailed drawing including cutting , bending & welding complete.

1. For **mild steel** specifications for MS reinforcement as per **Item No. 7** shall be apply.
2. The dowel bars shall be provided and anchored in pier caps / abutment caps and super structure as per detailed drawings for free ends and fixed ends. G.I. pipes and other, materials such as mastic asphalt as directed by Engineer-in-charge or as per drawing shall be provided G. I. pipes shall as approved by Engineer-in-charge.
3. The payment shall be made per **running meter** of dowel bars in anchored condition
4. Unit rate shall include cost of all materials, labour and equipments to complete the Job

Item No. 104 :: Providing 12 mm thick pre-moulded asphalt filler joints as per drawing.

1. Open joints shall be constructed at the location as directed by the Engineer-in-charge using a wood strip metal (plate or other suitable material which is subsequently removed. When removing the material, care shall be exercised to avoid chipping or breaking the corners of the concrete. The edge of the concrete, at the joints, shall be well finished. Reinforcement shall not extend across an open joint.
2. When preformed filler is to be provided, the filler shall be placed in correct position before concrete is placed against the filler. The filler material shall form part of the joint and while concreting the slab, care shall be taken to prevent the former being displaced. After the work is completed, the exposed face of the joint shall be cleaned of all loose material sticking to it.
3. The material used for filling expansion joint shall be bitumen impregnated felt. Impregnate felt shall conform to the requirement of IS; 1838, and shall be got approved from the Engineer-in-charge. The joint shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided.
4. The expansion joint shall be measured in **Square metres**. Thickness of the expansion joint will be 12 mm. width of expansion joint shall be equal to full depth of the slab.
5. The rate shall include the cost of all materials, labour, equipments & incidental charges for fixing the joints complete in all respects as per these specifications and as shown on the drawing.

Item No. 105 :: Providing and fixing tar papper bearing ,shall be provided between abutment / pier cap and RCC slab.

2001. DESCRIPTION

This work shall consist of furnishing and fixing tar paper bearings in position in accordance with the details shown on the drawings, to the requirements of these specifications or as directed by the Engineer.

2002. GENERAL

1. Tar paper Bearing plates, bars, rockers, assemblies and other expansion or fixed devices shall be constructed in accordance with the details shown on the drawings.
2. The tar paper bearings may either be supplied directly to the engineer by the manufacturer to be installed by the Contractor or the contractor is to supply and install the bearings as part of the contract. In the former cases, the manufacturer shall be associated with the installation of the bearings to the full satisfaction of the engineer, whereas in the latter case, the contractor shall be solely responsible for the satisfactory supply and installation of the bearing. In the detailed description of the specification, a general reference shall be made to the Contractor or manufacturer and the interpretation shall be as per terms of contract.
3. The contractor shall exercise the utmost care in setting and fixing all tar paper bearings in their correct positions and ensuring that uniformity is obtained on all bearing surfaces.
4. Tar paper Bearings shall be handled with care and stored under cover.
5. When tar paper bearing assemblies or plates are shown on the drawings to be placed (not embedded) directly on concrete, the concrete tar paper bearing area shall be constructed slightly above grade (not exceeding 12 mm) and shall be finished by grinding.
6. It shall be ensured that the tar paper bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. This mortar pads (not exceeding 12 mm) may even be made to meet with this requirement.

7. It shall be ensured that the bottoms of girders to be received on the tar paper bearings are plane at the locations of these tar paper bearings and care shall be taken that the tar paper bearings are not displaced while placing the girders.

8. M. S. bearings sliding on M. S. Plates shall not be permitted. For sliding plate tar paper bearings stainless, steel surface sliding on stainless steel plate with mild steel matrix shall be used. The other option shall be to provide PTFE surface sliding on stainless steel.

9. Some types of tar paper bearings which have been successfully used in various bridges in India have been covered by these specifications. For innovative types of structures or in special cases, special types of tar paper bearings to suit the requirements may have to be provided for which special specifications may be laid down by the Engineer.

The item shall be measured and paid in **Sq.m.** basis of work done.

Item No. 106 :: Providing flood gauge marks on sub structure as per design including painting complete.

1. The width of the flood gauge shall be 60 cm. and will have cannerly yellow background colour. The flood gauge marking will be in 10 cm. thick strips of alternative black and white colour. The width of the strip shall be as under :-
 - (a) At every 10 cm. 15 cm. width
 - (b) At every 1/2 m. 25 cm. width in black
 - (c) At every metre... 35 cm. width in white

The lettering shall be in black colour and of 10 cm. height. The lettering shall show every metre and 1/2 m. level. The lettering shall show based on either GST B.M. or Arbitrary B.M. as furnished by Engineering-in-charge.

2. All the painting work shall be done in 3 coats. The paint shall be of approved make.
3. The measurement for payment shall be on **Running meter** basis measured in vertical.
5. The unit rate includes the cost of materials, labour, painting, equipment if any to complete the work.

Item No. 107 :: Wall painting (three coats) with Plastic emulsion paint of approved brands like Apex or equivalent and manufacture on undecorated wall surfaces to give an even shade including thoroughly brushing the surface free from mortar droppings and other foreign matter and sand papered smooth. (Black & White Strip).

1.0. Materials

Water shall conform M-1. The plastic emulsion paint shall conform to I.S.: 5411-1969 (Part-I).

2.0. Workmanship

The painting work shall be for subsequent coat of plastic emulsion paint of approved brand & manufactures on undecorated wall surfaces to give an even shade as directed.

2.1. Scaffolding : Wherever scaffolding is necessary it shall be erected in such a way that as far as possible on part of scaffolding shall rest against the surface to be white or colour washed. A properly secured strong and well tied suspended platform (Zoola) may be used for white washing. Where ladders are used pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the floors and walls. For white washing of ceilings, proper stage scaffolding shall be erected where necessary.

2.2. Preparation of surface : The undecorated surface to be distempered shall be thoroughly brushed from dust, dirt, grease, mortar dropping and other foreign matter and sand papered smooth. New plaster surface shall be allowed to dry for at least 2 months before applications of distemper.

2.2.1. All unnecessary nails shall be removed. Pitting in plaster shall be made good with plaster again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed. The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with I.S; 2395 (Part 01) 1966. Before applying distempering, any unevenness shall be made good by applying putty made of plaster of Paris mixed with water on entire surface including filling up the undulation and then sand papering the same after it is dry.

2.3. Preparation of Mix :

This shall be done as per manufacture's instructions. The thinning of emulsion is to be done with water and not with turpentine. The quantity of thinner to be added shall be as per manufacturer instructions.

2.4. Application :

2.4.1. Before pouring into small containers for use, the paint shall be stirred thoroughly in item container. When applying also, the paint shall be continuously stirred in the smaller container, so that its consistency is kept uniform.

2.4.2. The paint shall be laid on evenly and smoothly by means of crossing and laying off the crossing and consist of covering the area over with paint, brushing the surface hard for the first time over and then, brushing alternately in opposite direction two or three times and then finally brushing lightly in direction at right angles to the same. In this process, no brush Marks shall be left after the laying off is finished. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings, etc. shall be left on the work. The full process of crossing and laying off will constitute one coat.

2.4.3. The paint shall be applied with brush or rollers. For undecorated surfaces, the surface shall be treated with minimum **three coats** of cement water proofing paint. The second or subsequent coat shall not be started until the proceeding coat as become sufficiently hard to resist marking by brushing being used.

2.4.4. The surface on finishing shall present a flat velvety smooth finish. It shall be even and uniform in shade without patches, brush marks, paint drops etc.

2.5. Precautions :

(a) Old brushes if they are to be used with emulsion paints shall be completely dried of turpentine or oil paint by washing in warm soap water. Brushes shall be quickly washed in water immediately after use and kept immersed in water fusing break periods to prevent the paint from hardening on the brush.

(b) In the preparation of wall for plastic emulsion painting, no oil base petals shall be sued in filling cracks, holes etc.

(c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

(d) Washing or surfaces treated with emulsion paint shall not be done within 3 to 4 weeks of application.

2.6. Protective measures : The surface of doors, windows, floors, articles, of furniture etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Such surfaces shall be cleaned of white wash splashed if any.

3.0. Mode of measurements and payment

3.1. All the work shall be measured in the decimal system as under:

(a) Dimensions shall be measured to the nearest 0.01 m.

(b) Area in individual item shall be worked out to the nearest 0.01 sq.m.

All the work shall be measured in sq.mt. Deductions for jambs, soffits, sills etc. for openings not exceeding 0.5 sq.mt. each in area, for ends of joists, posts, beams, girders, steps etc. not exceeding 0.5 sq.mt. each in area and for openings exceeding 0.5 sq.mt. and not exceeding 3.0. sq.mt. each in area, deductions and additions shall be made as under.

3.2. No deductions shall be made for ends of joists, beams, posts, etc. and openings not exceeding 0.5 sq mt. each. No addition shall be made for reveals, jambs, soffits, sills etc. of these openings not for finish around ends of joints, beams, posts etc.

3.3. No deductions for openings exceeding 0.5 sq.mt. but not exceeding 3 sq.mt. each shall be made as follows and no addition will be made for reveals, jambs, soffits etc. of these openings :

(a) When both the faces of walls are provided with finish, deduction shall be made for one face only.

(b) When each face of wall is provided with different finish, deduction shall be made for that side of frame for door, windows, etc. on which width of reveals is less than that of the other side. Where width of reveals on both faces of wall are equal, deduction of .50% of area of opening on each face shall be made from total area of finish.

(c) When only one face of wall is treated and the other face is not treated, full deduction shall be made if the width of reveal on the treated side is less than that

on the untreated side, but if the width of the reveal is equal or more than on the untreated side neither deductions nor additions to be made for reveals, jambs, soffits, sills etc.

- 3.4** In case of area of openings exceeding 3 sq. mt. each, deductions shall be made for openings but jambs, soffits, sills shall be measured.
- 3.5.** No deductions shall be made for attachment such as casing, conducts, pipe, electric wiring and the like.
- 3.6.** Corrugated surfaces shall be measured flat as fixed and not girth. The quantities so measured shall be increased by the following percentage and the resultant shall be included with the general areas:
- (a) Corrugated steel sheets..... 14%
 - (b) Corrugated A.C. sheets..... 20%
 - (c) Semi corrugated A.C. Sheets..... 10%
 - (d) Nainital pattern roof (Plain sheeting sheets)..... 10%
 - (e) Naintial pattern roof (with corrugated sheets)..... 25%
- 3.7.** Cornices and other wall features, when they are not picked out in a different finish/colour shall be girthed and included in the general area.
- 3.8** Extra payment shall be done on ceiling and sloping roofs.
- 3.9.** The rate shall include the cost of ail materials, labour, scaffolding, protective measures etc. involved in all the operations described above.
- 4.0** The rate shall be for a unit of **One sq.** meter.