

NAME OF WORK:-CONSTRUCTION OF VARIOUS STRUCTURE MINOR BRIDGE, BOX CULVERT,PROTECTION WALL, GABION WALL AND SLAB DRAIN OF WAGHODIA, KARJAN, DABHOI, SINOR, SAVLI AND PADRA TALUKA DIST. VADODARA UNDER MMGSY(N) PACKAGE NO. 53/ 2025-26 1) JHAJHAD MOLETHA ROAD AT ROAD KM. 1/200 TO 1/400 TA:- SHINOR 2) AWAKHAL TERSA ROAD AT ROAD KM. 0/400 TO 0/600 IN TA. SHINOR 3) MANJROL DAMAPURA ROAD AT KM. 0/600 TO 0/800 IN TA. DABHOI. 4) HADOD SABHOI ROAD AT KM. 1/800 TO 2/000 IN DIST. KARJAN. 5) DABHOI KARNET ROAD AT KM.4/600 TO 4/800 IN TA. DABHOI. 6) SHANKARPURA BODINDRA ROAD AT KM.0/6 TO 0/8 TA. WAGHODIA. 7) PATOD TO ZAVERIPURA ROAD AT KM 0/200 TO 0/400 TA. PADRA 8) RANU TO VADADLA ROAD AT 1) 0/800 TO 1/000 , 2) 1/400 TO 1/600 TA. PADRA. 9) TUNDAV TO NAMISARA ROAD AT CH. 1/6 TO 1/8 TA:-SAVLI. 10) CHORANDA RANAPUR ROAD AT KM 6/2 TO 6/4 IN TA. KARJAN.

TECHNICAL SPECIFICATIONS

For BOQ

TECHNICAL SPECIFICATIONS

1.0 PREAMBLE:-

1.1 The Technical Specifications contained herein shall be read in conjunction with the other Bidding Documents as specified in this Volume.

1.2 Site Information:-

1.2.1 The information given here under provided elsewhere is given in good faith by the Employer but the Contractor shall satisfy himself regarding all aspects of site conditions and no claim will be entertained on the plea that the information supplied by the Employer is erroneous or insufficient.

2.0 GENERAL REQUIREMENTS: -

The technical specifications in accordance with which the entire work described herein after shall be constructed and completed by the Contractor shall comprise of the "SPECIFICATION"

2.1 The "SPECIFICATION" for each item is attached with tender is based on following.

(1) "SPECIFICATION FOR ROAD AND BRIDGE WORKS" (Fifth Revision printed in year 2013) issued by the Ministry of Road Transport & Highways (MORT & H), Government of India and Published by the Indian Roads Congress, hereinafter to as MORT & H Specifications.

(2) The General Technical Specifications for Road works.

(3) The General Technical Specifications for Bridge works.

Note:- (2) To (3) are Conventional Specifications Booklets usually attached for (R&B) Works.

2.2 If, a particular clause (which is incorporated in "SPECIFICATION") of specification booklets (1) to (3) above is Amended / Modified/ Added upon then the Amendment/ Modification/Addition shall supersede the relevant clause incorporated in "SPECIFICATION"

2.3 In, so far as Amended / Modified / Added Clause may come in conflict or be inconsistent with any of the provisions of the MORT & H Specifications under reference, the Amended/Modified/ Added Clause and the additional specifications shall always prevail.

2.4 In the absence of any definite provisions on any particular issue in the aforesaid Specifications, reference may be made to the latest codes and specifications, of IRC and BIS in that order. Where even these are silent, the construction and completion of the works shall conform to sound engineering practice as approved by the 'Engineer' and , in case of any dispute arising out of the interpretation of the above, the decision of the 'Engineer' shall be final and binding on the Contractor.

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ITEM WISE SPECIFICATION

Item No.1 : - Dismantling the existing structure including removing and stacking the dismantled materials as and where directed. (A) R.C.C. work

202 DISMANTLING CULVERTS, BRIDGES AND OTHER STRUCTURES/ PAVEMENTS

202.1 Scope

This work shall consist of dismantling and removing existing culverts, bridges, pavements, kerbs and other structures like small buildings, 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 designated for removal, shall be removed upto the limit and extent specified in the drawings or as indicated by the Engineer.

Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed, adjacent pavement, structures 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.

202.2 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 up to at least 600 mm 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 material, 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 with 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 the new work as dowels or ties are not 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 drawings 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 machined surfaces shall be painted with a mixture of white lead and tallow and all loose s shall be securely wired to adjacent 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.

202.3 Dismantling Pavements and Other Structures

In removing pavements, kerbs, gutters, and other structures like guard-rails, fences, holes, catch basins, inlets, etc., where portions of the existing construction are to be left e finished work, the same shall be removed to an existing joint or cut and chipped to a 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 courses in carriageway and shoulders etc., designated for oval shall be broken to pieces whose volume shall not exceed 0.02 cu.m and used with approval of the Engineer or disposed of.

202.4 Back-filling

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

202.5 Disposal of Materials

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

202.6 Measurements for Payment

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

i)	Dismantling brick/stone masonry/ concrete (plain and reinforced)	cu.m.
ii)	Dismantling flexible and cement concrete pavement	cu.m.
iii)	Dismantling steel structures	tonne
iv)	Dismantling timber structures	cu.m.
v)	Dismantling pipes, guard rails, kerbs, gutters and fencing	Rmt
vi)	Utility services	No.

202.7 Rates

The Contract unit rates for the various items of dismantling shall be paid 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 dismantled materials with all lifts and leads.

Item No.2:- Demolition of Brick work and stone masonry including stacking of serviceable materials and disposal of unserviceable materials with all lead and lift.(ii) In Cement Mortar.

This work shall consist of **Demolition of Brick work and stone masonry** and shall be carried out as per relevant detailed specification of **Item No.1** of this contract.

The measurement of logo board Sign shall be Measured in **Cu.m.**

Item No.3:- Diversion of watercourse / providing cofferdam and bund or island as may be necessary for foundation and maintaining the same for the period as may be necessary.

1. The item provides for the Design, Construction & Demolition of Temporary Cofferdam or any other suitable means as may be necessary and approved by Engineer-in-charge to facilitate construction of open foundation, pile foundation, pile cap, sub structure & super structure of whole bridge. This item will include dewatering of foundations, trenches, which will be covered in the item of open excavation. The contractor shall take all necessary protective measures against possible erosion due to tide variations if any and maintain the coffer dams, bund or island in proper manner during construction. He shall not be entitled for any payment or compensation in the event of washing of the coffer dam, bund or island at any time, either due to tidal waters if any or floods, or any other reasons whatsoever, and the contractor shall reconstruct the same if required at his risk and cost. The size of the coffer dam, bund

or island shall be such as would allow without obstruction and inconvenience, enough working free space all around the foundation works.

2. The contractor shall plan, construct and maintain satisfactorily necessary diversion channels and protective works so as to safely pass the stream flow and also satisfactorily meet with any sudden rise of flow due to tides, flood or any other reason, without damaging the foundation works. The coffer dam or bund shall be such as to give sufficient working space for construction, inspection and installations of pumping machinery inside the enclosed area. The coffer dam or bund shall be of adequate section and properly designed, constructed to prevent ingress of water as practically as possible in the foundation pits and to protect green concrete or masonry work.
3. Adequate pumping arrangement shall be made for dewatering the inside of coffer dam, bunds etc. Pumps of adequate capacity and in required number shall be provided to ensure adequate pumping.
4. The coffer dam, bund or island shall be completely removed and their materials shall be disposed of in the manner as directed by the Engineer-in-charge when no longer required.

5. Measurements for Payment

The rate for this item of work shall be per **Each** for the whole bridge structure span and shall be paid at the Numbers tendered for the work on completion of the entire work.

6 Rates

The Contract unit rates 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. The unit cost includes cost of maintenance till all operations to complete the entire bridge structure as may be necessary.

Item No.4:- Demarcation of road alignment including marking out road line by providing and fixing wooden pegs or steel rod of required size at every 25 M to 50 M. including excavating trenches ion both sides of 0.30 m. x 0.30M. including supplying of labours and all materials for every work etc. complete.

The Center line axis of the Bridge with approaches shall be surveyed along their lengths. Center line pegs for Bridge with approaches including foundation pegs at each location and at suitable distance of 3.0 m c/c along the approach on each side shall be fixed.

All deviation angles of the central line axis for the Major Bridge with approaches including tangent distances shall be demarcated with pegs fixed in to the ground.

109 SETTING OUT

109.1 The Contractor shall establish working bench marks tied with the Reference bench mark in the area soon after taking possession of the site. The Reference bench mark for the area shall be as indicated in the Contract Documents and the values of

the same shall be obtained by the Contractor from the Engineer. The working bench marks shall be at the rate of four per km and also at or near all drainage structures, over-bridges and underpasses. The working bench marks/levels should be got approved from the engineer. Checks must be made on these bench marks once every month and adjustments, if any, got approved from the Engineer and recorded. An up-to-date record of all bench marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Engineer for his record.

109.2 The lines and levels of formation, side slopes, drainage works, carriageways and shoulders shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross-sections are obtained everywhere.

109.3 In order to facilitate the setting out of the works, the centre line of the carriageway or highway must be accurately established by the Contractor and approved by the Engineer. It must then be accurately referenced in a manner satisfactory to the Engineer, at every 50 m intervals in plain and rolling terrains and 20 m intervals in hilly terrain and in all curve points as directed by the Engineer, with marker pegs and chainage boards set in or near the fence line, and a schedule of reference dimensions shall be prepared and supplied by the contractor to the Engineer. These markers shall be maintained until the works reach finished formation level and are accepted by the Engineer.

109.4 On construction reaching the formation level stage, the center line shall again be set out by the Contractor and when approved by the Engineer, shall be accurately referenced in a manner satisfactory to the Engineer by marker pegs set at the outer limits of the formation.

109.5 No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall commence until the center line has been referenced.

109.6 The Contractor will be the sole responsible party for safe-guarding all survey monuments, bench marks, beacons, etc. The Engineer will provide the Contractor with the data necessary for setting out the center line. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the Contract shall be verified by the Contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions and levels. The Contractor shall, in connection with the staking out of the center line, survey the terrain along the road and shall submit to the Engineer for his approval, a profile along the road center line and cross-sections at intervals as required by the Engineer.

The construction staking shall be done by personnel who are trained and experienced in construction layout and staking of the type and kind required in the Contract.

Field notes shall be kept in standard, bound field notebooks as approved by the Engineer. Field notes shall be subject to inspection by the Engineer and shall be the property of the Employer.

The Contractor shall correct any deficient staking or construction work which resulted from inaccuracies in the staking operations or from the Contractor's failure to report inaccuracies in the plans or survey data furnished by the Department.

109.7 After obtaining approval of the Engineer, work on earthwork/construction can commence. The profile and cross-sections as per Section 305, shall form the basis for measurements and payment. The Contractor shall be responsible for ensuring that all the basic traverse points are in place at the commencement of the contract and, if any, are missing, or appear to have been disturbed, the Contractor shall make arrangements to re-establish these points. A "survey File" containing the necessary data will be made available for this purpose. If in the opinion of the Engineer, design modifications of the center line or grade are advisable, the Engineer will issue detailed instructions to the Contractor and the Contractor shall perform the modifications in the field, as required, and modify the ground levels on the cross-sections accordingly as many times as required.

There will be no separate payment for any survey work performed by the Contractor. The cost of these services shall be considered as being included in the rate of the items of work in the Bill of Quantities.

109.8 Precision automatic levels, having a standard deviation of ± 2 mm per km, and fitted with micrometer attachment shall be used for all double run levelling work. Setting out of the road alignment and measurement of angles shall be done by using Total Station with traversing target, having an accuracy of one second. Measurement of distances shall be done preferably using precision instruments like Distomat.

109.9 The work of setting out shall be deemed to be a part of general works preparatory to the execution of work and no separate payment shall be made for the same.

The rate on Lump sum basis shall include all equipment, survey instruments, necessary survey, supply and fixing of pegs including, fixing of pillars for intermediate stations labour, materials required in completing the job as required, as per direction of Engineer-in-charge. The rate shall be paid Job. for completed item as directed by Engineer incharge.

the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Note:

The quality of the result produced by this test method is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/ sampling/ inspection/etc. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

3. Description of Method

Low Strain Integrity Testing may be applied to any concreted pile (e.g. concrete piles, drilled shafts, augured cast in place piles, concrete filled pipe piles). The test requires the impact of a small hand held hammer on the shaft top and the measurement of the shaft top motion (acceleration or velocity). The input compression wave from the hammer is reflected from pile toe (or a change in cross sectional area or pile material quality) and returns to the pile top at a time related to the speed of travel of the wave in the pile material.

The pile top velocity is displayed as a function of time with an exponentially increasing magnitude such that the pile toe reflection is enhanced. The averaged, amplified velocity, averaged for several impacts, is the standard result of the Pulse Echo Method. The force as a function of time, if available, provides additional information as to the pile quality near the pile top.

The Transient Response Method result shows the ratio of velocity to force transforms for all relevant frequencies in a plot called Mobility. It should be shown together with the related low frequency pile stiffness. Transient Response requires that hammer force is measured.

4. Test Equipment

Provide a Pile Integrity Tester (PIT) or an equivalent equipment. following minimum requirements:

The analog to digital resolution shall be at least 24 bits.

The sampling frequency shall be at least 25,000 Hz.

Data shall be stored such that additional processing or further wave analysis is possible.

Data shall be displayed in the field for evaluations of preliminary data quality and interpretation.

The equipment shall allow attachment of a motion sensing device capable of measuring acceleration, velocity or displacement due to the impact of the pile top with a hand held hammer.

The equipment shall have the PIT (Pile Integrity Tester) performs the wave equation based nondestructive test known as Pulse or Sonic Echo Test, or a Low Strain Dynamic Test.

The PIT test consists of attaching one or two accelerometers to the foundation, and using a hand held hammer to impact it. The PIT collects the acceleration data and displays curves that reveal any significant changes in cross section that may exist along the pile. The software post processes the data and generates reports, while the software simulates a PIT test and performs simplified signal matching to assess the shape of the pile.

5. Test Personnel

The field testing shall be performed by an experienced technician with at least one year experience in integrity testing. The interpretation of the records requires extensive experience by a graduated engineer with at least Three years experience in integrity testing.

6. Test Preparation

For the cast in place piles, integrity testing shall not be performed until the concrete has cured for a minimum of seven (7) days unless otherwise approved by the engineer. The pile head shall be free from water, dirt or other debris. The concrete at the pile top surface must be relatively smooth and provide sufficient space for attaching the motion sensing device and for the hammer impact area.

50% of total piles shall be integrity tested. The location of piles for designated for integrity testing shall be specified by the engineer after pile installation. Additional piles may be selected for testing at the discretion of the engineer if circumstances either during or after pile installation should make a piles' integrity suspect, or if the initial tests reveal major defects.

7. Result Presentation

The testing engineer shall present a report 5 working days after performing the field test to provide the final test results and integrity evaluation. For each pile tested, the averaged, amplified velocity versus time record shall be included in the report, with a table summarizing results and conclusions. Additional plots and analyses can be included as required or suggested by the testing engineer.

8. Acceptance and Rejection

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

9. Remedial Action

Rejected or questionable piles may be replaced. Questionable piles may also be subjected to further testing, e.g., static load testing, dynamic load testing, core drilling, ultrasonic logging, etc. Remedial action may include pressure grouting through core holes. If the pile top appears questionable, further pile top cutoff and retesting may be advisable. If a majority of piles diagnose as "inconclusive", partial or even complete pile excavation or another test method may be necessary for pile acceptance.

Related ASTM Standards

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D6026 Practice for using significant digits in Geotechnical Data.

10. The rate shall be for a unit of **Km.**

Item No.5:- Providing flood gauge marks on substructure as per design including painting complete.

1. The width of the flood gauge shall be 60 cm. and will have caneri 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.. 15cm. width
- (b) At every 1/2m. 25 cm. width in black
- (c) At every meter .. 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 levels based on either GST B.M. or Arbitrary B.M. as furnished by Engineer-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 **Rmt** basis.
4. The unit rate includes the cost of materials, labour, painting, equipment if any to complete the work.

Item No.6:- Providing masonry steps with cement pointing on approaches as directed .

1. Stones subject to mark deterioration will not be accepted. The stone shall be sound, hard, durable and fairly regular in shape and its thickness in any one direction shall not be less than 15 cm.
2. Before laying the stones, the slope of embankment shall be trimmed to the required profile put up by means of line and pages to receive the steps and kerb on it. Depression shall be filled and thoroughly compacted. The width of the tread shall be 30 cm. (clear) and shall extend further 15 cm. below next tread, thickness of the stone work of the tread shall depend upon the slope of the embankment as under:-
 - (a) Slope 1 to 2 .. 15cm.
 - (b) Slope 1 to 3.. 10cm.

The thickness of the stones work shall be uniform throughout and shall not be less than the height of the riser depending upon the slope of the embankment as stated above. There shall not be more than 3 stones in the total 45 cms. width of the tread.

3. Kerb of 15 cm. width & 25 cm. depth, flush with the embankment slope line shall be provided to prevent spilling of earth on the steps. Width of the steps between the kerbs shall be 90cms. Unevenness and voids shall be filled with quarry spalls and exposed faces of the tread riser and kerb of the stones work shall be cement pointed in proportion as specified so that they are stable and remain in line and level. For cement pointing relevant specifications of that item shall apply.
4. The item shall be paid on **Steps.** and unit rate includes the cost of material, labour and tools including cement pointing to complete the work.

Item No.7:- Filling available excavated earth/Wethered rock in trenches, sides of foundations etc. in layers not exceeding 20 cm in depth consolidating each deposited layer by ramming and watering.

1.0 WORKMANSHIP

- 1.1. The earth to be used for filling shall be free from salts, organic or other foreign matter all clots of earth shall be broken.

- 1.2. As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris brick bats mortar dropping etc. and filled with earth in layers not exceeding 20 cms. each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with the ends of crow-bars, where rammer cannot be used.
- 1.3 The foundation shall be similarly filled with earth in layers not exceeding 20 cms adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 1.4 The finished level of filling shall be kept to shape intended to be given to shape.
- 1.5 In case of large area the consolidation may be done by power rollers, where so specified. The extent of consolidation required shall also be as specified.

2.0. Mode of Measurements & Payment

- 2.1. The payment shall be made for filling in plinth and trenches. No deduction shall be made for shrinkage or voids, if consolidated as instructed above.
- 2.2. The rate shall be for a unit of one **Cum.**

Item No.8:- Excavation for foundation in sand , gravel , clay soft soils & murrum etc. Including sorting and strutting and dewatering as necessary and disposing of excavated stuff as directed. (A) Depth upto 3.0M. (B) Depth from 3.0 m to 6.0 m

304.1. Scope

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, headwalls, cutoff walls, pipe culverts and 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, work shall include construction of the necessary cofferdams and cribs their subsequent removal; all necessary sheeting, shoring, bracing, and pumping; the removal of all logs, stumps, grubs and other matter and obstructions, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site the disposal of all surplus material.

301.2 Classification of Excavated Material

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, cobble stone, etc. compacted murrum or stabilized soil requiring use of pickaxe 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 riverbed, 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/flyover 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 200 m of the blast site.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason like people living within 20 m of blast sites etc. and excavation must be carried out by chiseling, 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.

301.3.3 Excavation-General

All excavations shall be carried out in conformity with the directions laid here-in-under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilized as deemed fit or as approved by the Engineer.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc. as per Clause 306, and take appropriate drainage measures to keep the site free of water in accordance with Clause 311.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the Contractor with suitable material of characteristics similar to that removed and compacted to the requirements of Clause 305.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an appropriate manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimize erosion and ponding, allowing for natural drainage to take place.

301.3.4 Methods, Tools and Equipment

Only such methods, tools and equipment as approved by the Engineer shall be adopted/ used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

301.3.5 Rock Excavation

Rock, when encountered in road excavation, shall be removed up to the formation level or as otherwise indicated in the drawings. Where, however, unstable shales or other unsuitable materials are encountered at the formation level, these shall be excavated to the extent of

500 mm below the formation level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formations the rock protrudes above the specified levels. Rocks and boulders which are likely to cause differential settlement and local drainage problems shall be removed to the extent of 500 mm below the formation level in the formation width including side drains.

Where excavation is done to levels lower than those specified, the excess excavation shall be made good as per Clauses 301.3.3 and 301.6 to the satisfaction of the Engineer.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when pierced by a crowbar shall be removed.

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 convenience for the Contractor in executing the work and shall not be measured and paid separately.

Foundation sealing, dewatering, including pumping shall be deemed to be incidental to the work unless separate provision is made for in the Contract.

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) Construction of necessary cofferdams, cribs, sheeting, shoring and bracing and their subsequent removal;
- (iii) Removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundations including trimming of bottoms of excavations;
- (iv) Foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
- (v) Backfilling, clearing up the site and disposal of all surplus material within all lifts and leads or as otherwise specified; and
- (vi) All labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specification.

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.9:- Providing & filling in foundation as base course with ordinary cement concrete of M 15 mix and providing necessary vertical pin headers including formwork vibrating ramming & curing complete.

Ordinary cement concrete of specified Grade shall be carried out in accordance with the following specification.

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coarse aggregates are specified by volume as given in table below for different grades of concrete designated as ordinary M. 10, M. 15, M.20 and M.25.
2. In the designation of a concrete mix, letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150 mm. cubes expressed in kg/cm².
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 meter in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for "bulking" shall be made as per IS : 2386 (Part-III).
4. Ingredients required for ordinary concrete containing one 50 Kg. bag of cement of 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. of cement, to be taken as sum of the individual volumes of fine and coarse aggregates max	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 kg. of cement max.
1	2	3	4	5
(1 Cubic meter = 1000 liters)				
Ordinary	Liters			Liters
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. ½ & 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 proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & 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 shall be 1: 11/2, 1:2 and 1:3 for maximum size of aggregates 10 mm, 20 mm. and 40 mm. respectively (after carrying out sieve analysis).

Note-2A mix leaner than M.100 (1:3:6) may be used for non- structural parts, if provided in the contract. In such case grading of aggregates shall be by volume. Other requirements for mixing, placing & 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 and R.C.C. Piles	40 mm
(ii)	R.C.C. well staining	63 mm
(iii)	Well cap or pile cap; solid type piers, abutment and wing-walls, and their pier caps	40 mm
(iv)	R.C.C. works in cross girders deck slab, wearing coats, kerb, light posts, blast walls, approach slab etc. and hollow type piers, abutments, wing-walls and their pier caps	20 mm
(v)	R.C.C. bearings.	20 mm.
(vi)	For any other item of construction not covered by items (i) to (v)	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 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 works.

8. Cement shall be stored above the ground level in perfectly dry and water tight sheds. 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. The aggregate shall be stored in such a way as to prevent admixture of foreign materials. Different size of fine or coarse aggregate shall be stored in separate stock-piles sufficiently away from the each other to prevent intermixing the materials.

9. The water for mixing shall be potable water to 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 show 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 shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent 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 be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant 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 Engineering-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes places. All form 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 within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting being given, it 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 design 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 be the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter 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 1.2 meters. When trucking or chutes are used they shall be kept clean and used in such a 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 covered 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 well surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles 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 corners and close spots.

16. All concrete shall be compacted to produce a dense homogeneous 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, vibration, traffic, rapid temperature changes, frost and driving out 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, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonary work over the foundation concrete may be started after 48 hours of its 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. Form work shall however be divided into following two distinct categories:-

(1) Shuttering i.e., form work required for forming the concrete.

(2) Scaffolding i.e., form-work 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 rivets 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 prescribe lines occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, specially in long spans to counteract the effects of any fixed as to provide for such camber. Forms shall be so 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, chambers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20. The inside surfaces of shuttering shall, except in the case of permanent form work or where otherwise agreed to by the Engineer-in- charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or pre-stressing tendons and anchorages. Different release agents shall not be used in form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form work does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Where ever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendon's. The form work 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 a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre-stressed structures. Where there are re-entrant angles in the concrete sections the form work should be removed, at those sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage 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 pouring 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 men, 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 formwork, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete, the removal of the load-supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subjected at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength tests 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 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 mortar. No permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to reuse the formwork, 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 be 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, honey comb spots, broken edges or corners 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 that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets/honeycombs, in the opinion of the Engineer-in-charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of 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 by regular slump tests. Following slump shall be adopted for different types of works.

Type of Work	Slumps	
	Where vibrators are used	Where vibrators are not used
1 1 Mass concrete in RCC foundations, footings and retaining walls	10 mm to 25 mm	80 mm
2 Beams, slabs and columns simply reinforced.	25mm to 40 mm	100 to 120 mm
3 Thin R.C.C. section or section with congested steel	75 mm to 125 mm	125mm to 150mm

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 less 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 whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveal 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.

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 present 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 is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapchi 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 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 payment will be made on **Cu.m.** basis of the finished work.

31. The unit rate for concrete shall include the cost of all materials, labour, tools and plan 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 show 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.

Item No.10:- Providing and Casting in situ controlled Cement Concrete M-30 for R.C.C. Raft and cutt-off walls including necessary shuttering laying, vibrating, ramming and curing complete.

1701. DESCRIPTION

The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these specifications and in conformity with the lines, grades and dimensions, as shown -on the drawings or as directed by the Engineer. The relevant clause No. 1100 of MORTH 5th revision on shall be followed for pile work.

1702. MATERIALS

All materials shall conform to Section 1000 of MORT&H Specifications.

1703 GRADES OF CONCRETE

1703.1 The grades of concrete shall be designated by the characteristic strength as given in Table 1700-1, where the characteristic strength is defined as the strength of concrete below which not more than 5 per cent of the test results are expected to fall.

Table 1700-1: Grades of Concrete

Type of Concrete/Grade Designation			Characteristic Strength in MPa
Nominal Mix Concrete	Standard Concrete	High Performance Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M40	M35	35
	M45	M40	40
	M50	M45	45
		M50	50
		M55	55
		M60	60
		M65	65
		M70	70
		M75	75
		M80	80
		M85	85

		M90	90
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1. Nominal Mix Concrete is made on the basis of nominal mix proportioned by weight of its main ingredients – cement, coarse and fine aggregates and water.
2. Standard concrete is made on the basis of design mix proportioned by weight of its ingredients, which in addition to cement, aggregates and water, may contain chemical admixtures to achieve certain target values of various properties in fresh condition, achievement of which is monitored and controlled during production by suitable tests. Generally, concrete grades up to M50 are included in this type.
3. High Performance Concrete is similar to standard concrete but contains additional one or more mineral admixtures providing binding characteristics and partly acting as inert filler material which increases its strength, reduces its porosity and modifies its other properties in fresh as well as hardened condition. Concrete of grades Upto M90 are included in this type.
4. For concrete of grades higher than M90, the design parameters may be obtained from specialized literature and experimental results.

1703.2 The minimum grades of concrete and corresponding minimum cement content and maximum water/cement ratios for different exposure conditions shall be as indicated in Table 1700-2.

1703.3 For concrete subjected to sulphate attack the minimum grades of concrete, minimum cement content and maximum water/cement ratios and types of cement for different concentration of sulphate content shall be as indicated in Table 1700-3.

Table 1700-2: Requirement of Concrete for Different Exposure Condition Using 20mm Aggregate

Exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m ³	Minimum Grade of Concrete
Moderate	0.45	340	M25
Server	0.45	360	M30
Very Server	0.40	380	M40

Note:

- (i) All three provisions given in the above table for a particular exposure condition shall be satisfied.
- (ii) The term cement for maximum w/c ratio and minimum cement content shown in Table includes all cementitious materials mentioned in Clause 1715.2. The maximum limit of flash and ground granulated blast furnace slag in the blended cement shall be as specified in IS:1489(Part 1) and IS:455 respectively.
- (iii) For plain cement concrete, with or without surface reinforcement, the Minimum grade of concrete can be lowered by 5MPa and maximum water/cement ratio exceeded by 0.05.

Cement content shown in the above table shall be increased by 40 kg/m³ for use of 12.50 mm nominal size aggregates and decreased by 30 kg/m³ for use of 40mm nominal size aggregates.

Table 1700-3: Requirement of Concrete Exposed to Sulphate Attack

Class	Concentration of Sulphates as SO ₃			Type of Cement (Note ii)	Minimum Cement Content kg/m ³	Maximum Water / Cement Ratio	Minimum Grade of Concrete
	In Soils		In Ground Water, g/l				
	Total SO ₃ , %	SO ₃ , in 2:1 Water: Soil Extract, g/l					
1)	Traces	< 1.0	< 0.3	-OPC, PPC or PSC	280	0.5	M25
2)	2.0 to 0.5	1.0 to 1.9	0.3 to 1.2	-OPC PPC or PSC -SRPC	330	0.5	M25
3)	0.5 TO 1.0	1.9 TO 3.1	1.2 TO 2.5	-SRPC -PPC or PSC	330 350	0.5 0.45	M25 M30
4)	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	-SRPC	370	0.45	M35
5)	>2.0	>5.0	>5.0	-SRPC With Protective Coatings	400	0.4	M40

Notes: If the requirements of maximum water/cement ratio, minimum grade of concrete and minimum cement content from other durability considerations as given in Table 1700-2 are more stringent than those given in this table, then the former will govern.

OPC: Ordinary Portland Cement, PPC: Portland Pozzolona Cement. PSC: Portland Slag Cement, SRPC: Sulphate Resisting Portland Cement.

The minimum cement content shall be as low as possible but not less than the quantities specified in Table 1700-2 and 1700-3.

The maximum cement content excluding any mineral admixtures (Portland cement component alone) shall not exceed 450 kg/cu.m.

1703.4 Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. 'Design Mix' or 'Nominal Mix'. For all items of concrete, only design mix shall be used, except where nominal mix concrete is permitted as per drawing or by the Engineer. Nominal mix may be permitted only for minor bridges and culverts or other incidental construction,

where strength requirements are upto M 20 only. Nominal mix may also be permitted for non-structural concrete or for screed below open foundations.

1703.5 If the contractor so proposes, the Engineer may permit the use of concrete of higher grade than that specified on the drawing, provided the higher-grade concrete meets the specifications applicable. The additional cost of such higher-grade concrete shall be borne by the Contractor.

1704 PROPORTIONING OF CONCRETE

Prior to the start of construction, the contractor shall design the mix in case of design mix concrete or propose nominal mix in case of nominal mix concrete, and submit to the Engineer for approval, the proportions of materials, including admixtures to be used at the Contractor's option, subject to the approval of the Engineer.

1704.1 Requirements of Consistency

The mix shall have the consistency which will allow proper placement and compaction in the required position. Every attempt shall be made to obtain uniform consistency. Slump test shall be used to measure consistency of the concrete.

The optimum consistency for various types of structures shall be as indicated in Table 1700-4, or as directed by the Engineer. The slump of concrete shall be checked as per IS:516.

Table 1700-4 : Requirements of Consistency

Type		Slump (mm) (at the Time of Placing of Concrete)
1)	a) Structure with exposed inclined surface required low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcement, e.g. Solid columns, piers, abutments, footings, well staining	40 - 50
3)	RCC structure with fair degree of congestion of reinforcement, e.g. pier and abutment caps, box culverts, Well curb, well cap, walls with thickness greater than 300 mm	50 - 75
4)	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 - 125
5)	Underwater concreting through tremie e.g. bottom plug, Cast in-situ pilling	150 - 200

Notwithstanding the optimum consistency indicated against SI. No. 1 to 3, the situation should be properly assessed to arrive at the desired workability with the adjustment of admixture in each case, where the concrete is to be transported through transit mixer and placed using concrete pump. Under these circumstances, the optimum consistency during placement for the items of work of SI. No. 1 to 3, can be

considered ranging from 75 mm to 150 mm. This is, however, subject to satisfying the other essential criteria of strength, durability etc. and approval of the Engineer.

1704.2 Requirements for Design Mixes

1704.2.1 Target Mean Strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the current margin.

- i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.
- ii) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 1700-5:

Table 1700-5: Current Margin for Initial Design Mix

Concrete	Current Margin (MPa)	Target Mean Strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69
M 60	14	74
M 65	15	80
M 70	15	85
M 75	15	90
M 80	15	95
M85	16	101
M90	16	106

The initial current margin given in Table 1700-5 shall be used till sufficient data is available to determine the current margin as per Sub-Clause 1704.2.1(i).

1704.2.2 Trial mixes

The Contractor shall give notice to the Engineer to enable him to be present at the time of carrying out trial mixes and preliminary testing of the cubes. Prior to commencement of trial mix design, all materials forming constituents of proposed design mix should have been tested and approval obtained in writing from the Engineer. Based on that results of material, draft mix design calculation for all grades

of concrete to be used in the works, shall be prepared after taking into account the provisions in the contract Technical Specifications, Guidelines of IS:10262, IS:SP:23 and IRC:112 and submitted to the Engineer for approval. Prior to commencement of concreting, trial mix design shall be performed for all grades of concrete and trial mix which has been found successful, shall be submitted by the Contractor and approval obtained. During concreting with the approved trial mix design, if source of any constituents is changed, the mix design shall be revised and tested for satisfying the strength requirements.

The initial trial mixes shall be carried out in a laboratory approved by the Engineer. However, Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full-fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. Sampling and testing procedures shall be in accordance with these specifications.

When the site laboratory is utilized for preparing initial mix design, the concreting plant and means of transport employed to make the trial mixes shall be similar to that proposed to be used in the works.

For each trial mix, a set of six cubes shall be made from each of three consecutive batches for purposes of testing. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these Specifications. The mean strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

1704.2.3 Control of strength of design mixes

(a) Adjustment to Mix Proportions

Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the Engineer's approval, in order to minimize the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

(b) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with Clause 1704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced thereafter.

(c) Additional Trial Mixes

In case any changes are observed in the properties of fresh concrete and/or strength of hardened concrete on the basis of early age tests, additional mixes and tests shall be carried out during production, so as to control and bring the quality of concrete within acceptable limits. In case of any change in the source or properties of materials, the design of mix shall be established afresh.

1704.3 Requirements of Nominal Mix Concrete

Requirements for nominal mix concrete unless otherwise specified shall be as given in Table 1700-6.

Table 1700-6 : Requirements for Nominal Mix Concrete

Concrete Grade	Total Quantity of Dry Aggregate by Mass per 50 kg of Cement to be taken as the Sum of Individual Masses of Fine and Coarse Aggregates (kg)	Proportion of Fine to Coarse Aggregate (by Mass)	Maximum Quantity of Water for 50 kg of cement (Liters)	
			PCC	RCC
M 15	350	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5	25	
M 20	250		25	22

1704.4 Additional Requirements

Concrete shall meet with any other requirements as specified on the drawing or as directed by the Engineer. Additional requirements shall also consist of the following Overall limits of deleterious substances in concrete:

(a) Total acid soluble chloride content in the concrete mix expressed as chloride ions shall not exceed the following values by mass of cement.

- Prestressed Concrete : 0.10 percent
- Reinforced concrete (in sever, very sever or extreme exposure condition) : 0.20 percent
- Reinforced concrete in moderate exposure Condition : 0.30 percent

(b) The total water soluble sulphate content of the concrete mix expressed as SO₃, shall not exceed 4 percent by mass of cement in the mix.

For concrete made with Portland pozzolona cement, Portland blast furnace slag cement or mineral admixtures. the setting time and rate of gain of strength are different form those for concrete made with OPC alone. Such modified properties shall be taken into account while deciding the de-shuttering time, curing period, early age loading and time of prestressing. Additional cube samples may be required to be taken for verifying the concrete properties.

1704.5 Suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the Engineer's approval:

- a) Nature and source of each material
- b) Quantities of each material per cubic meter of fully compacted concrete
- c) Either of the following :
 - (i) appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirements) as specified

(ii) Full details of tests on trial mixes.

d) Statement giving the proposed mix proportions for nominal mix concrete

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

1704.6 Checking of Mix Proportions and Water/Cement Ratio

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement per bag as given by the manufacturer is accepted, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stock at site and not by bag, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained by in a clean and serviceable condition. Their accuracy shall be periodically checked.

The specified water/cement ratio shall always be kept constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible, the frequency for a given job being determined by the Engineer according to the weather conditions. The amount of water to be added shall then be adjusted to compensate for variations in moisture content. For the determination of moisture content in the aggregates IS:2386 (Part III) shall be referred. Suitable adjustments shall also be made in the weight of aggregates to allow for their variation in their moisture content.

1704.7 Grading of \aggregates for Pumped Concrete

Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe.

The grading of aggregates shall be continuous and shall have sufficient ultra fine materials (material finer than 0.25 mm). Proportion of fine aggregates passing through 0.25 mm shall be between 15 and 30 percent and that passing through 0.125 mm sieve shall not be less 5 percent of the total volume of aggregate. Admixtures to increase workability can be added. When pumping long distance and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactory after adding plasticizers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

1705 ADMIXTURES

1705.1 Chemical Admixtures

Chemical admixtures such as superplasticizers, or air entraining, water reducing, accelerating and retarding agents for concrete, may be used with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of their products only after obtaining complete information of all the actual constituents of concrete as well

as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the work. Admixtures/additives conforming to IS:9103 may be used subject to approval of the Engineer. However, admixtures/additives generating hydrogen or nitrogen and containing chlorides, nitrates, sulphides, sulphates or any other material likely to adversely affect the steel or concrete, shall not be permitted.

The general requirements for admixtures are given in Clause 1007 of these Specifications.

Compatibility of the admixtures with the cement and any other pozzolona or hydraulic addition shall be ensured by for avoiding the following problems

- i) Requirement of large dosage of superplasticizer for achieving desired workability.
- ii) Excessive retardation of setting.
- iii) Excessive entrainment of large air bubbles.
- iv) Unusually rapid stiffening of concrete.
- v) Rapid loss of slump
- vi) Excessive segregation and bleeding.

1705.2 Mineral Admixtures

For use of mineral admixtures, refer Clauses 1714.1 and 1715.2.

1706 SIZE OF COARSE AGGREGATE

The size (maximum nominal) of coarse aggregates for concrete to used in various components shall be given as Table 1700-7.

TABLE 1700-7 : Maximum Nominal Size of Coarse Aggregates

Components	Maximum Nominal Size of Coarse Aggregate (mm)
i) RCC well curb	20
ii) RCC/PCC well staining	40
iii) Well cap or Pile Cap Solid type piers and abutments	40
iv) RCC work in girders, slabs, wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20
v) PSC work	20
vi) Any other item	As specified by the Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values :

- a) 10 mm less than the minimum lateral clear distance between main reinforcements

- b) 10 mm less than the minimum clear cover to the reinforcements
- c) One quarter of minimum thickness of member

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

1707. EQUIPMENT

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under:

- a) Production of Concrete:
 - i) For overall bridge length of less than 200 m – batch type concrete mixer, diesel or electric operated, with a minimum size of 200 liters automatic water measuring system and integral weighed (hydraulic/pneumatic type)
 - ii) For overall bridge length of 200 m or more – concrete batching and mixing plant fully automatic, with minimum capacity of 15 cum per hour.

All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Its accuracy shall be checked over the range in use, when set up at each site and thereafter periodically as directed by the Engineer.

The accuracy of the measuring devices shall fall within the following limits:

Measurement of Cement : ± 3 percent of the quantity of cement in each batch

Measurement of Water : ± 3 percent of the quantity of water in each batch

Measurement of Aggregate : ± 3 percent of the quantity of aggregate in each batch

Measurement of Admixture : ± 3 percent of the quantity of admixture in each batch

- b) Transportation of Concrete :
 - i) Concrete dumpers minimum 2 tonnes capacity
Powered hoists minimum 0.5 tonnes capacity Chutes
 - ii) Buckets handled by cranes
 - iii) Transit truck mixer
 - iv) Concrete pump
 - v) Concrete distributor booms
 - vi) Belt conveyor
 - vii) Cranes with skips
 - viii) Tremies

- c) For Compaction of Concrete :
- i) Internal vibrators size 25mm to 70mm
 - ii) Form vibrators minimum 500 watts
 - iii) Screed vibrators full width of carriageway (upto two lanes)

1708 BATCHING, MIXING, TRANSPORTING, PLACING AND COMPACTION

1708.1 General

Prior to start of concreting, the Contractor shall submit for approval of the Engineer, his Programme along with list of equipment proposed to be used by him for batching, mixing, transporting and placing concrete.

1708.2 Batching of Concrete

In batching concrete:

- The quantity of cement, aggregate and mineral admixtures, if used, shall be determined by mass.
- Chemical admixtures, if solid, shall be determined by mass.
- Liquid admixtures may be measured in volume or mass, and
- Water shall be weighed or measured by volume in a calibrated tank.

The concrete shall be sourced from on-site or off-site batching and mixing plants, or from approved Ready Mixed Concrete plants, preferably having quality certification.

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

The water/cement ratio shall always be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregates shall be made as frequently as possible, depending on weather conditions. The amount of added water shall be adjusted to compensate for any observed variations in the moisture content. To allow for the variation in mass of aggregate due to variation in moisture content, suitable adjustment in the mass of aggregate, shall also be made. Accurate control shall be kept on the quantity of mixing water, which when specified, shall not be changed without approval.

1708.3 Mixing Concrete

1708.3.1 Mixing at Site

All concrete shall be machine mixed. In order to ensure uniformity and good quality of concrete the ingredients shall be mixed in a power driven batch mixer with hopper and suitable weigh batching arrangement or in a central mix plant. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed and a 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 mixing be done for less than 2 minutes. It shall be ensured that the mixers are not loaded above their rated capacities and are operated at a speed recommended by the manufacturer. When mineral admixtures are added at the mixing stage, their thorough and uniform blending with cement shall be ensured, if necessary by longer mixing time. The addition of water after the completion of the initial mixing operation, shall not be permitted.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch and also before changing from one type of cement to another.

1708.3.2 Ready Mix Concrete

Use of ready mix concrete proportioned and mixed off the project site and delivered to site in a freshly mixed and unhardened state conforming to IS:4926, shall be allowed with the approval of the Engineer.

1708.4 Transporting Concrete

Mixed concrete shall be transported from the place of mixing to the place of final deposit as rapidly as possible by methods which will prevent the segregation or loss of the ingredients. The method of transporting or placing of concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position so that no contamination, segregation or loss of its constituents materials take place.

Concrete may be transported by transit mixers or properly designed buckets or by pumping. Transit mixers or other hauling equipment when used should be equipped with the means of discharge of concrete without segregation. During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to be reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

When concrete is conveyed by chute, the chute shall be of such size and design as to ensure practically continuous flow. Slope of the chute be so adjusted that the concrete flows without excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

In case concrete is to be transported by pumping, the fresh concrete should have adequate fluidity and cohesiveness to be pumpable. Proper concrete mix proportioning and initial trials should ensure this. The conduit shall be primed by pumping a batch of mortar through the line to lubricate it. Once the pumping is started, it shall not be interrupted, as concrete standing idle in the line is liable to cause plug. The operator shall ensure that some concrete is always there in the pump's receiving hopper during operation. The lines shall always be maintained clean and free of dents.

Pipelines from the pump to the placing area shall be laid with minimum bends. For large quantity placements, standby pumps shall be available. Suitable air release valves, shutoff valves etc. shall be provided as per site requirements. The pumping of priming mix i.e. rich mix of creamy consistency, to lubricate the concrete pump and pipelines, shall precede the pumping of concrete. Continuous pumping shall be done to the extent possible. After concreting, the pipelines and accessories shall be cleaned immediately. The pipes for pumping shall not be made of material which has adverse effect on concrete. Aluminum alloy pipelines shall not be used.

1708.5 Placing of Concrete

All formwork 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 has been obtained. If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the 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.

The concrete shall be deposited as nearly as practicable in its original position to avoid re-handling. Methods of placing should be such as to preclude segregation. Care should be taken to avoid displacement of reinforcement or movement of formwork. To achieve this, concrete should be lowered vertically in the form and horizontal movement of concrete inside the forms should, as far as practicable, be minimized.

The concrete shall be placed and compacted before its initial setting so that it is amenable to compaction by vibration. The workability of concrete at the time of placement shall be adequate for the compaction equipment to be used. If there is considerable time gap between mixing and placing of concrete, as in the case of ready mixed concrete plants or off-site batching and mixing plants, concrete mix shall be designed to have appropriately higher workability at the time of discharge from the mixer, in order to compensate the loss of workability during transit. This is generally achieved by suitable chemical admixtures. Keeping these considerations in view, the general requirement for ready mixed concrete plants or off-site batching and mixing plants, is that concrete shall be discharged from the truck mixer within two hours of the time of loading. A longer period may be permitted if suitable retarding admixtures are used.

In the wall forms, drop chutes attached to hoppers at the top should preferably be used to lower concrete to the bottom of the form. As a general guidance, the permissible free fall of concrete may not exceed 1.5 meters and under no circumstances shall it be more than 2 meters. When free fall of larger height is involved, self compacting concrete having adequate fluidity, cohesiveness and viscosity and which uniformly and completely fills every corner of the formwork by its own weight without segregation, shall be used.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases.

Concrete when deposited shall have a temperature of not less than 5° C and preferably not more than 30° C and in no case more than 40°C. It 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 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

1708.6 Compaction of Concrete

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc. shall be avoided.

When internal vibrators are used, they shall be inserted vertically to the depth of the layer being placed and ordinarily shall penetrate the layer below for a few centimeters. The vibrator should be kept in place until air bubbles cease escaping from the surface and then withdrawn slowly to ensure that no hole is left in the concrete, care being taken to see that it remains in continued operation while being withdrawn. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and a half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.

Mechanical vibrators used shall comply with IS:2502, IS:2506, IS:2514 and IS:4656.

1709. CONSTRUCTION JOINTS

Construction joints shall be avoided as far as possible. In no case shall the locations of such joints shall be changed or increased from those shown on the drawings except with express approval of the Engineer.

Joints should be positioned where they are readily accessible for preparation and concreting. Construction joints should be positioned to minimize the effects of the discontinuity of the durability, structural integrity and appearance of the structure. As far as possible, joints should be provided in non-aggressive zones, but if joints in aggressive zones cannot be avoided, they should be sealed. Joints should be located away from the regions of maximum stress caused by loading; particularly where shear and bond stresses are high.

In beams and slabs joints should not be near the supports. Construction joints between slabs and ribs in composite beams, shall be avoided. For box girders, there shall be no construction joint between the soffit and webs.

Joints should be either vertical or horizontal. For a vertical construction joint, the lifts of concrete shall finish level or at right angles to the axis of the member. Concreting shall be continued right up to the joint.

Before resuming work at a construction joint when concrete has not yet fully hardened, All laitance shall be removed thoroughly. The surface shall be roughened, taking care to avoid dislodgement of coarse aggregates. Concrete shall be brushed with a stiff brush soon after casting, while the concrete has only slightly stiffened. If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed. Fully hardened concrete shall be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles. The Practice of first placing a layer of mortar or grout when concreting joints, shall be avoided. The old surface shall be soaked with water, without leaving puddles, immediately before starting concreting. The new concrete shall be thoroughly compacted against it.

Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement shall be protected. In all cases, where construction joints are made, the joint surface shall not be contaminated with release agents, dust, or sprayed curing membrane and reinforcement shall be firmly fixed in position at the correct cover.

The sequence of concreting, striking of forms and positioning of construction joints for every individual structure, shall be decided well in advance of the commencement of work.

1710 CONCRETING UNDER WATER

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used, shall be got approved from the Engineer before any work is started.

Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall not be less than 16°C, nor more than 30°C.

Coffer dams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 m per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimize the formation of laitance, care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

All under water concreting shall be carried out by tremie method only. The number and spacing of the tremies should be worked out to ensure proper concreting. However, it is necessary to have a minimum number of 2 tremies for any concreting operation, so that even if one of the tremies goes out of commission during concreting, the other one can be used to complete the work. The tremie concreting when started, should continue without interruption for the full height of the member being concreted. The capacity of the concrete production and placement equipment should be sufficient to enable the underwater concreting to be completed uninterrupted within the stipulated time.

The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket, as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise the tremie slowly in order to allow a uniform flow of concrete. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete and shall not be taken out of concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. It is advisable to use retarders or suitable superplasticizers to retard the setting time of concrete, which shall be established before the commencement of work.

1711 CONCRETING IN EXTREME WEATHER

1711.1 Concreting in Cold Weather

Where concrete is to be deposited at or near freezing temperature, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5°C and that the temperature shall be maintained above 4°C until the concrete has hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated artificially other than by the heat transmitted to it from other ingredients of the concrete. Stock piled aggregate may be heated by the use of

dry heat or steam. Aggregates shall not be heated directly by gas or on sheet metal over fire. In general, the temperature of aggregates or water shall not exceed 65°C. Salt or other chemicals shall not be used for the prevention of freezing. No frozen material or materials containing ice shall be used. All concrete damaged by frost shall be removed. Concrete exposed to freezing weather shall have entrained air and the water content of the mix shall not exceed 30 liters per 50 kg of cement. To counter slower setting of concrete, accelerators can be used with the approval of the Engineer. However, accelerators containing chloride shall not be used.

1711.2 Concreting in hot Weather

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 30°C while placing. This shall be achieved by using chilled mixing water, using crushed ice as a part of mixing water, shading stock piles of aggregates from direct rays of the sun, sprinkling the stock piles of coarse aggregate with water to keep them moist, limiting temperature of cement below 30°C at the time of use, starting curing before concrete dries out and restricting time of concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered as part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 30°C during the work.

1712 PROTECTION AND CURING

1712.1 General

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately after compaction of the concrete.

The concrete shall be protected from:

- a) Premature drying out particularly by solar radiation and wind
- b) High internal thermal gradients
- c) Leaching out by rain and flowing water
- d) Rapid cooling during the first few days after placing
- e) Low temperature or frost
- f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.
- g) Vibration caused by traffic including construction traffic.

Concrete shall be protected, without allowing ingress of external water, by means of wet (not dripping) gunny bags, hessian etc. Once the concrete has attained some degree of hardening (approximate 12 hrs after mixing), moist curing shall commence and be continued through the requisite period. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

1712.2 Water Curing

Water for curing shall be as specified in Section 1000 of these specifications.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members before they have attained adequate strength.

The concrete should be kept constantly wet by ponding or covering or use of sprinklers/perforated pipes for a minimum period of 14 days after concreting, except in the case of concrete with rapid hardening cement, where it can be reduced to 5 days. Water should be applied on surfaces after the final set. Curing through watering shall not be done on green concrete. On formed surfaces, curing shall start immediately after the forms are stripped. The concrete shall be kept constantly wet with a layer of sacking, canvas, hessian or similar absorbent material.

1712.3 Steam Curing

Where steam curing is adopted, it shall be ensured that it is done in suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete. Steam curing is applied in enclosures or tunnels through which concrete members are transported on a conveying system. Alternatively, portable enclosures or plastic covers are placed over precast members and steam is supplied to the enclosures. The rate of increase or decrease of temperature should not be more than 10°C to 20°C per hour and the maximum temperature shall be about 70°C. The maximum temperature shall be maintained until the concrete has attained the desired strength required at the end of steam curing period and shall be decided by prior trials. When steam curing is discontinued, the air temperature shall not drop at a rate exceeding 10°C per hour, until a temperature of about 10°C above the ambient temperature outside has been reached. Steam curing of concrete shall be followed by water curing for at least 7 days. The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

1712.4 Curing Compound

Membrane forming curing compounds consisting of waxes, resins, chlorinated rubbers etc. may be permitted by the Engineer in special circumstances. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist cured and no curing compound shall be permitted in locations where concrete surfaces are required to be bonded together.

Liquid membrane forming compounds shall conform to ASTM C 309 and the curing efficiency shall be as per ASTM C 156.

Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking. The membrane formed shall be stripped off after 14 days, when curing is complete. Impermeable membranes, such as sheet materials for curing concrete conforming to ASTM C 171 or polyethylene sheeting covering closely the concrete surface, may also be used to provide effective barrier against evaporation.

1713 FINISHING

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with 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 corners, and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar. The mortar shall be of 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 possible. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance of the member, shall be rejected. Surface defects of a minor nature may be accepted. On acceptance of such work, the same shall be rectified as directed by the Engineer.

1714 CONCRETE WITH BLENDED CEMENTS OR MINERAL ADMIXTURES

1714.1 Production of Concrete

In order to improve the durability of the concrete, use of blended cement or blending of mineral admixtures, is permitted. The maximum limit of flyash and ground granulated blast furnace slag in concrete, shall be as specified in Clause 1715.2. Blending at site shall be permitted only through a specific facility with complete automated process control to achieve the specified design quality or through RMC plants with similar facility.

1714.2 Modified Properties

For concrete made with Portland Pozzolona Cement, Portland Blast furnace slag cement or mineral admixtures, the setting time and rate of gain of strength are different from those of concrete made with OPC alone. Cognizance of such modified properties shall be taken in deciding de-shuttering time, initial time of prestressing, curing period and for early age loading.

1714.3 Compatibility of Chemical Admixtures

Compatibility of chemical admixtures and superplasticizers with Portland Pozzolona cement, Portland blast furnace slag cement and mineral admixtures shall be ensured by trials outlined in Clause 1705.

1714.4 Additional Tests

In addition to the strength tests prescribed in other Sections of these Specifications, the following additional tests are required to be carried out from considerations of durability.

i) Rapid Chloride Ion Permissibility Test

Rapid Chloride Ion permeability test on as per ASTM C 1202 at 56 days for extreme, very severe and severe conditions of exposure. The permissible value of Chloride-Ion permeability for extreme condition 800 Coulombs very severe condition 1200 coulombs and severe exposure condition 1500 coulombs.

ii) Water Permeability Test

Water permeability test as per DIN: 1048 Part 5-1991 shall be carried out as described in Clause 1717.2.5.5.

1715 HIGH PERFORMANCE CONCRETE

1715.1 General

High Performance Concrete shall be used where special performance requirements of high strength, high early strength, high workability, low permeability and high durability for severe service environments, are required. Production and use of such concrete in the field shall be carried out with high degree of uniformity between batches and very stringent quality control.

1715.2 Materials

Cement, mineral admixtures, chemical admixtures, aggregates and water shall conform to Section 1000 of these Specifications and this Section.

Flyash when used, shall neither be less than 20 percent nor shall be greater than 35 percent of the total by mass of ordinary Portland cement and flyash and shall conform to grade-1 of IS:3812.

Ground granulated blast furnace (GGBS) slag when used, shall neither be less than 50 percent nor greater than 70 percent of the total mass of ordinary Portland cement and GGBS and shall conform to IS:12089, Silica fume conforming to IS:15388 shall be used.

The cement content of concrete inclusive of any mineral admixtures shall not be less than 380 kg/m³. The cement content excluding any mineral admixtures (Portland cement content alone) shall not exceed 450 kg/m³. The water/cement (cement plus all cementitious materials) ratio should generally not exceed 0.33 but in no case shall be more than 0.40.

1715.3 Compatibility of Admixtures

Compatibility of the superplasticizer and admixtures with the cement and any other Pozzolanic or hydraulic dilutes shall be ensured by trials as outlined under Clause 1705.

1715.4 Characteristic Strength and Target Mean Strength

Characteristic strength and the initial target mean strength of concrete, shall be as given in Table 1700-8. The target mean strength shall be calculated as per Clause 1704.2 after obtaining data on standard deviation from sufficient samples.

Table 1700-8 : Characteristic Compressive Strength and Target Mean Strength

Grade Designation	Specified Compressive Strength (MPa)	Characteristic Strength at 28 days	Target Mean Strength (MPa)
M 40	40		52
M 45	45		58
M 50	50		63
M 55	55		69
M 60	60		74
M 65	65		80
M 70	70		85
M 75	75		90
M 80	80		95

M 85	85	101
M 90	90	106

1715.5 Workability and Other Requirements

Workability, concrete mix design, field trial mixes, chloride and sulphate contents shall be as laid down in other Sections of these Specifications.

1715.6 Mixing of Concrete

The concreting plant and means of transportation employed to make trial mixes and to transport them to representative distances shall be similar to the corresponding plant and transport to be used in the works. The optimum sequence of mixing of ingredients shall be established by trials. Mixing time may be longer than in normal grade concrete mixes.

The temperature of concrete at the time of placement shall not exceed 25°C. The temperature of concrete at the mixing stage should be lower, to allow for rise in temperature during transport. When considerable distance of transport is involved, particular attention should be paid to ensure retention of slump as targeted for placement.

1715.7 Prototype Testing

Mock-up trials or prototype testing may be carried out to ensure that the concrete can be satisfactorily placed and compacted, taking into account the location of placement and provision of reinforcement, and required adjustments made in concrete mix design and/or detailing of reinforcement.

1715.8 Curing of Concrete

High performance concrete containing silica fume is more cohesive than normal mixes hence, there is a little or no bleeding and no bleed water to rise to the surface to offset water loss due to evaporation. Plastic shrinkage cracking is possible, if curing is not proper. Initial curing should commence soon after initial setting of concrete. Concrete should be covered with moist covers, opaque colour plastic sheets or suitable curing compound. Final moist curing should commence after final setting of concrete and continue for at least 14 days.

1715.9 Additional Tests for Concrete

Apart from the strength tests prescribed in other Sections of these Specifications, the additional tests as specified under Clause 1714.3, shall also be carried out.

1716 TOLERANCES

Tolerances for dimensions/shape of various components shall be as indicated in these Specifications or shown on the drawings or as directed by the Engineer.

1717 TESTS AND STANDARDS OF ACCEPTANCE

1717.1 Concrete shall conform to the surface finish and tolerance as prescribed in these Specifications for respective components.

1717.2 Random sampling and lot by lot acceptance inspection, shall be made for the 28 days cube strength of concrete.

1717.3 Concrete under acceptance, shall be notionally divided into lots for the purpose of sampling before commencement of work. The basis of delimitation of lots shall be as follows:

- i) No individual lot shall be more than 30 cu.m in volume
- ii) Different grades of mixes of concrete shall be divided into separate lots.
- iii) Concrete of a lot shall be used in the same identifiable component of the bridge.

1717.4 Sampling and Testing

Concrete for preparing 3 test cubes shall be taken from a batch of concrete at point of delivery for construction, according to procedure laid down in IS:1199.

A random sampling procedure shall be adopted which ensures that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes.

150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28 day test strength result for each cube shall form an item of the sample. Tests at other age shall also be performed, if specified.

Where automated batching plant/Ready Mixed Concrete Plant is located away from the place of use and the time gap between production and placement is more than the initial setting time or where any ingredients are added subsequent to mixing, separate sets of samples shall be collected and tested at batching plant and at location of placement. The results shall be compared and used to make suitable adjustment at batching plants so that properties of concrete at placement are as per the requirements.

1717.5 Test Specimen and Sample Strength

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

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 percent of the average. If variation is more, the test results of the sample are invalid.

1717.6 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-9.

Table 1700-9 : Minimum Frequency of Sampling

Quantity of Concrete in Work, m ³	No. of Samples
1 — 5	1
6 — 15	2
16 — 30	3
31 — 50	4
51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof

At least one sample shall be taken from each shift of work.

1717.7 Acceptance criteria

1717.7.1 Compressive Strength

1) Cubes

The concrete shall be taken as having the specified compressive strength when both the following conditions are met:

- The mean strength determined from any group of four consecutive non-overlapping samples exceeds the specified characteristic compressive strength by 3 MPa.

- Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

2) Cores

When the concrete does not satisfy both the conditions given in (1) above, representative cores shall be extracted from the hardened concrete for compression test in accordance with the method described in IS:1199 and tested to establish whether the concrete satisfies the requirement of compressive strength.

Evaluation of compressive strength by taking cores may also be done in case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests.

The locations from which core samples are to be taken and their number shall be decided so as to be representative of the whole of the concrete under consideration. However, in no case shall fewer than three cores be tested. Cores shall be prepared and tested as described in 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 of the grade of concrete specified for the corresponding age and no individual core has strength less than 75 percent of the specified strength.

1717.7.2 Chloride and Sulphate Content

The total chloride and sulphuric anhydride (SO_3) content of all the constituents of concrete as a percentage of mass of cement in the mix, shall not exceed the values given in this Section.

1717.7.3 Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.4 Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.5 Permeability Test

Water permeability test as per DIN:1048 Part 5-1991 shall be carried out as described below :

- i) A cylindrical test specimen 150 mm dia and 160 mm high shall be prepared.
- ii) After 28 days of curing, the test will be conducted between 28 and 35 days. The test specimen shall be fitted in a machine such that specimen can be subjected to a water pressure of up to 7 bars. Atypical machine is shown in Appendix-1700/1.
- iii) The concrete specimen shall be subjected to a water pressure of 0.5 N/mm² from the top for a period of 3 days. The pressure shall be maintained constant throughout the test period. If the water penetrates through to the underside of the specimen, the test may be terminated and the specimen rejected as failed.
- iv) After 3 days, the pressure shall be released and the sample shall be taken out. The specimen shall be split in the middle by

compression applied on two round bars on opposite sides above and below.

- v) When the split faces show signs of drying (after 5 to 10 minutes), the maximum depth of penetration in the direction of height shall be measured with the scale and extent of water penetration established.
- vi) The mean of maximum depth of penetration obtained from three specimens thus tested, shall be taken as the test result and it shall not exceed 25 mm.

1717.7.6 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance, shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable even after investigation, the Contractor shall remove the rejected concrete forthwith.

1717.7.7 When durability of concrete is desired the rapid chloride ion permeability test as stated under Clause 1714.3.1 shall also be performed in addition to above tests.

1500 FORM WORK

1501 DESCRIPTION

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish, as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support.

1502 MATERIALS

All materials shall comply with the requirements of IRC:87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use/re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC:87 may also be used if approved by the Engineer.

1503 DESIGN OF FORMWORK

1503.1 The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Formwork, Falsework and Temporary Structures" and these specifications. The forms shall be such as to ensure that they can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

1503.2 The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Engineer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information as per Appendix 1500/I, to the Engineer for approval.

Notwithstanding any approval or review of drawing and design by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety of formwork.

1503.3 In the case of prestressed concrete superstructure, careful consideration shall be given to redistribution of loads on props due to prestressing.

1504 WORKMANSHIP

1504.1 The formwork shall be robust and strong and the joints shall be leak-proof. Ballies shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

1504.2 The number of joints in the formwork shall be kept to a minimum by using large sized panels. The design shall provide for proper "soldiers" to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC joint sealing tapes, foam rubber or PVC T-section, is essential to prevent leakage of grout.

1504.3 As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum number of nails shall be used and these shall be of the double-headed type. Alternatively, if the nails are of the normal type, they shall be left partially projecting without being driven to their full length, so that they can be withdrawn easily.

1504.4 Use of ties shall be restricted, as far as practicable. Wherever ties are used they shall be used with HDPE sheathing so that they can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.

1504.5 Unless otherwise specified, or directed, chamfers or fillets of size 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as directed by the Engineer.

1504.6 Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.

1504.7 The formwork shall be constructed with pre-camber to the soffit to allow for deflection of the formwork. This shall be in addition to the pre-camber for the permanent structure as shown on the drawings.

1504.8 Where centering trusses or launching trusses are adopted for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted shall be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion. Launching truss, casting truss of span more than 40 m and travelling forms, shall be load tested before they are put to use.

1504.9 The formwork shall be so made as to produce a finished concrete true to shape, line and levels and dimensions as shown on the drawings,

subject to the tolerances specified in respective Sections of these specifications, or as directed by the Engineer.

1504.10 Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

1504.11 Forms 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 during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

1504.12 The formwork shall ensure the correct final shape of the structure, with the calculated amount of positive or negative camber. The deformation of falsework, scaffolding or propping and the instantaneous or deferred deformation due to various causes arising in prestressed structures, shall be properly accounted for.

1504.13 Suitable camber shall be provided to horizontal members of structure, specially in long spans, to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.

1504.14 The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating oils (machine oils) shall be prohibited for use as coating.

1505 LINING OF FORMWORK

The formwork shall be lined with material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout for the construction of any one structure. The contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and embedded metal parts shall be carefully detailed and their use shall be subject to the approval of the Engineer.

1506 PRECAUTIONS

The following precautions shall be observed:

- i) It shall be ensured that any cut-outs or openings provided in any structural member to facilitate erection of formwork, are closed with the same grade of concrete as that of the structure, after formwork is removed.
- ii) Provision for safe access to the formwork shall be made at all levels as required.
- iii) Close watch shall be maintained to check for settlement of formwork during concreting and any settlement shall be promptly rectified.
- iv) Natural ground shall be checked for bearing capacity and likely settlement before erection of the staging.
- v) it shall be ensured that water used for curing or rain water does not stagnate near the base plate of the staging.
- vi) For shutters used for deep and narrow member, temporary openings in the sides shall be provided to facilitate pouring and compaction of concrete.

1507 PREPARATION OF FORMWORK BEFORE CONCRETING

The inside surfaces of forms shall, except in the case of permanent formwork or where otherwise agreed to by the Engineer, be coated with a release agent supplied by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come in contact with any reinforcement or prestressing tendons and anchorages. Different release agents shall not be used in formwork for exposed concrete.

Before re-use of forms, the following actions shall be taken :

- i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.
- ii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.
- iii) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.
- iv) It shall be ensured that the reinforcement or the surface of the hardened concrete shall not come in contact with the release agent.
- v) All forms shall be thoroughly cleaned immediately before concreting.

The Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork. However, such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

1508 REMOVAL OF FORMWORK

The scheme for removal of formwork (Le. de-shuttering and de-centering) shall be planned in advance and furnished to the Engineer for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer. The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

Form work shall not be released unless the concrete has achieved strength of at least twice the stress the concrete may be subjected at the time of the removal of formwork. When no test is conducted for determination of strength of concrete and where the time of removal of formwork is not specified, the same shall be as under :

	Walls, piers, abutments, columns and vertical faces of structural members	12 to 48 hours as may be decided by the Engineer
	Soffits of Slabs (with props left under)	3 days
	Props left under slabs	14 days
	Soffits of Girders (with props left under)	7 days
	Props (left under girders)	21 days

The above time schedule is applicable when ordinary Portland Cement is used without any admixtures at an ambient temperature exceeding 10°C.

For concrete made with Portland pozzolona cement, Portland slag cement or mineral admixtures, additional cube samples shall be taken for verifying the strength of concrete to decide the time of deshuttering.

Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

Additional precautions as given in Clause 8.17 of IRC: 87, shall also be followed.

1509 RE-USE OF FORMWORK

When the formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before their use again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

All bent steel props shall be straightened before re-use. The maximum permissible deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

1510 SPECIALISED FORMWORK

Specialised formwork such as slipform, floating caisson and travelling form, wherever used shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions supplied to the Engineer. In case proprietary equipment is used, the supplier shall furnish drawings, details, installation instructions etc, in the form of manuals along with the formwork.

For slipform, the rate of climb of the formwork shall be designed for each individual case taking into account various parameters including the grade of concrete, concrete strength, concrete temperature, ambient temperature and concrete admixtures.

For floating caisson, the details of fabrication, floating to site and placing in position shall be as given in Clause 1203.5 of these Specifications.

In order to verify the time and sequence of striking/removal of specialised formwork, routine field tests for the consistency and strength development of concrete are mandatory.

For specialised formwork, the form lining material may be either plywood or steel sheet of appropriate thickness.

1511 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.

1718 MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in **Cum.** basis with finished work. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

1719 RATE

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per Section 1500 of these Specifications. If the concrete is found to be acceptable by the Engineer as sub-standard work, the Contractor shall be subjected to reduction in his contact unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\text{Percentage reduction in rate} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

Item No.11:- Providing and fixing in position of steel grade FE-500D/FE-550D For R.C.C./P.C.C Work for RCC Raft, Retaining wall, Pier, Abutment, return wall, pier, Abutments, Abutment cap, pier cap, seismic arrester, Pedestal. Including cutting hooking, tying, welding etc., complete as per detailed drawing and specification.

01. GENERAL

This work shall consist of furnishing and placing T.M.T. reinforcement bars (intentioned) of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer in charge.

1602. MATERIAL

1602.1. T.M.T. Bars

For Reinforced cement Concrete, the reinforcement steel as the case may be, shall consist of the following grade of reinforcing bars.

Table 1000-3 Grades of Reinforcing Bar

Grade Designation	Bar Type Confirming Governing Specifications	IS Characteristics Strength f_y Mpa	Elastic Modules GP
Fe 240	IS: 432 part I Mild Steel	240	200
Fe 415	IS: 1786 High Strength Deformed steel Bar (HSD)	415	200
Fe 500 or Fe 500D	IS: 1786 High Strength Deformed steel Bar (HSD)	500	200

Fe 550 or Fe 550D	IS: 1786 High Strength Deformed steel Bar (HSD)	550	200
Fe 600	IS: 1786 High Strength Deformed steel Bar (HSD)	600	200

All steel shall be produced from 'original procedure' who manufactures billets directly from iron ores and roll the billets to produced steel confirming to IS:1786 no re-rolled steel shall be incorporate in the works. However, in case the original producer give certificate that they are not producing bars of the required diameter, the engineer may allow the procurement of steel from other suppliers, provided that the reinforcement is manufactured from billets produced from original producers. In such cases, the manufacture's certificate alone shall not be considered as sufficient and the steel shall be got tested by the engineer in the NABL accredited laboratories only, as a third-party check. It shall be ensured that all the test result shall be confirmed to IS: 1786 requirements.

Only new steel shall be delivered to the site. Every bar shall be inspected before placing to its position and defective brittle or burnt bar shall be discarded. Bar with cracked ends of bars shall be discarded.

For the steel procured from original producers also, the Engineer/ Employer may carry out occasional checks on materials through third party as mentioned above, for confirming the test results shown in the certificates, in case of any doubt regarding the quality of steel supplied.

3.0. Pitch

3.1. Distance between bars shall be as specified in drawings and as directed by the Engineer in Charge all bars shall be placed at an accurate distance from each other and shall be bind tightly to maintain the desired pitch Suitable means shall be provided for holding bars securely in position

4.0. Binding wire

4.1. Mild steel binding wire shall be of 1.63 mm or 1.22 mm (16 to 18-gauge diameter and shall conform IS 280-1972

4.2. The use of black wire will be permitted for binding reinforcement bars. It shall be free from dirt, paint, grease or oil, oil scale or loose or thick rust and any other undesirable coating which may prevent adhesion of cement mortar at the time of binding

4.3. Only new binding wire shall be delivered to the site all binding wire shall be inspected before binding to its position and defective brittle, rusted, used wire, shall be discarded

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 bricks, 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 directed by the Engineer using a proper bar bender operated by hand power to obtain the correct radius of bends and shape.

Bars shall not be bent or straightened in a manner that will damage 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.

1605 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 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 pier and walls the vertical reinforcement shall be kept in position by means of timber templates with slots in them accurately, or with cover blocks tied to the Reinforcement Timber templates shall be removed after the concreting has progressed up to a level just below their location.

iii) Layers of reinforcements shall be separated by spacer bars at approximately One meter intervals. The minimum diameter of spacer bars shall be 12 mm 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. Refer Section 1000 of these Specifications 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 11 1/4 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 H.Y.S.D. 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 IS:9417 and to any supplemental and clause 1904.8 of these specifications to the satisfaction of the Engineer.

Welding may be carried out by metal arc welding process. Oxy-acetelene 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 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 any one 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 COUPLERS AND ANCHORAGES

1606.3.1 MECHANICAL COUPLERS

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 swaged 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.

1606.3.2 ANCHORAGES

Bars may be anchored with approved patented mechanical anchorages as indicated on the drawing or as approved by the Engineer. The anchorages shall be connected to the reinforcing bar by the use of taper thread system. The anchorages shall be capable of developing the characteristic strength of reinforcement without damage to concrete and shall have sufficient diameter and width to develop adequate shear cone strength. The connection shall develop 125% of the characteristic strength of 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 supply, fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted, by the Engineer.

Manufacturer's test certificate regarding compliance with Indian Standards for each lot of steel, shall be obtained and confirmatory tests in the presence of 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 re-testing shall be done and the 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 **MT.** 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 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 rate 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 coating work as well as sampling, testing and supervision required for the work. The rate shall be for a unit of **MT.**

Item No.12:- Providing and casting in situ controlled cement with of M30 for R.C.C. work in piers and abutment as per drawing including centering shuttering scaffolding where necessary laying vibrating curing and finishing complete. (A) Height from 0.0 M to 5.0 M (B) Height from 5.0 M to 10.0 M (C) Above 10.0 M

This work shall consist of providing and casting in situ controlled - cement concrete M-30 grade for **piers and abutment** and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work.

Item No.13:- Providing and casting in situ controlled cement concrete of M 30 Mix for R.C.C. works in pier cap abutment cap and dirt wall including controlled cement concrete of required drawings, centering shuttering, scaffolding wherever necessary laying vibrating curing and finishing complete.

This work shall consist of providing and casting in situ controlled - cement concrete M-30 grade for **pier cap abutment cap and dirt wall** and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work.

Item No.14:- Providing and Fixing in position Tar paper as bearing as per detailed drawings.

The tar paper used as bearing shall be made by impregnating paper or fiberglass mat with tar producing a waterproof material. The tar paper bearing shall not be in pieces stapled. It shall be in single piece covering the complete contact area. Tar paper bearing shall be laid with the sticky, glossy side down as the two sides are noticeably different in texture. Care shall be taken to ensure that the smoother side is on the top.

Good quality tar paper shall be used for the work as per prevailing norms. Before procuring the tar paper bearing, a sample of the same shall be approved by the Engineer-in-Charge.

The item shall be measured & paid on area basis in **Square meter**.

Item No.15:- Providing and casting in situ controlled cement concrete M-35 for R.C.C. solid slab including centering, scaffolding, curing and finishing complete.

This work shall consist of providing and casting in situ controlled - cement concrete M-35 grade for **R.C.C. solid slab** and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work.

Item No.16:- Providing and fixing in position steel bar reinforcement for Super Structure, Approach slab & wearing coat of steel grade FE-500D / FE-550D including cutting ,bending, hooking, tying, welding etc., complete as per detailed drawing and specification.

This work shall consist of Providing and placing in position **FE-500D / FE-550D TMT bar reinforcement For Super Structure, Approach Slab & Wearing Coat** including cutting, bending, hooking, and tying complete as per detailed drawing. and shall be carried out as per relevant detailed specification of **Item No.11** of this contract.

The payment will be made on **M.T.** basis of the finished work.

Item No.17:- Provision of an Reinforced cement concrete crash barrier at the edges of the road, approaches to bridge structures and medians, constructed with M-40 grade concrete with FE-500D/550D reinforcement conforming to IRC:21 and dowel bars 25 mm dia, 450 mm long at expansion joints filled with pre-moulded asphalt filler board, keyed to the structure on which it is built and installed as per design given in the enclosure to MOST circular No. RW/NH - 33022/1/94-DO III dated 24 June 1994 as per dimensions in the approved drawing and at locations directed by the Engineer, all as specified as per drawing attached.

This work shall consist of providing and casting **in situ-controlled cement concrete M 40 grade for crash barrier** shall be carried out as per relevant detailed specification of **Item No.10** of this contract and **Steel** shall be as per **Item No.11** Grade of concrete will be M-40. All above material shall be used as per complete working drawing and sanctioned by engineer in charge.

The item shall be measured & paid as finished work in **Rmt.**

Item No.18:- Providing P.V.C. 100 mm. diameter water spouts including necessary iron gratings as per drawings.

This work shall consist of furnishing and fixing in position of drainage spouts and drainage pipes for bridge decks.

2705 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 corrosive resistant material such as galvanized 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 to 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 18:226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanized.

2705.2. Placement

The galvanized 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 in the drawing 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 poly sulphide sealant or bituminous sealant as per IS: 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.

Drainage spouts shall be measured in **Each**.

The contract unit rate for each 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 flow drain pipes with all fixtures up to the point of ground drains wherever shown on the drawings.

Item No.19:- Providing and fixing marble slab including engraving and painting complete. (A) size 75 cm x 60 cm x 40 cm

1. Marble plate shall be white and of approved quality and shall be of size as mentioned in the item. Lettering shall be done by V-shape engraving and shall be filled with black paint of approved quality, lettering shall be done as directed by the Engineer-in-charge. The Marble plate shall be fixed in neat cement at a place as directed by the Engineer-in-charge. Cement shall conform to relevant IS Specification.
2. Measurement shall be per **Each** of marble plate fixed.
3. Unit rates includes cost of all material labour and tools to complete the work.

Item No.20:- Providing and casting in situ controlled cement concrete of M 30 for approach slab including form work curing and finishing complete.

This work shall consist Providing and casting in situ controlled cement concrete **M-30 for R.C.C. approach slab** including centering, scaffolding, curing and finishing complete. and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work

Item No.21:- Providing and fixing in position 20 mm thick premoulded joint filler in expansion joint for fixed ends of simply supported spans not exceeding 10 m to cater for a horizontal movement upto 20 mm, covered with sealant complete as per drawing and technical specifications.

2601 DESCRIPTION

The work shall consist of fabrication and installation of expansion joints. The filler joint, asphaltic plug joint, compression seal joint and reinforced elastomeric joint of slab seal, strip seal and box seal type shall conform to these Specifications.

2602 GENERAL

2602.1 The type of expansion joint proposed to be used shall conform to the design and got approved by the Engineer.

2602.2 Expansion joints shall be robust, durable, water-tight and easy for inspection, maintenance and replacement. Site fabricated expansion joints shall be prohibited. Expansion joints shall be procured from approved manufacturers and shall be of proven type.

2602.3 Alternative proprietary type deck joints proposed by the Contractor in lieu of the type specified shall comply in all respects with the manufacturer's specifications and meet the required range of movements and

rotations and be fit for the purpose of ensuring satisfactory long term performance. For such proprietary type deck joints the following information shall be provided.

- i) Name and location of the proposed manufacturer.
- ii) Dimensions and general details of the joint including material specifications, holding down bolt or anchorage details and installation procedures.
- iii) Evidence of satisfactory performance under similar environmental conditions of similar joints being produced by the manufacturer.

Acceptance of any alternative type of expansion joint shall be at the sole discretion of the Engineer. Such deck joints shall be installed in accordance with the manufacturer's recommendations and to the requirements of these Specifications. Vehicular traffic shall not be allowed over expansion joints after their installation for such period as may be determined by the Engineer.

2602.4 The expansion joint shall be provided to cover the entire carriageway, kerb and footpath, wherever provided. It shall follow the profile of the deck including the kerb, footway and fascia. The expansion joint for kerb, footway and fascia may be of different type and specification from that used for the carriageway and it shall cater to all movements and rotations for which the carriageway expansion joint is designed and shall be water tight.

2603 PERFORMANCE REQUIREMENTS

2603.1 The expansion joint proper and the transition zone (the zone of connection of joint assembly and the adjoining deck) shall satisfy the performance requirements specified herein. The expansion joint proper shall satisfy the performance requirements of both the bridge structure and the road users.

2603.2 Performance Requirements with Respect to Bridge Structure

The expansion joint shall:

- i) withstand the imposed loads including the impact load from live load and other sources,
- ii) allow expansion and contraction movement due to temperature, creep, shrinkage, pre-stressing and structural deformations,
- iii) permit relative rotation in elevation and plan due to the causes mentioned above,
- iv) be waterproof,
- v) be properly sealed,
- vi) ensure long life by being resistant to corrosion,
- vii) be easy to install,
- viii) be easy to maintain.
- ix) be easy to replace. and
- x) be resistant to the materials likely to collect/spill over the deck in its normal service.

2603.3 Performance Requirements with Respect to User

The expansion joint shall:

- i) provide smooth continuity at the top of the deck for riding comfort,
- ii) be skid resistant,
- iii) be non-damaging to rubber tyres,
- iv) make little or no noise during passage of vehicles,
- v) ensure that animal paws and hooves do not get entangled when used by animal drawn traffic,
- vi) permit passage of steel tyre of bullock carts without being damaged, and

- vii) look good aesthetically.

2606.1. Components

Strip seal expansion joint shall comprise the following items:

- i) Edge beams - This special claw leg profiled member shall be of extruded rolled steel section combining good weldability with notch toughness.
- ii) 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.
- iii) Rigid Anchorage - This shall be welded to the edge beam at staggered distance.
- iv) Anchor loops - This shall be made of weld able steel connecting the rigid anchorage with, deck reinforcement

2606.2. Material

- a) 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.
- b) 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
- c) Anchorage steel shall conform to IS:2061
- d) Anchor loop shall conform to 13:2062.

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 nun 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	Min 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.	Max 5 per cent Max 10 Shore A
Volume Change Change in hardness ASTM Oil no.3 Volume Change Change in hardness Cold Hardening Point	Max 25 per cent Max 20 Shore A Min -35 deg C

2606.3. Fabrication (Pre-installation)

- a) 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 meter 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.
- b) Anchor plates shall be cut to the required size by gas cutting. These shall be welded to the edge beams.
- c) Anchor loops shall be bent to the required shape and welded to anchor plates.
- d) The finally assembled joints shall then be clamped and transported to the work site.

2606.4. Handling and Storage

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.
- b) 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.
- c) 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 MODULAR STRIP/BOX SEAL EXPANSION JOINTS

2607.1 Components

A modular expansion joint shall consist of two or more modules/cells of individual capacity 80 mm to cater to a horizontal movement in excess of 80 mm. It shall allow movements in all three directions and rotation about all three axes as per the design requirements. The structural system shall consist of two edge beams, one or more central/separation beams or lamellas and cross support bars supporting individuals or multiple central beams to transfer the loads to the bridge deck through the anchorage system.

Edge Beams and Central Beams/Lamella : These shall be as per Clause 2606.1(i).

Anchorage : Anchorage of edge beam shall be as per Clause 2606.1 (ii). Studs and/or loop anchors with anchor plate may be used as anchorage of other components like joist box and covers of controlling system.

Sealing Element : This shall be as per Clause 2606.1 (iii). Minimum gap for inserting the neoprene seals in the expansion joint shall be 25 mm.

Support and Control System : The control system should allow closing and opening of the joint and also ensure that all modules open and close equally during all movement cycles of the joint. The overall support and control system shall be either single/multiple support bar control system or swivel joint system comprising of resilient/shock absorption components and elastic/sliding control system conforming to the specifications recommended by the manufacturer. The gap between the consecutive center beams at the joint surface shall be limited to 80 mm when the joint opens fully due to maximum contraction of deck.

2607.2. Material

- i) The steel for edge beams, center beam/lamella, transverse support bar and other steel components shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 or 52-3 (DIN), S235JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A36 or A588, CAN/CSA standard G40.21 Grade 300 W.
- ii) The sealing element shall be of Chloroprene Rubber (CR). The properties of CR shall be as specified in Table 2600-1.
- iii) The specification for all other materials shall be as per manufacturer's recommendation.

2607.3 Fabrication (Pre-installation)

- i) Profile of edge beam, center beam/lamella shall be long enough to cater for full carriageway width.
- ii) The fabrication of all components of the joints including anchorage system and transportation of assembled joints shall be as per manufacturer's specification.
- iii) **Lubricant cum Adhesive :** The type and application of material used in bonding the preformed joint seal to the steel nosing and concrete shall be as recommended by the manufacturer/supplier of the seal system.
- iv) **Corrosion Protection :** All steel sections shall be suitably protected against corrosion as stated in Clause 2606.3 (iv).

2607.4 HANDLING AND STORAGE

- i) Arrangement for transportation and storage shall be as per manufacture's Specification.
- ii) 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 joining.

2610 INSTALLATION OF EXPANSION JOINTS

2610.1 General Procedure

- i) Expansion Joints shall be installed under close supervision of the manufacturer's/supplier's engineer in order to ensure the quality of installation and its function as intended during the entire life span.

Detailed Installation Manual shall be supplied by the manufacturer/supplier.

- ii) The dimensions of the recess in the deck shall be established in accordance with the drawings or design data of the manufacturer, taking into account the width of gap for movement of the joint.
- iii) The pre-setting of expansion joint shall be done by means of an auxiliary construction.
- iv) The road surfacing/wearing coat shall be laid before commencing installation of joint. Before laying wearing coat, the recess portion shall be filled with sand and wearing coat shall be laid in a continuous manner over the deck slabs and recess portion. Prior to installation of the joints, portion of wearing coat over the recess shall be removed by a suitable method e.g. saw cutting and the infill sand shall also be removed.
- v) **Preparation of the Recess :** The size and form of recess shall suit the geometry of the expansion joint. However, the width shall not be less than the specified value for a particular type of joint. In order to avoid difficulties during installation, the following points must be checked and considered:
 - a) Dimension of recess
 - b) Levels
 - c) Skew and slope
 - d) Designed gap between bridge deck and abutment and/or between adjoining decks
 - e) Existing structural reinforcement according to the drawings

Reinforcing bars that would obstruct the installation of expansion joint shall be bent to accommodate the expansion joint anchorages. Cutting off or removal of interfering reinforcing bars shall only be done after consultation with the Engineer.

The recess shall be cleaned thoroughly. If necessary, the surface should be roughened. All loose dirt and debris shall be removed by wire brushing, air blowing and dried with hot compressed air.

- vi) **Shuttering :** Shuttering must be used to seal the space between the underside of the joint and the vertical face of the recess. The shuttering must be fitted in such a way that it forms an appropriate seal against the edge of the recess. The recess shall be shuttered in such a way that dimensions shown on the drawing are maintained. The formwork shall be rigid and firm.
- vii) **Placing in the Recess :** Level marks shall be set next to the recess. This enables a controlled leveling of the expansion joint. Lowering the expansion joint/joint construction/insert into the recess shall be done in such a way that the entire length of the joint is evenly lowered into the recess. Thereafter, the joint/joint construction/insert is precisely leveled and adjusted in the longitudinal, transverse and vertical planes. If required, the joint must also be adjusted to the gradient of the final surface level.

- viii) **Connection**

- a) The expansion joint/joint construction/insert shall be installed preferably in the early morning when the temperature is distributed almost uniformly over the whole bridge. Immediately before the installation, the actual temperature of the bridge shall be measured. If it is not within the considered tolerance, the pre Set adjustment shall be corrected. The joint/joint construction/insert shall be lowered in a predetermined position. Following placement of the joint/joint construction/insert in the prepared recess, the joint/joint construction/insert shall be leveled and finally aligned and the anchorage steel 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. With the expansion joint/joint construction/ insert finally held at both sides, the auxiliary brackets shall be released, allowing it to take up the movement of the structure. After carrying out the final fixing, the .protection against corrosion shall be completed.
- b) For fully assembled joints with one end fixed and other end movable e.g. modular strip/box seal joint, connection shall be as detailed below:

The 1st side : The fixed side of the assembled joint (either the abutment or the bridge deck side) is designated the 1st side for connecting the joint. The preliminary fixing is made by evenly placing and welding of reinforcing bars over the entire length between the anchor loops and the deck reinforcement. To facilitate concreting, it the gap between recess and shuttering is sealed by a grout seam. The seam must be left to dry prior to final concreting. After this, additional reinforcing bars are welded until all anchor loops are firmly connected to the deck reinforcement. The expansion joint shall be considered sufficiently fixed when no vibration is noted when it is lightly tapped. The expansion joint shall not be subjected to any loads that could in any way displace the precise location of this fixing.

The 2nd side : Depending on the size of the expansion joint and the expected movement during installation, the most suitable time must be determined for fixing of the 2nd (moveable) side. Usually this is the early morning hours with the smallest temperature deviations. The procedure is identical to that for the '1 st side. The joint shall be provisionally fixed to the reinforcement as fast as possible. Immediately afterwards, the fixation brackets shall be removed. Thereafter, the gap between recess and shuttering shall be sealed with grout seam and the remaining reinforcing bars welded as described previously.

ix) **Concreting**

- a) Prior to final concreting, the position of the joint/joint construction/ insert must be recorded. The Engineer must give written confirmation of the correct position of the joint and recess concreting. The recess shall be thoroughly watered. Before pouring

the concrete the joint construction should be protected by a cover. Controlled concrete having strength not less than that in superstructure subject to a minimum of M35, shall be filled into the recess. The water cement ratio shall not be more than 0.4. If necessary, admixtures may be used to improve workability. The concrete must exhibit low shrinkage. The freshly placed concrete shall be properly vibrated. Damage to the shuttering shall be avoided during vibration. The concrete shall be finished flush with the carriageway surfacing. The concrete shall be kept damp until it has cured in order to avoid fissures caused by drying too fast. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.

- b) For modular strip seal joint the space beneath the joint boxes shall be completely filled with concrete. So that traffic loads are safely transmitted into the structure.
- x) As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect it from traffic at site.
Expansion joint shall not be exposed to traffic loading before completion of carriageway surfacing.
- xi) The elastomeric sealing element may be field installed. For strip seal and modular strip seal joints the sealing element shall be in continuous lengths spanning the full carriageway width. Proper fit of the seal of the sealing element must be ensured. The seal shall be installed by suitable methods in such a way that it is not damaged.

2610.5 Specific procedure for Modular Strip/Box Seal Joint

- a) The procedure given Clause 2610.4 (i) and (ii) applies to modular strip/box seal joint also.
- b) To ensure proper fit of the seal, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scraper or compressed air.
- c) The actual junction of the surfacing/wearing coat with the block out concrete/steel edge section 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.

2610.6 Specific Procedure for Reinforced Elastomeric Joint

Expansion joints shall be installed as per approved drawing. The procedure for installation of various components shall be as follows:

i) Steel Inserts

- a) Deck casting shall be done leaving pockets or recesses for steel inserts and anchors of the expansion joint as per drawing.
- b) Steel inserts shall be lowered at the appropriate location inside the pocket.

- c) The top of the insert shall be flush with the finished level of wearing course maintaining the camber.
- d) Spacer bars, duly set appropriately to the month of installation, shall be fitted under proper supervision.
- e) Anchor rods shall be tied/welded with the existing deck main reinforcement, maintaining level and alignment.
- f) Welding between anchor rods and deck reinforcement is preferable. If welding is not possible, strong steel tie wires shall be used for fastening under proper supervision.

ii) Spacer Bar

- a) Spacer bars shall be used to ensure proper positioning of bolts and also leveling of the steel inserts during fixing of the same with the deck reinforcement and casting second stage concreting in the pocket thereafter.
- b) The 2nd stage concreting operation shall preferably be started within 24 hours of fixing the steel inserts. In such cases, spacer bars should be removed just after concreting is finished. If there is a substantial time lag between fixing of inserts and concreting, then any one of the following methods shall be adopted, depending on the support condition:
 For simply supported bridge resting on simple elastomeric bearings, (with no dowel pins), insert shall be placed in position with spacer bars at every alternate joints. Such joints shall be called restrained joints hereafter. In other words, inserts shall not be fixed simultaneously at two ends of one span. If the above condition is satisfied, inserts with spacer bars shall be kept in position for a substantially longer period at such restrained joints. Spacer bars shall be removed after concreting of such restrained joints and inserts placed in position with spacer bars at the other unrestrained joints thereafter.
 For bridges resting on other than elastomeric bearings (including bearings with dowel pins at one end), after placing and aligning the inserts and securing the same, the spacer bars shall be removed. Concreting shall be done with great care so that inserts are not dislocated or distorted.
- c) While removing the spacer bar after concreting, one must take care to see that the concrete is not damaged during withdrawal of spacer bar. If the spacer bar happens to be snugly fitted, it shall not be pulled by any means; it shall be gas cut in two pieces and then removed.

iii) Concreting of Pocket

- a) Concreting of pocket shall be done with great care using proper mix conforming to grade similar to that of the deck casting besides ensuring efficient bonding between deck and steel insert. Also proper care shall be given for ensuring efficient bonding with the already cast concrete.

Requirement of concrete as per Clause 2610.9.1 shall be followed.

- b) Needle vibrators shall be used. Care shall be taken so that the position of steel insert is not disturbed during vibration.
- c) Spacer bar shall be removed within an appropriate time before the joint is required to permit movement.

iv) Fixing of Elastomeric Slab Unit (ESU)

- a) Special jig shall be used to preset the ESU during installation
- b) ESU (mounted on the jig, if preset) shall be lowered to position.
- c) The line and level on the ESU should be adjusted.
- d) ESU shall be removed and coated with special adhesive
- e) ESU shall be placed in position again, ensuring waterproof joining at required faces.
- f) ESU shall be tightened with stainless steel nuts and lock washers in position. Tightened nuts shall be locked with lock washers.
- g) Special sealant shall be poured inside the plug holes.
- h) The elastomeric plugs shall be pressed in position after applying adhesive on the appropriate surface.
- i) ESU shall be fitted in position after completion of wearing course. While completing this part of the wearing course, adequate care shall be taken to ensure a waterproof joining with the already existing wearing course.

v) Pre-setting

- a) The main purpose of pre-setting of the steel inserts at the time of its installation is to ensure as closely as possible the condition that in the long run at the mean average annual temperature, the ESU remains at its nominal state.
The steel insert unit of expansion joint can be fixed in any month of the year. The expansion gap between bridge super structures may vary from time to time; hence the initial fixing distance between fixing points will obviously depend on the month of installation of steel insert. The c/c distance between stainless steel fixing of bolts as indicated in the drawing can be taken as only nominal. The same shall be modified by pre-setting depending on:
The difference between the mean temperature of the month of fixing of steel insert and the annual average temperature, and
The elapsed period between the casting and/or pre-stressing and fixing of steel insert for calculating the remnant creep and shrinkage.

vi) Special Requirements for Installation

- i) The supplier shall provide detailed working drawings showing the location of all bolts, recesses and holes necessary for the installation of the joint shall be obtained from the supplier before construction of bridge deck area adjacent to the joint.

- If required detailing of reinforcing bars in superstructure shall be modified to ensure that there will be no interference in the installation of the joint.
- ii) All bearing surfaces and recesses which are in contact with the joint assembly shall be checked with a straight edge to ensure flatness of profile.
 - iii) No holes shall be drilled for fixing bolts within 7 days of concreting. Holes for the bolts shall be drilled to the size and depth shown on the drawings.
 - iv) Sections of the jointing making the completed joint shall follow a straight line.
 - v) The fixing bolts shall not be placed in a position until at least 4 weeks after stressing is completed in post-tensioned box or beam and slab structures. Prior to placing sections of jointing, contact surfaces shall be cleaned to remove all grease, tar, paint, oil, mud or any other foreign material that may affect adhesion of the sealant.
 - vi) Sealant shall only be applied to dry contact surfaces. Sufficient quantity shall be applied to the contact surfaces so that sealant is extruded when the jointing is fixed in position.
 - vii) Final sealing of the finished expansion joint shall be completed immediately after installation. All exposed ends, joints between units, other areas of possible leakage, voids between the sides of the jointing and concrete or plates, shall be filled with sealant.
 - viii) Bolt cavities shall be cleaned and plugged with neoprene cavity plugs. Prior to placing the plugs sufficient sealant shall be placed in the cavities to cause extrusion of the sealant by the plugs.
 - ix) All excess sealant shall be removed from the jointing and adjacent areas.

2611 Procedure for installation of various joints, shall also take into account suppliers own specific procedures for installation of each type of joint as the suppliers shall be responsible for performance of the joints for the period of guarantee.

2612 TESTING AND ACCEPTANCE STANDARDS

2612.1 Before installing joints in a bridge, sufficient evidence of the reliability of the proprietary products shall be furnished. A copy of the fatigue and wear test reports, as applicable depending upon the type of joint, carried out by a recognized laboratory/university/ institute on the joint components as a part of product development test, shall be furnished once for the entire lot of supply. The tests covered in Clauses 2612.1. 0) to 2612.1. (vi) need not be carried out on the materials of the joints of supply lot but shall be carried out from time to time by the

original manufacturer as per their product development and quality plan for the same type of joints to ensure the performance requirement of the particular joint component against fatigue and/or wear.

- i) For single strip seal and modular strip seal joints, the manufacturer shall produce complete report of the test of anchorage system from a recognized laboratory to determine optimum configuration of anchorage assembly under dynamic loading in support of the efficacy of the anchorage system adopted for the entire lot of joints.
- ii) For modular strip seal joints the manufacturer shall produce a test report from a recognized laboratory that the sliding bearings (suspension system) have been fatigue tested for six million load cycles with a frequency of 5 Hz and the loads of 80 kN, 120 kN and 160 kN.
- iii) For modular strip seal joints the manufacturer shall produce a test report from a recognized laboratory that the wearing of sliding interface of bearings of modular joints has been tested for a total sliding distance of 5000 m at a load of 48 kN.
- iv) For modular strip seal joints the manufacturer shall also produce a test report from a recognized laboratory that the sliding material of sliding springs of expansion joints has been tested for a total sliding distance of 20,000 m with a load equivalent to a stress of 30 MPa.
- v) For modular strip seal joints the manufacturer shall also produce a test report from a recognized laboratory that the butt-welded splicing of centre beams has been tested with two million load cycles with a load equivalent to a stress of 165 MPa.
- vi) In case of reinforced elastomeric joints abrasion resistance test shall be carried out in accordance with IS:3400 (Part 3) or DIN 53516.

2612.2 Pre-installation Criteria

The pre-installation criteria shall include the routine tests and acceptance tests as described below:

2612.2.1 Routine Tests

Routine tests including tests for materials conforming to specifications shall be carried out by the original manufacturer i.e., in case of imported joints, by the foreign manufacturer as part of their quality control procedure for all joints to be supplied by them. Detailed documentation of all the tests and inspection data as per complete quality control procedure shall be supplied by the original manufacturer in the form of Quality Control Report. Routine tests shall include:

Raw materials inspection, Process inspection, and Complete dimensional check as per approved drawings.

- i) **Raw Material Inspection :** Test on all raw materials used for the manufacturing of joints as per relevant material standard based on these Specifications shall be carried out by the manufacturer.

- a. **Confirmation of the Grade of Steel :** Grade of the steel for the edge beam shall be confirmed by conducting tests for yield stress, tensile strength and elongation. Corresponding to RST 37-2 or 37-3 or 52-3 (DIN), 5235 JRG2 or S355K2G3 of EN10025 (DIN 17100), ASTM A36 or A 588, CAN/CSA standard G 40.21 grade 300 W or equivalent to Grade B of IS: 2062. The manufacturers/ suppliers shall have in-house testing facilities for conducting these tests.
- b. Tests for steel for the anchorage shall conform to IS:2062.
- c. The tests as indicated in Table 2600-1 shall be made for checking the following properties of the chloroprene seal: (a) hardness, (b) tensile strength, (c) elongation at fracture, (d) tear propagation strength, (e) residual compressive strain, (f) change in hardness, (g) change in tensile strength, (h) change in elongation at fracture, (I) ageing in ozone, and (j) swelling behaviour in oil. The manufacturers/suppliers shall have in-house testing facilities for conducting these tests.
- ii) **Process Inspection :** Process inspection including inspection of all manufacturing processes adopted to manufacture the joints e.g., welding, corrosion protection, clamping, pre-setting, greasing, bonding by adhesives and riveting, as appropriate, shall be carried out by the manufacturer.
- iii) **Complete Dimensional Check :** Complete dimensional check of all components of joint as well as the assembled joint with respect to the approved drawings and tolerances as per these Specifications, shall be carried out by the manufacturer.

2612.3 Acceptance Tests

2612.3.1 In addition to the tests specified under Clause 2612.1, the manufacturer as well as the local supplier in case of imported joints shall have complete in-house testing facilities for the following tests. The Engineer shall insist upon these tests before acceptance of the joint.

- i) **Cyclic Motion :** Cyclic motion test may be carried out once on one complete joint assembly or one meter sample piece selected at random from the entire lot of supply for each type of joint irrespective of movement capacity. The test sample shall be subjected to 5000 expansion and contraction cycles at minimum 30 cycles per hour. The test movement shall be 10 percent more than the design expansion/ contraction movement. Any sign of distress or permanent set of any component or the assembly due to fatigue, will lead to rejection of entire lot of supply.
- ii) **Ponding :** Prior to acceptance, 25 percent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25 mm above the highest point of deck. The width of ponding shall be at least 50 mm beyond the anchorage block of the joint on either side. The

depth of water shall not fall below 25 mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

- iii) **Debris Expelling Test** : Debris expelling test shall be carried out on one metre sample piece selected at random from the entire lot of supply. The fully open gap shall be filled flush with granular debris and cycled 25 times for full opening and closing. The mass of debris repelled after 25 cycles shall be expressed as the percentage of initial mass. The percentage expelled shall not be less than 75.
- iv) **Pull-out Test** : Pull-out test shall be carried out on one meter sample piece selected at random from the entire lot of supply. The joint shall then be stretched until the sealing element slips off from its housing. The minimum stretching of the joint before slip-off shall be least 150 percent of the rated movement capacity of the seal.
- v) **Vehicular Braking/Traction Test** : This is the only initial acceptance (in-house) test. This test may be carried out once on one complete joint assembly or one metre sample piece selected at random from the entire lot of supply for each type of Joint irrespective of movement capacity. The test sample shall be installed between two blocks of concrete in its mean position. A truck wheel load of 40 kN shall be drawn across the specimen with an engaged ratchet with wheel locked to stimulate locked brakes and then rolled back. The cycle shall be repeated for 50,000 times with a period of 2 seconds. Continuous water cooling will be necessary to control excessive heat generated during the test.
- vi) **Erosion Protection Test** : Adequacy of the treatment for protection of steel sections against corrosion should be checked.

2612.3.2 Applicability of Acceptance Tests on Different Types of Joints

The acceptance tests described in Clause 2612.2.1 shall be applicable as per Table 2600-5 for different types of joints.

Table 2600-5 : Applicability of Acceptance Tests on Different Types of Joints

Performance Evaluation Tests	Asphaltic Plug Joint	Compression Seal Joint	Reinforced Elastomeric Joint	Single Gap Strip/Box Seal Joint	Modular Strip/Box Seal Joint
Cyclic motion	Not Applicable	Applicable	Applicable	Applicable	Applicable
Ponding	Not Applicable	Applicable	Applicable	Applicable	Applicable*
Debris expelling test	Not Applicable	Applicable	Applicable	Applicable	Applicable*
Pull-out test	Not Applicable	Not Applicable	Not Applicable	Applicable	Applicable*

Vehicular braking/traction test	Not Applicable	Not Applicable	Applicable	Applicable	Applicable*
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- ❖ For modular strip seal expansion joint ponding test, debris expelling test, pull-out test and vehicular braking/tractor test shall be carried out on one metre edge beam samples only, complete with sealing element and anchorage, to be supplied by manufacturer.

Note: For all expansion joints which are proprietary a minimum guarantee of 10 years for their satisfactory performance shall be given by the contractor.

2613 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.

2614 MEASUREMENTS FOR PAYMENT

The expansion joint shall be measured in **running meters**.

2615 RATE

In the case of supply and installation contract, the contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for procuring and fixing the joints complete in all respects as per these Specifications. For filler joints, the rate per **meter** shall include the cost of sealant for the depth provided in the drawing.

In the case of supply contract, the contract unit rate shall include cost of all components of expansion joint including anchorage system, pre-installation fabrication, transportation of assembled joints, handling and other incidental charges. In the case of installation only contract, the contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for installation of the joints complete in all respects as per these Specifications.

Item No.22:- 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

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 M15 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:

D 15 (Filter)	
-----	<5
D 85 (Base)	
D 15 (Filter)	
4< -----	< 20
D 15 (Base)	
D 50 (Filter)	
-----	< 25
D 50 (Base)	

Notes:

1) Filter design may not be required if embankment consists of CH or 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, D 15 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 150 mm.

2504.3 Construction Operations

Before laying the pitching, the side of banks shall be trimmed to the required slope and profiles by means of lines and pegs at intervals of 3 m. Depressions shall be filled and thoroughly compacted.

The filter granular material shall be laid over the prepared base and 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, of these Specifications in case of dry rubble pitching. It shall be in nominal mix cement concrete (M 15) conforming to Clause 1704.3, of these Specifications 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 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 all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

2504.4 Toe Protection

A toe wall shall be provided at the junction of slope pitching and launching apron of a guide bund so as to prevent the slope pitching from sliding down. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Section 1400 of these Specifications or in cement

concrete of M 15 grade. The pitching/revetment shall be of stones in wire crates or cement concrete blocks in M15 grade. For protection of ties of bank slopes terminating either in short aprons at bed levels or anchored in flooring/rocky bed, the provision 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 boulders/cement concrete block and boulder/block filled wire crates in apron shall be measured in cubic metres.

The filter and stone pitching shall be measured separately in cubic metres unless otherwise specified.

Rubble stone/cement concrete block 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 per Section 300 of these Specifications.

If directed by the Engineer, the materials shall have to be stacked at site before laying and such stacking shall be considered incidental to the work.

2510 RATE

The contract unit rate for the construction of embankment for guide bund shall cover the cost of all materials including transportation, laying, compacting, all labour, tools, equipment, sampling and testing, supervision and all incidentals necessary for completing the work according to these Specifications.

The contract unit rate for apron shall include the cost of all material, labour, tools and plant for completing the work according to these Specifications. Excavation up to an average depth of 150 mm shall also be deemed to be included in the rate as dressing of the bed. Excavation

beyond the depth of 150 mm shall be paid for separately unless otherwise specified.

The contract unit rate for stone/cement concrete block pitching on slopes shall include the cost of preparing the bases, laying and compacting the filter and placing of 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 rubble stone/cement concrete block flooring shall include the cost of all material, labour and tools and plant for completing the work as per specifications for the relevant item.

Item No.23:- Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification

This work shall consist of Providing and laying Filter material underneath pitching in slopes and shall be carried out as per relevant detailed specification of **Item No.24** of this contract.

The item shall be measured & paid as finished work in **Cum.**

Item No.24:- 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 wight passing through the sieve
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 Material 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 as shown on drawing and as directed.

2. Materials shall be first stacked in boxes of 2 m. x 1.½ m. x 0.5 m. size on fairly level ground and measured for cross checking the adequacy of the quantity required.
3. The filter media behind abutment and return wall shall consist of three layers, the first layer of rubble of required size, the second layer of stone aggregates of 40 to 63 mm size and the third layer of coarse sand. The total thickness of the filter media shall not be less than 600mm as specified in the item.
4. The measurement for payment shall be made as finished work on **Sq.m.** basis
5. The unit rate includes the cost of materials, scaffolding labour and tools to complete the work.

Item No.25:- Providing & laying weep hole in Abutments, and returns by using PVC/ A.C. pipe of 100mm including laying in proper grade and jointing the completed as per detailed specification.

Weep holes shall be provided in solid plain concrete/reinforced concrete, brick/stone masonry, abutment, wing wall and return walls as shown on the drawing or directed by the Engineer to drive moisture from the back filling. Weep holes shall be provided with 100 mm dia P.V.C./A.C. pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry, weep holes shall be 80 mm wide, 150 mm high or circular with 150mm diameter. Weep holes shall extend through the full width of concrete/masonry with slope of about 1 vertical:20 horizontal towards the draining face. The spacing of weep holes shall generally be 1m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.

Weep holes in concrete/brick masonry structure shall be measured in **Each.**

The contract unit rate for weep hole shall include the cost of all labour.

Item No.26:- Providing and laying of Extruded Bioaxial Polypropylene Geogrid 30 KN as per clause no 3102.8 and approval design and specification with accessories like tie strips,nuts & bolts and loops/lugs for

joining reinforcing elements with the facia ,pannels and overlaps and other protective elements as per detailed specification.

703 GEOGRID

703.1 Scope

The work covers the use of geogrids in sub-base of pavement, below approach slab, erosion control of slopes, reinforced soil slopes and reinforced soil walls including supplying and laying as per design, drawing and these specifications.

The use of geogrids as a component for reinforced soil slopes and walls shall be as per Section 3100.

703.2 Materials

703.2.1 General

Geogrids shall be either made from high tenacity polyester yarn jointed at cross points by weaving, knitting or bonding process with appropriate coating or from polypropylene or polyethylene or any other suitable polymeric material by an appropriate process. Geogrids manufactured by extrusion process are integrally jointed, mono or bi-directionally oriented or stretched meshes, in square, rectangular, hexagonal or oval mesh form. The geogrids manufactured by weaving/knitting/bonding process shall be formed into a stable network such that ribs, filaments or yarns retain their dimensional stability relative to each other including selvages.

703.2.2 Sub-base Reinforcement

Geogrid for use as reinforcement of sub-base layers of flexible pavements shall meet the requirement as per the design subject to the minimum requirements as given in Table 700-7.

703.2.3 Geo Grid

The geogrid application shall have the minimum tensile strength of 30 kN/m, when tested as per ASTM D5035 (Minimum Average Roll Value in Machine Direction). The aperture opening size shall be minimum 20 mm x 20 mm and average grid thickness shall be minimum 1.0 mm. Geogrid for erosion control application shall be UV stabilized. The geogrid shall have ultraviolet stability of 70 percent after 500 hrs exposure as per ASTM D4355.

Table 700-7 : Minimum Requirements for Geogrid for Sub-Base of Flexible Pavement

Property	Test Method	Unit	Requirement
Stiffness at 0.5%	ISO-10319	kN/m	>350; both in

strain			machine and cross-machine direction
Tensile strength @2% strain	ASTM D6637	kN/m	>15% of T_{int} ;both in machine and cross-machine direction
Tensile strength @5% strain	ASTM D6637	kN/m	>20% of T_{int} ,t both in machine and cross-machine direction
Junction Efficiency for extruded geogrids	GRI-GG2-87or ASTM-WK 14256	-	90% of rib ultimate tensile strength
Ultraviolet stability	ASTM D4355	-	70% after 500 hrs exposure

- 1) All numerical values in the Table represent MARV in the specified direction.
- 2) All geogrids shall be placed along machine direction parallel to the centre line of roadway alignment.

703.2.4 Reinforced Soil Slopes and Walls

The strength and other requirements shall be as per Section 3100.

703.3 Installation and Construction Operations

703.3.1 Sub-base Reinforcement

Prior to laying of geogrid, the surface shall be properly prepared, cleaned and dressed to the specified lines and levels as shown on the drawings. The geogrid shall be laid within the pavement structure as shown on the drawings.

Geogrid reinforcement shall be placed flat, pulled tight and held in position by pins or suitable means until the subsequent pavement layer is placed.

No vehicle shall be allowed on geogrid unless it is covered by at least 150 mm thick sub-base material.

703.3.2 The geogrid applications shall be installed in accordance with the manufacturer's recommendation and as per Clause 706.3.

703.3.3 Reinforced Slopes and Walls

The geogrid for reinforced slopes and walls shall be installed in accordance with the manufacturer's recommendation and as per Section 3100.

703.4 Measurement for Payment

The geogrid shall be measured in **Sqm.** as per planned dimensions with no allowance for overlapping at joints, anchoring at toe and crest of the slope. Excavation, back fill, bedding and cover material shall be measured separately as per relevant clauses of the Specifications. Reinforced soil slopes and walls shall be measured as per Section 3100.

703.5 Rate

The contract unit rate for the accepted quantities of geogrid in place shall be in full compensation for furnishing, preparing, hauling, and placing geogrid including all labour, freight, tools, equipment, and incidentals to complete the work as per specifications.

Item No.27 :- Providing and fixing in position Mild steel dowel bars in pier caps or abutment caps for anchorage in fixed end as per detailed drawings including cutting, bending and welding complete.

- 1.** For Mild Steel, specifications of reinforcement shall apply.
- 2.** The Mild 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 Numbers of dowel bars in anchored condition.
- 4.** Unit rate shall include cost of all materials, labour and equipment's to complete the Job.

The item shall be measured in **Each.**

Item No.28 :- Providing and fixing in position Mild steel dowel bars in pier caps or abutment caps for anchorage in free end as per detailed drawings including cutting, bending and welding complete.

This work shall consist Providing and fixing in position Mild steel dowel bars in pier caps or abutments caps for anchorage in free end shall be carried out as per relevant detailed specification of **Item No.27** of this contract.

The item shall be measured in **Each**.

Item No.29:- Clearing and grubbing road land including uprooting rank vegetation , grass , bushes , shrubs , saplings and trees of girth upto 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials (I) By Mechanical means in area of light jungle.

201.1 Scope

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, rubbish, top organic soil, etc. to an average depth of 150 mm 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 leads and lifts. 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. 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.

201.3 Methods, Tools and Equipment

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., falling 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 bottom of the subgrade. Also, all vegetation such as roots, undergrowth, 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 meters, 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 loads and lifts. 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 **Hectare**. Cutting of trees upto 300 mm in girth and removal of their stumps, including removal of stumps upto 300 mm in girth left over after trees have been cut by any other agency, and trimming of branches of trees extending above the roadway and backfilling to the required compaction shall be considered incidental to the clearing and grubbing operations. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and 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 backfilling 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 the purpose of cutting of trees and removal of roots and stumps, the girth shall be

measured at a height of 1 m 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

201.6.1 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 labor, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm girth excavation and backfilling 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 materials 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.30:- Back filling between returnwall shall be selected soil having properties as $C=0\text{Kg/Sq. } \phi=30^\circ$ 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 depressing which occur during the process using Vibratory roller 8T to 10T. (E) From Borrow area With all lead & lift.

- The fill shall be a select granular fill with the following properties:
- Peak drained or effective angle of friction of compacted fill (as per IS 2720: part 13) shall be Greater than 30° .
- % fines (passing 75 micron sieve) shall be less than 15%. Sieve Analysis test shall performed as per IS 2720 (part 4),
- Material with more than 15% passing 75 micron sieve, but less than 10% of particle smaller than 15 microns are acceptable provided PI is less than 6 and angle of friction is not less than 30°
- The fill material shall be free from organic and any other deleterious matter and shall not react adversely (chemically, electrically or biologically) with the reinforcement material and / or fascia material.
- Liquid limit & Plastic Limit test shall performed as per IS 2720 (Part 5). Plasticity index shall be less than 6.
- Co-efficient of uniformity (Cu) shall be ≥ 2 .
- Top 500 mm of fill below Sub grade shall satisfy the effective CBR criteria with Sub grade material in addition to the above requirement.
- Recommended guidelines for gradation of the reinforced soil are given below:

Sieve Size (mm)	% Finer
75	100
4.75	85-100
0.425	60-90
0.075	< 15

Plasticity Index (PI) shall not exceed 6 and $C_u > 2$

- The fill shall be compacted to 95% of the maximum laboratory density obtained from modified protocol compaction test performed as per IS 2720 (Part 8)
- Fill within 0.5m of the bottom of pavement (subgrade) shall be compacted to a minimum of 98% of the MDD.
- The liquid limit and plasticity index (performed as per IS 2720: Part 5) of the fill shall be restricted to 40 and 20 respectively.
- The organic content shall be limited to 5% and the fill shall be free from deleterious matter.
- ~~■ If Fly ash is used as retained fill then it shall be in conformity with IRC SP 58. Top 500 mm of retained fill below Subgrade shall satisfy the effective CBR criteria with Subgrade material in addition to the above requirements.~~

DRAINAGE BAY

Drainage Bay shall be provided as shown in the approved drawings. The width of the drainage bay shall be 600 mm behind the facing element.

Backfill and drainage material to be separated by permeable non-oven geotextile

TESTS FOR REINFORCED AND RETAINED FILL

The sand which is proposed to be used as reinforced fill shall be tested to ascertain the suitability for required quantity, grading, type and availability of required quantity etc. The sand to be used as retained fill behind the reinforced fill, in case it is not natural soil, shall be tested for its shear characteristics and permeability to evaluate earth pressure, drainage characteristics etc. for external stability of the wall.

The backfill is tested at two stages. The first stage is to ascertain the suitability of the fill while the second stage to ensure that the backfill envisaged in design is used during construction. To ascertain the suitability of the fill, samples should be drawn from the borrow area by drawing a grid of 25 m c/c to full depth, logging and sampling for ascertaining suitability of the borrow material as per MORTH 2013 Specifications. Following tests shall be carried out as per Indian Standards.

- i) Sieve Analysis - IS: 2720 Part - 2 tests per 3000 cu.m. of soil
- ii) Atterberg Limit Tests- IS: 2720 Part- 5-2 tests per 3000 cu.m. of soil
- iii) Compaction Tests - IS: 2720 relevant part corresponding to modified as well as Standard Proctor test - 2 tests per 3000 cu.m. of soil
- iv) Direct Shear Tests - IS: 2720 Part 13 & 39 to ascertain the peak angle of shearing resistance. The tests should be done at 95 percent of Modified Proctor Density at -2 percent of OMC at a frequency of 1 per 3000 cu.m. of fill.

During construction the quality control should be exercised by conducting one set of density test of 3000 sq.m. of compacted area considering the importance of compaction in reinforced soil walls. (Clause 903.2.2 of MORTH 2013) One set shall consist of 6 tests. The density tests shall be carried out in accordance with IS-2720 Part 28. Density measurement by nuclear gauge may be carried out as an alternative. For such a test the number of tests per set shall be doubled. If the retained fill is borrowed tests mentioned above should be carried out at same frequency of reinforced fill. Frequency during construction shall be as per MORTH 2013 Specifications.

DRAINAGE AGGREGATE

The drainage material shall consist of clean crushed stone or gravel with particle size gradation as shown below (as per IRC SP : 102- 2014)

Sieve Analysis test shall performed as per IS 2720 (Part 4) and one test is recommended per 250 cum of drainage material. Percentage passing through different size of sieve is given in the following table:

Sieve size	%age finer
37.5 mm	90-100%
20 mm	80-100%
12.50 mm	0-20%

Besides meeting gradation requirement it is to be ensured that the aggregates are not friable, flaky, elongated and are sound in strength.

6.1 Method of Measurement and Payment

The Earth fill / Sand & filling shall be measured and pay in the **Cum.** basis of finished work.

Rate:

The Contract unit rates for the items of all labour, material, tools, equipment and incidentals necessary to complete the work to the Specifications & payment shall be done in Cu.m.

Item No.31:- Construction of 150/200 mm thick compacted coarsed granular subbase (Grade-I crushed B.T materials of 53 mm to 26.5 mm @ 35 %, 26.5 mm to 4.75 mm @ 45% , Below 2.36 mm @ 20 %) by providing close graded material , mixing in a mechanical mix plant at OMC, carriage of a mix material to work site, spreading uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve desired density , complete clause as per 401.

Scope :

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

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

401.3.2 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 upto 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 crossfall or on super elevation. For carriageway having crossfall 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 crossfall (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 **Cum.**

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
- iv) carrying out the required tests for quality control.

Item No.32:- Providing and Laying 150/250 mm thick W.B.M. of Grading - II, of required compacted thickness in each layer of 100 mm using B.T.M.C. metal of size 53mm to 22.4mm in layers including 13% stone screening 11.2mm size and 7% stone dust as filler, including spreading, watering and consolidation by vibratory roller as per MoRTH specifications etc. complete as directed by Engineer-in-charge.

404.1 Scope

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

404.2 Materials

404.2.1 Coarse Aggregates

Coarse aggregates shall be stone metal obtained from quarries approved by the Executive Engineer prior to collection. The aggregates shall conform to the physical requirements set forth in Table 400-8. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water

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

Table 400-8 : Physical Requirements of Coarse Aggregates for Water Bound Macadam for Sub-base/Base Courses

Sr. No.	Test	Test Method	Requirements
1	Los Angeles Abrasion value or Aggregate impact value	IS: 2386(Part 4) IS: 2386 (Part-4) or IS:5640*	40 percent (Max) 30 percent (Max)
2	Combined Flakiness and Elongation Indices (Total) **	IS:2386 (Part-1)	35 percent (Max)

* Aggregates which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS:5640.

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

*** In case water bound macadam is used for sub-base, the requirements in respect of Los Angeles Value and Aggregate Impact Value shall be relaxed to 50 percent and 40 percent maximum respectively.

404.2.2 Crushed or Broken Stone

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

404.2.5 Grading Requirement of Coarse Aggregates

The coarse aggregates shall conform to one of the Gradings given in Table 400-9 as specified.

404.2.6 Screenings

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

Table 400-9 : Grading Requirements of Coarse Aggregates

Grading No.	Size Range	IS Sieve Designation	Percent by weight Passing
1)	63 mm to 45 mm	75 mm	100
		63 mm	90 — 100
		53 mm	25 — 75
		45 mm	0-15
		22.4 mm	0 — 5

2)	53 mm to 22.4 mm	63 mm	100
		53 mm	95 — 100
		45 mm	65- 90
		22.4 mm	0-10
		11.2 mm	0 — 5

Note : The compacted thickness for a layer shall be 75 mm.

Screenings shall conform to the grading set forth in Table 400-10. The quantity of screenings required for various grades of stone aggregates are given in Table 400-11. The Table also gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 75 mm.

The use of screenings shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites, etc. as they are likely to get crushed to a certain extent under rollers.

404.2.7 Binding Material

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

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m³ per 10 m².

Table 400.10: Grading For Screenings

Grading Classification	Size of Screenings	IS Designation	Sieve	Percent by Weight Passing the Sieve
A	13.2 mm	13.2 mm		100
		11.2 mm		95 —100
		5.6 mm		15 - 35
		180 micron		0 —10
B	11.2mm	11.2mm		100
		9.5 mm		80 —100
		5.6 mm		50 — 70
		180 micron		5 — 25

Table 400-11 : Approximate Quantities of Coarse Aggregates and Screenings Required for 75 mm Compacted Thickness of Water Bound Macadam (WBM) Sub-Base/Base Course for 10 m² Area

Classification				Screenings
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	Size Range	Compacted Thickness	Loose Qty.	Stone Screening		Crushable Type Such as Moorum or Gravel	
				Grading Classification & Size	For WBM Sub-base! Base Course (Loose Quantity)	Grading Classification & Size	Loose Qty.
Grading 1	63 mm to 45 mm	75 mm	0.91 to 1.07 m ³	Type A 13.2 mm	0.12 to 0.15 m ³	Not uniform	0.22 to 0.24 m ³
-do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 to 0.22 m ³	-do-	-do-
Grading 2	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 m ³	-do-	-do-

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

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

404.3 Construction Operations

404.3.1 Preparation of Base

The surface of the sub-grade/sub-base/base to receive the water bound macadam course shall be prepared to the specified grade and camber and cleaned of dust, dirt and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained.

Where the WBM is to be laid on an existing metalled road, damaged area including depressions and potholes shall be repaired and made good with the suitable material. The existing surface shall be scarified and re-shaped to the required grade and camber before spreading the coarse aggregate for WBM.

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

404.3.2 Inverted Choke/Sub-surface Drainage Layer

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

grade as directed by the Engineer. Section 700 shall be applicable for use of geosynthetics.

404.3.3 Lateral Confinement of Aggregates

For construction of WBM, arrangement shall be made for the lateral confinement of aggregates. This shall be done by building adjoining shoulders along with WBM layers. The practice of constructing WBM in a trench section excavated in the finished formation must be completely avoided.

Where the WBM course is to be constructed in narrow widths for widening of an existing pavement, the existing shoulders should be excavated to their full depth and width up to the sub-grade level except where widening specifications envisages laying of a stabilised sub-base using in-situ operations in which case the same should be removed only up to the sub-base level.

404.3.4 Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade/ sub-base in the required quantities from the stockpiles to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 75 mm. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards.

No segregation of coarse aggregates shall be allowed and the coarse aggregates, as spread shall be of uniform gradation with no pockets of fine material.

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

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

404.3.5 Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of 80 to 100 kN static weight. The type of roller to be used shall be approved by the Engineer based on trial run.

Except on super elevated portions and carriageway with unidirectional cross-fall, where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the center line of the road, in successive passes uniformly overlapping preceding tracks by at least one-half width.

Rolling shall be carried out on courses where coarse aggregates of crushed/ broken stone are used, till the road metal is partially compacted. This will be followed by application of screenings and binding material where required in Clauses 404.3.6 and 404.3.7.

However, where screenings are not to be applied as in the case of aggregates like brick metal, laterite and Kankar for sub-base construction, the compaction shall be continued until the aggregates are thoroughly keyed. Rolling shall be continued and light sprinkling of water shall be done till the surface is well compacted.. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely with templates and longitudinally with 3 m straight edge. Any irregularities, exceeding 12 mm, shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to the desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

Material, which gets crushed excessively during compaction or becomes segregated, shall be removed and replaced with suitable aggregates.

404.3.6 Application of Screenings

After the coarse aggregates have been rolled to Clause 404.3.5, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be equipped with pneumatic tyres and operated so as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregates. These operations shall continue until no more screenings can be forced into voids of the coarse aggregates. The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

404.3.7 Sprinkling of Water and Grouting

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

In case of lime treated soil sub-base, construction of water bound macadam on top of it shall be taken up after curing as per Clause 402.3.9 and as directed by the Engineer.

Application of binding material : After the application of screenings in accordance with Clauses 404.3.6 and 404.3.7, the binding material where it is required to be used (Clause 404.2.7) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

404.3.8 Setting and Drying

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

404.4 Surface Finish and Quality Control of Work

404.4.1 The surface finish of construction shall conform to the requirements of Clause 902.

404.4.2 Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

404.4.3 The water bound macadam work shall not be carried out when the atmospheric temperature is less than 10°C in the shade.

404.4.4 Reconstruction of Defective Macadam

The finished surface of water bound macadam shall conform to the tolerances of surface regularity as prescribed in Clause 902. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. The area treated shall not be less than 10 sq.m. In no case shall depressions be filled up with screenings or binding material.

404.5 Arrangements for Traffic

During the period of construction, the arrangements for traffic shall be done as per Clause 112.

404.6 Measurements for Payment

Water bound macadam shall be measured as finished work in position in **cubic metres**.

404.7 Rate

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations which includes

[i] Making arrangements for traffic to Clause 112 as above 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 lift.

[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

[v] Carrying out the required tests for quality control.

Item No.33:- Providing & Laying bituminous grout 37.5 mm.thick compacted with bitumen of grade VG 30 at rate 1.99% by weight of mix for mixing & 2.5Kgs/10Smt bitumen grade VG 30 for tack coat and using B.T. Chips of required gradation including cleaning and heating asphalt premix materials by hot mix process in proper gradation and laying with

paver finisher and consolidation work as per MORT & H specification including cost of labour , materials & plants, fuel , oil etc complete.

506.1 Scope

This work shall consist of a two-layer composite construction of compacted crushed coarse aggregates with application of bituminous binder after each layer and key aggregates on top for the second layer, in accordance with the requirements of these Specifications to serve as a base course and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Thickness of the course shall be 75mm.

Built-up spray grout shall be used in a single course in a pavement structure.

506.2. Materials

506.2. 1. Bitumen: Clause 504.2. 1 shall apply.

506.2.2. Aggregates: The coarse aggregate shall conform to Clause 504.2.2.

The aggregate shall satisfy the physical requirements set out in Table 500-3 .The coarse and key aggregates for built-up spray grout shall conform to the grading given in Table 500-7.

TABLE 500-7. GRADING REQUIREMENTS OF COARSE AND KEY AGGREGATES FOR BUILT-UP SPRAY GROUT

IS Sieve	Per cent by weight passing the sieve	
	Coarse Aggregate	Key Aggregate
53.0mm	100	-
26.5mm	40-75	-
22.4mm	-	100
13.2mm	0-20	40-75
5.6mm	-	0-20
2.8mm	0-5	0-5

506.3. 1. Weather and seasonal limitations: The provisions of Clause 501.5.1, shall apply.

506.3.2. Equipment: The provisions of Clause 505.3.2. shall apply.

506.3.3. Preparation of base: The base on which the built up spray grout course is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections in accordance with clause 501 and 902. A priming coat where needed shall be applied in accordance with Clause 502 with suitable primer as directed by the Engineer.

506.3.4. Tack coat:

A tack coat over the base shall be applied as per Clause 503.

506.3.5. Spreading and rolling coarse aggregates for the first layer: Immediately after the application of tack coat, the coarse aggregates in a dry and clean form shall be spread uniformly and evenly preferably by mechanical means at the rate of 0.5 cum. per 10 sq.m area.

Immediately after spreading of the aggregates, the entire surface shall be rolled with a 80-100 kN smooth wheeled roller. Rolling shall commence at the edges and progress towards the center except in superelevated and unidirectional cambered portions where it shall proceed from the lower edge to the higher edge.

After initial rolling, the surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding, or removing necessary amounts of aggregate, followed by rolling.

Rolling shall be stopped before voids in the aggregate layer are closed to such an extent as to prevent free and uniform penetration of the binder.

506.3.6. Application of binder-first spray: The binder shall be heated to the temperature appropriate to grade of bitumen approved by the Engineer and sprayed on aggregate layer at the rate of 15 kg/10 sq. m. (in terms of straight-run bitumen) in a uniform manner with the help of mechanical sprayers capable of spraying bitumen uniformly at specified rates and temperatures.

506.3.7. Spreading and rolling of coarse aggregate for the second layer: Immediately after the first application of the binder, the second layer of coarse aggregates shall be spread and rolled to Clause 506.3.5.

506.3.8. Application of binder-second spray: The second aggregate layer shall then be given a binder spray at the rate of 15 kg/10 sq.m. (in terms of straight-run bitumen) to Clause 506.3.6.

506.3.9. Application of key aggregate: Immediately after second application of the binder, key aggregates in a clean and dry state shall be spread uniformly and evenly, preferably by mechanical means at the rate of 0.13 cum./ 10 sq.m. so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform application of the key aggregates. The entire surface shall then be rolled with a 80-100 kN smooth-wheeled roller to Clause 506.3.4. While rolling is in progress, additional key aggregates, where required, shall be spread by hand. Rolling shall continue until the entire course is thoroughly compacted and key aggregates are firmly in position.

506.4. Surface Finish and Quality Control

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.

506.5. The built-up-spray-grout shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before allowing any traffic over it. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

506.6. Arrangements for Traffic: During the period of construction, arrangement of traffic shall be done to Clause 112.

506. 7. Measurements for Payment: Built-up spray grout shall be measured as finished work in **MT.**

506.8. Rate: The contract unit rate for built-up spray grout shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8 (i) to (xi).

Item No.34:- Providing laying and rolling 25 mm thick open graded premixed bituminous carpet with B.T. aggregate as specified and using bitumen for mixing with aggregate at the rate of 3.36% i.e 33.60 kg/M.T. of total mix including heating and mixing in drum mix plant and spreading the same with paver finisher and consolidation with power roller including necessary firewood oil, lubricants, labour charges etc. using contractor's own drum mix plant and equipment, tool etc. completed in accordance with the requirement of specification.

510.1.1 Scope

This work shall consist of preparation, laying and compaction of an open-graded premix surfacing material of 25 mm thickness composed of small-sized aggregate premixed with bituminous binder on a previously prepared base, in accordance with the requirements of these Specifications to serve as a wearing course.

510.1.2 Materials

510.1.2.1 Binder

The binder shall be viscosity grade bitumen of a suitable grade as specified in the Contract, or as directed by the Engineer, and satisfying the requirements of IS:73. For selection of grade of bitumen guidance may be taken from Table 500-1.

510.1.2.2 Aggregates

The aggregates shall conform to Clause 504.2.2 except that the water absorption shall be limited to a maximum of 1 percent. The Polished Stone Value, shall not be less than 55, when tested as per BS:812-114.

510.1.2.3 Proportioning of Material

The materials shall be proportioned in accordance with Table 500-23.

Table 500-23 : Quantities of Materials Required for 10 m² of Road Surface for 25 mm Thick Open-graded Premix Surfacing

	Material	Quantity
Aggregates		
a)	Nominal Stone size 13.2 mm (passing 22.4 mm sieve and retained on 11.2 mm sieve)	0.18 m ²
b)	Nominal Stone size 11.2 mm (passing 13.2 mm sieve and retained on 5.6 mm sieve)	0.09 m ²
	Total	0.27m ²
a)	For 0.18 m ³ of 13.2 mm nominal size stone of 52 kg bitumen per m ³ 9.5 kg	9.5 kg
b)	For 0.09 m ³ of 11.2 mm nominal size stone of 56 kg bitumen per m ³	5.1 kg
	Total	14.6 kg

510.1.3 Construction Operations

510.1.3.1 Weather and Seasonal Limitations

Clause 501.5.1 shall apply.

510.1.3.2 Preparation of Surface

The underlying surface on which the bituminous surfacing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross-section in

accordance with Clause 501. A prime coat where needed shall be applied in accordance with Clause 502 as directed by the Engineer.

510.1.3.3 Tack Coat

A tack coat complying with Clause 503, shall be applied over the base preparatory to laying of the surfacing.

510.1.3.4 Preparation of Premix

Hot mix plant of appropriate capacity and type shall be used for the preparation of the mix material. The hot mix plant shall have separate dryer arrangement for heating aggregate.

The temperature of the binder and aggregate at the time of mixing, laying and compaction shall be in conformity with the temperature given in Table 500-3. The difference in temperature between the binder and aggregate shall at no time exceed 14°C. Mixing shall be thorough to ensure that a homogeneous mix is obtained in which all particles of the aggregates are coated uniformly.

The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or hand barrows. The vehicles employed for transport shall be clean and the mix being transported covered in transit if so directed by the Engineer.

510.1.3.5 Spreading and Rolling

The pre mixed material shall be spread on a previously prepared base to Clause 501 by a paver unless specified otherwise in the Contract to the desired thickness, grades and crossfall (camber). The cross-fall should be checked by means of camber boards and irregularities levelled out. Excessive use of blades or rakes should be avoided. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 8–10 tonne rollers, smooth wheel tandem type or other approved equipment. Rolling shall begin at the edge and progress towards the centre longitudinally, except that on superelevated and uni-directional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions, which become apparent, shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled and all the roller marks eliminated. In each pass of the roller the preceding track shall be overlapped uniformly by at least onethird width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels. In no case shall fuel/lubricating oil be used for this purpose. Excess use of water for this purpose shall also be avoided.

Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below the rolling temperature indicated in Table 500-3.

510.1.3.6 Seal Coat

A seal coat conforming to Clause 511 of the type specified in the Contract shall be applied to the surface immediately after laying the surfacing.

510.1.4 Opening to Traffic

No traffic shall be allowed on the road until the seal coat has been laid. After the seal coat is laid, the road may be opened to traffic according to Clause 511.4.

510.1.5 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902. For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

510.1.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

510.1.7 Measurement for Payment

Open graded premix surfacing shall be measured as finished work, for the area instructed to be covered, in **M.T.**

510.1.8 Rate

The contract unit rate for open-graded premix surfacing shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2.

Item No.35:- Providing and laying seal coat with B.T. aggregate as specified using aggregate at the rate of 0.18cum/10sqmt and bitumen grade VG-30 for mixing with aggregate at the rate of 4.5 % i.e. 45.00 Kg/M.T. of total mix including heating and mixing in drum mix plant and spreading the same by paver finisher and consolidation with power roller including necessary fire wood oil, lubricants, labour charges using contractor's own drum mix plant, machineries and equipment, tools (including flushing & screened stone dust etc. complete in accordance with the requirement of specification.

511.1 Scope

This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and cross fall (camber).

Seal coat shall be of either of the two types specified below:

- A. Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chips.
- B. Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

511.2 Materials

511.2.1 Binder

The requirements of Clauses 51 0.1.2.1 and 51 0.2.2.1 shall apply.

The quantity of bitumen per 10 square metres, shall be 9.8 kg for Type A, and 6.8 kg for Type B seal coat. Where bituminous emulsion is used as a binder, the quantities for Type A and Type B seal coats shall be 15 kg and 10.5 kg respectively.

511.2.2 Stone Chips for Type A Seal Coat

The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7 mm size defined as 100 percent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 10 square metre area. The chips shall satisfy the quality requirements 05 Section 500 Bases and Surface Courses (Bituminous) given in Table 500-8 except that the upper limit for water absorption value shall be 1 percent.

511.2.3 Aggregate for Type B Seal Coat

The aggregate shall be sand or grit and shall consist of clean, hard, durable, uncoated dry particles, and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cum per 10 sqm area.

511.3 Construction Operations

511.3.1 Weather and Seasonal Limitations

The requirements of Clause 501.5.1 shall apply.

511.3.2 Preparation of Surface

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.

511.3.3 Construction of Type A Seal Coat

The construction operations shall be the same as described in Clause 509.3.3 to 509.3.5.

511.3.4 Construction Type B Seal Coat

511.3.4.1 Using Paving Bitumen

The construction operations shall be the same as in Clause 510.1.3.

511.3.4.2 Using Emulsion

The construction operations shall be the same as in Clause 510.2.4.

511.4 Opening to Traffic

In the case of Type B seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of Type A seal coat, traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases traffic shall be rigorously limited to 20 km per hour until the following day.

511.5 Surface Finish and Quality Control Work

The surface of construction shall conform to the requirements of Clause 902.

For control on the quality of materials and the works carried out, the relevant provisions of **Section 900** shall apply.

511.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

511.7 Measurement for Payment

Seal coat, Type A or B shall be measured as finished work, over the area specified to be covered, in **M.T.** at the thickness specified in the Contract.

511.8 Rate

The contract unit rate for seal coat 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.

Item No.36:- Providing and applying tack coat with emulsion RS1 grade at the rate of 4.0 kg/ 10 Sq.mt. including cost of asphalt and preparing the surface heating, and applying etc. complete.

503.1 Scope

The work shall consist of the application of a single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or as instructed by the Engineer. The work shall be carried out on a previously prepared surface in accordance with Clause 501.8.

503.2 Materials

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with 15:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to 15:73. The use of cutback bitumen RC:70 as per 15:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer. The type and grade of binder for tack coat shall be as specified in the Contract or as directed by the Engineer.

503.3 Weather and Seasonal Limitations

Bituminous material shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 1 ooc. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

503.4 Construction

503.4.1 Equipment

The tack coat shall be applied by a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

503.4.2 Preparation of Base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and

any extraneous material and be otherwise prepared in accordance with the requirements of Clauses 501.8. The granular or stabilized surfaces shall be primed as per Clause 502. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high-pressure air jet, or by other means as directed by the Engineer.

503.4.3 Application of Tack Coat

The application of tack coat shall be at the rate specified in Table 500-5, and it shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract, then it shall be the rate specified in Table 500-5. No dilution or heating at site of RS1 bitumen emulsion shall be permitted. Paving bitumen if used for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for cutback, 50°C to 80°C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed or 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.

Table 500-5 : Rate of Application of Tack Coat

Type of Surface	Rate of Spray of Binder in Kg per sq. m
Bituminous surfaces	0.20-0.30
Granular surfaces treated with primer	0.25-0.30
Cement concrete pavement	0.30-0.35

503.4.4 Curing of Tack Coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

503.5 Quality Control of Work

For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

503.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

503.7 Measurement for Payment

Tack coat shall be measured in terms of surface area of application in **Sq.m.**

503.8 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. The rate shall cover the provision of tack coat, at 0.2 kg per square metre or at the rate specified in the Contract, with the provision that the variation between this quantity and actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

Item No.37:- Road marking with hot applied thermo plastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorsing glass beads@ 250 gms 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 coefficent on cement road shall be min 130mcd/m2/lux and Asphalt road shall be min 100 mcd/m2/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity,wet reflectivity and skid resistnce as mentioned in the section 15 of IRC35-2015. warrenty for retro reflectivity shall be two years

803 ROAD MARKINGS

803.1 Scope

The work shall consist of providing road markings of specified width, layout and design using paint of the required specifications as given in the Contract and as per guidelines contained in from IRC:35-1997.

803.2 Materials

Road markings shall be of ordinary road marking paint hot applied thermoplastic compound, reflectorized paint or cold applied reflective paint as specified in the item and the material shall meet the requirements as specified in these Specifications.

803.3 Ordinary Road Marking Paint

803.3.1 Ordinary paint used for road marking shall conform to Grade I as per IS:164.

803.3.2 The road marking shall preferably be laid with appropriate road marking machinery.

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	30-30	30-30
Titanium Dioxide	10.0 min.	—
Calcium Carbonate and Inert Fillers	42.0 max.	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 D36/BS-3262-(Part I), shall be as below:

a) Luminance :

White: Daylight luminance at 45°-65 percent min. as per AASHTO M 249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M 249

- 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°C ± 9.5°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 reflectorized 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 Requirements 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	0-10	10 to 30
Below 180 micron	- -	0 to 15

b) Roundness: The glass beads shall have a minimum of 70 percent true spheres.

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 paint 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

Special Requirement for Hot Applied Thermoplastic Marking and Audible Vibratory Profile Marking Application on Road

1. The application of Hot Applied Thermoplastic and Audible Vibratory marking must be done with Either Fully Automatic or Semi-Automatic Application Machine only. No Manual Machine is allowed to use for the application of the Thermoplastic marking.
2. The Applicator must have their own machines for Thermoplastic profile Marking, and the proof ownership to be submitted to the Authority for source approval.
3. The Applicator should be either Manufacturer or authorized by the original manufacturer of the Material. The applicator should submit such authorization certificate to the Authority for the approval before commencing the work.
4. The manufacture should be ISO certified organization and the copy of the certificate should be submitted to the Authority.
5. Performance Criteria: Material should be confirming to MoRTH specification and test Certificate should be submitted as per the IRC 35-2015 for the reflectivity and luminance test time to time.
6. The Applicator should organize onsite testing for the reflectivity performance with reflectometer initially at 7 days and afterwards at interval of every 6 months up to 2Years. And performance should meet IRC 35-2015 criteria.
7. The Applicator should submit in original warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period of 2 years. The warranty should be in original and jointly signed by the original manufacture and Authorized applicator.

803.6.8 Measurements for Payment

803.6.8.1 The painted markings shall be measured in **Sqm.** 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 to these Specifications.

Item No.38:- Cautionary Warning Sign :-Providing and fixing sing boards made out of 2mm aluminium sheet; size 90 x 90 x 90 cms. equilateral triangle as per design of IRC-67-1977. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with retro reflectivesheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm, 75 x 75 x 6mm as required; painted with best quality 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 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) Engineer Grade(VR)

801.1. General

The work shall consist of Grade (Fabrication, supply and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the Code of Practice for Road Signs, IRC:67-2010.

801.2. Materials

The various materials and fabrication of the traffic signs shall conform to the following requirements:

801.2.1. Concrete : Concrete for foundation shall be of M 15 Grade as per Section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

801.2.2. Reinforcing steel: Reinforcing steel shall conform to the requirement of IS:1786 unless otherwise shown on the drawing.

801.2.3. Bolts, nuts, washers: High strength bolts shall conform to IS : 1367 whereas precision bolts, nuts, etc., shall conform to IS: 1364.

801.2.4. Plates and supports: Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS Specifications.

801.2.5 Substrate

Sign panels shall be fabricated on aluminum sheet, aluminum composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminum alloy conforming to IS:736-Material Designation 24345 or 1900. Aluminium Composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LOPE) between two thick skins/sheets of aluminum with overall thickness and 3 mm

or 4 mm (as specified in the Contract), and aluminum skin of thickness 0.5 mm and 0.3 mm respectively on both sides.

The mechanical proportion of ACM and that of aluminum skin shall conform to the requirements given in Table 800-1, when tested in accordance with the test methods mentioned against each of them.

Table 800-1 : Specifications for Aluminium Composite Material (ACM)

Sr. No.	Description	Specification	
		Standard Test	Acceptable Value
A	Mechanical Properties of ACM		
1)	Peel off strength with retro reflective	ASTM 0903	Min. 4 N/mm
2)	Tensile strength	ASTM E8	Min. 40 N/mm ²
3)	0.2% Proof Stress	ASTM E8	Min. 34 N/mm ²
4)	Elongation	ASTM E8	Min.6%
5)	Flexural strength	ASTM 393	Min. 130 N/mm ²
6)	Flexural modulus	ASTM 393	Min. 44.00 N/mm ²
7)	Shear strength with Punch shear test	ASTM 732	Min. 30 N/mm ²
B	Properties of Aluminium Skin		
1)	Tensile strength (Rm)	ASTM E8	Min. 65 N/mm ²
2)	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm ²
3)	Elongation	ASTM E8	A50 Min. 2%
4)	0.2% Proof Stress	ASTM E8	Min. 10 N/mm ²

801.2.6 Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick with Aluminium and 3 mm thick with Aluminium Composite Material. All other signs be at least 2 mm thick with Aluminium and 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads.

801.2.7 In respect of sign sizes not covered by IRC:67, the structural details (thickness, etc.) shall be as per the approved drawings or as directed by the Engineer.

801.3 Traffic Signs having Retro-Reflective Sheeting

801.3.1 General Requirements

The retro-reflective sheeting used on the sign 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 co-efficient of retro-reflection, day/night time colour luminous, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance and its having- passed these tests shall be obtained from a Government Laboratory/Institute, by the manufacturer of the sheeting. The retro-

reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-prismatic Grade retro-reflective element material as given in Clauses 801.3.2 to 801.3. 7. Guidance on the recommended application of each class of sheeting may be taken from IRC:67.

801.3.2 High Intensity Grade Sheeting

801.3.2.1 High Intensity Grade (Type III)

This high intensity retro reflective sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic having a smooth surface or as an unmetallized micro prismatic

reflective material element. 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 0:4956-09) as indicated in Table 800-2.

**Table 800-2 : Acceptable Minimum Co-efficient of Retro-Reflection for High Intensity Grade Sheeting (Type III) (Encapsulated Lens Type)
(Candelas Per Lux Per Square Meter)**

Observation Angle in Degrees	Entrance Angle in Degrees	White	Yellow	Orange	Green	Red	Blue	Brown
0.1 ^{0B}	-4 ⁰	300	200	120	54	54	24	14
0.1 ^{0B}	-30 ⁰	180	120	72	32	32	14	10
0.2 ⁰	-4 ⁰	250	170	100	45	45	20	12
0.2 ⁰	-30 ⁰	150	100	60	25	25	11	8.5
0.5 ⁰	-4 ⁰	95	62	30	15	15	7.5	5.0
0.5 ⁰	-30 ⁰	65	45	25	10	10	5.0	3.5

A minimum of Coefficient of Retro-reflection (RA)cd/fc/ft²(cd-xl-1m²).

B Values for 0.1° observation angles are supplementary requirement that shall apply only when specified by the purchaser in the Contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.4 Prismatic Grade Sheeting

801.3.4.1 Prismatic Grade Sheeting (Type VIII)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. 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 E 810) as indicated in Table 800-4.

801.3.4.2 Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. 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 E 810) as indicated in Table 800-5.

Table 800-4: Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting (Type VIII) (Candelas Per Lux Per Square Metre)

Observation Angle in Degrees	Entrance Angle in Degrees	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow w/ Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	1000	750	375	100	150	45	30	800	600	300
0.1° ^B	+30°	460	345	175	46	69	21	14	370	280	135
0.2°	-4°	700	525	265	70	105	32	21	560	420	210
0.2°	+30°	325	245	120	33	49	15	10	260	200	95
0.5°	-4°	250	190	94	25	38	11	7.5	200	150	75
0.5°	+30°	115	86	43	12	17	5	3.5	62	69	35

A Minimum Coefficient of Retro reflection (R^A) cd/fc/ft² (cd-Ix- 1m²).

B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

Table 800-5: Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting (Type IX) (Candelas Per Lux Per Square Metre)

Observation Angle in Degrees	Entrance Angle in Degrees	White	Yellow	Orange	Green	Red	Blue	Fluorescent Yellow/ Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	600	500	250	66	130	130	530	400	200
0.1° ^B	+30°	370	280	140	37	74	17	300	220	110
0.2°	-4°	380	285	145	38	76	17	300	230	114
0.2°	+30°	215	162	82	22	43	10	170	130	65
0.5°	-4°	240	180	90	24	48	11	190	145	72
0.5°	+30°	135	100	50	14	27	6.0	110	81	41
0.1°	-4°	80	60	30	8.0	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2.0	36	27	14

A Minimum Coefficient of Retro reflection (RA) cd/fc/ft² (cd-Ix- 1m²).

B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.4.3 Prismatic Grade Sheeting (Type XI)

A Retro-reflective sheeting typically manufactured as a cube corner. The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. The retro-reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflective (determined in accordance with ASTM E 810) as indicated in Table 800-6.

Table 800-5: Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting (Type IX) (Candelas Per Lux Per Square Metre)

Observation Angle in Degrees	Entrance Angle in Degrees	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow/Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	830	620	290	83	125	37	25	680	500	250
0.1° ^B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	1	460	350	175
0.2°	+30°	220	165	77	22	33	10	7.0	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7.0	5.0	120	90	45
0.1°	-4°	120	90	42	12	18	5.0	4.0	96	72	36
0.1°	+30°	45	34	16	5.0	7.0	2.0	1.0	36	27	14

A Minimum Coefficient of Retro reflection (RA) cd/fc/ft² (cd-Ix- 1m²).

B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.5 Adhesives

The sheeting shall have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent other preparation for adhesion to a smooth clean surface, in a manner recommended by the sheering manufacturer. The adhesive 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. The sheeting shall be applied in accordance with the manufacturer's specification.

801.3.6 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminum sheeting shall be de-greased either by acid or hot alkaline etching and all Traffic Signs, Marking and other Road Appurtenances.

Scale/dust removed to obtain a 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. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5mm. Where screen printing with transparent colors is proposed, only butt joint 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 manner specified by the manufacturer.

801.3.7 Messages/Borders

The messages (legends, letter, numerals etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory sign boards. Screen Printing shall be processed and finished with material and in a manner specified by the sheeting manufacture. For the informatory and other sign boards, the messages (legends, letters, numerals, etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent colored area on white sheeting, the co-efficient of retro-reflective shall be less than 50 percent of the values of corresponding color in Table 800-2 to 800-8 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-reflective sheeting or made out of durable transparent overlay except those in black which shall be of non- reflective sheeting or opaque in case of durable transparent overlay.

801.3.8 Color for Signs

801.3.8.1 Signs shall be provided with retro-reflective sheeting and or overlay film screening ink. The reverse side of all signs shall be painted grey.

801.3.8.2 Except in the case of railway level crossing signs the sign posts shall be painted in 250mm side bands , alternately black and white . The lowest band next to be ground shall be in black.

801.3.8.3 The color of the material shall be located within the area defined by the chromaticity coordinates in Table 800-7 and comply with the luminance factor when measured as per ASTM D-4956.

Table 800-5: Colour Specified Limits (Daytime)

Colour	1		2		3		4		Daytime Luminance Factor(Y%)	
	x	y	x	y	x	y	x	y	Min.	Max.
White	0.303	0.300	0.368	0.366	0.340	0.3939	0.274	0.329	15	--
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	24	45

Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771	2.5	11
Red	0.648	0.351	0.35	0.265	0.629	0.281	0.565	0.346	2.5	11
Blue	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216	1	10
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	12	30
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390	1	6
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	--
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	--
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	--

The colour shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

801.3.8.4 The Regulatory/Prohibitor and warning signs shall be provided with white background and red border. The legend/symbol for these signs shall be in black colour. The Mandatory sign shall be provided with Blue background and white Symbol/letter.

801.3.8.5 The colours chosen for informatory or guide signs shall be distinct for different classes of roads. For National Highways, these signs shall be of green background and for Expressways these signs shall be of blue background with white border, legends and word messages.

801.3.9 Refurbishment

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminum backing or materials as per Clause 801.2.5, per-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

801.3.9 Sizes of Letters

801.3.10.1 Letter size should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8

Table 800-8: Acceptable Limits for Sizes of Letters

Design Speed (Km./hr.)	Minimum 'x' Height of the letters (mm)	Minimum Distance/Clear Visibility Distance (m)	Sight Distance from Center Line (m)
40	100	45	12
50	125	50	14
65	150	60	16
80	250	80	21
100	300	90	24
120	400	115	32

The thickness of the letters and their relation to the x-heights are indicated in Table IV (a) of the Annexure-4 of IRC:67 to facilitate the design of the informatory signs and definition plates.

801.3.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for Expressway, National and State Highways and 100 mm for other roads. In case of overhead signs, the size ('X' height) of letters may be minimum 300 mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The size of the initial uppercase letter shall be 1-1/3 times x-height. In urban areas, letter size shall be 100 mm on all directional signs. For easy and better comprehension, the word message shall be written in upper case letters only.

801.3.10.3 Letter size on definition plates attached with normal sized signs should be 100 mm or 150 mm. In the case of small signs, it should be 100 mm. Where the message is long, as for instance in "NO PARKING" and "NO STOPPING" signs, the message may be broken into two lines and size of letters may be varied in the lines so that the definition plate is not too large. The lettering on definition plates will be in upper case letters.

801.3.11 Warranty and Durability

The Contractor shall obtain from the manufacturer a ten year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflectance sheeting of micro-prismatic sheeting and a seven-year warranty for high intensity grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting. The Contractor/supplier shall also furnish the LOT numbers and certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty and that the contractor/supplier is the authorized converter of the particular sheeting.

All signs shall be dated during fabrication with indelible markings to indicate the start of warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement or repair/restoration of the retro-reflective efficiency.

A certificate in original shall be given by the sheeting manufacturer that its offered retroreflective sheeting has been tested for various parameters such as co-efficient of retroreflection, day/night time colour and luminance, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance; the tests shall be carried out by a Government Laboratory in accordance with various ASTM procedures and the results must show that the sheeting has passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate.

801.4 Installation

801.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS:1239, Rectangular Hollow Section conforming to IS:4923 or Square Hollow Section conforming to IS:3589. 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 up to 0.9 sq.m shall be mounted on a single post, and for greater area two or more supports shall be provided. 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.

801.4.2 All components of signs (including its back side) and supports, other than the reflective portion and G. I. posts shall be thoroughly de-scaled, cleaned, primed and painted with two coats of epoxy/ fibre glass/ powder coated paint. Any part of support post below ground shall be painted with protective paint.

801.4.3 The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

801.5. Measurements for Payment The measurement of standard cautionary shall be in **Each** of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square metres.

A warranty for 7 years for the retro reflective sheeting from original manufacturer and certified copy of three years outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor.

801.6. 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.

Item No.39:- Hazard Marker Sign :-Providing and fixing sing boards made out of 2mm aluminium sheet; size 90 x 30cms. rectangle as per the design/drawing attached (IRC) pretreated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm & 50 x 50 x 5mm painted with best quality epoxy coatings The fixing at site shall be in 1:2:4 CC block of size 45x45x 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

This work shall consist of Providing and fixing **Hazard Marker Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Hazard Marker Sign** shall be in **Nos.** of different types of signs supplied and fixed, while for direction and place identification signs.

Item No.40:- Regulatory/Mandatory signs :-Providing and fixing sing boards made out of 2mm aluminium sheet; size 60cms. diameter circle as per the design of IRC-67-1977 pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm 75x75x6mm as required; 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 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

This work shall consist of Providing and fixing **Regulatory/Mandatory signs** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Regulatory/Mandatory signs** shall be in **Nos.** of different types of signs supplied and fixed, while for direction and place identification signs

Item No.41:- 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 best quality 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 work shall consist of Providing and fixing **Chevron Sign Board** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract. The measurement of **Chevron Sign** shall be in **Each** of different types of signs supplied and fixed, while for direction and place identification signs.

Item No.42:- Providing and fixing hectometer as per I.R.C. type design including painting lettering etc. complete fixing in C.C. 1:5:10.

1. Hectometer stone shall be of approved quality and as per I.R.C. 26 (Type design for 200 meter stones) and shall be fixed in C.C. 1:5:10 which will consist of one part of cement, five part of good sand and ten parts of machine crushed metal 40 mm nominal size. Rate includes all labour and curing etc. necessary for concrete.
2. The measurement for payment shall be made per **Each.** of Hectometer stone fixed in position.
3. Unit rate for hectometer stone includes the cost of all materials, labour, tools, fixing, finishing curing, lettering and painting as directed by the Engineer-in-charge.

Item No.43:- Cat Eye/ Road Stud / RPM: Supplying Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panles with micro prismatic lens (No Glass lens) capable of providing total internal reflection of 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 Specification of Category A of MORTH Circular No RW/NH/33023/10-97 - Do III Dt 11.06. 1997. The height, width and length shall not exceed 20mm, 130 mm and 130mm and with minimum reflective area of 13 sq cm 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. The applicator of the Cat Eye should be authorized Applicator/ Converter of the original manufacturer of the Cat Eye I road studs and copy of the certificate has to be submitted to authority for source approval.
2. For Cat eye with twin molded Shanks application the anchorage should be provided by drilling with the Drilling machine only and not manually.
3. The applicator use the epoxy adhesive or fixing of the Cat eye I RPM as recommended by the original manufacturer only. No other adhesive should be allowed to use on the road.
4. Performance Criteria: Material should be confirming to MoRTH specification and Test Certificate should be submitted as per the IRC 35-2015 for the reflectivity and luminance test time to time. The Applicator should submit a letter in original issued by the original manufacturer of the RPM I Cat Eye for the same before commencing the work.
5. The applicator should submit warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period of 2 years. The warranty should be in original and jointly signed by the original manufacture and Authorized applicator.

1.0 Measurement for Payment

The measurement of Cats eye shall be in **Each** of markers supplied and fixed.

2.0 Rate

The contact unit rate for Cats eye shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed.

Item No.44:- Metal Beam Crash Barrier (Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2 m centre to centre, 1.8 m high, 1.1 m below ground/road level, all steel parts and fitments to be galvanized 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, 330 mm long complete as per clause 811)

The work shall consist of furnishing and erection of metal crash 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 double beam 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 IS 1367 and LS 1364.

2.2 Concrete for anchor assembly shall be in proportion of 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm size) which includes concrete foundation block of size 1.10 x 0.5 x 0.5 mt for each post. The concrete work shall be carried out in accordance with the relevant MORT&H specifications

3.0 Construction Operation :

3.1 Installation of posts :

3.1.0. Workmanship

3.1.1. The ground shall be roughly leveled and after making the position of post, at 2.0 mt. C/C the foundation pit shall be excavated in true line and level as shown on drawing or as directed by the Engineer in charge.

3.2 The Pit shall be back filled with R.C.C. 1:2:4 as shown on drawing or as directed.

3.3 While casting foundation concrete, steel post shall be embedded in concrete work at 2.0mt C/C with necessary hold fast. 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.

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 bolts or clips used for fastening the guard rail or fittings to the posts shall be drawn up tightly, Each bolt shall have sufficient length to extend at least 6 mm through and beyond the full nut, except where such extensions might interfere with or endanger traffic in which case the bolts shall be cut off flush with the nut.

4.3 All railings shall be erected, drawn and adjusted so that the longitudinal tension will be uniform throughout the entire length of the rail.

4.4 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 Meal beam crash barrier will be measured and paid by **Rmt.** 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" type crash barrier complete in place in all respect as per these specifications.

Item No.45 :- Citizens information Board:Providing and fixing of typical information board as per instruction. Two MS plates of 1.6m thick, of 900mm x 750mm size fixed at top & bottom duly welded with MS angles pf 25 x 25 x 5mm thick M.S plate shall be welded by two vertical M.S flates 5 mm thick to 75 mm x 75 mm of 12 SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 750mm, below ground level. Painting new letters & figure of any shade with ready mixed synthetic enamel paint of superior quality in required shade and colour, All sections of framed posts and steel tube will be painted with primer and two coats of epoxy paints as per drawing

This work shall consist of Providing and fixing **Citizens information Board** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

The measurement of Citizens information Board shall be Measured in **Nos.**

Item No.46 :- Supply & fixing logo board of diamond size (600 x 600 mm) 16 gauge & board plate size (900 x250 mm) 16 gauge thick M S Plate and 2.40 meter deep length single angle 75 x 75 x 6 mm size including fitting and painting lettering with luminous colour as per drawing etc.

This work shall consist of Providing and fixing **logo board** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

The measurement of logo board Sign shall be Measured in **No.**

Item No.47 :- Providing and fixing guard stone as per I.R.C. type design including white washing etc. complete fixing in C.C. 1:5:10.

1. The guard stone shall be of approved quality and of 20 cm x 15 cm. size and its length shall not be less than 75 cms. The top portion shall be rounded. The top 38 cm. shall be chisel dressed on all sides. The size, shape and dimensions of the guard stones shall be exact and shall be neatly dressed and finished.
2. The guard stone shall be fixed in position as directed by the Engineer-in-charge in earth. The exposed part of the guard stones shall be given three coats of white wash. Any excavation necessary for fixing of the guard stones shall be done by the contractor at his own cost. The measurement for payment shall be per number of guard stone fixed in position.
3. Unit rate of guard stone includes the cost of all materials, labors, tools, fixing & white washing as directed by the Engineer-in-charge.
4. In case of Deep/Causeway the guard stone shall be fixed in masonry of head wall as directed by Engineer-in-charge.

1.0 Measurement for Payment

The measurement of Cats eye shall be in **Each** of markers supplied and fixed.

Item No.48:- Providing & casting in situ controlled cement concrete M-20 mix for retaining wall and providing necessary pin headers including shuttering, scaffolding, laying, vibrating, curing and finishing complete without V-Groves. (A) 0 to 5 mt

This work shall consist of providing & casting in situ Controlled cement concrete M-20 mix and providing necessary pin headers including shuttering, scaffolding, laying, vibrating, curing and finishing complete without V-Groves. return and shall be carried out as per relevant detailed specification of **Item No.10** of this contract. Formwork, reinforcement and concrete shall conform to relevant sections of these specifications.

The item shall be measured & paid as finished work in **Cu.m.**

Item No.49 :-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 vibratory roller 8T to 10T.(A) From Borrow pits with all leads and lifts.

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 contractor's own earth. No railway land / Gujarat State land to be used as source of earth, contractor shall arrange own earth. 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:

305.2.1.1The materials used in embankments sub grades, earthen shoulders and miscellaneous back fills 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.

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 70 and plasticity index exceeding 45; 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 500 mm 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 S03) per liter when tested in accordance with BS:1377 Test 10, but using a 2: 1 water-soil ratio shall not be & deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other Cementous materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as S03) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the contract, of metallic items forming part of the Permanent Work

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 third of the compacted layer thickness.

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

MORTH TABLE 300-1: - DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS

Sr. No.	Type of work	Maximum Laboratory dry unit weight when tested as per IS:2720(part 8)
1.	Embankments up to. 3 meters height, not subjected to extensive flooding.	Not less than 15.2 kN/cum.
2.	Embankments existing 3 meters height of embankments of any height subject to long period of inundation	Not less than 16.0 kN/cum.

3.	Sub grade and earthen shoulders/ Verges/backfill	Not less than 17.5 kN/cu.m.
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Notes:

- (1) This Table is not applicable for lightweight fill materials e.g. cinder, fly ash etc.
- (2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.
- (3) The materials to be used in sub grade should also. Satisfy design CBR at the dry unit weight Applicable as per Table 300-2 of MORT&H.

305.2.1.6 The material to be used in subgrade 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 Clauses 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Accreditation Committee shall be followed.

305.2.1. 7 The material 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 material 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 from the toe of the embankment required as per the consideration of stability with a minimum width of 10m.

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.

305.2.2.4 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 shall be ensured that the sub grade material when compacted to the density requirements as in MORTH Table 300-2 shall yield the design CBR value of the sub grade.

MORTH TABLE 300-2:- COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUB GRADE

Sr. No.	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 clay	
	a) Sub grade and 500 mm portion Just below the sub-grade	Not allowed.
	b) Remaining portion of embankment	90-95%

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

- (i) The value 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 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, MORTH Clause 305.4.6 shall apply.

305.3.3 Stripping and Storing topsoil: 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 subjected to traffic 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 levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in MORTH 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 MORTH Table 300-2, the ground shall be loosened up to a level 0.5 m below the sub grade level, watered and compacted in layers in accordance with MORTH Clauses 305.3.5 and 305.3.6 to not less than 97 per cent of dry density as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or sub grade work shall not proceed until the foundations for Embankment/sub grade have been inspected by the Engineer for satisfactory condition and approved.

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 MORTH Clause 305.2.1.1, at least 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 not exceeding 200mm. compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per MORTH Clause 305.3.6. 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 MORTH 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 harrowing until 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 cannot 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 7) or 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, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per MORTH 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. Vibratory rollers 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 vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for this site trials hall first be submitted to the Engineer for approval.

Each layer of the material shall be thoroughly compacted to the densities specified in MORTH Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to MORTH Clause 903.2} 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). The Contractor shall maintain a record of the same.

When density measurements reveal any soft areas in the embankments /sub grade /earthen shoulders, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage: The surface of the embankment/ sub grade 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 MORTH 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, and cross sections and dimensions shown on the drawings' or as directed by the Engineer subject to the surface tolerance described in MORTH 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 (MORTH 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 MORTH Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of MORTH 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 sub grade under special conditions

305.4.1 Earthwork for widening existing road embankment:

When an existing embankment and/or sub grade 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/sub grade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/sub grade. 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. And 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 sub grade to be placed against sloping ground:

Where an embankment /sub grade to be place against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in MORTH Clause 305.4.1 before placing the embankment /sub grade 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 MORTH Clause 309 in proper sequence with the embankment and sub grade 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 sub grade level, the same shall be scarified to a depth of 50 Rm or more if specified, o as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new sub grade level is compacted to the desired density.
- (ii) If the existing road surface is of cement concrete type and lies within 1 m of the new sub grade level the same 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 500 mm of subgrade is available.

305.4.4 Embankment and sub grade 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 up to 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 sub grade 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 all' 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 Appendix 6 of IRC: 78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the Just below the sub grade type of material, the extent of backfill, its laying d compaction etc. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of MORTH 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 MORTH Clause 2502/309.3.2 (B) 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 ten 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 geo synthetic 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 MORTH Clause 305.3.

305.4.6 Embankment Construction under Water and Waterlogged 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 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 305.2.1. 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 the Contractor shall bring the resultant level up to formation level with acceptable material 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.

Rolling and watering of earthwork in layers with power roller including filling in depression which occur during the process.

1. For spreading materials in layers and bringing the appropriate moisture content, the embankment materials shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness, Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down here under

Moisture content of the materials shall be checked at the source of supply and if found less than that specified for compaction; the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances.

If the materials delivered to the road bed is too wet it shall be dried, by evaporation and exposure to the sun, till the moisture content is brought down to acceptable standard for compaction should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required level by the above procedure. Work of compaction shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS 2720 (Part-II) and unless otherwise mentioned shall be so adjusted, making due allowance for evaporation losses, that at the time of the compaction it is in the range of 1 percent to 2 percent below the optimum Moisture content determined in accordance with ISI (Part-VII). Highly expansive clays shall however be compacted at 2 to 4 percent above the optimum moisture content.

After adding the required amount of water, the soil shall be processed by means, of harrows. Rotary mixers or as otherwise approved until the layer is uniformly wet. Clods or hard lumps of earth shall be broken to have maximum size of 150mm when being placed lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5-meter portion of the embankment below the sub grade.

Hauling equipment shall be dispersed uniformly over entire surface of the previously constructed layer to minimize cutting of uneven compaction.

Where the embankment is to be constructed on low area ground that will not support the weight of trucks or other hauling equipment the lower part of the fill should be constructed by dumping successive loads in a uniformly distributed layers of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

2. **COMPACTION:** Only compacting equipment approved by the Engineer-in-charge shall be employed to compact the materials. The contractor shall demonstrate the efficiency of the plants he intends to use for carrying out compaction trials.

Each layer of the materials shall be thoroughly compacted to the densities specified in Table below:

Table:-

Sr. No.	Type of Work / Materials	Field dry density/MDD as percentage of maximum laboratory dry density as per IS : 2720 (Part VII)
1	Top 0.5-meter portion of embankment below sub grade level and shoulders	Not less than 97.
2	Other portion of embankment	Not less than 95.
3	Highly expansive class	85 to 90.

Subsequent layers shall be placed only after finished layer has been tested according to M.O.S.T. specification clause 902 and accepted by the Engineer-in-charge.

When density measurements reveal any soft areas in the embankment further compaction shall be carried out as directed by the Engineer-in-charge If insight of that

the specified compaction is not achieved, the materials in the soft areas shall be removed and replaced by approved materials and compacted to the density requirement, to the satisfaction of the Engineer-in-charge.

3. The contract unit rate includes cost of mechanical roller required for consolidation including all labour equipment fuel, hire charges, tolls, and incidentals necessary.

305.4.8 Plying of Traffic:

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or sub grade 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 sub grade shall conform to the requirements of MORTH Clause 902. Control on the quality of materials and works shall be exercised in accordance with MORTH Clause 903.

305.7 Sub grade Strength:

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

305.7.2 Sub grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub grade shall be determined on undisturbed samples cut out from the compacted sub grade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

305.8 MEASUREMENTS FOR PAYMENT:

305.8.1 Earth embankment/ sub grade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in **cubic meters** 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 cum. of compacted fill and all bulking or shrinkage shall be ignored.

305.8.4 Construction of embankment under water shall be measured in cum.

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

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

305.8.7 Work involving loosening and re-compacting of ground supporting embankment /sub grade shall be measured in cum.

305.8.8 Removal of unsuitable material at embankment/sub grade foundation and replacement with suitable material shall be measured in Cum.

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

305.8.10 Dismantling and removal of existing cement concrete pavement shall be measured vide MORTH 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 cum.

305.9 RATES:

305.9.1 The Contract unit rates for the items of embankment and sub grade 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 otherwise in the contract.
- (ii) Setting out.
- (iii) Compacting ground supporting embankment/sub grade except where removal and replacement of unsuitable material or loosening and re-compacting is involved;
- (iv) Scarifying or cutting continuous horizontal benches 300mm wide on slopes of existing embankment and sub grade as applicable;
- (v) Cost of watering or drying of material in borrow areas and/or embankment and sub grade 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 sub grade including rounding of corners;
- (viii) Restricted working at sites of structures
- (ix) Working on narrow width or embankment and sub grade;
- (x) Excavation in all soils from borrow pits/designated borrow areas in jungle Clearing and grubbing and transporting the material to embankment sub grade site with all lifts and leads unless otherwise provided for contractor.
- (xi) All labour, material, tools, equipment and incidentals necessary to com etc. the work to the Specifications.

- (xii) Dewatering and
- (xiii) Keeping the embankment/completed formation free of water as per Clause 311.

In case the Contract unit rate specified is inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the contract for construction of embankment and sub grade 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.

Item No.50:- Construction of 200 mm thick compacted coarsed granular subbase by providing coarse graded machine crushed B.T. material satisfying MOST specification (Grade-V crushed B.T. stone aggregate 26.5 mm to 9.5 mm @ 50 %, 9.5 mm to 2.36 mm @ 20% and 2.36 mm below @ 30 %) 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.

This work shall consist Construction of 200 mm thick compacted coarsed granular subbase by providing coarse graded machine crushed B.T. material satisfying MOST specification (Grade-V crushed B.T. stone aggregate 26.5 mm to 9.5 mm @ 50 %, 9.5 mm to 2.36 mm @ 20% and 2.36 mm below @ 30 %) and shall be carried out as per relevant detailed specification of **Item No.31** of this contract. Formwork, reinforcement and concrete shall conform to relevant sections of these specifications.

The item shall be measured & paid as finished work in **Cu.m.**

Item No.51:- Informatory Signs :-Providing and fixing sing boards made out of 2mm aluminium sheet; size 80 x 60cms. rectangle as per the design of IRC-67-1977 pre treated with phospheting process & acid teching; coated with one coat of epoxyprimer and two coats of best qualityepoxy paint; reflectorised with retro refiective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand postand frame fabricated from suitable sizeiron angle of 35 x 35 x 3mm75x75x6mm as required; painted with best qualityepoxy coatings in black and whitebends. the details of symbol for eachboard shall details of symbol for eachboard shall be as per the instruction ofengineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x45 x 60cms. for each leg. including excavation curing tec. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

This work shall consist of Providing and fixing **Informatory Signs** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Informatory Signs** shall be in **Nos.** of different types of signs supplied and fixed, while for direction and place identification signs.

Item No.52 :- Diversion sing board :-Providing & Fixing sign boards made out of 2mm aluminium sheet, size 180 x 60 cms. rectangle as per the attached drawing pre treated with phospheting process & acid etching. coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; Letters and numerals should be as per IRC-30-1968,3.1m long (2nos) stand post and frame fabricated from iron angle of 35x35x3mm, 50x50x5mm painted with best quality epoxy coatings in black and white bends. The fixing at site shall be in 1:2:4 CC block of size 45 x 45x 60cms for each leg, including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

This work shall consist of Providing and fixing **Diversion sing board** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Diversion sing board** shall be in **Nos.** of different types of signs supplied and fixed, while for direction and place identification signs.

Item No.53:- Supplying and fixing reinforced concrete heavy duty non pressure pipes with collars for culverts including setting and joining the pipes in C.M. 1:2 watering and laying (To level of slops of I.S. 458 / 1971 Class NP4 of following internal diameter. (v) 900 mm dia.

1. 2901 SCOPE

This work shall consist of furnishing and installing reinforced cement concrete pipes, of the type, diameter and length as per design and details and at locations shown on the drawings or as ordered by the Engineer and in accordance with the requirements of these Specifications.

2902 MATERIALS

All materials used in the construction of pipe culverts shall conform to the requirements of

Section 1000.

Each consignment of cement concrete pipes shall be inspected, tested, if necessary, and approved by the Engineer either at the place of manufacture or at the site before their incorporation in the works.

2903 EXCAVATION FOR PIPE

The foundation bed for pipe culverts shall be excavated true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in existing embankments, taken down to levels as shown on the drawings. In case of high embankments where the height of fill is more than three times the external diameter of the pipe, the embankment shall first be built to an elevation above the top of the pipe equal to the external diameter of the pipe, and to width on each side of the pipe of not less than five times the diameter of pipe, after which a trench shall be excavated and the pipe shall be laid.

Where trenching is involved, its width on either side of the pipe shall be a minimum of 150 mm or one-fourth of the diameter of the pipe whichever is more and shall not be more than one-third the diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

The pipe shall be placed where the ground for the foundation is reasonably firm. Installation of pipes under existing bridges or culverts shall be avoided as far as possible. When during excavation the material encountered is soft, spongy or other unstable soil, and unless other special construction methods are called for on the drawings or in special provisions, such unsuitable material shall be removed to such depth, width and length as directed by the Engineer. The excavation shall then be backfilled with approved granular material which shall be properly shaped and thoroughly compacted upto the specified level.

Where bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/ boulders in this area be removed and the space filled with approved earth, free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Trenches shall be kept free from water until the pipes are installed and the joints have hardened.

2904 BEDDING FOR PIPE

The bedding surface shall provide a firm foundation of uniform density throughout the length of the culvert, shall conform to the specified levels and grade, and shall be of one of the following two types as specified on the drawings :

i) First Class Bedding : Under first class bedding, the pipe shall be evenly bedded on a continuous layer of well compacted approved granular material, shaped concentrically to fit the lower part of the pipe exterior for at least ten percent of its overall height or as otherwise shown on the drawings. The bedding material shall be well graded sand or another granular material passing 5.6 mm sieve suitably compacted/rammed. The compacted thickness of the bedding layer shall be as shown on the drawings and in no case shall it be less than 75 mm.

ii) Concrete Cradle Bedding : When indicated on the drawings or directed by the Engineer, the pipe shall be bedded in a cradle constructed of concrete having a mix not leaner than M 15 conforming to Section 1700.

The shape and dimensions of the cradle shall be as indicated on the drawings.

The pipes shall be laid on the concrete bedding before the concrete has set.

2905 LAYING OF PIPE

No pipe shall be laid in position until the foundation has been approved by the Engineer. 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 a minimum of 450 mm.

The arrangement for lifting, loading and unloading concrete pipes from factory/yard and at site shall be such that the pipes do not suffer any undue structural strain, any damage due to fall or impact. The arrangement may be got approved by the Engineer.

Similarly, the arrangement for lowering the pipe in the bed shall be got approved by the Engineer. It may be with tripod-pulley arrangement or simply by manual labour in a manner that the pipe is placed in the proper position without damage.

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. In case of use of pipes with bell-mouth, the belled end shall face upstream. The pipes shall be fitted and matched so that when laid in work, they form a culvert with a smooth uniform invert.

Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

2906 JOINTING

The pipes shall be jointed either by collar joint or by flush joint. In the former case, the collars shall be of RCC 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 pipe. 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 center coincides with the joint and an even annular space is left between the collar and the pipe.

Flush joint may be internal flush joint or external flush joint. In either case, the ends of the pipes shall be specially shaped to form a self-centering joint with a jointing space 13 mm wide. The jointing space shall be filled with cement mortar, 1 cement to 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.

For jointing pipe lines under light hydraulic pressure, the recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

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.

2. 2907 BACKFILLING

Trenches shall be backfilled immediately after the pipes have been laid and the jointing material has hardened. The backfill soil shall be clean, free from boulders, large roots, excessive amounts of sods or other vegetable matter, and lumps and shall be approved by the Engineer. Backfilling upto 300 mm above the top of the pipe shall be carefully done and the soil thoroughly rammed, tamped or vibrated in layers not exceeding 150 mm, particular care being taken to thoroughly consolidate the materials under the haunches of the pipe. Approved pneumatic or light mechanical tamping equipment can be used.

Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of high embankment, after filling the trench upto the top of the pipe 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 layers are added and compacted.

3. 2908 HEADWALLS AND OTHER ANCILLARY WORKS

Headwalls, wing walls, aprons and other ancillary works shall be constructed in accordance with the details shown on the drawings or as directed by the Engineer. Masonry for the walls shall conform to Sections 1300, 1400 or 1700 as applicable. Aprons shall conform to Section 2500

4. 2909 OPENING TO TRAFFIC

No traffic shall be permitted to cross the pipes unless height of filling above the top of the pipes is at least 600 mm.

5. 2910 MEASUREMENTS FOR PAYMENT

RCC pipe culvert shall be measured as complete work in **Running metre** along its length between the inlet and outlet ends. Culverts with multiple rows of pipes shall be measured as one unit, irrespective of the number of rows.

6. 2911 RATE

The Contract unit rate for the pipe culvert shall include the cost of pipes including loading, unloading, hauling, handling, storing, laying in position and jointing and all ancillary works such as excavation, bedding for pipes, backfilling, concrete, masonry and aprons and incidental costs to complete the work as per these Specifications.

Item No.54:- Providing and casting in situ controlled cement concrete M-30 for R.C.C. solid slab including centering, scaffolding, curing and finishing complete.

This work shall consist Providing and casting in situ controlled cement concrete **M-30 for R.C.C. solid slab** including centering, scaffolding, curing and finishing complete. and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work

Item No.55:- Providing and casting in situ ordinary cement concrete M-200 for Kerbs/Kerb blocks including formwork, curing and finishing complete

1. Description

The work shall consist of scarifying the existing road surface to required depth, preparing pre cast kerb with kerb laying machine of required shape and size and fixing them in place in traffic island at Junction or as directed; as per drawing and joining them in C.M.1:3 and filling the central island portion with selected soil and compacting it and painting the sides as directed.

2. Material:

2.1: M-25 Pre-Cast Kerb: (1) Water shall conform to M-1 (2) Cement shall conform to M-3 (3) Sand shall conform to M-6 (4) Mortar shall conform to M-11 (5) Aggregates shall conform to M-12 (6) Shuttering shall conform to M-26.

Precast C.C. Block: M25 Precast block shall be sharp, smooth and in true line, level and shape as per drawing or as directed. Expansion joint shall be provided at every 10 mt. length

Construction

The road surface shall be excavated to required depth on approved alignment. For the base of stone C.C. 1:5:10 base concrete shall be provided conforming to Standard Specification The vertical C.C. stones shall be fixed as shown in drawing to line and level and expansion joint shall be provided. The outer sides of the vertical kerb stones shall be applied a coat of primer and subsequently white washed with two coats

Mode of Measurement and Payment: The measurement shall be on **Cum.** basis and shall include all the work including necessary excavation, C.C. Blocks and soil filling and joining C.C. Blocks in C.M.1:3, curing, white washing , with all labour, material tools & plants etc complete.

sides exposed at right angles to each other. The surface touching the wall may not be planed unless it is required in order to straighten up the member or to obtain the overall size within the tolerances specified.

Item No.56:- Providing & casting in situ controlled cement concrete M-25 mix and providing necessary pin headers including shuttering, scaffolding, laying, vibrating, curing and finishing complete without V-Groves. (1) Piers (2) Abutments (3) RCC Return (4) Retaining Wall

This work shall consist Providing and casting in situ controlled cement concrete **M-25 for R.C.C. Piers, Abutments, RCC Return, Retaining Wall** including centering, scaffolding, curing and finishing complete. and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work

Item No.57:- Providing and casting in situ controlled cement concrete of M 40 for average 100 mm. thick wearing coat laid as directed including tamping vibrating finishing curing and filling in joints with bitumen complete.

This work shall consist Providing and casting in situ controlled cement concrete **M-40 for average 100 mm. thick wearing coat** including centering, scaffolding, curing and finishing complete. and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work

Item No.58:- Providing G.I. 100 mm. diameter water spouts including necessary iron gratings as per drawings.

This work shall consist of furnishing and fixing in position of drainage spouts and drainage pipes for bridge decks.

2705 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 corrosive resistant material such as galvanized 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 to 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 18:226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanized.

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 in the drawing 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 IS: 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.

Drainage spouts shall be measured in **Each**.

The contract unit rate for each 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 flow drain pipes with all fixtures up to the point of ground drains wherever shown on the drawings.

Item No.59:- Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts including setting and joining the pipes in C.M. 1:2 watering and laying (To level of slops of I.S. 458 / 1971 Class NP4 of following internal diameter. (v) 1000 mm dia.

This work shall consist **Supplying and fixing reinforced concrete heavy duty non pressure pipes (v) 1000 mm dia.** including **setting and joining the pipes in C.M. 1:2 watering and laying (To level of slops of I.S. 458 / 1971 Class NP4 of following internal diameter** and shall be carried out as per relevant detailed specification of **Item No.53** of this contract.

The payment will be made on **Rmt.** basis of the finished work

Item No.60:- Scarifying gravelled macadam or bitumen macadam surface 6 cm to 10 cm.depth including stacking useful materials on road side and disposing off remaining stuff.

1.0 The layer of the existing layer metaling shall tie excavated and shall be screened on site of work. Stacking of 75% of metal obtained from screening shall be done by filling in the standard steel boxes of 2 m x 1.5 m x 0.5 mt. size which shall be supplied by department if available on rent, otherwise contractor shall make his own arrangements. No deductions for voids shall be made from the gross measurements. Where any doubt exist as to whether the quantity of stacks of metal in any hectometer is not confirming with cubical content of the standard pharas 2 m x 1.5 m x 0.5 m shall be got corrected by the contractor if so ordered by the Engineer-in-charge for which no extra payment shall be claimed by the contractor. If the quantity of metal in any stack in a particular hectometer is found To be less then the standard measurements viz. 1.5 cmt the entire collection in the hectometre shall be paid on the basis of the quantity so found. Regular stacks shall be done by the contractor on a fairly level ground. Stacking of the metal shall be done in a manner as directed by the Engineer-in-charge.

2.0 The remaining material except 75% of metal obtained from screening process shall be used in embankment with all lead and lift. It shall be directly deposited at the required location in specified layers. No handling or Conveyance charges shall be paid if the materials is temporarily deposited else where and Subsequently convey to site of deposition. The sequence of operations should be arranged properly. Material not required for any use whatsoever may be disposed off by the contractor at his own cost in manner approved by the Engineer-in-charge. The material utilised in the embankment will be deducted from the net quantity of earthwork in embankment i arrived at within the chainage measured.

Measurement & payment:-

3.0 The measurement & payment shall be made on **square meter** basis, the contractor shall maintain all stacks in regular and proper size fill the whole materials shall not be measured and finally accepted by the department. The spreading of materials shall not be allowed till the materials are fully stacked and completed kilometer wise.

4.0 The rate includes the cost of scarifying macadam, screening, deposting conveyance with all lead and lift, filling the boxes including all labour tools, equipments and all other incidental expenses

Item No.61:- 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 phospheting 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 reflective sheeting 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 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 7years 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 work shall consist of Providing and fixing **Cautionary Warning Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Cautionary Warning Sign** shall be in **EACH.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty for 7years 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.

Item No.62:- Hazard Marker Sign :-Providing and fixing sign boards made out of 2.0 mm aluminium sheet / 4 mm ACP (Aluminum composite Panel); size 90x30 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting 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 reflective sheeting 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 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 work shall consist of Providing and fixing **Hazard Marker Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Hazard Marker Sign** shall be in **EACH.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty for 7years 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.

Item No.63:- 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 phospheting 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 reflective sheeting 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 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 work shall consist of Providing and fixing **Regulatory / Mandatory Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Regulatory / Mandatory Sign** shall be in **EACH.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty for 7years 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.

Item No.64:- 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 reflective sheeting 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 best quality 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 work shall consist of Providing and fixing **Chevron sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Chevron sign** shall be in **EACH.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty for 7years 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.

Item No.65:- Providing and fixing pre-cast concrete kerb stone of gray cement based concrete block 30cm length,30cm height and 15cm thick of M25 grade concrete as per approved design and including excavation for fixing in proper line and level,filling the joint with C:M 1:3 (1cement:3 fine sand) etc complete.

This work shall consist of Providing and fixing **pre-cast concrete kerb stone** and shall be carried out as per relevant detailed specification of **Item No.55** of this contract.

801.5. Measurements for Payment

The measurement of shall be in **Rmt.**

Item No.66:- Facility Informatory Sign :-Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 80 x 60 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 reflective sheeting 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 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 work shall consist of Providing and fixing **Facility Informatory Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Facility Informatory Sign** shall be in **NOS.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty for 7years 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.

Item No.67:- 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 phospheting 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 reflective sheeting 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 work shall consist of Providing and fixing **Diversion Ahead Sign** and shall be carried out as per relevant detailed specification of **Item No.38** of this contract.

801.5. Measurements for Payment

The measurement of **Diversion Ahead Sign** shall be in **NOS.** of different types of signs supplied and fixed, while for direction and place identification signs. A warranty

for 7years 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.

Item No.68:- 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.

This work shall consist of **Supplying and fixing reinforced concrete heavy duty non pressure pipes** and shall be carried out as per relevant detailed specification of **Item No.53** of this contract.

801.5. Measurements for Payment

The measurement of shall be in **Rmt.**

Item No.69:- Supplying and laying of mechanically bonded polypropylene non woven geotextile (250gsm) as filter media behind gabion units, Beneath the mattress and application as per MoRTH 700 Type-I geotextile. The width of geotextile roll shall not be less than 4.5 m, at easily accessible location including top and bottom, with all leads and lifts, manpower and machinery, materials, labour etc. complete and as directed by Engineer - In - Charge.

701 GEOSYNTHETICS FOR ROAD AND BRIDGE WORKS

701.1 Application and General Requirements

The specification covers the various applications of geosynthetic materials for use in road and bridge works including supplying and laying as per contract specifications.

Geosynthetic is a general classification for all synthetic materials used in geotechnical engineering application. It includes geotextiles, geogrids, geostrips, geomembranes, geonets, geocomposites, geocells, geosynthetic mats, paving fabric and glass grid etc. Geo fabrics made from natural fibers such as jute, and coir referred to herein under natural geotextiles may also be used in different geotechnical engineering applications.

i) Geotextiles : Any permeable synthetic textile used with foundation, soil , rock, earth , or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

The geotextile fabric shall be a non-woven fabric consisting of long-chain polymeric filaments or yarns such as polypropylene, polyethylene or polyester or any combination thereof, formed into a stable network such that the filaments or yarns retain their relative position to each other.

There are several application areas for geotextiles requiring specific functions namely separation, filtration, drainage, reinforcement or a combination thereof.

701.2 Testing, Certification and Acceptance

701.2.1 Geosynthetic Materials Shall be Tested and Certified in the Following Manner.

- a) The manufacturer shall have ISO or CE certification for manufacturing process and quality control.
- b) The manufacturer shall provide manufacturer's test certificate for every lot supplied from the factory.
- c) The supplier shall provide third party test reports from an independent laboratory with valid accreditation for all the test values in Manufacturer's test certificate.

701.2.2 Geosynthetics shall be tested in accordance with tests prescribed by BIS. In absence of IS codes, tests prescribed either by ASTM, EN, BS or ISO shall be conducted.

701.2.3 The material shall meet the requirements as specified in the contract.

701.3 Marking

Geosynthetic rolls shall be marked with the following information:

- a) Manufacturer's name
- b) Roll number
- c) Grade
- d) Length
- e) Date of manufacture; and
- f) Product identification details

701.4 Packing, Storage and Handling

701.4.1 Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, sunlight and contaminants. The protective wrapping with a tarpaulin or opaque plastic sheet shall be maintained during periods of shipment and storage.

During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect from site construction damage, precipitation, prolonged ultra-violet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 71 °C, and any other environmental condition that may damage the physical properties of the geosynthetics.

701.4.2 If the outer layer of the geosynthetic is damaged, or exposed to sunlight for a period beyond that is permitted the outermost wrap of the rolls shall be discarded, and only the remaining undamaged/unexposed material shall be used. If the geosynthetic rolls become wet, the water proof cover shall be removed, the rolls shall be elevated off the ground and exposed to wind in order to dry the fabric. The paving fabric used with bitumen overlays shall be completely dry prior to

installation.

702.1

Scope

The work covers the use of geotextile materials for drainage, separation/filtration and erosion control works including supplying and laying as per design, drawing and these specifications.

For drainage/filtration function, geotextile shall be able to convey water across the plane of the fabric throughout its design life.

For separation function the geotextile shall prevent intermixing of two layers of dissimilar materials, throughout the design life of the structure shall be as specified in Table 700- 1

Table 700-1 : Minimum Geotextile Strength Property Requirements

Installation Condition	Type	Strength Property Requirement (MARV)							
		Grab Strength in Newton (N) as per ASTM D 4632/ IS:13162 Part 5		Tear Strength in Newton (N) as per ASTM D 4533/ IS:14293		Puncture Strength in Newton (N) as per IS:13162 Part 4		Burst Strength in Newton (N) as per ASTM D 3786/ IS:1966	
		Elongation at Failure							
		<50%	>50%	<50%	>50%	<50%	>50%	<50%	>50%
Harsh Installation Condition	Type I	1400	900	500	350	500	350	3500	1700
Moderate Installation Condition	Type II	1100	700	400	250	400	250	2700	1300
Less severe Installation Condition	Type III	800	500	300	180	300	180	2100	950

Note :-

1) All numeric values in the above table represent Minimum Average Roll Value (MARV) in weaker principal direction. The MARV is derived statistically as the average value minus two standard deviations.

2) When the geotextiles are joined together by field sewing, the seam strength shall be at least 60 percent of the material's tensile strength. All field seams shall be sewn with thread as strong as the material in the fabric.

3) The puncture strength if determined in accordance with ASTM D 6241, the minimum requirement in terms of "Newton (N)" shall be as follows:

Installation Condition	Strength Property requirement (MARV)	
	Puncture Strength in Newton (N) as per ASTM D 6241	
	Elongation at Failure	
	<50 %	>50 %
Harsh Installation Condition	2800	2000
Moderate Installation Condition	2250	1400
Less severe Installation Condition	1700	1000

702.2.2 Ultraviolet Stability Requirements

The material shall satisfy the ultraviolet stability requirements specified in Table: 700-2.

Table 700-2 : Requirements for Ultra Violet Stability

SR.No.	Properties of Fabric	Requirements (Retained Strength)
1)	Grab Strength	Not less than 70 % after 500 hours of exposure
2)	Tear Strength	
3)	Puncture Strength	
4)	Burst Strength	

Construction :-

After preparation of foundation for gabion structure as per the specifications along the road alignment geotextile shall be rolled out as indicated in the drawings. The entire roll shall be placed on surface of Gabion structure which comes in contact with earth. Wrinkles and folds in the fabric shall be removed by stretching as required.

Adjacent rolls of geotextiles shall be overlapped, sewn, or joined as required. For curves, the geotextile shall be folded or cut and overlapped in the direction of construction. Folds in the geotextile shall be stapled or pinned approximately 0.6 m centre-to-centre. Before covering, the condition of the geotextile shall be checked for damage (i.e., holes, nips, tears, etc) by the Engineer.

The geotextile shall be placed in intimate contact of soil ensuring slight tension, to avoid wrinkles or folds and shall be anchored on a properly shaped surface as indicated in drawings and approved by the Engineer. It shall be ensured that the placement of the overlying material be placed in such a manner that it does not tear/puncture the geotextile. Anchoring of the terminal ends of the geotextile shall be accomplished as per drawings through the use of key trenches or aprons at the crest and toe of slope

Measurement for Payment :-

The geotextile for separation and for filter layer shall be measured in **square metres** as per planned dimensions with no allowance for overlapping at transverse and longitudinal joints. Excavation, back fill, bedding and cover material shall be measured separately as per relevant items of the contract.

Item No.70:- Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units, Mesh Type 10x12, Mesh wire dia 2.7/3.7 mm and Selvedge wire Dia. 3.4mm /4.4mm of dimension including transportation & placing at indicated places as direction of Engineer incharge including tools , plants, labour, material ,royalty charges etc. in all respect with safety precautions & all lead & lift.

47.1 Material

These units are fabricated soft flexible heavily galvanized and PVC coated double twisted steel woven wire mesh units (Figure 47.1). The facing section of the unit is formed by connecting the back panel and a diaphragm to the main unit. This creates rectangular shaped cells used for stone confinement.

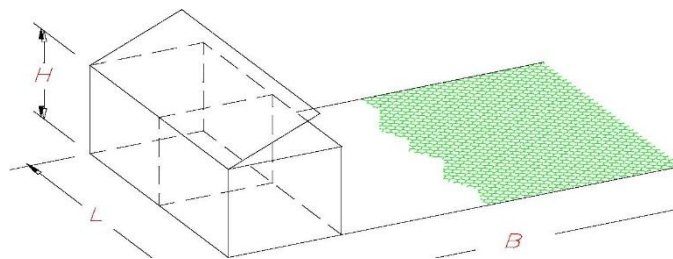


Figure (47.1)

47.2 Wire

All tests on the mesh, 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 350 N/mm² in accordance with IS 280. Wire tolerances (Table 47.1) shall be in accordance with IS 16014:2012 (Class T1).

Elongation: Elongation shall not be less than 10%, in accordance with IS 16014:2012 and MoRTH (Fifth Revision) Clause 3100. Test must be carried out on a sample at least 20 cm long.

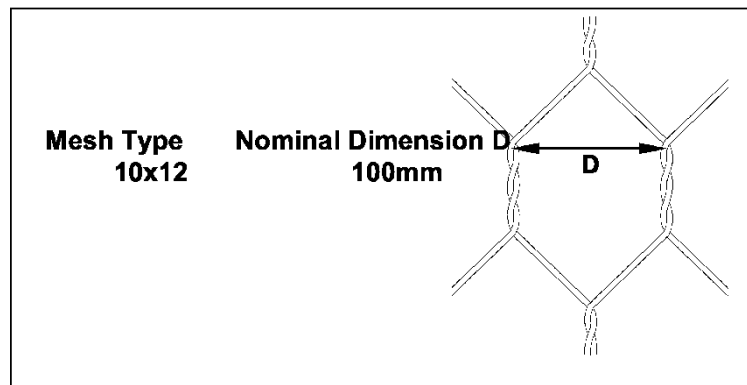
47.2.1 ZN+10%Al coating

Zn+ 10% Al alloy coating: Minimum quantities of Zn+ 10% Al alloy shall be as shown in Table 47.11 in clause 47.4.

Adhesion of Zn+ 10% Al alloy coating: The adhesion of the Zn+ 10% Al alloy coating to the wire shall be such that, when the wire is wrapped ten 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 IS 4826:1979.

47.2.2 PVC (Polyvinyl Chloride) Coating PVC coating thickness: Nominal ± 0.5 mm, Minimum ± 0.4 mm; Specific weight: 1.3 kg/dm³ \pm 1.35 kg/dm³ in accordance with IS 13360, Part3,

section 1. Hardness: between 50 and 60 Shore D, according to IS 13360, Part 5, section 11
 Tensile strength: Higher than 20.6 MPa, according to IS 13360, Part 5, section 1
 Elongation at break: not less than 200% in accordance with IS 13360, Part 5, section 1.



47.3 Wire mesh (10x12 mesh type):

Mesh wire: Diameter ± 2.70 mm zinc coated wire inside PVC coating and 3.70 mm when measured with external PVC coating;(ID/OD - 2.7mm/3.7mm)

Selvedge and reinforcement steel wire: Diameter ± 3.40 mm zinc coated wire inside PVC coating and 4.40 mm when measured with external PVC coating;(ID/OD - 3.4mm/4.4mm).

Mesh opening: Nominal Dimension $D = 100$, as per Fig. 3.2

Tolerances in Mesh Opening size: -2% to + 2%

DT mesh shall have minimum 10 numbers of mesh openings per meter of mesh perpendicular to twist of mesh.

Procedure for verification of mesh opening

- Reinforced gabion facia shall be unfolded on the plain ground.
 - Any shrink in the unfolded Gabion Mesh shall be removed, by stretching the Mesh panel.
 - Marking on the ground shall be made from the Centre of the twist of one mesh and the second. Marking shall be done at 1 m distance.
 - The number of mesh Openings in the 1 m shall be counted & verified.
- Figure (47.2) DT mesh

47.4 Tolerances

Wire: The wire shall meet diameter tolerance and minimum Zn+10%Al coating requirement mentioned in the following table

Gabion facia and tail unit tolerance: $\pm 5\%$ on the length, width, and height.

Table 47.1

Wire Diameter mm	2.2 mm	2.7 mm	3.4 mm
Wire Tolerance(+)mm	0.06	0.06	0.07
Minimum Qty of Zn+ 10% Al alloy (gm/m ²)	230	245	265

47.5 Standard size

Gabion facia and tail with double twist hexagonal mesh units shall have dimensions as per drawings.

47.6 Fabrication

Gabion facia and tail with double twist hexagonal mesh units shall be manufactured with all components mechanically connected at the production facility. The external face, reinforcing panel, and lid of the unit shall be woven into a single unit. The ends, back, and diaphragm shall be factory connected to the base. All perimeter edges of the mesh forming the basket shall be selvedge with wire having a larger diameter.

The facing element of a Gabion facia and tail with double twist hexagonal mesh unit is divided into two cells by means of a diaphragm positioned at approximately 1 m centres. The diaphragm shall be secured in position to the base so that no additional lacing is necessary at the job-site.

47.7 Structural Backfill in between reinforcement

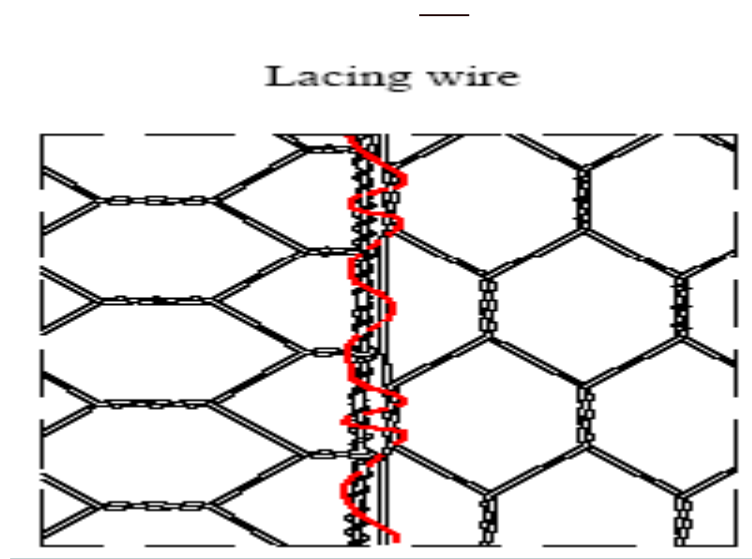
The structural backfill shall be of good quality, free draining granular soil and plasticity index should be less than 9. The percentage of fines passing 75 micron sieve should not be greater than 15%. The maximum particle size in the structural fill shall not be more than 75 mm. The structural fill material should be basically free draining and it should be devoid of dirt and deleterious material.

47.8 Construction Requirements

47.8.1 Assembly

Gabion facia and tail with double twist hexagonal mesh units are supplied folded flat and packed in bundles. The facing section of the units are assembled individually by erecting the sides, back, ends, and diaphragm, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners of the basket shall be connected first, followed by the internal diaphragm to the outside walls. All connections shall be made using lacing wire or ring fasteners. The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 150 mm pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting. Refer Figure 47.3.

Figure (47.3)



The use of ring fasteners shall be in accordance with the manufacturer's recommendations.

Following assembly of the facing section the reinforcing panel shall be unfolded to the required length and the shipping folds removed. Folds can be removed by placing the fold over a 50 mm x 100 mm board and walking along the sides.

47.8.2 Installation of units

Prior to installing the assembled units, the foundation on which these units are to be placed shall be cut or filled and graded to the lines and grades shown on the construction drawings. Surface irregularities, loose material, and vegetation shall be removed during the preparation of the foundation

The units are carried to their final position and connected with the adjoining empty units along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in second paragraph Section **47.8.1**. Whenever a structure requires more than one layer of units, the upper layer shall be connected to the top of the lower layer along the front and back edges of the contacts.

47.8.3 Internal Connecting Wires

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 remain exposed or unsupported after the structure is completed. Lacing wire or prefabricated internal connecting wires shall be used as internal connecting wires.

47.8.4 Placement of the Structural Backfill

The soil reinforcement mesh panel should be unfolded; the shipping folds flattened out, and pulled tight to minimize further creep age. Prior to starting this operation, a

filter geotextile shall be placed at backfill interface. The geotextile should have a 250 cm return at both top and bottom.

The granular backfill specified by the engineer shall be installed in lifts of approximately 30 cm, and dumped in the middle section of the soil reinforcement mesh panel. Compacting is to precede parallel to the wall, ensuring that the compacting machine does not come in contact with the mesh panel or within 1 m of the rear of the face section. The homogeneity of the backfill and the level of compaction required shall be verified.

47.8.5 Lid Closing

Once the baskets are completely full, the lids shall be pulled tight until the lid meets the perimeter edges of the basket. A tool like a lid closer can be used. 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 the above sections.

47.8.6 Mesh Cutting and Folding

Where shown on the drawings or otherwise directed by the engineer, the Gabion facia and tail with double twist hexagonal mesh units may 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 earlier. Any reshaped Gabion facia and tail with double twist hexagonal mesh units shall be assembled, installed, filled and closed as specified in the previous sections.

47.9 Method of Measurement

Quantities shall be determined from cross sections and the linear distance, and paid in **Cubic metre.**

The quantity to be paid for "gabion facia and mechanically woven, double twisted, hexagonal shaped Zn+10%Al alloy + PVC coated steel wire mesh integrated tail as reinforcement" shall be the number of units measured in their final position. Project conditions and design will determine the actual size of units to be used.

The bid price shall include the in place cost of all materials, equipment, and labour, including gabion facia and integrated tail mechanically woven, double twisted, hexagonal shaped Zn+10%Al alloy+ PVC coated steel wire mesh tail as reinforcement.

47.10 Testing

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" for the material with every lot/shipment.

Tensile strength test and Zn+10%Al alloy + PVC coating test on basic wire shall be done on one sample per every 10,000 numbers of units supplied.

47.10.1 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 47.2.2. While removing the PVC coating by stripping, take care not to remove any of the metallic surface.

47.10.2 Selvedge strength test:

A tensile test on mesh sample shall be carried out in order to estimate selvedge strength test. The test shall be carried out as per procedure outlined below. The selvedge strength shall be minimum 25 kN/m.

a. Take a DT mesh of approximately 1.0 m width.

The height of the sample shall be such that after salvaging on both the sides (1 m), there shall be at least two mesh repetitions between the two selvedge wires, so that effective height of the sample shall be more than 300 mm.

Sample shall be loaded on the UTM in a direction parallel to twist, with the samples being gripped at the two selvedge wires & not mesh twist.

The distance between the two selvedge wires shall be recorded as Initial gauge length. Distance between the two end gripping points (pins) along the width of the sample shall be recorded as the unit width under test. The width shall be at least 700 mm. The load shall be applied gradually to the sample and the test be continued till the break point.

The peak load and the % elongation shall be recorded.

The strength of the selvedge connection shall be (peak load/unit width under test) expressed in kN/m.

NB. If the sample slips at any of the gripping point during the test, such a test shall be discarded and a new sample shall be taken.

47.11 Eligibility of Manufacturer

The Manufacturer of Gabion facia with integrated tail mesh shall have:

- In-house facility in the manufacturer's plant in to test the tensile strength of the basic wire and Mesh Panels using computerized testing facilities which forms mechanically woven double twisted mesh panels.
- In-house test facility in the manufacturer's plant for Zn+10%Al alloy coating test.
- In-house facility in the manufacturer's plant to test selvedge strength and mesh panel strength.
- A valid ISO 9001:2008 accreditation from an internationally accredited organization for its Gabion facia with integrated tail mesh manufacturing facilities
- Proven experience in supplying and designing for structures with composite soil reinforcement systems, in which gabion is one of facia component for a minimum height of 25m, with supporting documentary evidence.

- The supplier shall produce performance certificate of Gabion facia with integrated tail of at least 5 year old structure from government department.
- In-house design capability & same shall be ISO9001:2008 certified by an internationally accredited organization.
- Manufacturer of mesh should provide a performance bond for material for minimum 5 years to the client.
- Manufacturer should undertake for site supervision during the execution of RS wall work.
- The Manufacturer / Supplier should not have a history of poor performance such as abandoning the works, financial failures, blacklisting. If it is observed, Manufacturer / Supplier will be automatically disqualified.

47.11 Basis of Payment

Accepted gabion facia and integrated tail mechanically woven, double twisted, hexagonal shaped Zn+10%Al + PVC coated steel wire mesh tail as reinforcement unit will be paid on **Cu.m.** basis item included in the contract.

Item No.71- Providing and laying rubble for apron (each stone weighing not less than 40 Kg.) including hand packing and filling in the interstices with quarry spall.

This work shall consist of laying rubbles/stones directly on the bed of river for protection against scour.

The stone used in apron shall be sound, hard, durable and fairly regular in shape. Stone subject to marked deterioration by water or weather shall not be used. The size of stone shall conform to IRC : 89. The size of stone shall be as large as possible. In no case any fragment shall weigh less than 40 Kg. The specific gravity of stones shall be as high as possible and it shall not be less than 2.65.

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 meter thick and to the full height of the specified thickness of the apron at intervals of 30 meters all along the length and width of the apron. Within these walls, the stone then shall be hand packed.

The surface on which the apron is to be laid shall be leveled and prepared for the length and width as shown on the drawings or as directed. In case the surface on which apron is to be laid is below the water level, the ground level may be raised up to low water level by dumping earth and the apron laid thereon.

The apron shall be measured in **cubic meter**.

The contract unit rate for one cubic meter of finished work of apron shall include the cost of all material, labour, tools and plants for completing the work according to above specifications. Excavation up to an average depth of 150 mm shall be deemed to be included in the rate as dressing of the bed. Excavation beyond this depth shall be paid for separately.

Item No.72:- Providing and laying Filter Media 600mm Thick directed at the back of Abutment, return and wing walls as per detailed specification.

This Work Shall Consist **600mm Thick Filter Media** shall be carried out as per relevant detailed specification of **Item No.24** of this contract.

The payment will be made on **Cu.m.** basis of the finished work.

Item No.73:- Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units, Mesh Type 10x12, Mesh wire dia 2.7/3.7 mm and Selvedge wire Dia. 3.4mm /4.4mm of dimension including transportation & placing at indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. in all respect with safety precautions & all lead & lift.

A) 3 x 2 x 1 m

This work shall consist **Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units. of size (A) 3 x 2 x 1 m** including transportation & placing at indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. shall be carried out as per relevant detailed specification of **Item No.71** of this contract.

The payment will be made on **Nos** basis of the finished work.

Item No.74:- Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units, Mesh Type 10x12, Mesh wire dia 2.7/3.7 mm and Selvedge wire Dia. 3.4mm /4.4mm of dimension including transportation & placing at indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. in all respect with safety precautions & all lead & lift.

A) 3 x 2.5 x 1 m

This work shall consist **Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units of Size (A) 3 x 2.5 x 1 m** including transportation & placing at indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. shall be carried out as per relevant detailed specification of **Item No.70** of this contract.

The payment will be made on **Nos.** basis of the finished work.

Item No.75:- Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac(Zinc+10% Aluminum)+PVC Coated Gabion Units, Mesh Type 10x12, Mesh wire dia 2.7/3.7 mm and Selvedge wire Dia. 3.4mm /4.4mm of dimension including transportation & placing at

indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. in all respect with safety precautions & all lead & lift.

A) 3 x 1.5 x 1 m

This work shall consist **Supplying & Laying of Mechanically Woven, Double twisted hexagonal shaped Galmac (Zinc+10% Aluminum)+PVC Coated Gabion Units of Size (A) 3 x 1.5 x 1 m** including transportation & placing at indicated places as direction of Engineer incharge including tools ,plants ,labour,material ,royalty charges etc. shall be carried out as per relevant detailed specification of **Item No.70** of this contract.

The payment will be made on **Nos** basis of the finished work.

Item No.76:- Quantity of Stones for filling mattress & terramesh unit with all leads and lifts, manpower and machinery, materials, labour etc. complete and as directed by Engineer - In - Charge.

1. Material

Naturally occurring rounded stone or quarried stone are acceptable. The stone materials with high specific gravity are preferable since the gravity behavior of the structure is predominant. To ensure the durability of the structure, the stones must be weather resistant, non-friable, insoluble and sufficiently hard. These stones shall have Aggregate Impact Value less than 30 per cent when tested in accordance with IS: 2386 (Part 4) or IS:5640. The most appropriate size of the stone varies from 1.5 to 2.5 times the dimension of the mesh. The stone should be large enough to prevent its escape through the mesh. Additionally it should be ensured that stones to be used in gabions/ revet mattresses have individual weight in the range of 15 to 40 kg.

2. Installation Procedure for gabions filled in-situ:

1. The gabion is opened and unfolded on a hard surface and creases not required for forming the box pressed out.
2. The front and rear sides, ends and diaphragm are lifted into position to form a box shape.
3. The edges should be laced together starting from the top corner in a continuous operation using alternate single and double twists at spacing between 100 mm and 150 mm. Individual ties of lacing wire must not be used. Alternatively fasteners can be used for tying the edges together. Manual or pneumatic tool should be used for fastening.
4. The initial layer of gabions should be placed on a flat surface.
5. A number of gabions are placed in position and secured together as described in 3

above. 6. The end gabion is partly filled with suitable stone to form an end anchor and bracing wires are fixed at 300mm spacing to prevent the front side from bulging. The gabions are tensioned by applying a load to the end remote from the anchor gabion, ensuring the load distributed over whole area of last gabion.

7. Facing stone should be having regular shape and dressed with the help of skilled mason to get good appearance and alignment.

8. Batter has to be maintained as per the design.

9. One meter high gabions should be filled to one-third height, braced; filled to two third height and braced again, half meter height gabion requires only one row of bracing at 250 mm height. The gabion is overfilled by approximately 50 mm to 75 mm to allow for settlement of the infill (due to self weight). Stones to be used for filling shall conform to specifications in section 3 (g) indicated above.

10. The mesh lid is folded down, stretched into position and the lid laced to the front sides and the top of the diaphragms.

11. The remaining row of gabions may then be filled sequentially.

12. It is essential that each gabion is properly laced and fixed to adjacent gabions above, below and on each side.

Procedure for Revet Mattress laid in dry conditions:

1. The Mattress is opened and unfolded on a levelled surface and creases that are not required for forming the box pressed out.

2. The front and rear sides, ends and diaphragm are lifted into position to form a box shape. 3. Mattresses are laid directly onto the ground to be protected, so the slope must be stable by itself and must not be so steep as to cause the revetment to slide. These units are normally laid down the slope of the bank, at right angles to the current. However, if the banks and the bed are to be covered completely, the units on the bed itself should be laid in the direction of the flow.

4. The edges are laced together starting from the top corner in a continuous operation using alternate single and double twists at spacing between 100 mm and 150 mm. Individual ties of lacing wire must not be used. Alternatively fasteners can be used for tying the edges together. Manual or pneumatic tool should be used for fastening.

5. A number of Mattresses are placed in position and secured together as described in 3 and 4 above.

6. The Mattresses are filled with stones of suitable size – about 1.5 to 2.5 times the

dimensions of the mesh. Stones to be used for filling shall conform to specifications in section 3 (g) indicated above

7. The corners should be filled properly. Compaction is not necessary.

8. The Mattresses are then covered with lids, which are folded down, stretched into position and laced with usual lacing operation.

9. It is essential that all Mattresses are properly laced and fixed to adjacent Mattresses along all corners with the same lacing operation.

Measurement & Payment

Measurement for Payment Gabion walls/revet mattresses so constructed shall be measured in **Cubic meter** of finished work. The contract unit rate for the construction shall cover the cost of excavation or filling for foundation, double twisted wire mesh, rock filling including transportation, laying, all labour, testing, technical supervision and all incidentals necessary for completing the work according to these specifications. The cost also covers the provision of technical expert advice, design and working details which shall be arranged by the Contractor. Transportation of rock fill shall be incidental to the work and shall not be paid extra.

Other points

1) The contractor shall be required to provide complete design with working drawings in required numbers. This shall be supported by certificate from the supplier of gabions and revet mattresses that he has proven experience in supplying and designing Gabions for Retaining walls / Scour Protection / Erosion Control for atleast three major projects in India and providing technical backup like designing using in house facilities and technical assistance at site. The Supplier shall produce an authentic documentary evidence to prove his experience for Supplying, Designing and providing technical assistance at site for at least three Major Projects in India.

2) The Contractor should have proven experience in supplier's technology of Gabions and revet Mattress. The relevant designs should be provided by the supplier, which shall be approved by the Consultants/Client.

3) The contractor shall take prior approval from the Engineer-in-charge before placing the order on the Manufacturer/Suppliers of Wire mesh Gabion materials. Engineer-in-charge will give the approval in writing after satisfying himself about the conditions described above.

4) The contractor shall have to give a certificate from the manufacturer regarding the

supply of sufficient quantity of Double Twisted Wire mesh Gabions to the contractor for this project. 5) The contractor shall provide "Performance Guarantee" for all the works including gabion and revet mattresses under normal maintenance.

Item No.77:- Providing and fixing in position of steel grade FE 500D/ FE-550D (TMT) for Box Culvert & Approach Slab,Retaining wall Including cutting hooking, tying, welding etc., complete as per detailed drawing and specification.

This work shall consist of Providing and placing in position **FE-500D / FE-550D TMT bar reinforcement For Box Culvert, Approach Slab & Retainig wall** including cutting, bending, hooking, and tying complete as per detailed drawing. and shall be carried out as per relevant detailed specification of **Item No.11** of this contract.

The payment will be made on **M.T.** basis of the finished work.

Item No.78:- Dismantling steel work including distempering and stacking the materials with all lead and lift.

This work shall consist of **Dismantling Steel Work** and shall be carried out as per relevant detailed specification of **Item No.1** of this contract.

The measurement of Dismantling of steel shall be Measured in **kg.**

Item No.79:- Providing parapet of controlled cement concrete M-30 as per detailed drawings with necessary reinforcement including, shuttering, laying vibrating and finishing to line and level complete. (ii) Cast in situ.

This work shall consist **Providing parapet of controlled cement concrete M-30** and shall be carried out as per relevant detailed specification of **Item No.10** of this contract.

The payment will be made on **Cu.m.** basis of the finished work.

**Deputy Executive Engineer
Panchayat (R & B) Sub Division
Dabhoi**

**Deputy Executive Engineer
Panchayat (R & B) Sub Division
Padra**

**Deputy Executive Engineer
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