

SECTION-5
Technical Specifications

Name of Work :- Construction of Slab Drain at Chainage 8/500 on Bayat-Ratadiya-Sherdi-Aasambiya Road. Ta. Mandavi, Dist. Kachchh.

SPECIFICATION INDEX

It. No.	Description of Item	Applicable specification reference
	Section (A) PRELIMINARY WORKS	
1	Clearing and grubbing site/road/land [including uprooting all vegetation, grass, bush shrubs, saplings and trees with girth, removal of stumps of trees of girth of all sizes including removing stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable materials as directed by Engineer with all leads and lifts etc. complete as per specification. before commencement and after completion of the work.	As per Separate Sheet attached.
2	Detailed survey of site using Total station, and Marking out the centre line of bridge along longitudinal and transverse axis, and taking Various utilities and all other details of all component , structures, boundary and complete line out and levelling with precise levels using total station /theodolite including constructing necessary CC pillars for lines and levels and establishing necessary bench marks including making AUTOCAD drawings showing all levels, details of utilities, boundary etc all and providing soft copies in AUTOCAD etc. complete as directed.	As per Separate Sheet attached.
3	Providing and installation of barricades including supplying, painting with fluorescent paint and fixing CGI sheets 24 SWG of 1.8 m height and M.S. Posts angle 40 x 40 x6 mm at 2.0 m c/c and dismantling the same after completion of work as directed by Engineer and as per site requirements.	As per Separate Sheet attached.
4	Dismantling of structures and sorting of the dismantled material, disposal of unserviceable material and stacking serviceable materials as directed by Engineer with all leads and lifts etc. complete as per specification and as per site requirements.	As per Separate Sheet attached.
a)	Dismantling bricks / Stone masonry, PCC Kerb Median	As per Separate Sheet attached.
b)	Dismantling of Concrete Structures	As per Separate Sheet attached.
c)	Scarifying existing Approaches flexible pavement. (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.)	As per Separate Sheet attached.
d)	Dismantling steel work including distempering and stacking the materials with all lead and lift and Steel Material is Property of R&B /Client as directed by Engineer Incharge.	As per Separate Sheet attached.
	Section (B) FOUNDATION & SUBSTRUCTURE	

It. No.	Description of Item	Applicable specification reference
5	Excavation for foundation in sand, gravel, clay soft soils and murrum (Soft and Hard) etc. Including shoring, strutting dewatering including pumping as necessary, backfilling the trenches with suitable excavated material in layers of 15 to 20 cms and disposing of the surplus excavated stuff with all leads and lift , preparation of bed for concreting of foundations etc. complete as directed by Engineer and as per specification.	As per Separate Sheet attached.
a)	Depth upto 3.0m.	As per Separate Sheet attached.
b)	Depth from 3.0m.to 6.0m.	As per Separate Sheet attached.
6	Excavation in large boulders and soft rock by welding including shoring, strutting and dewatering as necessary and disposing of the excavated stuff as directed.	As per Separate Sheet attached.
7	Providing and laying in situ M-15 grade bedding concrete in foundation / below pile cap including dewatering, shuttering, mixing in mechanised batch mix plant, compacting, curing etc. complete true to level and position as directed by Engineer and as per specification.	As per Separate Sheet attached.
8	Providing and laying in-situ RCC M-30 grade Controlled Cement Concrete in foundations of piers, abutments, return wall, pile caps etc. including centering, shuttering, mixing in mechanised batch mix plant, compaction, curing and dewatering if necessary, excluding reinforcement as per specification and as directed by Engineer.	As per Separate Sheet attached.
9	Providing and laying M-30 grade Controlled cement concrete for cast-in-situ piers, abutments, return wall, staircase, etc. at any height or depth as per approved design and drawings, with necessary centering, shuttering, mixing in mechanised batch mix plant, scaffolding, transporting, placing, compacting by mechanical vibrators, finishing, curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement as directed by Engineer and as per specification.	As per Separate Sheet attached.
10	Providing and laying in situ controlled M-30 grade cement concrete for RCC caps over piers and abutments , staircase ,including necessary scaffolding formwork, centering, mixing in mechanised batch mix plant, transporting, placing, compacting by mechanical vibrators, finishing and curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement, as directed by Engineer and as per specification.	As per Separate Sheet attached.
11	Providing and laying in situ controlled M-40 grade cement concrete for RCC pedestals over piers and abutments ,staircase ,including necessary scaffolding formwork, centering, mixing in mechanised batch mix plant, transporting, placing, compacting by mechanical vibrators, finishing and curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement, as directed by Engineer and as per specification.	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
12	Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for piers, abutments, returns and retaining wall including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.	As per Separate Sheet attached.
13	Providing and laying Tar Paper bearing below solid slab as directed by engineer in charge.	As per Separate Sheet attached.
14	Providing and applying one coat of zinc-rich epoxy primer and two coats of coal tar epoxy paint of reqd. thickness as per specifications to all concrete surfaces in contact with earth in foundation and substructure including all cost of material, labour, transportation and preparing the surfaces by cleaning, washing, brushing etc. complete as directed by Engineer and as per specification.(Paint shall be got approved from Engineer).	As per Separate Sheet attached.
15	Providing and filling sand behind abutments and between returns in layers as directed	As per Separate Sheet attached.
16	Providing and laying 600 mm thick filter media behind abutment as per detailed drawing & specifications etc complete.	As per Separate Sheet attached.
17	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.	As per Separate Sheet attached.
Section (C) SUPERSTRUCTURE		
18	Providing and laying, M-40 grade RCC in-situ or Pre-cast T-Beam Deck slab and Solid Slab type superstructure, deck sheet if required, as per approved drawing and technical specifications, section 1500, 1700 and 2200 of MORTH using 6mm to 20mm machine crushed well graded stone aggregate, sand of approved quality, OPC 53 grade cement with contractor's own concrete mix design etc. complete as per specifications. the rate is inclusive of all materials, Mineral admixtures if required, including necessary mixing in fully automatic batch mix plant, transport, curing, vibrating, ramming, finishing, placing in position, centering, shuttering, scaffolding, staging, formworks, establishing casting yard, transporting using trailer, launching or shifting using crane or any other approved means, making thrust bed, thrust block, gantry, etc all complete. Deshuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required with including cost of finishing equivalent to F3 type exposed concrete and form mark. (Minimum cement content :- 440 kg/cum), (Excluding steel reinforcement) (A) For various types of RCC type superstructure in M40 grade	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
19	Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for super structure including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.	As per Separate Sheet attached.
20	Providing and applying one coat Epoxy Phenolic primer of DFT 50 micron and two coats of Epoxy Phenolic coating of DFT 100 microns each or any other equivalent epoxy coating system to all concrete surfaces exposed to atmosphere in Substructure, superstructure etc. all including cost of material, labour, transportation, scaffolding and preparing the surfaces by cleaning, washing, brushing, etc. complete and as directed by Engineer and as per specification. (Paint shall be got approved from Engineer and tested from approved laboratory).	As per Separate Sheet attached.
21	Providing and carrying out load test on bridge deck with simulated loading including provision, placing and removal of loading, supplying, fixing and removing deflection measuring instruments etc. complete with platforms for fixing the instruments etc. complete as per the details supplied and specification and as directed by Engineer and including submission of required results in triplicate after satisfactory completion of the load test.	As per Separate Sheet attached.
Section (D) MISCELLANEOUS ITEMS		
22	Providing and casting RCC Crash Barrier /RCC Crashbarrier with Friction slab / Central Verge /Medium in M-40 controlled concrete with cast-in-situ or precast members as per detailed drawings including necessary scaffolding, centering, formwork, mixing in mechanised batch mix plant, transporting, placing, compacting, finishing, curing, etc. complete including providing and fixing of inserts if any with all leads and lifts as per drawing & specification and as directed by Engineer, excluding reinforcement.	As per Separate Sheet attached.
23	Type - A, "W" : 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 galvanised by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150 x 75 x 5 mm, 330 mm long complete as per clause 811)	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
24	Providing and casting insitu controlled cement concrete M-40 in Wearing Coat using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, scaffolding, staging, etc. complete, placing in position, vibrating, curing, tamping, deshuttering filling in joints with bitumen with all contractor's materials (except steel reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.	As per Separate Sheet attached.
25	Providing and laying precast RCC Footpath Slab in controlled cement concrete of M-30 grade (minimum 70 mm thickness) including necessary reinforcement and providing and setting cement chequered tiles in CM 1:5 as per drawing including necessary formwork, curing and finishing complete.	As per Separate Sheet attached.
26	Providing and casting insitu controlled cement concrete M-30 in RCC Approach Slab using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, scaffolding, staging, etc. complete, placing in position, vibrating, curing, deshuttering, fixing inserts, pockets wherever necessary with all contractor's materials (except steel reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.	As per Separate Sheet attached.
27	Providing and casting insitu controlled cement concrete M-25 in RCC Railing and Parapet using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, staging, etc. complete, placing in position, vibrating, curing, deshuttering, fixing embedments, inserts, pockets wherever necessary with all contractor's materials (except steel reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.	As per Separate Sheet attached.
28	Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for super structure including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.	As per Separate Sheet attached.
29	Providing and applying one Primer Coat and two coats of Synthetic Enamel Paint on Anticrash Barrier and Median Verge surface area exposed to Atmosphere in superstructure including making of strip of two colours including cost of material, labour, transportation, scaffolding and preparing the surfaces by cleaning, washing, brushing, sand / grit blasting etc. complete and as directed by Engineer and as per specification.	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
30	Painting two coats (Excluding priming coat) on new steel and other metal surface with synthetic enamel paint , brushing to give an even shade including cleaning surface of all dirt, dust and other foreign matter.	As per Separate Sheet attached.
31	Providing and fixing 100 mm dia. G.I. Drainage spouts, as per MOST Drg. No. SD/303 including grating with suitable clean out fixtures including all leads and lifts etc. complete as per specification, design & drawings and as directed by Engineer.	As per Separate Sheet attached.
32	Providing and fixing UPVC pipe as Longitudinal Runner Pipe , Down take pipes, conduits below footpath including cost of all materials, labour, fixing in true line and level, including bends, fixtures, special, etc. complete with all lifts and leads etc. as per specifications and as directed by engineer incharge.	As per Separate Sheet attached.
a)	75 mm dia	As per Separate Sheet attached.
33	Providing & fixing in position 100 mm Dia. A.C. pipes as weep holes in Abutments and Return Walls completed in all respect as per specification and as directed by Engineer.	As per Separate Sheet attached.
	Section (E) APPROACHES & AMENITIES	As per Separate Sheet attached.
34	Box cutting the road surface to proper slope, and chamber for making a base for road work including removing the excavated stuff and depositing on the road side as directed up to all lead & Lift.	As per Separate Sheet attached.
35	Earth work in embankment using selected soil and hard murrum, approved by engineer in charge, with contractor's own earth by all lead, and lift, including breaking clods dressing with all lead and lift including watering rolling and consolidation of subgrade in layers of 300 mm or as directed by engineer in charge, at OMC to required dry density including filling the depressions which occur during the process using power roller 8T to 10T	As per Separate Sheet attached.
36	Carting of excavated material such as murrum, earth, kapachi, gravel, brickbats, kankar, debris, sand, dismantled material, including, Spreading , levelling loading, unloading, stacking etc. complete at non objectional place as directed by engineer in charge	As per Separate Sheet attached.
	a) Lead up to 5 Km.	As per Separate Sheet attached.
37	Providing, laying and compacting natural gravel and sand (river bed material C.B.R. not less than 10%) below sub base course including carriage of materials spreading in uniform layer manually on prepared base and compacted with vibratory roller to achieve desired density including all materials, labour etc. complete.	As per Separate Sheet attached.
38	Construction of granular sub-base (Grade -I, Crushed B T Materials of 53 mm to 26.5 mm @ 35 %, 26.5 mm to 4.75 @ 45 %, below 2.36 mm @ 20 %) by providing close grade material, spreading uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve desire dencity, complete clauses as per 401.	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
[a]	For Grading - I Material	As per Separate Sheet attached.
39	Providing and laying W.B.M. of M.C. metal of size 45 mm to 90 mm size including 0.27 Cu.m stone screening & 0.08 cum stone dust as filler including spreading watering & consolidation by Vibratory roller 80 KN to 100 KN static Weight. 100 mm thick compacted.	As per Separate Sheet attached.
40	Providing and laying W.B.M. of M.C. metal of size 45 mm to 63 mm size including 0.12 Cu.m stone screening & 0.08 cum stone dust as filler including spreading watering & consolidation by Vibratory roller 80 KN to 100 KN static Weight. 2 layer of 75 mm thick compacted.	As per Separate Sheet attached.
41	Providing and laying bituminous grout base course 37.5mm thick using Emulsion for tackcoat at the rate of 4.00 kg/10 sqmt on WBM surface using B.T. Stone aggregate as per required gradation with the asphalt of VG-30 grade at the rate of 1.99% i.e. 19.90 Kg/M.T. by weight by mix including heating and mixing in drum mix plant, transporting the mix spreading the same by paver finisher and consolidation by vibratory roller including cost of all materials, fuels, labours, tools and plants etc. using contractors own drum mix plant etc complete.	As per Separate Sheet attached.
[a]	37.50 mm Thick	As per Separate Sheet attached.
42	Providing and laying 37.5 mm thick compacted bituminous macadam with B.T. Aggregate as per M.O.R.T & H Gradation and Asphalt VG-30 @ 4 Kg/10 Sq Mt and 2.50 Kg/10 sq Mt on existing B.T. Surface for tack coat & Asphalt grade VG-30 for mixing @ 34.00 Kg/M.T. ie 3.40% of total mix weight of the including heating the aggregates and Asphalt by continuous batching of drum mix plant and spreading the same by paver finisher and consolidation with vibratory roller 80 KN to 100 KN Static weight including providing all materials, Equipments, tools and plants, oil, kerosene, firewood, labour charges etc. comp. using contractor's own machineries drum mix plant and paver finisher etc complete.	As per Separate Sheet attached.
43	Providing and laying Bituminous Seal Coat with stone chips 6 to 10 mm size 0.18 Cum/10sqmt i.e. using 0.66 cmt Agg per M.T. mix using Asphalt VG-30 @ of 4.50% of mix including heating the asphalt and aggregate by continuous batching drum mix plant and paver finisher and consolidating by vibratory roller including providing equipment, tools, plant, firewood, oil, kerosene, labour charge etc, using the contractors own machinery and plant.	As per Separate Sheet attached.
44	Supplying and fixing road sign board of MS Plates and angle iron including painting, lettering, etc. complete including excavation, etc. complete as per IRC type design - Reflective Type.	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
45	Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beads 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 coefficient on cemend road shall be min 130 mcd/m2/lux and asphalt road shall be min 100mcd/m2/lux during the service life during the day time.the marking should meet the performancecriteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section -15 of IRC 35-2015.warranty for retro reflectivity shall be two year	As per Separate Sheet attached.
46	Providing and laying Double Walled Corrugated Pipes (DWC) of Polyethene conforming to IS-14930-II of 90mm O.D. with fittings and necessary connecting accessories of same material at required depth for laying cable into crash barrier etc. complete as per specification and as directed by engineer incharge.	As per Separate Sheet attached.
47	Cat eye/Road stud/ RPM:Supplying of Twin Shanks Raised pavement markers made of polycarbonate and ABS moulded body and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635kgs.tested in accrodance to ASTM D 4280 type H and complying to specifications of category A of MORTH circular No RW/NH/33023/10-97-DO III Dt 11.06.1997. The height,width and length shall not exceed 20 mm,130 mm and 130mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35+/-5 degree. The strength of detachment of the integrated cylindrical shanks,(of diameter not less than 19+/-2 mm and the height not less than 30+/-2 mm) from the body is to be a minimum value of 500 kgf. Fixing will be by drilling hole on the road for the shanks to go inside, without nails and using epoxy based adhesive as per manufacturers recommendation and color of the marker should be as per the IRC 35-2015 and as directed by engineer-in-charge.	As per Separate Sheet attached.
48	Supplying and fixing the necessary sign boards as per site requirements and as directed and approved by Engineer (Retro-reflective Type)	As per Separate Sheet attached.
[A]	Facility informatory Sign:-	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
	<p>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 Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm /65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with 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 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting</p>	As per Separate Sheet attached.
[B]	Cautionary Warning Sign:	As per Separate Sheet attached.
	<p>out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 90 x 90 x 90 cms. equilateral triangle as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with 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 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by Contractor. (A) Class - C Type - 11 Retro Reflective Sheetting</p>	As per Separate Sheet attached.
[C]	Regulatory / Mandatory sign:	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
	<p>Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 60 cms Dia Circle as per design of IRC-67- 2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per theinstruction of engineer in charge. The fixing at site shall be 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 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting</p>	As per Separate Sheet attached.
[D]	Flexible Median Marker	As per Separate Sheet attached.
	<p>Flexible Median Marker : Providing and fixing of flexible median marker that are made of tough,high impact resistant,injection-molded,thermoplastic body with property of flexibility to provide high durability.The dimension of flexible median marker should not exceed 18.4 cm in height (including shank height),12.5cm in width,0.65cm in thickness and shank depth shall be 3.4cm the body structure shall be rounded at all its corners and edges.The plastic used for molding the flexible median marker should survive impact load of 5kg continuously for 750 times at room temperature.The logo of the manufacturer shall be embossed on either side of the body in the injection molding process.The median marker shall have flame like shaped body with,fluorescent yellow color retro-reflective sheeting of size not less than 90 cm square,with fully reflective micro prismatic cube corners as its retro-reflective elements as per IRC 67 2012 and ASTM D4956-09 type XI specifications reflectivity values.The retro-reflective sheeting shall be one or both sides of the flexible median marker and shall be edge protected with no exposed edges which will prevent edge lifting, vandalism, sheeting damage, etc.The flexible median marker shall be fixed by a combination of epoxy adhesive and grouting as recommended by manufacturer and engineer in charge.</p>	As per Separate Sheet attached.
[E]	<p>Providing and Fixing of NJ Reflector made up of 2mm Aluminium of size 100 x 100mm duly pasted with Reflective shetting of Florescent yellow Type -11 Fixed to the Bridge wall/ Parapet with Nails.</p>	As per Separate Sheet attached.

It. No.	Description of Item	Applicable specification reference
[F]	Blinkers : Providing & fixing solar power road traffic flasher / blinker (24 hour operations) having 300 mm round light source, cluster of high intensity ultra bright LED visibility greater than 500mtr red or amber or as required. Flashing duty cycle 50% operation for 24 hours located 3.0mtr above the ground level on post of 80NB MS Post, design in line with IS 7537-1974 specification of road traffic signals Solar model 12V, 20WP/124, 40W, Battery 12V 60Ah/12 V 110 AH. Operating temperature 0 to 50 C, Humidity 93% EH (NC) complete with Installation.	As per Separate Sheet attached.
49	Supplying & laying of Uni-Axial / Bi-axial extruded high modulus polypropylene geogrid conforming to MORT&H specification for base/sub-base reinforcement having minimum tensile strength 30kN/m in the longitudinal and transverse direction, with 10.5kN/m and 21kN/m tensile strength at 2% and 5% strain respectively in the longitudinal and transverse direction, junction efficiency not less than 95% and with 38mm X 38mm mesh opening.	As per Separate Sheet attached.
50	Providing the Diversion by proper means i.e. In proper grade, camber and approach etc. for easy passing of traffic incl. Providing necessary sign board, making etc. as per instructions of Engineer in charge and maintaining the same during the period of work up to completion of work.	As per Separate Sheet attached.
51	Providing and fixing guard stone as per I.R.C. type design including white washing etc. complete.(ii) Fixing in C.C. 1:5:10	As per Separate Sheet attached.
52	Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal diameters.(vii) 1200mm dia.	As per Separate Sheet attached.
53	Providing and laying Pitching on slopes laid over prepared filtermedia including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications. A. Stone/ Boulder	As per Separate Sheet attached.

Deputy Executive Engineer
R & B Sub Division (Panchayat)
Mandvi

Executive Engineer
R & B Division (Panchayat)
Kachchh

GENERAL TECHNICAL SPECIFICATIONS

1.0

1.1 GENERAL:

These specifications cover the items of work in structural and non-structural parts of the works coming under purview of this document. All work shall be carried out in confirmation with these specifications. In general, provisions of Indian Standard, Indian Road Congress codes, MORT&H specifications, standard specification of Gujarat Govt., other national standards shall be followed unless otherwise specified. These specifications are not intended to cover the minor details. The work shall be executed in accordance with best modern practices & all latest codes and standards referred to in these specifications and their revisions issued 30 days prior to submission of tender shall be read in conjunction with the various other documents forming the contract viz. Tender specifications, Schedule -B contractor drawings and other related documents.

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections read in conjunction with General Conditions of Contract. The same shall not however apply in the case of lump-sum items. All measurements and computations unless otherwise indicated shall be carried nearest to the following limits :

- (i) length and breadth 10 mm
 - (ii) height, depth or thickness of earthwork, sub-base, bases, surfacing, and structural members 5 mm
 - (iii) areas, 0.01 Sq. Metre
 - (iv) cubic contents 0.01 cubic metre
- in recording dimensions of work the sequence of length, width and height or depth or thickness shall be followed.

2.0 Measurement

ORDER OF PRECEDENCE

For this document, in case of errors, omissions and/or disagreement between written and scaled dimensions on the drawings or between the drawings and specifications etc. the following order of precedence shall apply:

- a) Between scaled dimensions and written dimensions / description on a drawing the later shall be accepted.
- b) Between the written or shown description/or dimensions in the drawing, and the corresponding one in the specification, the later shall apply.
- c) For execution stage the following order of precedence shall apply.
 - i) Execution drawings/ notes/ modifications specifically approved for construction.
 - ii) Specific provisions of specifications and conditions of this contract document.
 - iii) In the absence of above, standard specifications of PWD and good engineering practices in that order.
 - iv) In case of conflicting provisions of IS specifications and IRC specifications, former shall prevail, i.e. IS specifications would have precedence over IRC specifications unless tender provisions are specific for the particular item of work.
 - v) However, notwithstanding anything said above, the interpretation/ decision of the Panchayat R&B (Division), Kachchh/ Engineer-in- charge shall be final and binding.

1. Inclusive documents:

The provisions of all conditions of contract, those specified in this tender as well as execution drawings, and notes or other specifications issued in writing by the Engineer-in-charge shall form part of these specifications.

2 Order of precedence, clarifications and interpretations:

When the various specifications and codes referred to in preceding portion are at variance with these specifications and or with each other, the order of precedence will generally be as under; The attention of the contractor is drawn to those clauses of IS Codes which require either supplementing specifications from the Engineer-in-charge or the call for mutual agreement of such specifications between the supplier and purchaser.

In such cases, it shall be responsibility of the contractor to seek clarifications on any uncertainty, ambiguity and obtain prior approval of the Engineer-in-charge, before taking up supply/construction etc.

3 Measurement and Payments:

- (a) The methods of measurement and payment shall be as described under various items and in the Schedule -B. Where specific definitions are not given, methods described in IS Code will be followed. Should there be any detail of construction of materials which has not been referred to in the specifications or in the Schedule -B and drawings but the necessity for which may be implied or inferred there from, or which are usual or essential for the completion of the work in the trades, the same shall be deemed to be included in the rates quoted by the contractor in the Schedule -B.
- (b) **Unacceptable work**
All defective works are liable to be demolished, rebuilt and defective materials replaced by the contractor at his own cost. In the event of such works being accepted by carrying out repairs etc. as specified by the Engineer-in-charge, the cost of repairs will be borne by the contractor and will be paid for the works actually carried out by him at reduced rates of the tendered rates, as may be considered reasonable by the Engineer-in-charge, in the preparation of final or on account bills.

4 Measurement of lead for Materials :

Where lead is specified in the contract for construction materials, the same shall be measured as described hereunder.

Lead shall be measured over the shortest practicable route and not the one actually taken and the decision of the Engineer-in-charge in this regard shall be taken as final. Distance upto and including 100 meters shall be measured in units of 50 metres, exceeding 100 metres but not exceeding 1 KM. in units of 100 metres and exceeding 1 km. in units of 500 metres. The half and greater than half of the units shall be reckoned as one and less than half of the units ignored. In this regard, the source of the material shall be divided into suitable blocks and for each block the distance from the centre of the block to the centre of placing pertaining to that block shall be taken as the lead distance.

1.2 SPECIFICATIONS FOR EARTH WORK EXCAVATION AND BACK FILLING

1. Scope:

This part of the specifications deals with general requirements for earthwork in excavation in different materials, site grading, filling in areas shown in drawings, back filling around foundations, plinths and approach ramps, conveyance and disposal of excess excavated soil or stacking them properly as directed by the Engineer-in-Charge and all operations covered within the intent and purpose of these specifications.

2 Applicable Codes:

The provisions of the latest Indian Standards listed below in addition to those mentioned in tender document, but not restricted to, shall form part of these specifications:

IS: 1200 : Method of measurement of building and civil engineering works Part 1: Earth work

IS: 1498: Classification and identification of soil for general Engineering purposes.

IS:2720 : Method of test for soils (All Parts)

IS:2809 : Glossary of terms and symbols relating to soil engineering

IS:3764 : Safety code for excavation work

IS:4988 : Glossary of terms and classifications of earth moving Machinery (All Parts)

3. Drawings:

The Engineer-in-charge will furnish, wherever in his opinion, such drawings are required to show the areas to be excavated/filled, sequence of priorities etc. The contractor shall

follow such drawings strictly.

4. **Classification of earth:**

For purpose of earthwork soil shall be classified as under;

Loose/soft soil: Any soil which generally yields to the application of picks and shovels, phawras, rakes or any such ordinary excavating implements or organic soil, gravel, silt, sand turf, loam, clay, peat etc. fall under this category.

Dense/Hard Soil: Any soil which generally, requires the close application of picks, or jumpers or scarifiers to loosen it. Stiff clay, gravel and cobble stone etc. fall under this category.

(Note: Cobble stone is the rock fragment usually rounded or semi-rounded having maximum diameter in any one direction between 80 & 300mm)

Mud: Mud is mixture of ordinary soft soil and water in fluid or weak solid state.

Soft/Disintegrated rock: (Not requiring blasting) This shall include the type of rock and boulders which may be quarried or split with crow-bars. Laterite and hard conglomerates also come under this category.

Hard Rock: (Requiring blasting). This shall include the type of rock or boulder which for quarrying or splitting requires the use of mechanical plant or blasting. (Note: Boulders is a rock fragment usually rounded by weathering, disintegration or abrasion by water or ice having a maximum dimension in any direction of more than 300mm.

Hard Rock: (Requiring blasting but where blasting is prohibited) Under this category shall fall hard rocks which though normally requires blasting for their removal but blasting is prohibited and excavation has to be done by chiseling, wedging or other suitable method.

5 **General:**

5.1.1 The contractors shall furnish all tools, plant, instruments qualified supervisory staff, labour, materials, any temporary works, consumables and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with the requirements of specifications.

5.1.2 The contractor shall carry out the survey of the site before excavation and set out properly all utility and service lines and establish levels for various works such as earthwork in excavation for grading, foundations, plinth filling, drains, cable trenches, water pipelines, culverts, retaining walls etc. These will be checked by the Engineer-in-charge or his representative and thereafter recorded plan duly signed by the contractor shall be furnished to the Engineer-in-charge for his approval before starting actual foundation excavations.

5.1.3 The excavation shall be done to correct lines and levels. This shall include where required, proper strutting & strong shoring to maintain excavation and impart safety against collapse of soil, and erection and maintenance of sand barricades around excavations with warning signs displayed during night for safety purposes. The warning signs shall be with reflector type paints.

5.1.4 The rates quoted shall include for stacking of excavated material in regular heaps, bunds, rip rap with regular slopes as directed by the Engineer-in-charge within all leads and leveling the same so as to provide natural drainage. Soil excavation shall be properly stacked as directed by the Engineer-in-charge. As a rule all softer materials shall be laid along the centre of the heaps, the harder and more resistant materials, forming the casing on the sides and the top.

6 **Clearing:**

The area to be excavated/filled shall be cleared of all fences, trees, tree guard, M.S. grill above road divider and filled up earth in between road divider, plan logs, stumps, bush, vegetation, rubbish, slush, road, pavement structure, if any required, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they

shall be removed. The material so removed shall be disposed off as directed by the Engineer-in-charge. Where earth fill is intended, the area shall be cleared of all loose or soft patches, top soil containing objectionable matter/materials before filling commences. No separate payment shall be made for such clearing works.

7 Precious objects, Relics, Objects of Antics etc.

All gold, silver, oil, minerals, archeological and other findings of importance or other materials of any description and all previous stones, coins, treasure traces, relics, antiquities, and similar things which may be found in or upon the site shall be the property of the Government of Gujarat and the contractor shall dully preserve the same to the satisfaction of the Engineer-in-charge and from time to time, deliver the same to him.

8 Excavation for Structures:

8.1 Description:

Excavation for structures shall consist of removal of materials for the construction of the foundations of approach structures, retaining walls, head walls, and other similar structures in accordance with the requirements of this specification on the lines and dimensions shown on the drawings or as directed by the Engineer-in-charge. The work shall include all necessary sheathing, strutting, shoring, bracing, draining, pumping, proper supporting underground service lines like gas, water pipe, drainage line, electric cables, telephone cables as directed by Engineer-in-charge and the removal of all logs, stumps, shrubs and other deleterious matter and obstructions etc. necessary for placing the foundations, trimming bottoms of excavation, backfilling, clearing up the site and disposal of all surplus materials.

8.2 Setting out:

After the site has been cleared, the limits of excavation for foundations shall be set out true to lines, and sections as shown on the drawing or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as string, pegs, nails, bamboos, stones, lime mortar, concrete etc., required in connection with the setting out. He shall be responsible for the maintenance of bench marks and other marks and stakes as long as they are required for the work in the opinion of the Engineer-in-charge.

8.3 Excavation:

Excavation shall be taken to the width of the lowest step of footing or the pile caps and the sides shall be left plumb where the nature of the soil allows it. Where the nature of the soil or the depth of excavated trench/pit does not permit vertical sides, the contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safe angle or both with due regard to the safety of personnel including labourers etc. and the works and to the satisfaction of the Engineer-in-charge. Non-compliance of these requirements would tantamount to negligence on the part of the contractor.

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

8.4 Dewatering and Protection:

All foundations shall be laid in dry condition. Where water is met with in excavation due to seepage, rain or other reasons, the contractor shall take adequate measures such as bailing, pumping, construction of diversion channels, drainage channels, bunds and any other necessary works to keep the foundation trenches/pits dry to lay foundation and to keep the green concrete/all foundations laid in dry protected against damage by or undermine its strength including erosion. In this regard and other details thereof, it shall be left to the choice of the contractor but subject to the approval of the Engineer-in-charge. Approval of the Engineer-in-charge shall however, not relieve the contractor of his responsibility for the adequacy of dewatering and protection arrangements and the safety of the works.

Pumping from inside of any foundation enclosures shall be done in such a manner as to preclude the possibility for the movement of water through any freshly placed concrete.

No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours there after unless it is done from a suitable sump separated from the concrete work by a water tight wall or similar means.

At the discretion of the contractor and at his cost, cement grouting or other approved methods may be used to prevent or to reduce seepage and to protect the excavation area. The contractor shall take all precautions in diverting channels and in discharging the drained water so as not to cause damage to the works or to adjoining property or hindrances to moving traffic on adjoining roads.

8.5 Preparation of Foundation:

The bottom of the foundation shall be leveled both longitudinally and transversely and stepped as directed by the Engineer-in-charge. Before the footing is laid, the surface shall be slightly watered and rammed. In the event of the excavation having been made deeper than shown on the drawing or as otherwise ordered by the Engineer-in-charge, the extra depth shall be made up with concrete and it shall be laid at the cost of the contractor. Ordinary soil filling shall not be used for the purpose to bring the foundation to level as per the design. When rock or other hard strata is encountered it shall be freed of all loose and soft materials cleaned and cut to a firm surface either level, stepped or serrated as directed by the Engineer-in-charge.

If there are any slips or blows in the excavation these shall be removed by the contractor at his own cost.

8.6 Backfilling:

To the extent available, selected surplus soils from the excavation shall be used as backfill as may be directed by the Engineer-in-charge and after obtaining his concurrence before actually taking any action in the re-use of this excavated stuff from foundation. Fill material shall be free from clods of earth, which shall be broken or removed. When the excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150mm size mixed with properly graded fine materials consisting of murrum or earth to fill up the voids and mixture used for filling.

If any selected fill material is required to be borrowed, the contractor shall make arrangement for bringing the material from outside borrow pits. The material sources shall be subjected to the prior approval of the Engineer-in-charge. The contractor shall make necessary access roads to such borrow areas at his own cost, if such access roads do not exist.

Backfilling of the foundation trenches/pits shall be done as soon as foundation work has been completed to the satisfaction of Engineer-in-charge and measured but not earlier than the full setting period of the concrete or masonry work. Backfilling shall be carried out in such a manner as not to cause undue thrust on any part of the structure. Annular space around foundations shall be back filled with coarse sand after clearing it of all debris and in layers of 150mm loose thickness, watered and compacted by vibratory roller to the satisfaction of the Engineer-in-charge and up to the original surface level. The remaining back filling shall be done in like manner as aforesaid, using excavated earth if approved or by borrowed earth from approved source.

8.7 Disposal of Surplus Excavation Materials:

The surplus excavated earth, after backfilling the trenches shall have to be removed from the site as directed. However, surplus earth will be property of contractor and contractor may dispose off or stock the same at their own risk. No payment for the carting of surplus will be made separately.

After completion and consolidation, if any short fall of earth is found then contractor has to bring the same to the required quantity of required quality in order to meet short fall at his / their own cost. Moreover if any settlement of road after reinstatement is observed

during the defect liability period of work, contractor shall be fully responsible for the defective work and patches / depressions / settlements shall be repaired with quarry spaul or metal at contractors own cost. If contractor fails to repair the patches / depressions / settlements in time, Engineer in Charge will repair it at all risk & cost of contractor.

Surplus earth shall not be disposed off in a way that leads to nuisance to the public or R&B (DIVISION) Naramda

9 Details of Casting yard

Casting yard shall be located very nearby from bridge site. It is very essential to have fencing and gate at the time of operation of casting yard. Entire area round about 1400 sq.m has to be developed with proper soling, filling of graded material with satisfactory compaction and top layer finished with good concrete. The area has to be divided in three parts (1) for casting and prestressing (2) stack yard (3) for shifting and placement. It may be kept in mind that during these activities, proper stack yard for dumping construction materials, are to be arranged very nearby from casting yard. Necessary precaution measures have to be regularized by deploying highly skilled professionals at casting yard. Entire sequence of the work has to be monitored by contractor and time to time review will be made by owner/ consultant. In this regard, it is imperative that total performance will depend on planning, hence a detailed chalk out plan with all micro activities are to be submitted to owner / consultant. Quality control will be as per IS / MORT&H specification and detailed test reports, etc. will be submitted by contractor to owner / consultant. For making good quality precast element and casting yard, entire responsibility will be of contractor. Expenditure on this account is not payable as extra but all the details of expenditures have to be included in item rates which are quoted by contractor.

10 Measurement and Rates:

The measurement shall be generally conforming to IS:1200 Part I, unless otherwise specified. Measurement for excavation of foundation footings shall be as required for the exact width, length and depth as shown or figured on the drawings or as may be directed by the Engineer-in-charge. If taken to a greater width, length or depth than shown or required, the extra work occasioned thereby shall be done at the contractor's expenses.

The dimensions of the trenches and pits shall be measured correct to the nearest cm and cubical contents shall be worked out in cubic meters, correct to two places of decimal. Measurements of filling excavated earth or sand in foundations shall be measured for the purpose of payment in cubic meter. The dimensions of the filling shall be measured correct to the nearest centimeters and cubical contents worked out in cubic meters correct to two places of decimal.

Rate for earth work shall include the following:

- (a) Excavation and disposing surplus earth up to a lead of 500m or at place as directed by the Engineer-in-charge.
- (b) Setting out works, profiles etc.
- (c) Site clearance such as cleaning of vegetation, shrubs, brushwood etc.
- (d) Leaving "Deadmen" or "Tell Tales" and their removal after measurement.
- (e) Bailing/pumping out water in excavation from rains, sub soil water etc.
- (f) Protection works, temporary supports for safety, by underpinning if need be to existing services, i.e. drains, water mains, cables and other utility services met within the course of excavation. Removal of electric and/ or telephone cables, posts etc. as necessary, shall be arranged by the Engineer-in-charge.
- (g) Forming (or leaving) steps inside deep trenches and their removal:
- (h) Removing slips or falls in excavation.
- (i) Fencing and/or other suitable measures for protection against risk of accidents, as approved by the Engineer-in-charge.
- (j) Excavation for insertion of planking and strutting where, required.
- (k) Backfilling the trenches by selected excavated material available at site.

1.3 SPECIFICATIONS FOR PLAIN, REINFORCED AND PRESTRESSED CONCRETE:

1. GENERAL

These specifications cover the requirements of plain, reinforced and prestressed concrete for use in various components of structures.

For all items of concrete in any portion of the structure or its associated works controlled concrete shall be used unless otherwise specified. Normal / ordinary concrete mix as shown on the drawing or as directed by the Engineer-in-charge, may be used.

The provisions of the latest revisions of the following I.S Codes shall form a part of this specification to the extent they are relevant.

IS-226	Specification for structural steel (standard quality).
IS-269	Specification for ordinary and low heat Portland cement
IS-280	Specification for mild steel wire for general engineering purpose.
IS-303	Plywood for general purposes.
IS-383	Specification for coarse and fine aggregate.
IS-432	(All Parts) Specifications for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement. Part-I – Mild steel and medium tensile bars. Part-II – Hard drawn steel wire.
IS-455	Specification for Portland blast furnace slag cement.
IS-456	Code of practice for plain and reinforced concrete (IS:456-2000)
IS-460	Specification for test sieves.
IS-516	Methods of test for strength of concrete.
IS-650	Standard sand for testing of cement.
IS-1139	Hot rolled mild steel, medium tensile steel and HYSD bars for concrete reinforcement.
IS-1199	Sampling and analysis of concrete.
IS-1200	Method of measurement of building works.
IS-1343	Code of practice for prestressed concrete.
IS-1489	Specification for Portland pozzolana cement.
IS-1542	Sand for plaster.
IS-1566	Specification for hard-drawn steel wire fabric
IS-1732	Dimensions for round & square steel bars for structural & general engineering purposes.
IS-1785	Plain hard drawn steel wire for prestressed concrete (Part-I) Cold drawn stress-relieved wire.
IS-1786	Specification for high strength deformed steel bars & wires for concrete reinforcement.

IS-1791	Batch type concrete mixers.
IS-2062	Specification for structural steel (fusion welding quality)
IS-2386	(All Parts) Method of test for aggregates for concrete.
IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS-2505	Immersion type concrete vibrators.
IS-2506	Screed board concrete vibrators.
IS-2722	Specification for portable swing weigh batcher (single and double bucket type).
IS-2751	Code of practice for welding of M.S. bars.
IS-2911	Code of practice for design and construction of pile foundation (Part-I & IV).
IS-3366	Pan vibrators
IS-3370	(All Parts) Code of practice for concrete structure for the storage of liquids.
IS-3558	Code of practice for the use of immersion vibrators for consolidating concrete.
IS-4656	Form vibrators for concrete.
IS-5525	Recommendation for detailing of reinforcement in reinforced concrete works.
IS-5640	Method of test for determining aggregate impact value of soft, coarse aggregate.
IS-5816	Method of test for splitting tensile strength of concrete cylinder.
IS-6006	Uncoated stress relieved strand for prestressed concrete.
IS-6461	Cement concrete : glossary of terms.
IS-8041	Specifications for rapid hardening Portland cement.
IS-8043	Specifications for hydrophobic Portland cement.
IS-8112	Specifications for high strength ordinary Portland cement.
IS-9103	Admixtures for concrete.
IS-12269	Specifications for 53 grade Ordinary Portland Cement.
IS-12330	Specifications for Sulphate resistance Portland Cement.
IS-12600	Specifications for Low Heat Portland Cement.
IS-14268	Specifications for Uncoated stress relieved Low Relaxation Steel.

1.1 OTHER CODES AND SPECIFICATIONS

Other IS codes pertaining to the items of cement concrete work in structural work not listed above shall also be deemed to come under the purview of this clause. All Indian Roads Congress Standards, specifications and codes of practice also come under this purview.

2.0 GRADE OF CONCRETE:

2.1 CONTROLLED CONCRETE:

For controlled concrete, design of the mix shall be carried out for the respective target strength and in its production all necessary precautions shall be taken to ensure that the required works cube strength is attained and maintained.

The controlled concrete grades are designated as M20, M25, M30, M35, M40, M45 and M50 and as per the technology used for such designation in IRC codes of practice.

2.2 ORDINARY CONCRETE (Concrete Grades M15 & below):

In case of ordinary / nominal grade concrete, mix is required to be arrived at by preliminary tests, proportions of cement, fine aggregates and coarse aggregates are specified by mass as given in Table 3

In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150mm cubes, expressed in N/mm².

3.0 STRENGTH REQUIREMENT OF CONCRETE:

Where Ordinary Portland Cement conforming to IS:269 or Portland Blast Furnace Cement conforming to IS:456 is used, the compressive strength requirements for various grades of concrete controlled as well as nominal shall be as given in Table 1. Where rapid hardening Portland cement is used, the 28 days compressive strength requirements shall be met at 7 days.

For controlled concrete, the mix shall be so designed for the so called Target strength as to attain in preliminary tests strength at least 33 per cent higher than that required on work tests, for concrete strength up to and including M25 and 25% higher for higher strengths.

Table 1

Grade of Concrete	Compressive Works Test Strength in N/mm ² on 150mm Cubes after Testing Conducted in accordance with IS: 516	
	Min. at 7 days	Min. at 28 days
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	26.80	40
M45	30.15	45

Note : In all cases, the 28 days compressive strength specified in Table 1 shall alone be the criterion for acceptance or rejection of the concrete.

4.0 MATERIALS :

4.1 CEMENT

Fresh quality cement shall be procured only from approved manufacturer / supplier and shall be subjected to prior approval of the Engineer-in-Charge. Following types of cement shall be used:

- All cement used for the work shall be ordinary Portland cement or such other cement as may be permitted by the Engineer-in-charge. Portland cement shall comply with the requirements of the latest issue of IS: 269.
High alumina cement, rapid hardening cement and Portland slag cement etc., can be used only when permitted by the Engineer-in-charge. Such cements shall be in accordance with relevant IS Codes. Portland Pozzolana cement when permitted by the Engineer-in-charge shall conform to IS 1489 Part I but it shall not be used for RCC structural member.
- Cement which has remained in bulk storage at the mill for more than 6 months or which has remained in bags at the dealers storage for over 3 months, or which has been stored

at project site for more than 3 months shall be retested before use. Cement shall also be rejected if it fails to confirm to any of the requirements of these specifications.

- iii) Different types of cements shall not be mixed.

4.2 FINE AGGREGATES:

Fine aggregates shall consist of natural sand, manufactured sand or an approved combination thereof and shall conform to IS: 383. The grading zone of sand proposed for use shall be supplied by the contractor and got approved by the Engineer-in-Charge.

The sand shall be siliceous material, sharp, hard, strong and durable and shall be free from adherent coatings, clay, dust, alkali, organic material, deleterious matter, lumps, etc.

Either natural or manufactured sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter. Natural sand shall be washed, unless specific written authority is given by the Engineer-in-charge to use sand that meets specifications and standards of cleanliness without washing. The cost of screening and washing must be borne by the contractor. The fine aggregate shall be taken from a source approved by the Engineer-in-charge.

4.3 COARSE AGGREGATES:

Coarse aggregates shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, organic or other deleterious matter. It will be from a source approved by the Engineer-in-charge. Coarse aggregate shall conform to IS: 383.

Coarse aggregate shall be washed if necessary to remove all vegetable and other perishable substances and objectionable amounts of other foreign matter, the cost of washing and screening being borne by the contractor.

Size of Coarse Aggregates

Following shall be the maximum nominal size of coarse aggregate for the different items of work if not specified in the item of works or their respective specifications:

Sr. No.	Item of Construction	Max. Nominal Size of Coarse Aggregate
(i)	RCC well staining concrete, RCC well curb & RCC piles in plum concrete	40 mm
(ii)	Well cap or pile cap, solid type piers, abutments and wing walls, and pier caps, footing of open foundation and general items of work in bridge and building construction.	25 /20 mm
(iii)	RCC works in girders, deck slab, wearing coat, kerbs, light posts, ballast walls, approach slab etc. and piers, abutments, returns, wing walls and retaining walls.	25 /20 mm
(iv)	RCC bearings, shells and other thin walled members and in zones of congestion.	25 /20 mm
(v)	For any other item of construction not covered by items (i) to (iv)	As specified in the drawings or as desired by the Engineer-in-Charge in case it is not specified on the drawing.

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

4.4 REINFORCING STEEL (Refer Clause 302.5 of IRC:21)

Reinforcing steel shall be clean and free from loose mill scales, dust, loose rust and coats of paints, oil, grease or other coatings which may impair or reduce bond.

- a) Fe 240 Mild steel shall conform to the latest edition of IS: 432 Part 1.

- b) Fe 415, Fe 500D and Fe 550D high strength deformed bars shall conform to IS: 1786, **TMT bars conforming to IS: 1786 shall only be used. Reinforcing steel shall be coated with Fusion bonded epoxy coating.**
- c) Structural steel sections and plates shall conform IS: 226 and IS: 2062.

4.5 WATER

Water used mixing and curing shall be free from injurious amounts of deleterious material. pH value of water shall not be less than 6. Potable water are generally considered satisfactory for mixing and curing concrete. Water shall be got tested before use in concrete and curing. The cost for the same shall be borne by the contractor. Permissible limits for solid shall be as below:

PERMISSIBLE LIMIT FOR SOLIDS

	Tested as per	Permissible limit max.
Organic	IS: 3025 (Pt.18)	200 mg/lit.
Inorganic	IS: 3025 (Pt. 18)	3000 mg/lit.
Sulphates (as SO ₃)	IS: 3025 (Pt. 28)	400 mg./lit.
Chlorides (as C1)	IS: 3025 (Pt. 32)	2000 mg. lit. for concrete work not containing embedded steel and 500 mg./lit. for prestressed /reinforced concrete work.
Suspended matter	IS: 3025 (Pt. 7)	2000 mg./lit.

4.6 ADMIXTURES

No materials other than essential ingredients i.e. cement, aggregate and water shall ordinarily be used in the manufacture of concrete or mortar. But the Engineer-in-Charge may permit the use of approved admixtures for improving the workability of the concrete, if so specified on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. Admixture where allowed shall conform to relevant IS: 9103.

Chloride content in admixture shall be independently tested for each batch before acceptance. The compatibility of the admixture with cement being used in works shall invariably be got tested and confirmed prior to its use in permanent works.

4.7 MATERIALS FOR REPAIR WORK

The use of epoxy formulations for bonding fresh concrete used for repairs will be permitted on written approval of the Engineer-in-Charge. Epoxies shall be applied in accordance with the instructions of the Manufacturer. The cost of such repair when approved by the Engineer-in-Charge shall be borne by the contractor.

4.8 STORAGE OF MATERIALS

i) Cement

The contractor shall make arrangements to the satisfaction of the Engineer-in-Charge for the storage of cement to prevent deterioration due to moisture and/or intrusion of foreign matter. Bulk cement shall be stored in approved waterproof bin or silo. Bagged cement shall be stored in a suitable weather tight warehouse in a manner to provide easy access for identification and inspection of each consignment. Stored cement shall meet the test requirements as per relevant BIS code at any time after storage, when a retest is ordered by the Engineer-in-Charge. Each consignment shall be stacked separately with the date of receipt flagged on it, not more than 12 bags being stacked in height, the bags being

arranged with headers and stretchers. Normally consignments shall be used in the order of receipt at site unless otherwise directed. In the case of large concrete pours the Engineer-in-charge will decide on the batch of cement to be used taking into consideration the quantity of cement with particular reference to the concerned concrete pours. Any additional work in handling and storage of cement contingent upon this requirement shall be to the contractor's account and no extra claim will be entertained. Cement shall be protected from exposure to moisture in transit, in storage at the works and until it enters the concrete mixers. The contractor shall keep accurate records of the deliveries of the cement and of its use in the work.

ii) **Aggregates**

Coarse and fine aggregates shall be stacked separately in such manner as to prevent contamination by foreign materials. All aggregates shall be stored on concrete or masonry platforms. Each size shall be kept separate with wooden, steel, concrete, or masonry bulk heads, or shall be stored in separate stacks, taking care to prevent the materials at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart. The aggregates shall be stored in easily measurable stacks of suitable heights as may be directed by the Engineer-in-charge.

iii) **Reinforcing Steel**

Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil, grease and distortions as directed by the Engineer-in-Charge.

LAUNCHING METHOD OF PSC I GIRDER

Step 1 Cast PSC I- girder at casting yard

Step 2 Carryout 1st stage Prestressing of the girder at casting yard

Step 3 Launch I-girder by using pneumatic rubber tyres type cranes (Sufficient Capacity), by two point lifting method; using spread beams (i.e. Lift PSC I- girder at c/c of bearing location) as per Drg, and Approved Methodology.

Step 4 Place all girders above their respective bearing locations.

Step 5 Cast deck slab over it.

Step 6 Carry out 2nd stage Prestressing

Entire operation shall be carry out by skilled labours only.

The Contractor shall submit methodology of Launching well in advance . It shall be Got approved by Prime Consultant/ Proof Consultant/ PMC & Engineer in charge.

Contractor shall obtain all necessary permission/ Approval from Various Department like Traffic Police etc. well in advance.

SPECIFICATIONS FOR QUALITY CONTROL FOR ROAD WORKS
as per MORT&H (5th Edition) Clause no.: 900

901 GENERAL

901.1 All materials to be used, all methods to be adopted and all works to be performed shall be strictly in accordance with the requirements of these Specifications. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out Quality Control for works and all the required tests as per Specifications and/or as directed by the Engineer. The provision and maintenance of the laboratory shall be as per Clause 120 and/or as directed by the Engineer. The list of equipment and the facilities to be provided shall be got approved from the Engineer in advance.

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

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

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

901.5 The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests as required by the Engineer from time to time. This shall include provision of laboratory equipment, transport, consumables, personnel including labour attendants, assistants in packing and dispatching and any other assistance considered necessary in connection with the tests.

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

901.7 The Contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer. Works falling short of quality shall be rectified/redone by the Contractor at his own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.

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

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

901.10 For cement, bitumen, steel, emulsion, road marking paint, sign boards, geo-synthetics and similar other materials where essential tests are to be carried out in the presence of Engineer at the manufacturer's plants or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor.

Manufacturer's test certificate together with invoice or delivery challan shall be furnished for every lot of supply apart from tests to be conducted at site laboratory for prime properties of the material like cement, bitumen, etc. Where facilities for testing of materials are not available at site laboratory the same shall be tested at an outside laboratory in the presence of the Engineer. For specialized items such as sign boards, road marking paint, etc. the Engineer may order for third party test from an approved laboratory.

901.11 The method of sampling and testing of materials shall be in accordance with the requirements of the relevant Indian Standards and these Specifications. Where they are contradicting, the provisions

in these Specifications shall be followed. Where they are silent, sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor. The cost of all tests shall be borne by the Contractor.

901.12 The materials for embankment construction shall be got approved from the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contractor who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period. Similarly, the supply of aggregates and other materials for construction shall be from sources approved by the Engineer. Responsibility for arranging uninterrupted supply of materials from the source shall be that of the Contractor.

901.13 Defective Materials

All materials which the Engineer has determined as not conforming to the requirements of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any instruction of the Engineer, the Engineer shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

901.14 Imported Materials

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

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

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

902 CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

902.1 General

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

902.2 Horizontal Alignment

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

902.3 Surface Levels

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

Table 900-1 : Tolerances in Surface Levels

1)	Subgrade	±20 mm
2)	Sub-base	
	a) Flexible pavement	±10 mm
	b) Concrete pavement	±6 mm
3)	Base-course for flexible pavement	
	a) Bituminous Base/Binder course	±6 mm
	b) Granular	
	i) Machine laid	±10 mm
	ii) Manually laid	±15 mm
4)	Wearing course for flexible pavement	
	a) Machine laid	±6 mm
	b) Manually laid	±10 mm
5)	Cement concrete pavement	±5 mm

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than the following limits:

- 4 mm for bituminous wearing course of thickness 40 mm or more
- 3 mm for bituminous wearing course of thickness less than 40 mm
- 5 mm for concrete pavement slab

For checking compliance with the above requirement for subgrade, sub-base and base course, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

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

902.4 Surface Regularity of Pavement Courses

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

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

Table 900-2 : Maximum Permitted Number of Surface Irregularities

Irregularity	Surfaces of Carriageways and Paved Shoulders				Surfaces of Laybys, Service Areas and all Bituminous Base Courses			
	4 mm		7 mm		4 mm		7 mm	
Length (m)	300	75	300	75	300	75	300	75
Number of Surface Irregularities on National Highways/ Expressways*	15	9	2	1	40	18	4	2
Number of Surface Irregularities on Roads of lower Category*	40	18	4	2	60	27	6	3

* Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m straightedge when placed parallel with, or at right angles to the centre line of the road at points decided by the

Engineer shall be:

for pavement surface (bituminous and cement concrete) 3 mm

for bituminous base courses 6 mm

for granular sub-base/base courses 8 mm

for sub-bases under concrete pavements 10 mm

for subgrade 15 mm

902.5 Rectification

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances in Clause 902.4, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

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

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

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

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

iv) **Water Bound Macadam/Wet Mix Macadam Sub-base/Base:** Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted as per Clause 404 in the case of Water Bound Macadam and to Clause 406 in the case of Wet Mix Macadam.

v) **Bituminous Constructions:** For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat, if needed, and recompacting as per specifications. Where the surface is high, the extra thickness in the affected layer shall be removed and replaced with fresh material and compacted to Specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width.

vi) **Dry Lean Concrete Sub-Base:** The defective length of the course shall be removed to full depth and replaced with material conforming to **Clause 601**. The area treated shall be at least 3 m long, not less than 1 lane width and extend to the full depth. Before relaying the course, the disturbed subgrade or layer below shall be corrected by levelling, watering and compacting.

vii) **Cement Concrete Pavement:** The defective areas having irregularity exceeding 3 mm but not greater than 6 mm when tested with a 3 metre long straight edge may be rectified by scrubbling or grinding using approved equipment. When required by the Engineer, areas which have been reduced in level by the above operation(s) shall be retextured in an approved manner either by cutting grooves (5 mm deep) or roughening the surface by hacking the surface. If high areas in excess 6 mm or low areas in excess of 3 mm occur, exceeding the permitted numbers and if the Contractor cannot rectify, the slab shall be demolished and reconstructed at the Contractor's expense and in no case the area removed shall be less than the full width of the lane in which the irregularity occurs and full length of the slab.

If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerances shall be demolished and reconstructed at the Contractor's cost.

902.6 Riding Quality

The riding quality of bituminous concrete wearing surface, as measured by a standard towed fifth wheel bump integrator, shall not be more than 2000 mm per Km.

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

903.1 General

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the Clauses for the relevant items of work.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Tables 900-3 and 900-4 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer.

**Table 900-3 : Control Tests and their Minimum Frequency for Sub-Bases and Bases
(Excluding Bitumen Bound Bases)**

S. No.	Type of Construction	Test	Frequency (min.)
1)	Granular	I) Gradation II) Atterberg limits III) Moisture content prior to compaction IV) Density of compacted layer V) Deleterious constituents VI) CBR	One test per 400 cu.m One test per 400 cu.m One test per 400 cu.m One test per 1000 sq.m As required As required
2)	Lime/Cement Stabilised Soil Sub-base	I) Quality of lime/ cement II) Lime/Cement content III) Degree of pulverization IV) CBR or Unconfined Compressive Strength test on a set of 3 specimens V) Moisture content prior to compaction VI) Density of compacted layer VII) Deleterious constituents	One test for each consignment subject to a minimum of one test per 5 tonnes Regularly, through procedural checks Periodically as considered necessary As required One set of two tests per 500 sq.m One set of two tests per 500 sq.m As required
3)	Water Bound Macadam	I) Aggregate Impact Value II) Grading of aggregate III) Combined Flakiness and Elongation Indices IV) Atterberg limits of binding material V) Atterberg limits of screenings	One test per 1000 cu.m of aggregate One test per 250 cu.m One test per 500 cu.m of aggregate One test per 50 cu.m of binding material One test per 100 cu.m of aggregate
4)	Wet Mix Macadam	I) Aggregate Impact Value II) Grading of aggregate III) Combined Flakiness and Elongation Indices IV) Atterberg limits of portion of aggregate passing 425 micron sieve V) Density of compacted layer	One test per 1000 cu.m of aggregate One test per 200 cu.m of aggregate One test per 500 cu.m of aggregate One test per 200 cu.m of aggregate One set of three tests per 1000 sq.m

Table 900-4 : Control Tests for Bituminous Works and their Minimum Frequency

S. No.	Type of Construction	Test	Frequency (min.)
1)	Prime Coat/Tack Coat/Fog Spray	I) Quality of binder	Number of samples per lot and tests as per IS:73, IS:217 and IS:8887 as applicable
		II) Binder temperature for application	At regular close intervals
		III) Rate of spread of Binder	Three tests per day
2)	Seal Coat/Surface Dressing	I) Quality of Binder	Same as mentioned under Serial No. 1
		II) Aggregate Impact Value or Los Angeles Abrasion Value	One test per 200 cu.m of each source and whenever there is change in the quality of aggregate
		III) Combined Flakiness and Elongation Indices	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		IV) Stripping value of aggregates (Immersion Tray Test)	One test of each source and whenever there is change in the quality of aggregate
		V) Water absorption of aggregate	-do-
		VI) Water sensitivity of mix	-do-
		VII) Grading of aggregate	Two tests per day
		VIII) Soundness (Magnesium Sulphate/ Sodium Sulphate)	One test for each source and whenever there is change in the quality of aggregate
		IX) Polished stone value (not applicable for SAM/SAMI)	-do-
		X) Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
		XI) Rate of spread of materials	Same as mentioned under Serial No. 1
		XII) Percentage of fractured faces (When gravel is used)	One test per 100 cu.m of aggregate
3)	Open-graded Premix Surfacing/Close-graded Premix Surfacing	I) Quality of binder	Same as mentioned under Serial No. 1
		II) Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		III) Combined Flakiness and Elongation Indices	Same as mentioned under Serial No. 2
		IV) Stripping value	Same as mentioned under Serial No. 2
		V) Water absorption of aggregates	Same as mentioned under Serial No. 2
		VI) Water Sensitivity of mix	Same as mentioned under Serial No. 2
		VII) Grading of aggregates	Same as mentioned under Serial No. 2

S. No.	Type of Construction	Test	Frequency (min.)
		viii) Soundness(Magnesium Sulphate and Sodium Sulphate)	Same as mentioned under Serial No. 2
		ix) Polished stone value	Same as mentioned under Serial No. 2
		x) Temperature of binder at application	At regular interval
		xi) Binder content	Two tests per day per plant
		xii) Percentage of fractured faces	Same as mentioned under Serial No. 2
4)	Bituminous Macadam	i) Quality of binder	Same as mentioned under Serial No. 1
		ii) Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		iii) Combined Flakiness and Elongation Indices	One test per 350 cu.m for each source
		iv) Stripping value	Same as mentioned under Serial No. 2
		v) Water absorption of aggregates	Same as mentioned under Serial No. 2
		vi) Water Sensitivity of mix	Same as mentioned under Serial No. 2
		vii) Grading of aggregates	Same as mentioned under Serial No. 2
		viii) Soundness (Magnesium Sulphate/ Sodium Sulphate)	Same as mentioned under Serial No. 2
		ix) Percentage of fractured faces	Same as mentioned under Serial No. 2
		x) Binder content	Same as mentioned under Serial No. 3
		xi) Control of temperature of binder and aggregate for mix and of the mix at the time of laying and rolling	Same as mentioned under Serial No. 2
		xii) Density of Comp layer	One test per 700 sq.m area
		xiii) Rate of spread of Mixed Material	At regular intervals
5)	Dense Bituminous Macadam/Bituminous Concrete	i) Quality of binder	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462
		ii) Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iii) Flakiness and Elongation Indices	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iv) Soundness test (Sodium or Magnesium Sulphate test)	One test for each source and whenever there is change in the quality of aggregate
		v) Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate

S. No.	Type of Construction	Test	Frequency (min.)
		vi) Sand equivalent test	One test for each source and whenever there is change in the quality of aggregate
		vii) Plasticity Index	One test for each source and whenever there is change in the quality of aggregate
		viii) Polished stone value	One test for each source and whenever there is change in the quality of aggregate
		ix) Percentage of fractured face	One test per 350 cu.m of aggregate when crushed gravel is used
		x) Mix grading	One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xi) Stability and voids analysis of mix including theoretical maximum specific of loose mix	Three tests for stability, flow value, density and void contents for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xii) Moisture Susceptibility of mix (AASHTO T283)	One test for each mix type whenever there is change in the quality or source of coarse or fine aggregate
		xiii) Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
		xiv) Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xv) Rate of spread of mix material	After every 5 th truck load
		xvi) Density of Compacted layer	One test per 700 sq.m area
6)	Sand Asphalt Base course	i) Quality of binder	Same as mentioned under Serial No. 2
		ii) Aggregate Impact Value or Los Angeles Abrasion Value	Same as mentioned under Serial No. 2
		iii) Sand equivalent test	Same as mentioned under Serial No. 2
		iv) Plasticity Index	Same as mentioned under Serial No. 5
		v) Mix grading & binder content	Same as mentioned under Serial Nos. 2 and 3
		vi) Stability of Mix	Same as mentioned under Serial No. 5
		vii) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	Same as mentioned under Serial No. 2
		viii) Thickness of layer	Same as mentioned under Serial No. 5
		ix) Density of Compacted layer	Same as mentioned under Serial No. 5

S. No.	Type of Construction	Test	Frequency (min.)
		(xiv) Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		(xv) Rate of spread of mix material	After every 5 th truck load
		(xvi) Density of compacted layer	One test per 250 sq.m area
9)	Mastic asphalt	I) Quality of binder	Same as mentioned under Serial No. 5
		II) Aggregate Impact Value and Los Angeles Abrasion Value	Same as mentioned under Serial No. 5
		III) Combined Flakiness and Elongation Indices	Same as mentioned under Serial No. 5
		IV) Stripping value	Same as mentioned under Serial No. 2
		V) Water Sensitivity of mix	Same as mentioned under Serial No. 5
		VI) Grading of aggregates	Two tests per day per plant on the individual constituent and mixed aggregates from the dryer
		VII) Water absorption of aggregates	Same as mentioned under Serial No. 5
		VIII) Soundness (Magnesium Sulphate/ Sodium Sulphate)	Same as mentioned under Serial No. 5
		IX) Percentage of fractured faces	Same as mentioned under Serial No. 5
		X) Binder content and aggregate grading	Same as mentioned under Serial No. 3
		XI) Control of temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling	At regular close intervals
		XII) Rate of Spread of Mixed Material	Regular control through check of layer thickness
		XIII) Hardness number	Minimum two tests per day
10)	Recycled Material Grading of aggregate		Two tests per day
11)	Cold Mixes		All tests as per S. No.5
12)	Quality of Modified Binder		Number of samples per lot and tests as per IS:15462.
13)	Geotextiles		The requirements of Section 700 shall apply

Note : Daily, weekly, monthly reports on test results shall be prepared indicating the location of sampling and testing, deviation from the specified values for materials and works and remedial action taken in respect of removal of defective work shall certified be prepared by the Contractor. The test record shall be certified by the Engineer that these tests were done in his presence and testing carried as per prescribed methodology.

903.2 Tests on Earthwork for Embankment, Subgrade Construction and Cut Formation

903.2.1 Borrow Material

Grid the borrow area at 25 m c/c (or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted for proper identification of suitable sources of material. The following tests on representative samples shall be carried out for every 3000 cum for each source:

- Sand Content [IS:2720 (Part-4)]: 2 tests per 3000 cu.m of soil.
- Plasticity Test [IS:2720 (Part-5)]: Each type to be tested, 2 tests.
- Density Test [IS:2720 (Part-8)]: Each soil type to be tested, 2 tests.
- Deleterious Content Test [IS:2720 (Part-27)]: As and when required by the Engineer.
- Moisture Content Test [IS:2720 (Part-2)]: Two tests.
- CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [IS:2720 (Part-16)] : One CBR test (average of three specimens) or closer as and when required by the Engineer.

903.2.2 Compaction Control

Control shall be exercised on each layer by taking at least one set of ten measurements of density for each 3000 sq. m of compacted area, or closer as required to yield the minimum number tests results for evaluating a day's work on statistical basis. The determination of density shall be in accordance with IS: 2720 (Part-28). Test locations shall be chosen only through random sampling techniques. If non-destructive tests are carried out, the number of tests shall be doubled. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased. The acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus:

$$\left[1.65 - \frac{1.65}{(\text{No. of samples})^{0.5}} \right] \text{ times the standard deviation}$$

However, for earthwork in shoulders (earthen) and in the subgrade, at least one set of ten density measurements shall be taken for every 2000 sq. m for the compacted area. In other respects, the control shall be similar to that described earlier.

903.2.3 Cut Formation

Tests for the density requirements of cut formation shall be carried out in accordance with Clause 903.2.2.

903.3 Tests on Sub-bases and Bases (Excluding Bitumen Bound Bases)

The tests and their frequencies for the different types of bases and sub-bases shall be given in Table 900-3. The evaluation of density results and acceptance criteria for compaction control shall be on lines similar to those set out in Clause 903.2.2.

903.3.1 Acceptance Criteria

the acceptance criteria for tests on the strength of cement/lime stabilized soil and distribution of stabilizer content shall be subject to the condition that the mean value is not less than the specified value plus:

$$\left[1.65 - \frac{1.65}{(\text{No. of samples})^{0.5}} \right] \text{ times the standard deviation}$$

903.4 Tests on Bituminous Construction

903.4.1 Tests and Frequency

The tests and their minimum frequencies for the different types of bituminous works shall be as given in Table 900-4. The Engineer may direct additional testing as required.

903.4.2 Acceptance Criteria

The acceptance criteria for tests on density shall be subject to the condition that the mean value is not less than the specified value plus:

$$\left[1.65 - \frac{1.65}{(\text{No. of samples})^{0.5}} \right] \text{ times the standard deviation}$$

903.4.3 Where the Contract specifies the surface roughness requirements, in terms of Bump Integrator value, the surface roughness shall be measured by a calibrated Bump Integrator as per the procedure described in IRC:SP:16. The measurements shall be taken at centre line of each lane for a minimum completed length of one Km.

903.5.2.5 Summary of Control Tests

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

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

1)	Levels, alignment and texture			
	I)	Level tolerance	Clause 902.3	
	II)	Width of pavement and position of paving edges	Clause 902.2	
	III)	Pavement thickness	Clause 902.3 and 903.5.2.4	
	IV)	Alignment of joints, widths, depth of dowel grooves	To be checked @ one joint per 400 m length or a day's work	
	v)	Surface regularity both transversely and longitudinally	Once a day or one day's work without disturbing the curing	
	vi)	Alignment of dowel bars and their accuracy/tie bars	To be checked in trial length as per Clause 602.6.5.2 and once on every 2 km.	
	vii)	Texture depth	Clause 602.12	
2)	Quality of materials and concrete shall be as under :			
	1) Cement Physical and chemical Tests		IS:269 IS:455 IS:1489 IS:8112 IS:12269	Once for each source of supply and occasionally when called for in case of long/ improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer
	2) Coarse and Fine Aggregates	I) Gradation	IS:2386	One test for every day's work of each fraction of coarse aggregate and fine aggregate, initially; (may be relaxed later at the discretion of the Engineer)
		II) Deleterious constituents	IS:2386 (Pt. 2)	-do-
		III) Water absorption	IS:2386 (Pt. 3)	Regularly as required subject to a minimum of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.
	3) Coarse Aggregate	I) Los Angeles Abrasion value or Aggregate Impact test	IS:2386 (Pt. 4)	Once for each source of supply and subsequently on monthly basis.
		II) Soundness	IS:2386 (Pt. 5)	Before approving the aggregates and every month subsequently.
		III) Alkali aggregate reactivity	IS:2386 (Pt. 7) IS:456	-do-

	4) Water	Chemical Tests	IS:2386	Once for approval of source of supply, subsequently only in case of doubt.
	5) Concrete	i) Strength of concrete	IS:516	2 cubes and 2 beams per 150 cu.m or part thereof (one for 7 day and other for 28 day strength) or minimum 6 cubes and 6 beams per day's work whichever is more.
		ii) Core strength on hardened concrete	IS:516	As per the requirement of the Engineer, only in case of doubt.
		iii) Workability of fresh concrete- Slump Test	IS:1199	One test per each dumper load at both Batching plant site and paving site initially when work starts. Subsequently sampling may be done from alternate dumper.
		iv) Thickness determination		From the level data of concrete pavement surface and sub-base at grid points of 5/6.25 m x 3.5 m
		v) Thickness measurement for trial length		3 cores per trial length
		vi) Verification of level of string line in the case of slip form paving and steel forms in the case of fixed form paving		String line or steel forms shall be checked for level at an interval of 5.0 m or 6.25 m. The level tolerance allowed shall be ± 2 mm. These shall be got approved 1-2 hours before the commencement of the concreting activity.

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 Though "SPECIFICATION" for each item are attached with tender they are 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 Building 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 specification, of IRC, IRS, IS 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.

If any damage is on account of defective work, then the Contractor will be required to immediately attend the same to the full satisfaction of Engineer-in-charge.

On completion of project, contractor shall submit 'As Built Drawings' for all components of project and also detailed drawings for methodology used for foundations, Sub structure, pylons construction, superstructure etc. as actually executed during construction. Contractor shall submit two nos. of hard copies and one copy in digital form. Final completion certificate and release of final bill will be made only after above submissions. If engineer-in-charge would find error in submissions, then contractor shall carryout corrections and will be required to make resubmissions.

Item No. 1 : Clearing and grubbing site/road/land [including uprooting all vegetation, grass, bush shrubs, saplings and trees with girth, removal of stumps of trees of girth of all sizes including removing stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable materials as directed by Engineer with all leads and lifts etc. complete as per specification. before commencement and after completion of the work.

MORT&H Specification of Cl. 201 mentioned below shall be followed in connection with this item.

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.

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.

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, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

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 leads and lifts. The disposal shall be in accordance with local, State and Central regulations

Measurements for Payment

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Cutting of trees upto 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.

Rates

- a. The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 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.
- b. 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.
- c. 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.
- d. 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 / estimates of the State Forest Department.
- e. 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.

All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

The rate on **Hectare** basis shall include all necessary equipment, materials required in completing the job as required, as per direction of Engineer-in-charge.

After completion of work the contractor has to reinstate and level the ground to its original ground to its original position and contractor also has to remove oil, derrises, dismantled materials, staging pedestal/Foundation from the site or instruction of engineer-in-charge.

The Rate shall be paid per Hectare.

Item No. 2 : Detailed survey of site using Total station, and Marking out the centre line of bridge along longitudinal and transverse axis, and taking Various utilities and all other details of all component , structures, boundary and complete line out and levelling with precise levels using total station /theodolite including constructing necessary CC pillars for lines and levels and establishing necessary bench marks including making AUTOCAD drawings showing all levels, details of utilities, boundary etc all and providing soft copies in AUTOCAD etc. complete as directed.

The work shall consist of carrying out a comprehensive topographical and engineering survey of the bridge site using modern electronic survey instruments such as Total Station / Theodolite, as directed by the Engineer-in-Charge (EIC), and shall include all labour, materials, equipment, tools, software, and incidentals required for completion of the work.

1. Site Reconnaissance & Control Survey

Initial reconnaissance of the site to understand terrain, access, existing structures, utilities, and reference points. Establishment of primary and secondary control points connected to permanent reference points. Control points shall be fixed with permanent markers and recorded with coordinates (X, Y, Z).

2. Detailed Topographical Survey

Conducting detailed topographic survey of the bridge location and its approaches using Total Station. Capturing ground levels, natural features, road alignment, water bodies, embankments, and adjoining land features. Survey coverage shall extend to limits as directed by EIC to cover all bridge components and approach areas.

3. Centre Line Setting Out

Marking the longitudinal centre line of the bridge. Marking the transverse axis at abutments, piers, foundations, and other structural components. Alignment shall be checked and re-verified before approval.

4. Utility & Structure Survey

Identification and mapping of all existing utilities including water pipelines, sewer lines, electrical cables and poles, telephone/OF cables, drainage lines, and any other underground or overhead utilities. Survey and recording of existing buildings, compound walls, culverts, drains, trees, permanent structures, and property boundaries.

5. Leveling and Bench Marks

Precise leveling using Total Station / Digital Level. Establishment of Permanent Bench Marks (PBMs) and Temporary Bench Marks (TBMs) at suitable locations. Construction of Cement Concrete (CC) pillars for permanent reference as directed by EIC, clearly marked and protected. All levels shall be reduced to approved datum.

6. Line Out for Structures

Providing complete line out for abutments, piers, foundations, retaining walls, and approaches. Coordinates and levels to be recorded and submitted for approval prior to construction. All deviation angles of the central line axis for both the two lane bridge including tangent distances shall be demarcated with pegs fixed in to the ground.

7. Preparation of Drawings

The contractor shall prepare detailed survey drawings in AutoCAD including topographical plan with contour levels, centre line plan, cross sections and longitudinal section, utility layout plan, boundary demarcation plan, bench mark location plan, and all structural reference lines and coordinates. All drawings shall be to scale and approved by EIC.

8. Submission of Data

Hard copy prints of drawings as required. Soft copies in AutoCAD (.dwg) and PDF format. Digital survey data, coordinates, and level books shall be submitted.

9. Accuracy Requirements

Angular accuracy and distance measurement shall comply with standard engineering survey practices.

Closure errors shall be within permissible limits. Any errors shall be rectified at contractor's cost.

10. Measurements

Measurement shall be taken on Lump Sum (L.S.) basis for complete work as described above.

Rate including constructing necessary CC pillars for lines and levels and establishing necessary benchmarks including making AUTOCAD drawings showing all levels, details of utilities, boundary, Longitudinal sections and cross sections etc. all and providing soft copies in AUTOCAD etc. complete as directed.

Item No. 3 : Providing and installation of barricades including supplying, painting with fluorescent paint and fixing CGI sheets 24 SWG of 1.8 m height and M.S. Posts angle 40 x 40 x 6 mm at 2.0 m c/c and dismantling the same after completion of work as directed by Engineer and as per site requirements.

1. Materials

All materials used shall be new, of standard quality, and approved by the Engineer-in-Charge (EIC).

(a) CGI Sheets

Corrugated Galvanized Iron (CGI) sheets of 24 SWG thickness. Sheets shall be free from rust, dents, warping, or defects. Minimum height of barricade shall be 1.80 m.

(b) M.S. Posts

Mild Steel angle posts of size 40 mm × 40 mm × 6 mm. Posts shall be straight, free from cracks, bends, and laminations. Length of posts shall be sufficient to ensure proper embedment and stability.

(c) Paint

Fluorescent or reflective paint of approved make for high visibility. Primer coat such as red oxide or zinc chromate shall be applied before final painting.

(d) Fasteners

Nuts, bolts, washers, clamps, and binding wire as required. All fasteners shall be corrosion resistant.

(e) Foundation Material (if required)

Cement concrete or rammed earth for fixing posts securely in ground as per site condition.

2. Scope of Work

The work shall consist of providing, erecting, maintaining, and dismantling temporary barricades at locations shown in drawings or as directed by EIC for safety, traffic control, and protection of work zones.

The scope includes supplying CGI sheets, M.S. angle posts, fasteners, and paint. Fabrication and erection of barricade panels of 1.80 m height. Fixing M.S. posts at 2.0 m centre-to-centre spacing. Embedding posts firmly in ground to required depth ensuring rigidity and stability. Fixing CGI sheets securely to M.S. posts. Surface preparation, priming, and painting with fluorescent paint for visibility. Providing openings, gates, or removable sections if required. Regular maintenance, re-painting, and straightening during the contract period. Dismantling barricades after completion of work and clearing site as directed.

3. General Workmanship

Barricades shall be erected in straight alignment, plumb, and properly braced. The structure shall withstand wind loads and accidental impact without collapse. No sharp edges or protruding bolts shall be left exposed. Barricades shall not obstruct drainage or access unless specifically instructed. Visibility of barricades during day and night shall be ensured. Damaged sheets or posts shall be replaced immediately at contractor's cost. Work shall comply with site safety norms and instructions of EIC.

Note:

- (i) Barricades on either side shall be measured individually.
- (ii) Once barricade has been provided and work started, removal of barricade will not be permitted till completion of pile, pile cap, pier and pier caps, portal beams, segment erection, I girder, erection, till completion of entire superstructure.
- (iii) While erecting barricade, the bottom gap between barricade and road should be plugged with cement concrete from inside, where required.
- (iv) There should be minimum openings at the end of barricade to allow access of trucks / Lorries and machine to site work area. Even these spacing should have proper opening & closing arrangements. It is specifically highlighted that barricading provided during construction shall be limited to 1m to 2m from outer edge of structure to be constructed. Barricading of height 2.0 m height as per GFCD. Payment shall be made at 70% on erection of barricade and 30% on removal of barricade after completion of project as per the instructions of Engineer.
- (v) For 2.0m barricades adequate blinking lights on barricade during night time must be ensured. The cost of this item should include provision for power pack / Gen set etc. so as to ensure the blinking of lights in night time as long as barricades are in position at the work spot.
- (vi) After completion of the entire work, the barricades shall be the property of the contractor.
- (vii) If the cleaning is not done including removal of posters regularly, a recovery shall be made at the rate of 0.1% of the accepted rate of item per fortnight on prorated basis of length not cleaned.
- (viii) The rates should be all inclusive for shifting/erecting/re-erecting the barricade for utility diversion/identification & road widening/diversions.
- (ix) The barricading shall be provided as per Item, Specification, Drawing, only. Any type of change / modification will not be allowed without written permission of Engineer In charge and in such case rate reduction will be imposed based on allowed barricading with written permission for specific area with valid reason.
- (x) Barricading of height 2.0m height as per tender drawing. Payment shall be made at 70% on erection of barricade and 30% on removal of barricade as per the instructions of Engineer.
- (xi) It is specifically highlighted that barricading provided during construction shall be limited to 1m to 2m from outer edge of structure to be constructed. Barricading of height 2.0 m height as per GFCD. Payment shall be made at 70% on erection of barricade and 30% on removal of barricade after completion of project as per the instructions of Engineer.

(Note: - Onetime payment shall be made for providing barricading from start of work till completion of work shifting. The barricading provided shall remain to be the property of the contractor on completion of

the work).

Work shall be carried out as directed by Engineer in charge

1. The relevant specifications as given in items shall apply to this item.
2. **The measurement shall be based on Sqmt area of barricading for barricading sheet** with proper numbering, structural steel, with necessary excavation, concrete base etc. including painting. Retro reflective work and blinkers shall be paid in relevant item.
3. The rate includes labour, material, equipment, shifting of barricading as per requirement of progress of work and removal the same after completion of work. (All material will be the property of the contractor after completion of the project).

The mode of payment shall be in per Sqmt basis.

Item No. 04 : Dismantling of structures and sorting of the dismantled material, disposal of unserviceable material and stacking serviceable materials as directed by Engineer with all leads and lifts etc. complete as per specification and as per site requirements.

- a) **Dismantling bricks / Stone masonry, PCC Kerb Median**
- b) **Dismantling of Concrete Structures**
- c) **Scarifying existing Approaches flexible pavement. (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.)**
- d) **Dismantling steel work including distempering and stacking the materials with all lead and lift and Steel Material is Property of R&B /Client as directed by Engineer Incharge.**

General

1. Since excavations for open foundations as well as for pile cap at some locations are to be carried out on existing road, it will be required to break open existing pavement structures. Also, as Urban development around is of recent origin of about 25 years, it is expected that masonry or concrete or any such structure may be encountered during excavation for foundation. Such obstructions irrespective of size, shape, weight shall be removed under this item.
2. The rate shall be for all labour including breaking, removing obstructions as above mentioned, conveying and stacking/disposing off the same as may be directed. (All the dismantled materials including reinforcement steel ,rubble etc shall be property of contractor)
3. The breaking of existing R.C.C. road pavement to the exact required size for foundation. The surface shall have to break by proper mechanical system approved by engineer-in-charge.
4. Where directed by the Engineer-in-charge holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and thoroughly compacted in line with surrounding area.
5. All materials obtained by dismantling shall be the property of Government. Unless otherwise specified, materials having any salvage value shall be placed in neat stack of like material within the right-of-way as directed by the Engineer-in-charge, for which contractor will remain responsible for its safe custody and preservation for 60 days after recording measurements of the salvaged material.
6. Pipe culverts that are removed shall be cleared and neatly piled on the right-of-way at points designated by the Engineer-in-charge.
7. Structural steel removed from old structure shall, unless otherwise specified or directed be stored in a neat and presentable manner on blocking in locations suitable for loading. Structures or portions thereof which are specified in the contract for re-erections shall be stored in separate piles.
8. Timber of lumber from old structures which is designated by the Engineer-in-charge as materials to be salvaged shall have all nuts and bolts removed from and shall be stored in neat piles in locations suitable for loading.
9. All the products of dismantling operations which in the opinion of the Engineer-in-charge cannot be used or auctioned shall be disposed as directed.

MORT&H specification no. 202 (**5th Revision**) (Pg. No-39) shall be followed in connection with this item as mentioned below. All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

Scope

This work shall consists of dismantling and removing existing culverts, bridges, Pavements, kerbs and other structures like guard-rails, fences, utility services, manholes, catch basins, inlets, etc., from the right of way which in the opinion of the Engineer interfere with the construction of road/bridges 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/ROW 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.

Dismantling Culverts & 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 and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts 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.

Dismantling Pavements & Other Structures

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

All concrete pavements, base courses in carriageway and shoulders etc., designated for removal shall be

broken to pieces whose volume shall not exceed 0.02 cu.m and used with the approval of the Engineer or disposed of.

Backfilling

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

Disposal of Materials

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

Dismantling of Barbed Wire Fencing:

Dismantling and removal of existing barbed wire fencing including barbed wire strands, making into coils/rolls, and dismantling of fencing posts. The work shall include excavation and removal of concrete foundation/base of posts, all necessary earthwork, and making good the disturbed ground to original profile. Serviceable materials shall be carefully stacked at a location as directed by the Engineer-in-Charge, and unserviceable materials shall be disposed of as directed, including all leads and lifts, complete.

Measurement of Payment

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

- | | |
|---|---------------|
| (a) Dismantling bricks / Stone masonry, PCC Kerb Median - | Cubic Metre |
| (Plain and Reinforced) masonry. | |
| (b) Dismantling of Concrete Structures | - Cubic Metre |
| (c) Dismantling/ Scarifying flexible and C.C Pavement | - Sq. m |
| (d) Dismantling steel structure | - Kg. |

Rates

The contract unit rates for the various items of dismantling shall be for payment in full for carrying out the required operations including full compensation for all labour, materials, tools equipment, safeguard and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary and for handling, salvaging, piling and disposing of the dismantled material within all lifts and lead.

The rate shall be for all labour including breaking, removing obstructions as above mentioned, conveying and stacking/disposing off the same as may be directed.

c) Scarifying existing Approaches flexible pavement. (Scarifying graveled macadam or bitumen macadam surface 6 cm to 10 cm. depth including stacking useful materials on road side and disposing off remaining stuff.).

1. The layer of the existing layer metaling shall be 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 (2m 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 pavement shall be claimed by the contractor. If the quantity of metal in -any stack in a particular hectometer is found to be less than the standard measurements viz. 1.5 cmt. the entire collection in the hector meter shall be paid on the basis of the quantity so found. Regular stacks shall be done by the contractor on a tairi level ground. Stacking of the metal shall be done in a manner as directed by the Engineer-in-charge.
2. 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 elsewhere 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 of 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 arrived at within the chainage measured.

3. The payment shall be made on sq.mt. basis, the contractor shall maintain all stacks in regular and proper size till the whole materials shall not be measured and finally accepted by the department. The spreading to materials shall not be allowed till the materials are fully stacked and completed kilometer wise.
4. The rate includes the cost of scarifying macadam, screening, depositing, conveyance with all lead and lift, filling the boxes including all labour, tools, equipments and all other incidental expenses.

Rate shall be paid per sq.mt.

Item No. 5 : Excavation for foundation in sand, gravel, clay soft soils and murrum (Soft and Hard) etc. Including shoring, strutting dewatering including pumping as necessary, backfilling the trenches with suitable excavated material in layers of 15 to 20 cms and disposing of the surplus excavated stuff with all leads and lift , preparation of bed for concreting of foundations etc. complete as directed by Engineer and as per specification.

(A) Depth upto 3.0m.

(B) Depth from 3.0m.to 6.0m.

304.1 Scope

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

1. After the site has been cleared the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc. required in connection with the setting out of works and the establishment of bench mark, center line stones and other marks and stakes as long as in the opinion of the Engineer-in-charge, they are required for the work.
2. Excavation shall be taken to the width of the lowest step of the footing. The contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personal and works and to the satisfaction of the Engineer-in-charge.
3. All the excavated materials shall be the property of the Government. Where the excavated materials is to be used in the construction of embankment, it shall be directly deposited at the required location, with all lead.
4. All useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge within all lead. Unsuitable and surplus materials not intended for use shall be disposed of as directed by the Engineer-in-charge.
5. Excavation shall be for ordinary soil such as vegetation or organic soil, turf, sand, silt, loam, clay, mud, black cotton soil, soft shale or soft murrum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, or other ordinary digging equipment. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm. occurring in such strata shall be deemed to be covered under this category. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

6. The relevant specifications given in respective para for earthwork in excavation and back filling shall apply for this item and disposing of and refilling the excavated materials up to All lead as directed.

7. Any damage to the road surface shall be reinstate by contractor by his own cost

MORT&H specifications as in section 304 (5th Revision) (Pg. No-59) shall be followed in connection with this item as mentioned below. All relevant provisions as have been included in the respective IRS and IS specification are also applicable.

Scope

Excavation for structures shall consist of the removal of material for the 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-in-charge. The work shall be include all necessary sheeting, shoring, bracing, draining and pumping and the removal of all logs, stumps, shrubs, and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus material.

Classification of Excavation

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 moorum, 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 moorum or stabilized soil requiring use of pick axe or shovel or both.
- iii) lime concrete, stone masonry and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
- iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

c) Hard Rock (requiring blasting) This shall comprise :

- i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required,
- ii) reinforced cement concrete below ground level and in bridge/ROB/RUB/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 has to be carried out by chiselling, wedging or any other agreed method.

f) Marshy soil

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

Authority for Classification

The classification of excavation shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

Construction Operations

Setting out

After the site has been cleared as per Clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. Clause 109 shall be applicable for the setting out operations.

Excavation

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

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

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

Dewatering and Protection

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

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

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

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

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

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

Preparation of Foundation

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of

excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete as per Clause 2104.1 at the cost of the Contractor. Ordinary filling shall not be permitted to bring the foundation to the design level as shown in the drawing.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M15 upto the top level of rock.

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

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

Slips and Slip-Outs

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

Public Safety

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

Backfilling

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

Disposal of Surplus Excavated Materials

Clause 301.3.11 shall apply.

Measurements for Payment

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

Preparation of rock foundation shall be measured in square metres.

Rates

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

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

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. 6 : Excavation in large boulders and soft rock by welding including shoring, strutting and dewatering as necessary and disposing of the excavated stuff as directed.

➤ **Scope of Work**

This item includes excavation in strata consisting of large boulders, soft rock formations and mixed strata requiring wedging or controlled breaking, carried out to the required lines, levels, slopes and widths as shown on drawings or as directed by the Engineer-in-Charge.

➤ **Method of Excavation**

Excavation shall be carried out by wedging / welding or controlled breaking methods. Blasting shall not be permitted unless specifically approved in writing by the Engineer-in-Charge. Mechanical breakers may be used where permitted. Excavation shall be carried out in stages to maintain stability of sides.

➤ **Shoring, Strutting and Safety**

Proper shoring, strutting, timbering or bracing shall be provided to prevent collapse of sides and to ensure safety of workmen, adjacent structures, roads and utilities. All safety precautions as per statutory regulations shall be followed. No separate payment shall be made for shoring, strutting or safety arrangements.

➤ **Dewatering**

The item includes pumping out of seepage water, rainwater or sub-soil water encountered during excavation. Dewatering shall be continued till completion of excavation and foundation works. Cost of pumps, fuel, labour and maintenance shall be deemed included in the rate.

➤ **Disposal of Excavated Material**

Excavated material shall be reused where permitted or disposed of at approved locations as directed by the Engineer-in-Charge. The rate shall include handling, loading, transportation and disposal within the specified lead and lift. No extra payment shall be admissible for additional handling or disposal.

➤ **Workmanship**

Excavation shall be carried out neatly and accurately to the specified lines and levels. Over-excavation, if any, shall be made good by the contractor at his own cost. The bottom of excavation shall be properly dressed and cleaned before proceeding with subsequent works. All loose fragments and debris shall be removed.

➤ **Mode of Measurement and Payment**

Measurement shall be taken in cubic metres based on the authorized dimensions of excavation. No allowance shall be made for bulking, voids or loose volume.

- The rate shall include excavation in large boulders and soft rock, wedging / welding and breaking operations, shoring and strutting, dewatering, handling, loading, transportation and disposal of excavated material, all labour, tools, plants, machinery, leads, lifts, royalties, taxes and all incidental charges, complete.

Item No. 7 : Providing and laying in situ M-15 grade bedding concrete in foundation / below pile cap including dewatering, shuttering, mixing in mechanised batch mix plant, compacting, curing etc. complete true to level and position as directed by Engineer and as per specification.

MORT&H specifications as in section 1000, 1500 & 1700 shall be followed in connection with this item. All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

1000 Materials

1002 SOURCES OF MATERIALS

The Contractor shall identify the sources of materials like coarse aggregate and fine aggregate and notify the Engineer regarding the proposed sources prior to delivery.

Samples of materials from the source shall be tested in the presence of Engineer for conformity to specifications. It shall also be ensured that the variation in test results of different samples, is within acceptable limits.

For manufactured items like cement, steel reinforcement and pre-stressing strands, the contractor shall intimate the Engineer the details of the source, testing facilities available with the manufacturer and arrangements for transport and storage of material at site. If directed by the Engineer, the contractor shall furnish samples and test results of recently received material. The Engineer, at his discretion, in case of doubt, may require the contractor to test the materials in an independent laboratory approved by the Engineer and furnish test certificates. The cost of these tests shall be borne by the contractor. The sampling and testing procedures shall be as laid down in the relevant Indian Standards and where they are not available, the same shall be carried out as per the directions of the Engineer. Only materials from sources approved by the Engineer shall be brought to the site. If the material from the approved source proves unacceptable at any time, the contractor shall identify new sources of acceptable materials conforming to specifications.

If any proprietary items are proposed to be used in the works, they shall be governed by the provisions of Clause 115.4 of these Specifications.

1006 CEMENT

Cement to be used shall be any of the following types with the prior approval of the Engineer.

- a) Ordinary Portland cement, 33 Grade, conforming to IS:269.
- b) Ordinary Portland cement, 43 Grade, conforming to IS:8112.
- c) Ordinary Portland cement, 53 Grade, conforming to IS:12269.
- d) Sulphate resisting Portland cement, conforming to IS:12330.
- e) Portland Pozzolana cement (fly ash based) conforming to IS:1489 (Part 1)
- f) Portland slag cement conforming to IS:455
- g) Rapid Hardening Portland cement, conforming to IS:8041.
- h) Low heat Portland cement conforming to IS:12600

Cement of 33 grade conforming to IS:269 shall be used only after ensuring that the minimum required

design strength can be achieved without exceeding the maximum permissible cement content of 450 Kg/cum of concrete (excluding any mineral admixture).

Cements of 43 and 53 grades conforming to IS:8112 and IS:12269 respectively may be used provided the minimum cement content mentioned elsewhere from durability considerations, is not reduced.

Sulphate resisting cement conforming to IS:12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS:456 are: sulphate concentration in excess of 0.2 percent in surrounding soil or 300 ppm (0.03 percent) in ground water. Cement conforming to IS:12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 450 kg/cum (excluding any mineral admixture).

Alternatively, Portland slag cement conforming to IS:455 with slag content more than 50 percent can be used instead of sulphate resisting cement when the sulphate content in the surrounding soil is less than 1 percent or the sulphate content in the ground water is less than 2500 ppm.

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

Total chloride content shall be 0.1 percent by mass of cement for the cement to be used in structures other than prestressed concrete structures and 0.05% by mass of cement in prestressed concrete structures. Also, total sulphur content calculated as sulphuric anhydride (SO₃) shall in no case exceed 3.5 percent.

Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C3A content from 5 to 8 percent shall be preferably used in concrete, instead of sulphate resisting cement.

Manufacturer's test certificate shall be submitted to the Engineer by the contractor for every consignment of cement. The certificate shall cover all the tests for chemical requirements, physical requirements and chloride content as per relevant codes as applicable.

Independent tests of samples drawn from the consignment, shall be carried out at the site laboratory or in an independent laboratory approved by the Engineer, immediately after delivery. The following properties shall be tested:

- i) Compressive strength.
- ii) Setting time.

The cost of the tests shall be borne by the Contractor.

Cement in bags in local storage for more than 3 months after completion of tests, may be re-tested for compressive strength and setting times (initial and final) before use and may be rejected if it fails to conform to any of the requirements.

Lot size for independent testing of cement at site shall be the quantity received at site on any day, subject to a maximum of 500 tonnes.

1007 COARSE AGGREGATES

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

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

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

The maximum value for flakiness index for coarse aggregate shall not exceed 35 percent. The coarse aggregate shall satisfy the requirements of grading as given in Table 1000-1:

Table 1000-1 : Grading Requirements of Coarse Aggregate

IS Sieve Size	Percentage Passing for Graded Aggregate of Nominal Size		
	40 mm	20 mm	12.5 mm
63 mm	—	—	—
40 mm	95 – 100	100	—
20 mm	30 – 70	95 – 100	100
12.5 mm	—	—	90 – 100
10 mm	10 – 35	25 – 55	40 – 85
4.75 mm	0 – 5	0 – 10	0 – 10

1008 FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS:2116. Natural sand, crushed stone sand or crushed gravel sand or a suitable combination of natural sand, crushed stone or gravel, shall be used as fine aggregates in plain, reinforced and prestressed concrete works. The fine aggregates shall be dense, durable, clean and free from veins and adherent coating and other deleterious substances. They shall not contain dust, lumps, soft or flaky materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Mechanised sand washing machines should be used to remove impurities from sand. Fine aggregates having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS:383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

Fine aggregate for structural concrete shall conform to the following grading requirements:

Table 1000-2 : Grading Requirements of Fine Aggregates

IS Sieve Size	Percent Passing for		
	Grading Zone I	Grading Zone II	Grading Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

Note : When the grading falls outside the limits of any particular grading zone of sieves other than 600-micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. However for crushed stone sand, the permissible limit on 150-micron IS Sieve is increased to 20 percent. Reference shall be made to Clause: 4.3 of IS:383.

1009 Steel

1009.1 Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS:1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. To increase the corrosion resistance properties, 0.3% to 0.5% copper may be added.

1009.2 Steel for Prestressing

The prestressing steel shall conform to any one of the following standards:

- Plain hard drawn steel wire conforming to IS:1785 (Part I) and IS:1785 (Part II)
- Cold drawn indented wire conforming to IS:6003
- High tensile steel bar conforming to IS:2090
- Uncoated stress relieved strands conforming to IS:6006
- Uncoated stress relieved low relaxation seven ply strand conforming to IS:14268

Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress strain curve etc. shall be obtained from the manufacturer. Pre-stressing steel shall be subjected to acceptance tests prior to actual use in the works.

1009.3 Reinforcement/Untensioned Steel

1009.3.1 Reinforcing Bars

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, the reinforcement/untensioned steel as the case may be, shall consist of the following grades of reinforcing bars.

Table 1000-3 : Grades of Reinforcing Bars

Grade Designation	Bar Type Conforming to Governing Specifications	IS Characteristic Strength f_y MPa	Elastic Modulus GP
Fe240	IS:432 Part I Mild Steel	240	200
Fe 415	IS:1786 High Strength Deformed Steel Bars (HSD)	415	200
Fe 500 or Fe 500D	IS:1786 High Strength Deformed Steel Bars (HSD)	500	200
Fe 550 or Fe 550D	IS:1786 High Strength Deformed Steel Bars (HSD)	550	200
Fe 600	IS:1786 High Strength Deformed Steel Bars (HSD)	600	200

Note : If any grade of steel given in the above table is not available steel of next higher grade may be used.

All steel shall be procured from 'Original producers' who manufacture billets directly from iron ores and roll the billets to produce steel conforming to IS:1786. No re-rolled steel shall be incorporated in the works. However, in case the original producers give certificate that they are unable to supply the steel within the required time period or 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 procured from the original producers. In such cases, the manufacturer'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 results conform to IS:1786 requirements.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bars shall be discarded. Bars with cracked ends 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.

1009.3.2 Coating of Reinforcing Bars

1009.3.2.1 Fusion Bonded Epoxy Coated Reinforcement

Fusion bonded epoxy coated reinforcement shall conform to IS:13620 or other international standards as approved by Engineer. The location of the source of supply of the coated bars shall be such as to ensure that the bars are not transported for a distance of more than 300 Km.

Additional requirements for the use of such reinforcement bars are given below:

- Patch up materials shall be procured in sealed containers with certificates from the agency who has supplied the fusion bonded epoxy bars.
- PVC coated G.I. binding wires of 18G shall only be used in conjunction with fusion bonded epoxy bars.
- Chairs for supporting the reinforcement shall also be of fusion bonded epoxy coated bars.
- The cut ends and damaged portions shall be touched up with repair patch up material.
- The bars shall be cut by saw-cutting and not by flame cutting.
- While bending the bars, the pins of work benches shall be provided with PVC or plastic sleeves.
- The coated steel shall not be directly exposed to sun rays or rains and shall be protected with opaque polyethylene sheets or such other approved materials.
- While concreting, the workmen or trolley shall not move directly on coated bars but shall move only on wooden planks placed on the bars.

1009.3.2.2 Hot Dipped Galvanized Bars

Hot dipped galvanized reinforcing steel shall be provided wherever specified. The coating shall conform to

1009.4 Grey Iron Castings

Grey Iron castings to be used for bearings shall have the following minimum properties:

- i) Minimum ultimate tensile strength 370 MPa
- ii) Modulus of Elasticity 147000 MPa
- iii) Brinell Hardness 230 MPa
- iv) Shear Strength 370 MPa
- v) Compressive Strength 1370 MPa

The testing shall be as specified in IS:210.

1009.5 Steel Forgings

Forged steel pins shall comply with clause 3, 3A or 4 of IS:1875 and steel forgings shall comply with clause 3, 3A or 4 of IS:2004. Raw materials of the forging shall be as per IS:1875 with minimum reduction ratio of 1.8:1. Alternatively, if forging is made from ingot, the minimum reduction ratio shall be 4:1. Forging shall be normalized.

1009.6 Structural Steel

Unless otherwise permitted, all structural steel shall, before fabrication, comply with the requirements of the following Indian Standards:

IS:226 : Structural Steel (Standard Quality)

IS:961 : Structural Steel (High Tensile)

IS:2062 : Weldable Structural Steel

IS:8500 : Weldable Structural Steel (medium and high strength qualities)

IS:1148 : Hot rolled rivet bars (upto 40 mm dia) for structural purposes

IS:1149 : High tensile rivet bars for structural purposes

IS:1161 : Steel tubes for structural purposes

IS:4923 : Hollow Steel sections for structural use

IS:11587 : Structural weather resistant steel

IS:808 : Specifications for Rolled Steel Beam, Channel and Angle Sections

IS:1239 : Mild Steel Tubes

IS:1730 : Dimension for Steel Plate, sheet and strip for structural and general Engineering purposes.

IS:1731 : Dimension for Steel flats for structural and general engineering purposes

IS:1732 : Dimension for round and square steel bars for structural and general engineering purposes.

IS:1852 : Rolling and cutting tolerances for hot rolled steel products The use of structural steel not covered by the above standards may be permitted with the specific approval of the Engineer. Refer to Section 1900 of these Specifications for further details.

1009.7 Stainless Steel

Stainless steel shall be austenitic chromium-nickel steel, possessing rust, acid and heat resistant properties conforming to IS:6603 and IS:6911. Mechanical properties/grade for such stainless steel shall be as specified by the accepting authority, but in no case inferior to mild steel. Generally, stainless steel is available as per AISI grades. AISI 304 which is equivalent to grade 04 Cr 18 Ni 110 of IS:6911 satisfies the requirements for mechanical properties of structural steel. Other grades of stainless steel for specific purposes may be provided as per specific requirements. For application in adverse/corrosive environment, stainless steel shall conform to AISI 316L or 02G17 Ni Mo2 of IS:6911.

1010 WATER

Water used for mixing and curing shall be clean and free from oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. In case of doubt regarding development of strength, the suitability of water proposed to be used for the production of concrete shall be ascertained by carrying out tests for the compressive strength of concrete and initial setting time of cement using the same water.

The sample of water taken for testing shall represent the water proposed to be used for concreting, taking into account seasonal variations, if any. The sample shall not receive any treatment before testing other than that being given to the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used, shall not be less than 90 percent of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS:516.

The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not be more than 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS:4031 (Part 5).

pH value of water shall not be less than 6. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted.

As a guide, the following concentrations represent the maximum permissible values:

- a) To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH. For details of test refer IS:3025(Part 22).
- b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal. H₂SO₄. For details of test refer IS: 3025(Part 23).
- c) The Permissible limit's for solids shall be as follows

	Tested as Per	Permissible Limit max
Organic	IS:3025(Pt.18)	200 mg/lit
Inorganic	IS:3025(Pt.18)	3000 mg/lit
Sulphates (SO ₃)	IS:3025(Pt.28)	400 mg/lit
Chlorides (Cl)	IS:3025(Pt.32)	2000 mg/lit for concrete work not containing embedded steel and 500 mg/lit for prestressed/reinforced concrete work
Suspended matter	IS:3025(Pt.17)	2000 mg/lit

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

1012 CONCRETE ADMIXTURES

1012.1 General

Admixtures may be added to the concrete before or during mixing with a view to modifying one or more of the properties of concrete in the plastic or hardened state.

1012.2 Mineral Admixtures

Any of the following mineral admixtures may be used as part replacement of Portland Cement with the approval of the Engineer.

Fly ash: conforming to of IS:3812-3

Granulated slag: Ground granulated slag obtained by grinding granulated slag conforming to IS:12089.

Silica fume: Silica fume is very fine, non- crystalline SiO₂, obtained as a by-product of Silicon and Ferro – Silicon alloy industries and shall conform to IS:15388

1012.3 Chemical Admixtures

1012.3.1 Information Required from the Manufacturer

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

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

- a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
- b) The chemical names of the main ingredients.
- c) The chloride content, if any, expressed as a percentage by weight of the admixture.
- d) Values of dry material content, ash content and relative density which can be used for Uniformity Tests.
- e) Whether it leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so to what extent.
- f) Confirmation regarding its compatibility with type of cement.
- g) Whether it increases the risk of corrosion of reinforcement or other embedments.
- h) Whether it affects the durability of concrete adversely.

1012.3.2 Physical and Chemical Requirements

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

- a) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixture".
- b) Except where resistance to freezing and thawing and to disruptive action of deicing salts is required, the

air content of freshly mixed concrete in accordance with the pressure method given in IS:1199, shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 percent of the test mix.

c) The chloride content of the admixtures shall not exceed 0.2 percent when tested in accordance with IS:6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 of these Specifications shall also not be exceeded.

d) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times. The tests that shall be performed along with permissible variations are as follows:

i) Dry Material Content : within 3 percent and 5 percent of liquid and solid

ii) Ash content : within 1 percent of the value stated by the manufacturer.

iii) Relative Density (for liquid admixtures) : within 2 percent of the value stated by the manufacturer.

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

1013 REINFORCED AND PRESTRESSED CONCRETE PIPES

Reinforced concrete pipes for highway structures shall be of NP4 type conforming to the requirements of IS:458. Prestressed concrete pipes (NP4) conforming to IS: 784 can also be used depending on the requirement.

1014 STORAGE OF MATERIALS

1014.1 General

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

1014.2 Bricks

Bricks shall not be dumped at site, but shall be stacked in regular tiers as they are unloaded, to minimize breakage and defacement. Bricks selected for use in different situations shall be stacked separately. Sufficient supply of bricks as required for the works, shall be available at site at any time.

1014.3 Aggregates

Aggregate stockpiles may be made on ground that is hard, well drained and devoid of vegetation.

Coarse aggregates, unless otherwise agreed by the Engineer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). In case of aggregates placed directly on the ground the material in the stock pile only up to a level of 30 cm above the ground level shall be taken out and used initially. Remaining material shall be permitted to be used in the final stages of work only after it has been fully cleaned.

1014.4 Cement

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

Cement shall be used in the sequence in which it is delivered at site. Each consignment shall be stored separately so that it may be readily identified and inspected. Any consignment or part of a consignment of cement which has deteriorated in any way during storage, shall not be used in the works and shall be removed from the site by the Contractor at his own cost.

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

The Contractor shall submit a monthly return to the Engineer showing the quantities of cement received and issued during the month and in stock at the end of the month.

1014.5 Reinforcement/Untensioned Steel

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

1014.6 Prestressing Materials

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

a) **Tendons** : Wires, strands and bars from which tendons are to be fabricated shall be stored about 300 mm above the ground in a suitably covered and closed space so as to avoid direct climatic influences and to protect them from splashes from any other materials and from the cutting operation of an oxy-acetylene torch or arc welding process in the vicinity. Under no circumstances shall tendon material be subjected to any welding operation or on site heat treatment or metallic coating such as galvanizing. Storage facilities and the procedures for transporting material into or out of the store, shall be such that the material does not become kinked or notched. Wires or strands shall be stored in large diameter coils which enable the tendons to be laid out straight. As a guide, for wires above 5 mm dia, coils of about 3 m dia without breaks or joints shall be obtained from manufacturer. Protective wrapping for tendons shall be chemically neutral. All prestressing steel must be provided with temporary protection during storage.

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

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

All prestressing steel shall be stored at least 300 mm above ground level and shall be invariably wrapped with a protective covering of tar paper or polythene or any other approved material.

The Contractor should ensure that prestressing steel is used within 3 months of it's manufacture. He should chalk out his prestressing programme in such a manner as to avoid the possibility of initial corrosion before placing in position.

1014.7 Water

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

1015 TESTS AND STANDARD OF ACCEPTANCE

All materials, even though stored in an approved manner shall be subjected to an acceptance test in accordance with the relevant IS specification prior to their immediate use.

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

1015.1 Testing and Approval of Material

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

The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of contract and the relevant specifications. The testing of all the materials shall be carried out by the Engineer for which the shall make all the necessary arrangements and bear the entire cost.

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

1015.2 Sampling of Materials

Samples provided to the Engineer for inspection are to be in labelled boxes suitable for storage.

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

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

1015.3 Rejection of Materials not Conforming to the Specifications.

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

1015.4 Testing and Approval of Plant and Equipment

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

1500 Formwork

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.

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 (i.e. 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 :

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

1512 MEASUREMENTS FOR PAYMENT

Unless stated otherwise, the rate for concrete in plain concrete or reinforced concrete or prestressed concrete, shall be deemed to include all formwork required in accordance with this Section, which shall not be measured separately.

Where it is specifically stipulated in the Contract that the formwork shall be paid for separately, measurement of formwork shall be taken in square metres of the surface area of concrete which is in contact with formwork.

1513 RATE

The unit rate of plain concrete or reinforced concrete or prestressed concrete as defined in respective Sections of these Specifications, shall be deemed to cover the costs of all formwork and staging, including cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.

Where the contract unit rate for formwork is specially provided as a separate item in the contract, it shall include the cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.

1700 STRUCTURAL CONCRETE

1701 DESCRIPTION

The work shall consist of producing, transporting, placing and compacting of structural concrete including

fixing formwork and temporary works etc. 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.

1702 MATERIALS

All materials shall conform to Section 1000 of these 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 percent 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

1) Normal 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 of 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 20 mm Aggregate**

Exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m ³	Minimum Grade of Concrete
Moderate	0.45	340	M25
Severe	0.45	360	M30
Very Severe	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 flyash 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 5 MPa 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 40 mm 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

Note: 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. Water-reducing admixtures (including plasticisers

or super-plasticisers) may 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 requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	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 piling	150 – 200

Notwithstanding the optimum consistency indicated against Sl. 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 Sl. 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 Grade	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
M60	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 test 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 concrete production plant and means of transport employed to make the trial mixes shall be similar to those 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 Adjustment 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 (Litres)	
			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 any other requirements as specified on the drawing or as directed by the Engineer. The overall limits of deleterious substances in concrete shall be as follows:

- 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 severe, very severe or extreme exposure condition) 0.20 percent Reinforced concrete in moderate exposure condition 0.30 percent
- 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 from 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 :

- Nature and source of each material
- Quantities of each material per cubic metre of fully compacted concrete
- Either of the following :
 - 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 requirement (s) as specified.
 - full details of tests on trial mixes.
- 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 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 the 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 weight due to

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 than 5 percent of the total volume of aggregate. Admixtures to increase workability can be added. When pumping long distances and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactorily after adding plasticisers and super plasticisers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

1705 ADMIXTURES

1705.1 Chemical Admixtures

Chemical admixtures such as superplasticisers, 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 superplasticiser for achieving the 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 AGGREGATES

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as given in 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 steining	40
iii) Well cap or Pile Cap Solid type piers and abutments	40
iv) RCC work in girder, 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 individual reinforcements

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

The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces the 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 litres automatic water measuring system and integral weigher (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. Their 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
- ii) Powered hoists minimum 0.5 tonne capacity
- iii) Chutes
- iv) Buckets handled by cranes
- v) Transit truck mixer
- vi) Concrete pump
- vii) Concrete distributor booms
- viii) Belt conveyor
- ix) Cranes with skips
- x) Tremies

c) For Compaction of Concrete :

- i) Internal vibrators size 25 mm to 70 mm
- 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, 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 plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall 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. Aluminium 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, the approval shall have to be obtained again from the Engineer. Concreting 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 rehandling. 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 minimised.

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 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 metres and under no circumstances shall it be more than 2 metres. 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 more than 300 mm in all other cases.

Concrete when deposited shall have temperature of not less than 5°C and preferably not more than 30°C and in no case more than 40°C. In case of site mixing, fresh concrete shall be placed and compacted in its final position within 30 minutes of its discharge from the mixer. When the concrete is carried in properly designed agitator operating continuously, the concrete shall be placed and compacted 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 full depth of the layer being placed and ordinarily shall penetrate the layer below for a few centimetres. 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 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 breakdown. 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 be changed or increased from those shown on the drawings except with the 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.

1711 CONCRETING IN EXTREME WEAT HER

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. Stockpiled 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 litres 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 fly ash 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.

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, m³	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:

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

b) 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 (SO₃) 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. A typical 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.

1718 MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in **cubic metres**. 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 contract 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. 8 : Providing and laying in-situ RCC M-30 grade Controlled Cement Concrete in foundations of piers, abutments, return wall, pile caps etc. including centering, shuttering, mixing in mechanised batch mix plant, compaction, curing and dewatering if necessary, excluding reinforcement as per specification and as directed by Engineer.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per ITEM NO.: 7 and all relevant provisions as have been included in the respective IRC and IS specifications are also applicable

Casting of Foundation should be at a level higher than low water level unless functionally required to be below low water level. In such cases dewatering shall be resorted to allow concreting in dry conditions. Foundations shall be of reinforced concrete. A minimum offset of 150 mm shall be provided beyond the outer faces of the outermost piles in the group. If the Foundation is in contact with earth at the bottom, a levelling course of minimum 80 mm thickness of M 15 nominal mix concrete shall be provided. In marine conditions or areas exposed to the action of harmful chemicals, Foundation shall be protected with a coating such as bituminous based coal tar epoxy or epoxy based coating or with suitable anti corrosive paint. Concrete with high alumina cement, shall not be used in marine environment.

Relevant specifications of plain and reinforced cement concrete shall apply to this item.

1118 MEASUREMENTS FOR PAYMENT

For the Foundation, the quantity of concrete shall be measured in **cubic metres** as per Section 1700 of these Specifications and reinforcement in pile cap shall be measured in tonnes as per Section 1600 of these Specifications.

1119 RATE

The contract unit rate for concrete in pile cap shall cover all costs of labour, materials, tools, plant and equipment, formwork and staging including placing in position, sampling and testing and all as per Section 1700 of these Specifications . Unit rate quoted shall also include the treatment to be given to the

surfaces of the pile cap. Reinforcement in the pile cap shall be paid for separately as per Section 1600 of these Specifications.

Item No. 9 : Providing and laying M-30 grade Controlled cement concrete for cast-in-situ piers, abutments, return wall, staircase, etc. at any height or depth as per approved design and drawings, with necessary centering, shuttering, mixing in mechanised batch mix plant, scaffolding, transporting, placing, compacting by mechanical vibrators, finishing, curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement as directed by Engineer and as per specification.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per ITEM NO.: 8 and all relevant provisions as have been included in the respective IRC and IS specifications are also applicable

2204 PIERS AND ABUTMENTS

2204.1 For concrete piers, horizontal construction joints shall be avoided as far as possible, by pouring the entire required concrete in one operation. Where construction joints are unavoidable, they shall be treated in accordance with Section 1700 of these Specifications or in accordance with special provisions as directed by the Engineer. No vertical construction joint shall be permitted.

Construction joints shall not be permitted in splash zones.

The work shall be strictly in accordance with the drawings or as directed by the Engineer.

2204.2 In case of tall piers and abutments, use of slipform shall be preferred. The design, erection and raising of slipform shall be subject to special specifications which will be furnished by the Contractor. The concrete shall also be subjected to additional specifications as necessary. All specifications and arrangements for use of slipform and placing of concrete therein shall be subjected to the approval of the Engineer.

2204.3 The top surface of foundation/well cap/pile cap over which new concrete is to be laid, shall be scraped with wire brush and all loose materials removed. In case reinforcing bars projecting from foundations are coated with cement slurry, the same shall be removed by tapping, hammering or wire brushing. Care shall be taken to remove all loose materials around reinforcements. Just before commencing masonry or concrete work, the surface shall be thoroughly wetted.

2204.4 In case of solid (non-spill through type) abutments and hollow concrete piers, weep holes as shown on the drawings or as directed by the Engineer, shall be provided in conformity with Clause 2706 of these Specifications.

2204.5 The surface finish shall be smooth, except on the earth face of abutments which shall be rough finished.

2204.6 In case of abutments likely to experience considerable movement on account of earth pressure from backfill of approaches and settlement of foundations, the construction of the abutment shall be followed by filling up of embankment in layers to the full height to allow for the anticipated movement during construction. Casting of superstructure resting on the abutment shall be taken up only thereafter.

2207 TESTS AND STANDARDS OF ACCEPTANCE

2207.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed requirements.

2207.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

2208 TOLERANCES IN CONCRETE ELEMENTS

- a) Variation in cross-sectional dimensions : +10 mm, -5 mm
- b) Misplacement from specified position in plan : 10 mm
- c) Variation of levels at the top : ± 10 mm
- d) Variations of reduced levels of bearing areas : ± 5 mm
- e) Variations from plumb over full height : ± 10 mm
- f) Surface unevenness measured with 3 m straight edge

All surfaces except bearing areas : 5 mm
Bearing areas : 3 mm

2209 MEASUREMENTS FOR PAYMENT

2209.2 Concrete in substructure shall be measured in **cubic metres** in accordance with Section 1700 of these Specifications, based on the quantity ordered or as shown on the drawings. No deduction shall be made for weep holes.

2209.3 Steel in concrete of substructures shall be measured in tonnes, in accordance with Section 1600 of these Specifications, based on the quantity ordered or as shown on the drawings.

2209.4 Weep holes shall be measured as per Section 2700 of these Specifications, based on the numbers provided or as shown on the drawings.

2210 RATE

The contract unit rates for masonry, concrete, reinforcement and weep holes shall include all works as given in respective Sections of these Specifications and cover all incidental items for furnishing and providing substructure as mentioned in these Specifications and shown on the drawings.

The rate is inclusive of all materials, including necessary mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, scaffolding, staging, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required, **including cost of** concrete finish and everything required to execute this item.

Item No. 10 : Providing and laying in situ controlled M-30 grade cement concrete for RCC caps over piers and abutments , staircase ,including necessary scaffolding formwork, centering, mixing in mechanised batch mix plant, transporting, placing, compacting by mechanical vibrators, finishing and curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement, as directed by Engineer and as per specification.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per ITEM NO.: 8 and All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

2200 SUB STRUCTURE

2205 PIER CAP AND ABUTMENT CAP

2205.1 The locations and levels of pier cap, abutment cap, pedestals and bolts for fixing bearings, shall be checked carefully to ensure alignment in accordance with the drawings.

2205.2 The surface of cap shall be finished smooth and shall have a slope for draining off water as shown on the drawings or as directed by the Engineer. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

2206 DIRT WALL, RETURN WALL AND WING WALL

2206.1 In case of cantilever return walls, no construction joint shall be permitted. The dirt wall and cantilever return walls shall be cast in one operation.

2206.2 For gravity type masonry and concrete return and wing wall, the surface of foundation shall be prepared in the same manner as that prescribed for construction of abutment. No horizontal construction joint shall be provided. Vertical construction joint may be provided, if shown on the drawing or as directed by the Engineer.

2206.3 Vertical expansion gap of 20 mm shall be provided in return wall/wing wall at every 10 metre intervals or as directed by the Engineer. The 20 mm gaps shall be filled with suitable type of asphaltic/bituminous board, so as to prevent embankment material from coming out. The cost of such board shall be borne by the Contractor and shall be incidental to the work.

2206.4 For masonry/concrete return walls and wing walls, weep holes shall be provided as prescribed for abutments or as shown on the drawings.

2206.5 The finish of the surface on the earth side shall be rough while that of the front face shall be smooth.

2206.6 Coping for wing wall/return wall in brick masonry/stone masonry shall conform to **Section 1300** of these Specifications.

2207 TESTS AND STANDARDS OF ACCEPTANCE

2207.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed requirements.

2207.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

2208 TOLERANCES IN CONCRETE ELEMENTS

a) Variation in cross-sectional dimensions	: +10 mm, -5 mm
b) Misplacement from specified position in plan	: 10 mm
c) Variation of levels at the top	: ± 10 mm
d) Variations of reduced levels of bearing areas	: ± 5 mm
e) Variations from plumb over full height	: ± 10 mm
f) Surface unevenness measured with 3 m straight edge	
All surfaces except bearing areas	: 5 mm
Bearing areas	: 3 mm

2209 MEASUREMENTS FOR PAYMENT

2209.2 Concrete in substructure shall be measured in cubic metres in accordance with Section 1700 of these Specifications, based on the quantity ordered or as shown on the drawings. No deduction shall be made for weep holes.

2209.3 Steel in concrete of substructures shall be measured in tonnes, in accordance with Section 1600 of these Specifications, based on the quantity ordered or as shown on the drawings.

2209.4 Weep holes shall be measured as per Section 2700 of these Specifications, based on the numbers provided or as shown on the drawings.

2210 RATE

The contract unit rates for masonry, concrete, reinforcement and weep holes shall include all works as given in respective Sections of these Specifications and cover all incidental items for furnishing and providing substructure as mentioned in these Specifications and shown on the drawings.

The rate is inclusive of all materials, including necessary mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, scaffolding, staging, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all

lead and lift with contractor's labour, tools & plants, machineries, as required, **including cost of** concrete finish and everything required to execute this item.

Item No. 11 : Providing and laying in situ controlled M-40 grade cement concrete for RCC pedestals over piers and abutments ,staircase ,including necessary scaffolding formwork, centering, mixing in mechanised batch mix plant, transporting, placing, compacting by mechanical vibrators, finishing and curing and casting, finishing with decorative panel as per drawing etc. complete excluding reinforcement, as directed by Engineer and as per specification.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per ITEM NO.: 8 & 10 and All relevant provisions as have been included in the respective IRC, IS & MoRTH specifications are also applicable.

The measurement shall be on cubic meter of concrete done.

The rate is inclusive of all materials, including necessary mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, scaffolding, staging, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required, **including cost of concrete finish** and everything required to execute this item.

Item No.12 :- Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for piers, abutments, returns and retaining wall including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.

All relevant provisions as have been included in the respective MORT&H clauses, IRC and IS specifications are also applicable.

Steel for reinforcement shall meet the requirements of **Section 1000** of MORT&H Specifications.

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 forholding 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

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 by thoroughly cleaning it using any suitable method such as sand blasting, mechanical wire brushing etc., as directed by the Engineer. Reinforcements shall be stored above the ground in a clean and dry condition, on blocks, racks or platforms 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.

In case of fusion bonded epoxy coated reinforcement or hot dipped galvanized bars used, reference shall be made Clause 1010.3.2 of Section 1000 of MORT&H specifications.

All the HYSD TMT bars shall be coated with **Fusion bonded epoxy coating**.

Bending of Reinforcement

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

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

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

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

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

Placing of Reinforcement

- a) The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcement and casting of concrete, which may result in rust formation on the surface of the bars, shall not be permitted.
- b) Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.
- c) Bars shall be kept in position usually by the following methods:
 - i) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover, shall be placed between the bars and formwork, subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.
 - ii) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed upto a level just below their location.

- iii) Layers of reinforcements shall be separated by spacer bars at approximately one metre 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 reinforcement 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 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 concreting is commenced.

Bar Splices

Lapping

All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, shall be permitted without approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other, and shall be kept apart by 25 mm or 1.25 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.

Welding

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.

While welding may be permitted for mild steel reinforcing bars conforming to IS:432, welding of deformed bars conforming to IS:1786 shall in general be prohibited. Welding may be permitted in case of bars of other than Fe 240 grade including special welding grade of Fe 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.

The method of welding shall conform to IS:2751 and IS:9417, any supplemental specifications 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 overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed.

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

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

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

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

Specimens of welded pieces of reinforcement taken from the site, shall be tested. The number and

frequency of tests shall be as directed by the Engineer.

Mechanical Couplers and Anchorages

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 percent of the characteristic strength of the reinforcement bar.

Anchorage

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 anchorage 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.

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 and placing of reinforcement shall be in accordance with these Specifications and shall be as checked and accepted by the Engineer.

Manufacturer's test certificate regarding compliance with Indian Standards for each lot of steel, shall be obtained and submitted to the Engineer. If required by the Engineer, the Contractor shall carry out confirmatory tests in the presence 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.

MEASUREMENT FOR PAYMENT

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

RATE

The contract unit rate for coated/uncoated reinforcement shall cover the cost of material, royalty, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings and 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.

Item No. 13 : Providing and laying Tar Paper bearing below solid slab as directed by engineer in charge.

2001. DESCRIPTION

This work shall consist of furnishing and fixing tar paper bearings in position in accordance with the details shown on the drawings, to the requirements of these specifications or as directed by the Engineer.

2002. GENERAL

1. Tar paper Bearing plates, bars, rockers, assemblies and other expansion or fixed devices shall be constructed in accordance with the details shown on the drawings.

2. The tar paper bearings may either be supplied directly to the engineer by the manufacturer to be installed by the Contractor or the contractor is to supply and install the bearings as part of the contract. In the former cases, the manufacturer shall be associated with the installation of the bearings to the full satisfaction of the engineer, whereas in the latter case, the contractor shall be solely responsible for the satisfactory supply and installation of the bearing. In the detailed description of the specification, a general reference shall be made to the Contractor or manufacturer and the interpretation shall be as per terms of contract.
3. The contractor shall exercise the utmost care in setting and fixing all tar paper bearings in their correct positions and ensuring that uniformity is obtained on all bearing surfaces.
4. Tar paper Bearings shall be handled with care and stored under cover.
5. When tar paper bearing assemblies or plates are shown on the drawings to be placed (not embedded) directly on concrete, the concrete tar paper bearing area shall be constructed slightly above grade (not exceeding 12 mm) and shall be finished by grinding.
6. It shall be ensured that the tar paper bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. This mortar pads (not exceeding 12 mm) may even be made to meet with this requirement.
7. It shall be ensured that the bottoms of girders to be received on the tar paper bearings are plane at the locations of these tar paper bearings and care shall be taken that the tar paper bearings are not displaced while placing the girders.
8. M. S. bearings sliding on M. S. Plates shall not be permitted. For sliding plate tar paper bearings stainless, steel surface sliding on stainless steel plate with mild steel matrix shall be used. The other option shall be to provide PTFE surface sliding on stainless steel.
9. Some types of tar paper bearings which have been successfully used in various bridges in India have been covered by these specifications. For innovative types of structures or in special cases, special types of tar paper bearings to suit the requirements may have to be provided for which special specifications may be laid down by the Engineer.

The item shall be measured and paid in **Sq.m.** basis of work done.

Item No. 14 :- Providing and applying one coat of zinc-rich epoxy primer and two coats of coal tar epoxy paint of reqd. thickness as per specifications to all concrete surfaces in contact with earth in foundation and substructure including all cost of material, labour, transportation and preparing the surfaces by cleaning, washing, brushing etc. complete

as directed by Engineer and as per specification.(Paint shall be got approved from Engineer).

Patented system of protective coating like epoxy polyurethane painting system, epoxy phenolic protective system and other systems shall be used only with the approval of Engineer after the assessment of the performance of the product, backed by certificates from users, acceptance tests as per published standards, pertinently to cover the material, processes, carbonation resistance, water vapour diffusion property, crack bridging properties, and UV resistance. **The Engineer shall take performance guarantee from the agency responsible for the execution of the work for a minimum period of 5 years.**

1. GENERAL

INTENT

This Section covers the Work of chemically resistant coating to the surfaces of the RCC Work

APPLICATOR

Ensure that all Work is done by a competent applicator licensed and/or approved by the chemically resistant coating material manufacturer. Submit the manufacturer's certification of this approval.

GUARANTEE

Furnish a written guarantee covering the materials and workmanship for a period of 5 years from the date of acceptance of the Work, and be responsible for making good, at your expense, any and all defects due to the failure of the coating materials or workmanship.

Provide completely corrosion resistant work with no leakage through or around the coating.

SUBMITTALS

Submit the proposed materials, schedule of applications and the manufacturer's literature for the materials and the recommended methods of application.

Submit sketches showing standard and special details for the corrosion protection. Submit the manufacturer's approval of the applicator.

Immediately prior to commencing Work in each Area, submit a letter of acceptance for the wall surfaces to be coated, signed by the applicator's authorized representative. Upon acceptance, submit a written guarantee.

2. PRODUCTS

Coating for Application on RCC surfaces (foundations/concrete surfaces) in contact with soil complete.

System Design – Epoxy Tar Based Coating

The coating shall be corrosion resistant coal tar epoxy coating with minimum of 50% solids content. The dry film thickness shall not be less than 200 microns per coat and should be applied in minimum two (2) coats. The cured film shall be tough and abrasion resistant. The Contractor must follow the manufacturer's guidelines for the preparation of surfaces, for mixing and application of coating.

3. EXECUTION

a. General

- Deliver materials to job site in factory sealed containers with manufacturer's identification on each package.
- The Contractor shall store the materials to protect them from damage.

b. Surface Preparation and Inspection

- Clean surfaces of deleterious material in accordance with the manufacturer's recommended practice.
- Prepare surfaces to be coated in accordance with manufacturer's instructions.
- Verify the surfaces are dry. (ASTM D4263)
- Have the coating manufacturer's authorized agent inspect surfaces to be coated and certify in writing to the Engineer-in-Charge that the surfaces are acceptable for the application of the coating. Do not apply the coating until written certification is received by the Engineer-in-Charge.

c. Concrete Repairs

- Chip out damaged concrete to sound concrete.
- Repair rebar if damaged.
- Clean concrete surfaces, dampen and hand place patching concrete in accordance with the pipe manufacturer's recommended practice. Wet cure immediately and as recommended by the manufacturer.

d. Application of Coating

- Confirm to the coating manufacturer's instructions for application.
- Schedule the Work to allow application to be performed in a manner that it conforms to the Manufacturer's recommendations.
- Apply coating only when atmospheric conditions are suitable and as recommended by the Manufacturer.

e. Protection of coating

- Protect the coating from damage.
- Allow to cure before further work or putting the coating into service.

f. Clean-up

- Promptly, as the Work proceeds and upon completion, clean up and remove from the site, rubbish and surplus material resulting from the Work of this Section.

Workmanship

The coating shall be applied in a neat, workmanlike manner, ensuring complete coverage without pinholes, blisters, cracks or holidays. The finished surface shall be uniform in colour and thickness. Any damaged or defective coating noticed during inspection shall be repaired by removing the affected portion and reapplying the coating at the contractor's cost.

Curing and Protection

After application, the coated surface shall be protected from dust, rain, moisture, direct sunlight and mechanical damage during the curing period as recommended by the manufacturer. No backfilling or further construction activity shall be carried out until the coating is fully cured and approved by the Engineer-in-Charge.

Quality Control and Inspection

The Engineer-in-Charge shall have the right to inspect the surface preparation, materials and application at all stages. Measurement of dry film thickness may be carried out using approved gauges. The contractor shall comply with all instructions issued during inspection.

4. RATE

- Relevant technical specifications, methodology, sequence of operation, and required testing specified by manufacturing company for above work shall be applicable to this item.
- **The measurement shall be in Sq.mts.**

The rate for this item includes all cost of material, labour, transportation, Taxes, Scaffolding and preparing the surfaces by cleaning, washing, brushing, sand / grit blasting etc. complete as directed by Engineer and as per specification. (Paint shall be tested from approved laboratory). Testing Certificate from Manufacturer's shall be Obtained.

Item No. 15 : Providing and filling sand behind abutments and between returns in layers as directed.

The filling shall be done as per MORT&H specifications (**5th Revision**) section **3104 & 3107.2** for relevant item and as approved.

1. Materials

- Sand shall be clean, coarse, well-graded river sand or approved sand, free from clay, silt, organic matter, salts, and deleterious materials.
- Sand shall be non-plastic and suitable for backfilling and drainage purposes.
- Material shall be approved by the Engineer-in-Charge (EIC) before use.

2. Scope of Work

The work shall consist of supplying, placing, and filling approved sand behind abutments and between return walls as shown in drawings or as directed by the Engineer-in-Charge. The sand shall be laid in horizontal layers of specified thickness. Each layer shall be uniformly spread, properly watered if required, and compacted to achieve dense and stable backfill. Care shall be taken to avoid damage to the structure, weep holes, drainage arrangements, and waterproofing layers. Filling shall be carried out simultaneously on both sides of the structure wherever applicable to maintain uniform pressure. The top surface shall be dressed to required level and slope.

3. General Workmanship

Sand filling shall be carried out in a systematic manner to prevent segregation and voids. Compaction shall be done using approved mechanical means or rammers as directed. Over-compaction causing displacement of structures shall be avoided. No filling shall be done until structural concrete has attained sufficient strength. Work shall comply with directions of EIC and good engineering practice.

3104 Earth fill

The fill material in the reinforced soil zone shall have drained or effective angle of friction not less than 30° , measured in accordance with IS:2720 (Part 13), by conducting a drained direct shear test. In case the fill material has 25 percent or more particles of 4.75 mm or larger, drained shear test using large shear box may be conducted (IS:2720:Part 39:Section 1). The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15
PI ≤ 6	

Materials with more than 15 percent passing 75 micron sieve, but less than 10 percent of particles smaller than 15 microns are acceptable provided PI is less than 6 and angle of friction is not less than 300° .

Fly ash may be used as fill material in reinforced soil walls provided its angle of internal friction is not less than 300° and PI is less than 6. Gradation requirements need not be completely satisfied. Reference may be made to IRC Guide lines on Use of Flyash in Road Embankments (IRC:SP-58). Fly ash shall also satisfy requirements concerning pH and environmental conditions of the fill vis-à-vis the reinforcement type as specified in Clause 3014.1.

The fill material used in the reinforced soil zone shall be free from organic or other deleterious materials and shall not react adversely (chemically, electrically or biologically) with the reinforcement material and/or facing material.

Properties of fill soil in the reinforced zone, unreinforced zone (or retained/back fill) soil and the foundation soil shall be determined accurately during the construction phase, as per quality assurance plans and directions of Engineer so as to ensure that these are the same as those considered in the design phase.

The fill soil in the unreinforced zone shall conform to the requirements specified in the design.

Environmental Conditions of Fill Steel Reinforcement

Where galvanized steel reinforcement is used, the fill material shall be free draining granular material and shall meet the following requirements as per Table as below,

Recommended Limits of Electrochemical Properties for Reinforced Fills with Steel Reinforcement

Property	Criteria	Test Method
Resistivity	> 3000 ohm-cm	AASHTO T-288
pH	> 5 and < 10	AASHTO T-289
Chlorides	< 100 PPM	ASTM D 4327
Sulphates	< 200 PPM	ASTM D 4327

Geosynthetic Reinforcement

Where geosynthetic reinforcement is used for reinforcing elements manufactured from polyester yarn, pH value of the fill material shall be between 3 and 9, and for reinforcing elements manufactured from PVA, PP and HDPE, the pH value shall be greater than 3.

3107.2 Fill Material

The fill material used as the reinforcing fill in the reinforced soil slope shall meet all the requirements for fill material specified in Clause 3104. However the friction angle of the fill material in this case shall not be less than 28°.

If necessary, then F.M. & Deleterious test shall be carried out as per direction of Engineer-in-charge.

The measurement for payment shall be made on Cum. basis after compaction.

The unit rate includes the cost of materials, labour, watering, ramming, compaction etc. Complete as per specifications and as directed by the engineer in charge

Item No. 16 : Providing and laying 600 mm thick filter media behind abutment as per detailed drawing & specifications etc complete.

- Well graded pebbles/ BT metals or metal of 40 mm to 63 mm size shall be used. The grading and tolerance of metal of pebbles should be as under.

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

The size shall be 40 mm to 63 mm wherein, tolerance limit for oversize shall be up to 15% and that for lower size should be up to 15%. below 20 mm. It shall be tightly placed to a thickness not less than 600 mm and provided over the entire surface behind abutments wings or return walls to the full height.

Filter Medium

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

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

$$\frac{D_{15} \text{ of Filter}}{D_{50} \text{ of Base Material}} < 5$$

$$\frac{D_{85} \text{ of Filter}}{D_{85} \text{ of Base Material}} < 25$$

Materials shall be first stacked in boxes of 2 m x 1.5 m x 0.5 m size on fairly level ground and measured.

The measurement for payment shall be **made on square meter basis**.

The unit rate includes the cost of materials, scaffolding, labour and tools to complete the work.

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, D15 means the size of that sieve which allows 15 percent by weight of the filter material to pass through it and similar is the meaning of D 50 and D 85 (15 being replaced with 50 and 85 respectively).
3. If more than one filter layer is required, the same requirement as above shall be followed for each layer. The finer filter shall be considered as base material for selection of coarser filter.
4. The filter shall be compacted to a firm condition. The thickness of filter is generally of the order of 200 mm to 300 mm. Where filter is provided in two layers, thickness of each layer shall be 600 mm.

Item No. 17 : 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. Materials

- Mild steel dowel bars shall conform to relevant IS specifications (IS 432 or as specified in drawings).
- Steel shall be free from rust, oil, grease, loose mill scale, cracks, and other defects.
- Welding electrodes shall be of approved make and suitable for structural steel welding.
- Binding wire, spacers, and supports shall be of approved quality.

2. Scope of Work

The work shall consist of providing, cutting, bending, positioning, and fixing mild steel dowel bars in pier caps or abutment caps for anchorage at fixed ends as per detailed drawings and as directed by the Engineer-in-Charge. The bars shall be cut and bent to required shape and dimensions. Proper alignment, spacing, and embedment length shall be ensured. Welding, wherever specified, shall be carried out to secure bars firmly in position. Care shall be taken to maintain correct cover and positioning during concreting operations. All bars shall be rigidly fixed to prevent displacement.

3. General Workmanship

Cutting and bending shall be done as per bar bending schedules. Bends shall be

smooth and without cracks. Welding shall be carried out by skilled welders, ensuring strong and continuous joints. Proper supports shall be provided to maintain position during concrete placement. Damaged or improperly placed bars shall be corrected or replaced. Work shall conform to drawings, IS codes, and directions of EIC.

4. Mode of Measurements

- Measurement shall be taken in unit of **Each** (Number) fixed in position.
- Weight shall be calculated based on standard theoretical weight for the diameter of bar as per IS code.
- No separate measurement for cutting, bending, welding, or binding.

5. Payment

- Rate shall include cost of steel, cutting, bending, welding, fixing, binding wire, labour, tools, plants, and all incidental charges.
- Work shall be complete in all respects as per drawings and specifications.
- **Nothing extra shall be paid.**

Item No. 18 : Providing and laying, M-40 grade RCC in-situ or Pre-cast T-Beam Deck slab and Solid Slab type superstructure, deck sheet if required, as per approved drawing and technical specifications, section 1500, 1700 and 2200 of MORTH using 6mm to 20mm machine crushed well graded stone aggregate, sand of approved quality, OPC 53 grade cement with contractor's own concrete mix design etc. complete as per specifications. the rate is inclusive of all materials, Mineral admixtures if required, including necessary mixing in fully automatic batch mix plant, transport, curing, vibrating, ramming, finishing, placing in position, centering, shuttering, scaffolding, staging, formworks, establishing casting yard, transporting using trailer, launching or shifting using crane or any other approved means, making thrust bed, thrust block, gantry, etc all complete. Deshuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required with including cost of finishing equivalent to F3 type exposed concrete and form mark. (Minimum cement content :- 440 kg/cum), (Excluding steel reinforcement)

(A) For various types of RCC type superstructure in M40 grade

1. **MORT&H specifications as in section 1000, 1500, 1700, 2300 (5th Revision) & Item no. 8** shall be followed in connection with this item. All relevant provisions as have been included in the respective IRC and IS a specification are also applicable. Relevant specifications given for pile foundations shall be applicable to this item.
2. **The measurement shall be in Cum, based on geometrical dimensions shown on approved drawing.**

Item No. 19 : Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for super structure including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.

Item specifications mentioned for **Item no.: 12** shall be followed for this item along with relevant MORT&H, IRC & IS guidelines.

The measurement in Metric Tonnes, **The Rate shall be as per 1609 of section 1600 of MORT&H.**

Item No. 20 : Providing and applying one coat Epoxy Phenolic primer of DFT 50 micron and two coats of Epoxy Phenolic coating of DFT 100 microns each or any other equivalent epoxy coating system to all concrete surfaces exposed to atmosphere in Substructure, superstructure etc. all including cost of material, labour, transportation, scaffolding and preparing the surfaces by cleaning, washing, brushing, etc. complete and as directed by Engineer and as per specification. (Paint shall be got approved from Engineer and tested from approved laboratory).

Scope of Work

The work shall consist of preparing concrete surfaces and applying one coat of Epoxy Phenolic primer followed by two coats of Epoxy Phenolic coating or approved equivalent epoxy system on all concrete surfaces of substructure, superstructure, and other components exposed to atmosphere, as shown in drawings or as directed by the Engineer- in-Charge. Surface preparation shall include cleaning, washing, brushing, and removal of dust, laitance, grease, oil, loose particles, and other foreign matter. Surface shall be dry, sound, and free from moisture before application. Primer coat shall be applied uniformly and allowed to cure before application of subsequent coats. Each coat of epoxy coating shall be applied only after the previous coat has properly dried. Application shall be done to achieve the specified dry film thickness and continuous protective layer without pinholes, runs, or holidays. Necessary scaffolding, staging, and access arrangements shall be provided for execution.

1. GENERAL

INTENT

This Section covers the Work of chemically resistant coating to the surfaces of the RCC Work.

APPLICATOR

Ensure that all Work is done by a competent applicator licensed and/or approved by the chemically resistant coating material manufacturer. Submit the manufacturer's certification of this approval.

GUARANTEE

Furnish a written guarantee covering the materials and workmanship for a period of 5 years from the date of acceptance of the Work, and be responsible for making good, at your expense, any and all defects due to the failure of the coating materials or workmanship.

Provide completely corrosion resistant work with no leakage through or around the coating.

SUBMITTALS

Submit the proposed materials, schedule of applications and the manufacturer's literature for the materials and the recommended methods of application.

Submit sketches showing standard and special details for the corrosion protection. Submit the manufacturer's approval of the applicator.

Immediately prior to commencing Work in each Area, submit a letter of acceptance for the wall surfaces to be coated, signed by the applicator's authorized representative. Upon acceptance, submit a written guarantee.

4. PRODUCTS

System Design – one coat Epoxy Phenolic primer of DFT 50 micron and two coats of Epoxy Phenolic coating of DFT 100 microns each or any other equivalent epoxy coating system to all concrete surfaces

The coating shall be corrosion resistant coal tar epoxy coating with minimum of 50% solids content. The dry film thickness shall not be less than 100 microns per coat or as directed and should be applied in minimum two (2) coats or as per Manufacturer specification & directed by engineer in charge.. The cured film shall be tough and abrasion resistant.

The Contractor must follow the manufacturer's guidelines for the preparation of surfaces, for mixing and application of coating.

1. EXECUTION

g. General

- Deliver materials to job site in factory sealed containers with manufacturer's identification on each package.
- The Contractor shall store the materials to protect them from damage.

h. Surface Preparation and Inspection

SURFACE PREPARATION: All surfaces shall be free from oil, grease, friable matter and general curing compounds (wax based curing membranes shall not be used in areas to be over coated). Concrete surfaces shall be cleaned using Wire Brush & if require high pressure water jetting, grit blasting or other methods approved by the Engineer. All Honey Combing should be repaired with Fiber Reinforced M-40 Grade Patch Repair Mortar .

- Clean surfaces of deleterious material in accordance with the manufacturer's recommended practice.
- Prepare surfaces to be coated in accordance with manufacturer's instructions.
- Verify the surfaces are dry. (ASTM D4263)
- Have the coating manufacturer's authorized agent inspect surfaces to be coated and certify in writing to the Engineer-in-Charge that the surfaces are acceptable for the application of the coating. Do not apply the coating until written certification is received by the Engineer-in-Charge.

i. Concrete Repairs

- Chip out damaged concrete to sound concrete.
- Repair rebar if damaged.
- Clean concrete surfaces, dampen and hand place patching concrete in accordance with the pipe manufacturer's recommended practice. Wet cure immediately and as recommended by the manufacturer.

j. Application of Coating

- Confirm to the coating manufacturer's instructions for application.
- Schedule the Work to allow application to be performed in a manner that it conforms to the Manufacturer's recommendations.
- Apply coating only when atmospheric conditions are suitable and as recommended by the Manufacturer.

k. Protection of coating

- Protect the coating from damage.
- Allow to cure before further work or putting the coating into service.

l. Clean-up

- Promptly, as the Work proceeds and upon completion, clean up and remove from the site, rubbish and surplus material resulting from the Work of this Section.

2. RATE

- **The measurement shall in Sq. m basis.**
- The rate includes labour, material, equipment as per specification and as directed by the engineer including all lead and lifts etc. complete.

Item No. 21 : Providing and carrying out load test on bridge deck with simulated loading including provision, placing and removal of loading, supplying, fixing and removing deflection measuring instruments etc. complete with platforms for fixing the instruments etc. complete as per the details supplied and specification and as directed by Engineer and including submission of required results in triplicate after satisfactory completion of the load test.

Load testing shall be based on IRC special publication No. 51 for equivalent static Designed live load including impact. This will include providing necessary dial gauges of required least count, a rigid independent staging for dial gauges, a safe and stable independent platform for observers with all necessary ancillaries and thermometers for noting surrounding temperature.

1. Materials & Equipment

- Test loads shall consist of calibrated vehicles, water tanks, sand bags, concrete blocks, or other approved loading arrangement to simulate design load conditions.
- Deflection measuring instruments such as dial gauges, digital displacement gauges, LVDTs, total station, leveling instruments or equivalent devices of required sensitivity shall be used.
- Measuring instruments shall be properly calibrated prior to testing.
- Platforms, staging, and supports for fixing instruments shall be rigid and stable.
- All materials required for loading arrangement and measurement shall be arranged by the contractor.

2. Scope of Work

The work shall consist of conducting load testing on the completed bridge deck to assess structural performance under simulated loading as per approved drawings, IRC/MoRTH specifications, and directions of the Engineer-in-Charge. The contractor shall design the loading arrangement to produce required test loads and critical loading positions. Necessary platforms, staging, and arrangements for installation of instruments shall be provided. Instruments shall be fixed at specified locations to measure deflection, settlement, rotation, or any other parameter as directed. Load shall be applied in stages and maintained for specified duration while observations are recorded. After completion of test observations, loads shall be removed carefully. The contractor shall record readings during loading, sustained loading, and unloading stages. All precautions shall be taken to ensure safety of structure, personnel, and equipment during testing.

3. General Workmanship

Testing shall be carried out under supervision of qualified engineers and technical personnel experienced in structural load testing. All measuring instruments shall be handled carefully and installed securely. Test procedure shall follow relevant codes and approved methodology. Any damage to structure during testing shall be rectified at contractor's cost. Testing shall be conducted only after approval from Engineer-in-

Charge.

1. Loading and unloading in stages the static load in the form of sand bags (weighed to confirm the actual weight) or P.C. concrete blocks placed on the deck in marked area of required length and breadth as directed by Engineer-in-charge.
2. **The payment shall be in M.T. for test load only.**
3. If the results of the load test are not satisfactory in the opinion of Engineer in charge, he shall instruct that the part of the structure concern shall be taken down and reconstructed to his satisfaction or that other remedial measures shall be taken to make the structure secure and strong as per requirements at the contractor own risk and cost.
4. The rate for this item shall include cost of all materials labour, machinery, plants gauges, jacks, everything required for conducting the test and submitting reports of the tests.

Item No. 22 :- Providing and casting RCC Crash Barrier /RCC Crash barrier with Friction slab / Central Verge /Medium in M-40 controlled concrete with cast-in- situ or precast members as per detailed drawings including necessary scaffolding, centering, formwork, mixing in mechanised batch mix plant, transporting, placing, compacting, finishing, curing, etc. complete including providing and fixing of inserts if any with all leads and lifts as per drawing & specification and as directed by Engineer, excluding reinforcement.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per ITEM NO.: 8 and All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

2703 RAILING AND CRASH BARRIER

2703.1 General

- a) Bridge railing/crash barrier includes the portion of the structure erected on and above the kerb.
- b) Railing/crash barrier shall not be constructed until the centering false work for the span has been released and the span is self-supporting.
- c) For concrete with steel reinforcement, specifications for the items of controlled concrete and reinforcement mentioned under relevant Sections of these Specifications shall be applicable.
- d) The railing/crash barrier shall be carefully erected true to line and grade. Posts shall be vertical with a tolerance not exceeding 6 mm in 3 m. The pockets left for posts shall be filled with non-shrink mortar.
- e) The type of railing/crash barrier to be constructed shall be as shown on the drawings and shall conform to IRC:5 and IRC:6.
- f) Care shall be exercised in assembling expansion joints in the railing/crash barrier to ensure that they function properly.
- g) The railing/crash barrier shall be of such design as to be amenable to quick repairs.
- h) The material of metal railing/crash barrier shall be handled and stored with care, so that it remains clean and free from damage. Railing/crash barrier materials shall be stored above the ground on platforms, skids, or other supports and kept free from grease, dirt and other contaminants.

Any material which is lost, stolen or damaged after delivery shall be replaced or repaired by the Contractor. Methods of repairs shall be such that they do not damage the material or protective coating.

2703.3 Cast In-Situ Concrete Railing/Crash Barrier

The portion of the railing/crash barrier or parapet which is to be cast in-situ shall be constructed in accordance

with the requirements for Structural Concrete Section and reinforcement conforming to Sections 1600 and 1700 of these Specifications.

Forms shall be fabricated conforming to the shape of railing/crash barrier shown on the drawings. It shall be ensured that no form joint appears on plane surfaces. For bridges/viaducts of length more than 500 m horizontal slip forms shall be used for casting of crash barriers.

All mouldings, panel work and bevel strips shall be constructed according to the details shown on the drawings. All corners in the finished work shall be true, sharp and clean-cut and shall be free from cracks, spalls or other defects. Castings of posts shall be done in single pour.

The measurement shall be **in cubic meter of concrete done**.

The rate for this item includes all materials, labour, plants and everything required to execute this item.

Item No. 23 : Type - A, "W" : 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 galvanised by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150 x 75 x 5 mm, 330 mm long complete as per clause 811)

811.3 Metal Beam Crash Barrier

811.3.1 Materials

Metal beam rail shall be corrugated sheet steel beams of the class, type, section and thickness indicated on the drawings. Railing posts shall be made of steel of the section, weight and length as shown on the drawings. All complete steel rail elements, terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized. All elements of the railing shall be free from abrasions, rough or sharp edges and shall not be kinked, twisted or bent.

The "W" beam type safety barrier shall consist of a steel post and a 3 mm thick "W" beam rail element. The steel post and the blocking out spacer shall both be channel section of 75 mm x150 mm & size 5 mm thick. The rail shall be 70 cm above the ground level and posts shall be spaced 2 m center-to-center. Double "W" beam barrier shall be as indicated in IRC:5 (Latest revision).

The thrie beam safety barrier shall have posts and spacers similar to the ones mentioned above for "W" beam type. The rail shall be placed at 85 cm above the ground level.

The "W" beam, the thrie beam, the posts, spacers and fasteners for steel barriers shall be galvanized by hot dip process (zinc coated, 0.55 kg per square metre; minimum single spot) unless otherwise specified. The galvanizing on all other steel parts shall conform to the relevant IS Specifications. All fittings (bolts, nuts, washers) shall conform to the IS:1367 and IS:1364. All galvanizing shall be done after fabrication.

Concrete for bedding and anchor assembly shall conform to Section 1700 of these Specifications.

811.3.2 Construction Operations

The line and grade of railing shall be true to that shown on the plans. The railing shall be carefully adjusted prior to fixing in place, to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

Unless otherwise specified on the drawing, railing steel posts shall be given one shop coat of paint (primer) and three coats of paint on structural steel after erection, if the sections are not galvanized. Any part of assembly below ground shall be painted with three coats of red lead paint.

Splices and end connections shall be of the type and designs specified or shown on the plans and shall be

of such strength as to develop full design strength of the rail elements.

811.3.3 Installation of Posts

Holes shall be dug or drilled to the depth indicated on the plans or posts may be driven by approved methods and equipment, provided these are erected in proper position and are free from distortion and burring or any other damage.

All post holes that are dug or drilled shall of such size as will permit proper setting of the posts and allow sufficient room for backfilling and tapping.

Holes shall be backfilled with selected earth or stable materials in layers not exceeding 100 mm thickness and each layer shall be thoroughly tamped and rammed. When backfilling and tamping are completed, the posts or anchors shall be held securely in place.

Post holes that are drilled in rock and holes for anchor posts shall be backfilled with concrete.

Posts for metal beam guardrail on bridges shall be bolted to the structure as detailed on the plans. The anchor bolts shall be set to proper location and elevation with templates and carefully checked.

811.3.4 Erection

All guard rail anchors shall be set and attachments made and placed as indicated on the plans or as directed by the Engineer.

All bolts or clips used for fastening the guardrail 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.

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

811.3.5 End Treatment for Steel Barrier

End treatments shall form an integral part of safety barriers which should not spear, vault or roll a vehicle for head-on or angled impacts. The two end treatments recommended for steel barriers are "Turned-down-guardrail" and "Anchored in back slope", as shown on the drawings or as directed by the Engineer.

811.3.6 Tolerance

The posts shall be vertical with a tolerance not exceeding 6 mm in a length of 3 m. The railing barrier shall be erected true to line and grade.

811.3.7 Measurements for Payment

Metal beam railing barriers will be measured by linear metre of completed length as per plans and accepted in place. Terminals/anchors of various types shall be paid for by numbers.

Furnishing and placing anchor bolts and/or devices for guard rail posts on bridges shall be considered incidental to the construction and the costs thereof shall be included in the price for other items of construction.

No measurement for payment will be made for excavation or backfilling performed in connection with this construction.

811.3.8 Rate

The Contract unit rate shall include full compensation for furnishing of labour, materials, tools, equipments and incidental costs necessary for doing all the work involved in constructing the metal beam railing barrier complete in place in all respects as per these Specifications.

Measurements shall be given on Running Meter provided.

Item No. 24 : Providing and casting insitu controlled cement concrete M-40 in Wearing Coat using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, scaffolding, staging, etc. complete, placing in position, vibrating, curing, tamping, deshuttering filling in joints with bitumen with all contractor's materials (except steel

reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.

For controlled concrete, design of the mix shall be approved after preliminary tests and all is attained and maintained. The controlled concrete shall be in eight grades designated as M-100, M-150, M-200, M-250, M-350 M-400 and M-450 with the suffix controlled' added to it.

Grade of Concrete **Compressive works test strength in kg/cm² 20mm 150 mm. cubes, conducted in accordance with IS.: 516**

	Min. at 7 days	Min. at 28 days
M 100	70	100
M 150	100	150
M 200	135	200
M 250	170	250
M 300	200	300
M 350	235	350
M 400	270	400
M 450	300	450

2. In the designation of concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubes compressive strength of that mix on 150 mm. cubes, expressed in kg/cm² where ordinary Portland cement conforming to IS : 269 or Portland blast furnace cement Conforming to IS: 455 is used, the compressive strength requirements for various grades of concrete shall be as given below on the next page :-

NOTE :- In all cases the in all cases, the 28 days compressive strength specified in the above Table shall along be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above Table such concrete shall be classified for all purposes as concrete belonging to the lower or the two grades between which its strength lies.

3. Concrete mix shall be designed on the basis of preliminary test so as attain a strength at least 33 per cent higher than that required on work tests. The proportions for ingredients chose shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the mean available, Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by containing the coarse aggregates in different sizes and bleding them in the right proportions as required aggregates of different sizes shall be stocked in separate stock piles. Required quantity of material shall be stock piled several hours, preferable a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in preliminary tests.
4. In proportioning concrete, the quantity of both cement and aggregate shall be determined reasonable number of bags shall be weighed separately to check the net

weight. Where cement is weighted from bulk stocks at site and not by bags 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 in a clean, and serviceable condition. Their accuracy shall be periodically checked.

5. It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS L 2386 (part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 210 kg. per cubic meter in plain concrete and not less than 300 kg/per cubic meter in reinforced concrete structural members. The minimum quantity of cement for pre-stressed concrete work shall not be less than 360 kg/per cubic meter of concrete nor shall it be more than 540 kg/per cubic meter of concrete.
6. Following shall be the maximum nominal size of coarse aggregate for the different items of work.

No.	Item of Construction	Max nominal size of coarse aggregate
1	RCC well curb, well steining	40 mm
2	Well cap solid type piers	63 mm
3	Abutment, wing wall, pier cap	40
4	RCC in cross girder, deck slab, wearing coarse, kerb, approach slab	20 mm
5	RCC pearing	As specified on drawing or as desired by Engineer in charge.
6	For any other item not covered in 1 to 5	-- do --

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.

7. Fine aggregate shall be clean, hard, coarse sand. It shall be free dust and such other substances. The sand shall be approved by the Engineer-in-charge.
8. All materials shall be stored as to prevent deterioration 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.
9. Cement shall be stored above the ground level in perfectly dry and watertight 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 aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse intermixing the materials.
10. The water for mixing shall be potable water to the satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required

workability for the job.

11. 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 uniform colour of the entire mass is obtained and each individual particle of the 'coarse aggregate shows complete coating of .mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.
12. Mixer which have been out of use 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 enhancing from one type of cement to another.
13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be transported and placed that no contamination, segregation or loss of its constituent materials takes place. 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 then shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within 3 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 vibrator are used not exceeding 0.30 meter in all other cases.
15. Unless otherwise agreed to be Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 meters. When trunking 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 wet surface with wire or bristle brushes care being taken to *avoid* dislodgment of particles of coarse aggregate. The surface shall then be throughout wetted all free water *removed* and then coated with neat cement grout. The first layers of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old particular attention being given to corners and close sports.
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 concreting under water, where vibrators can not be used. Sufficient *vibrator* 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 drying 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. Formwork shall however be delivered into following two district categories :-

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

Forms for shuttering shall be constructed only, in metal suitably lined. Forms for scaffolding construction and shuttering shall be true to shape and dimensions show on the drawings. All bolts and reverts shall be counter-suck 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 the ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure, ramming and vibration without deflection from the prescribed .lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing con concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to counteract the effects of any deflection. The formwork shall be so 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 provide at all angles of formwork to *avoid* sharp corners.
- 20 The inside surface of shuttering shall; except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge be coated with an approved materials to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacture's Instructions and shall not be allowed to come into contact with any reinforcement or pre-stressing tendons and anchorages. Different release agent shall not be used in form work for concrete which will be visible' in the finished works.
21. Special measure shall be taken to ensure that the form does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangement 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 tendons. The formwork should take due account of the calculated amount of positive or negative camber so also ensure the correct final shape of the structure having regard to the deformation due of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre-stressed structures. Where they are re-entrain angles in the concrete sections the form work 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. Form work shall be tight enough to prevent any appreciable loss of cement during vibrations Suitable tolerance should be provided in the formwork. Immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the engineer-in-charge due notice

before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment and general fitness but such inspection shall not relieve the contractor of his responsibility for safety of 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 that influence the setting of concrete and of concrete and of the materials used in the mix. Where curing operations are controlled by strength tests of concrete the removal of the load supporting of soffit forms may commence when concrete has attained strengthening props including the effect of any further additional loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and wall may be removed after 2 days, Tile 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 be cleaned and made good to the satisfaction of the Engineer-in-charge.
23. Immediately after the removal of forms, all exposed parts or bolts passing through the 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, honeycomb 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 aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets/ honey-combs, in the opinion of the Engineer-in-charge are of such an extent or character as to effect 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 test. Following slump shall be adopted for different types of works.

	Type of Work	Slump where vibrator is used	Slump where vibrator is not used
1	Mass conc. In RCC, foundation footing and retaining wall	10 to 25 mm	80 mm
2	Beam slab and column with simply reinforced	25 to 40 mm	100 to 120 mm

3	Thin RCC section or congested steel	40 to 50 mm	125 to 150 mm
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25. For controlled concrete preliminary tests shall consist of three sets of separate tests and in each set, tests shall be conducted on six specimens, Not more than one set of six specimens shall be made on any particular day of the six specimens in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. Work strength tests shall be made in accordance with IS : 516. EACH test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and, cubes shall be made at the rate of one for every 5 cubic meter of concrete or a part thereof. However if concreting done in a day is than 15 cubic meter, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out when ever the quality and grading of materials is changed irrespective of the quantity of concrete poured, The number of specimens may be suitable increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.
26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength. 20 per cent of the cubes cast each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.
27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in- charge. One carpenter with helper will invariably be kept throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position as not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Asstt. Engineer/Addl. Asstt. Engineer/Overseer or as instructed by the Engineer-in-charge, After removal of 'form work and suturing, the executive Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.
28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the been 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 CuMt. basis of the finished work.**
31. The unit rate for concrete shall include the cost of all materials, labour, tools and plant required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making -fixing and removing of all centers and forms required for the work.

Item No. 25 : Providing and laying precast RCC Footpath Slab in controlled cement concrete of M-30 grade (minimum 70 mm thickness) including necessary reinforcement and providing and setting cement chequered tiles in CM 1:5 as per drawing including necessary formwork, curing and finishing complete.

1. Materials

- Cement concrete shall be **Controlled Concrete of Grade M-30** conforming to relevant IRC/MoRTH specifications.
- Cement shall be OPC/PPC of approved make.
- Fine and coarse aggregates shall be clean, hard, durable, and graded as per specifications.
- Reinforcement steel shall be HYSD/TMT bars of approved grade conforming to relevant IS codes.
- Precast slab thickness shall be **minimum 70 mm** or as shown in drawings.
- Cement mortar for fixing tiles shall be in proportion **1:5 (1 Cement : 5 Sand)** using clean sand.
- Cement chequered tiles shall be of approved quality, size, pattern, and thickness as per drawings.
- Water used shall be clean and potable.

2. Scope of Work

The work under this item shall comprise casting, supplying, transporting, and laying precast RCC footpath slabs of M-30 grade controlled cement concrete of minimum 70 mm thickness with required reinforcement, and fixing cement chequered tiles over the same, complete in all respects as per approved drawings and directions of the Engineer-in-Charge (EIC). The contractor shall establish an approved casting yard with proper platform, curing arrangements, storage space, and quality control system. Concrete shall be produced in a mechanised batching and mixing system to ensure uniform quality and strength. Reinforcement shall be cut, bent, and placed as per bar bending schedule ensuring proper cover and spacing. Formwork shall be rigid, leak-proof, and of correct dimensions to produce slabs of accurate size and shape.

After casting, slabs shall be properly vibrated, finished, marked, and cured for the specified period. Only slabs achieving required strength and free from cracks, honeycombing, or defects shall be accepted for use. The contractor shall arrange safe loading, transportation, unloading, stacking, and handling of slabs without damage.

At site, the base shall be prepared true to line, level, camber, and gradient. Slabs shall be laid in correct alignment and slope to facilitate drainage. Cement chequered tiles of approved pattern shall be fixed over the slabs in cement mortar 1:5, properly pressed, aligned, and jointed. Joints shall be uniform and finished neatly. The work includes curing, surface finishing, cleaning, and protection of finished work until handover.

The item includes all labour, materials, tools, plants, lifting equipment, scaffolding if required, curing, transportation, and incidental works necessary to complete the footpath as a finished unit.

3. General Workmanship

All works shall be carried out by skilled labour under qualified supervision and in accordance with IRC/MoRTH specifications and directions of the EIC. Materials shall be of approved quality and tested where required. Reinforcement shall be free from rust, oil, and loose scale and properly tied to prevent displacement during concreting. Adequate concrete cover shall be maintained using cover blocks.

Concrete shall be machine mixed in controlled proportions and compacted using mechanical vibrators to achieve dense and homogeneous concrete. Hand mixing shall not be permitted unless specifically approved. Surface of precast slabs shall be smooth, true, and free from cracks, segregation, or honeycombing. Defective slabs shall be rejected.

Tiles shall be soaked if required and laid on fresh mortar bed with proper tapping to achieve full contact. Surface shall be even, non-slippery, and properly finished. All edges shall be straight and joints shall be flush and well filled. Curing of slabs and tiled surface shall be carried out for at least 7 days or as specified.

Finished surface shall conform to required line, level, cross fall, and gradient. Any damaged or uneven portion shall be removed and replaced at contractor's cost. The contractor shall ensure protection of finished work from traffic or damage until final acceptance.

4. Mode of Measurement and Payment

- Measurement shall be made in **Square Metres (Sq.M.)** of finished footpath surface.
- Measurement shall include RCC slab, reinforcement, and chequered tiles.
- No separate measurement for formwork, curing, transportation, or mortar bedding.
- Rate shall include cost of materials, reinforcement, casting, curing, transportation, laying, tile fixing, labour, tools and plants, and all incidental charges.
- Work shall be complete in all respects as per drawings and specifications.
- **Nothing extra shall be paid.**

Item No. 26 : Providing and casting insitu controlled cement concrete M-30 in RCC Approach Slab using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, scaffolding, staging, etc. complete, placing in position, vibrating, curing, deshuttering, fixing inserts, pockets wherever necessary with all contractor's materials (except steel reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.

MORT&H specifications for materials, Formwork and Structural concrete shall be followed and as per **ITEM NO.: 8** and All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

2704 APPROACH SLAB

Reinforced concrete approach slab with 12 mm dia bars at 150 mm c/c in each direction both at top and bottom in M30 grade of concrete covering the entire width of the roadway, shall be provided as per details given on the drawings or as approved by the Engineer. Minimum length of approach slab shall be 3.5 m and minimum thickness 300 mm.

The cement concrete and reinforcement shall conform to Sections 1700 and 1600 respectively of these Specifications.

The approach slab shall rest on a base of 150 mm thick M15 grade concrete or as shown on the drawings or as directed by the Engineer.

The measurement shall be on the basis of cubic meter of concrete.

The rate includes all required materials, labour, equipments, plants formwork, staging etc. required to carry out this item .

Curing to be made by creating /making cement mortar vata, curing pond size not more than 2.0 sqmt

Item No. 27 : Providing and casting insitu controlled cement concrete M-25 in RCC Railing and Parapet using 6 to 20 mm size coarse aggregates, to the required section at any height or depth including necessary shuttering, staging, etc. complete, placing in position, vibrating, curing, deshuttering, fixing embedments, inserts, pockets wherever necessary with all contractor's materials (except steel reinforcement), labour, tools and plants, etc. as directed and as per drawings and specifications and special conditions of contract.

MORT&H specifications for materials, Formwork and Structural concrete shall be as per **ITEM NO.: 8** and All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

The measurement shall be given on running metre basis.

The rate includes all materials, labour, equipment, plant, transportation etc. to execute this item.

Item No. 28 : Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for super structure including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.

The work shall be executed as per specification of Item No. 19 except for the item is work of Providing and placing in position High Yield Strength Deformed (HYSD) bars reinforcement (TMT Fe 550D grade) with fusion bonded epoxy coating conforming to IS 1786 of all categories for super structure including cutting, bending, hooking and tying with 18 gauge mild steel binding wires, supporting in position to ensure lines and levels during concreting, maintaining proper cover / spacing etc. complete as per specification and detailed drawing.

Item No. 29 : Providing and applying one Primer Coat and two coats of Synthetic Enamel Paint on Anticrash Barrier and Median Verge surface area exposed to Atmosphere in superstructure including making of strip of two colours including cost of material, labour, transportation, scaffolding and preparing the surfaces by cleaning, washing, brushing, sand / grit blasting etc. complete and as directed by Engineer and as per specification.

1. Materials

- Primer shall be metal/concrete compatible primer of approved make suitable for exterior atmospheric exposure.
- Synthetic enamel paint shall be high-quality, weather-resistant, glossy finish paint of approved brand and shade.
- Paint shall be suitable for bridge superstructure exposure conditions and durable against moisture and sunlight.
- Thinners, solvents, and cleaning agents shall be as recommended by manufacturer.
- Two distinct colours shall be used for strip marking as per drawings or directions of Engineer-in-Charge (EIC).
- All materials shall be approved by EIC prior to use.

2. Scope of Work

The work shall consist of preparing surfaces of anti-crash barrier, median verge, and other specified superstructure elements exposed to atmosphere, and applying one primer coat followed by two coats of synthetic enamel paint. Surface preparation shall include removal of dust, dirt, laitance, grease, oil, rust, old loose paint, and other foreign materials by brushing, washing, scraping, and sand or grit blasting wherever required to obtain a clean and sound surface.

Primer coat shall be applied uniformly over the prepared surface and allowed to dry thoroughly. Subsequent coats of synthetic enamel paint shall be applied after proper drying of previous coat to achieve smooth, even, and uniform finish of required thickness. Strips of two colours shall be marked in straight lines of specified width and pattern on barriers/median as per drawings. Necessary scaffolding, staging, platforms, and access arrangements shall be provided for execution at any height. Work shall include protection of adjoining surfaces and cleaning after completion.

3. General Workmanship

Painting shall be carried out by skilled painters under proper supervision and strictly as per manufacturer's instructions. Surface shall be dry and free from moisture before painting. Each coat shall be applied uniformly without sagging, streaking, or brush marks. Required drying time between coats shall be maintained. Finished surface shall be smooth, glossy, and free from defects such as blistering, peeling, or patchiness. Damaged or unsatisfactory portions shall be redone at contractor's cost.

4. Mode of Measurement and Payment

- Measurement shall be made in **Square Metres (Sq.M.)** of painted surface area.
- Measurement shall be based on net area actually painted.
- No separate measurement for surface preparation, scaffolding, colour striping, or multiple coats.
- Rate shall include cost of primer, paint, surface preparation, labour, scaffolding, tools and plants, transportation, strip marking, cleaning, and all incidental charges.
- Work shall be complete in all respects and approved by EIC.
- Nothing extra shall be paid.

Item No. 30 :- Painting two coats (Excluding priming coat) on new steel and other metal surface with synthetic enamel paint , brushing to give an even shade including cleaning surface of all dirt, dust and other foreign matter.

1.0 Materials

The enamel paint shall conform to M-44 B.

2.0 Workmanship

- 2.1. General : The materials required for work of painting work shall be obtained directly from approved manufactures or approved dealer and brought to the site in maker's drums; kegs. etc. with seal unbroken.
- 2.1.2. All materials not in actual use shall be kept properly protected, lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become state or flat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in smaller container. No left over paint shall be put back into stock tins. When not in use the containers shall be kept properly closed.
- 2.1.3. If for any reasons, things is necessary, the brand of thinner recommended by the manufacturer shall be used.
- 2.1.4. The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No painting on exterior or other exposed part o the work shall be carried out in wet, damp or otherwise unfavorable weather and all the surfaces shall be thoroughly dry before painting work is started.

2.2. Application of paint:

- 2.2.1. Brushing operations are to be adjusted to the spreading capacity advised by the manufacture of particular paint. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the -laying off is finished. The full process of crossing and laying off will

constitute one coat.

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

3.0 Mode of measurements and payment

- 3.1. The relevant specifications shall be followed for mode of measurements and payment. The rate is excluding priming coat.
- 3.2. The rate shall be for a unit of **one Sq. meter**.

Item No. 31 :- Providing and fixing 100 mm dia. G.I. Drainage spouts, as per MOST Drg. No. SD/303 including grating with suitable clean out fixtures including all leads and lifts etc. complete as per specification, design & drawings and as directed by Engineer.

2705 DRAINAGE SPOUTS

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

2705.1 Fabrication

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

2705.2 Placement

The galvanised assembly shall be given two coats of bituminous paint before placement. The whole assembly shall be placed in true position, lines and levels as shown on the drawings with necessary cut-outs 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.

Measurement shall be per number of water spout fixed.

Unit rate includes cost of all materials, labour and tools to complete the work.

Item No. 32 : Providing and fixing UPVC pipe as Longitudinal Runner Pipe , Down take pipes, conduits below footpath including cost of all materials, labour, fixing in true line and level, including bends, fixtures, special, etc. complete with all lifts and leads etc. as per specifications and as directed by engineer in charge. 75mm dia

Relevant specifications given for drainage spout as described shall be applicable to this item. The material shall be as per relevant code. The UPVC pipe shall be connected and clamped properly as per drawing, and as directed by Engineer in charge. The connection with drainage spout shall be proper and leak proof.

1.0 Materials :

1.1 U-PVC pipe conforming to IS-13592 (Type-A) of Prince/Supreme/Jain make as Longitudinal Runner Pipe. The specials and fittings required shall be of best quality.

2.0 Workmanship :

2.1 The U.P.V.C. Pipes of specified diameter shall be fixed as directed. U.P.V.C. Pipes, due allowance shall be made particularly in over ground pipe lines for any change in length of pipe line which may occur during installation or when pipe line is in service.

2.2 Above ground installation of U.P.V.C. pipe should be undertaken after precautions are observed for their protection against dirt sun rays and mechanical damage.

2.3 The U P.V.C. pipe lines should not be kept exposed above ground when it passes through public place, railway lines, roads, road side and footpaths.

2.5 Closet support spacing shall be provided, if recommended by the manufacturer.

2.6 The guide line indicated by the manufacturer regarding handling, transportation, storing, laying and jointing of pipes shall be kept in view during execution.

2.7 U.P.V.C. pipes shall be fixed on wall/ Structure with wooden plugs and suitable clamps.

2.8 Jointing the pipes :

2.8.1 The pipes and sockets shall be accurately cut. The ends of the pipes and fitting should be absolutely free from dirt and dust. The outside surface of the pipes and the inside of the fittings shall then be roughened with emery paper, and then solvent cement shall be applied to the matching surface and pushed home and joint. Since solvent cement is aggressive to U P.V.C. care must be taken to avoid applying excessive cement to the inside of pipe sockets as any surplus cement cannot be wiped off after jointing. Empty solvent cement tins, brushes, rags, of paper unpregnated with cement should not be buried in the trenches.

They should be gathered, not left scattered about, as they can prove to be a hazard to animals which may chew them.

2.8.2 If any manufacturer recommends its own methods of jointing the same shall be adopted after necessary approval from the Engineer-in-charge.

2.9 Laying pipes in trenches :

2.9.1 The pipes shall be laid over uniform relatively soft fine grained soil found to be free of presence of hard objects such as large flints, rocky projections, large tree roots etc. The width of the trenches shall be minimum width required for working.

2.9.2 The pipes laid underground shall not be less than one metre from the ground level. The pipe shall be positioned in the trenches so as to avoid any induced stresses due to reflection. Any deviation required shall be obtained by using proper type of rubber ring joints.

3.0 Mode of measurements & payment :

The measurement and payment will be on R.mt. of actual work executed.

Item No. 33 : Providing & fixing in position 100 mm Dia. A.C. pipes as weep holes in Abutments and Return Walls completed in all respect as per specification and as directed by Engineer.

All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

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 **AC. Pipes** of 100 mm diameter 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 150 mm diameter. OR directed by engineer in charge. 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 1 m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level which is higher or as directed by the Engineer.

2. Materials

Pipes shall be **100 mm diameter A.C. (Asbestos Cement) pipes** conforming to relevant IS specifications and of approved make.

Pipes shall be sound, straight, free from cracks, and capable of withstanding earth pressure and exposure conditions.

Filter media such as graded gravel, coarse sand, geotextile, or approved filter material shall be provided at the inlet end where required.

Jointing and sealing materials shall be cement mortar or approved sealant to ensure proper fixing and watertight embedment.

3. Scope of Work

The work shall consist of providing and fixing 100 mm diameter A.C. pipes as weep holes in abutments, return walls, wing walls, or other retaining structures at locations, spacing, levels, and slope as shown in drawings or as directed by the Engineer-in-Charge (EIC). Pipes shall be placed with suitable outward slope to facilitate drainage of water from backfill and prevent build-up of hydrostatic pressure.

The scope includes cutting pipes to required length, fixing during concreting or masonry work, ensuring correct alignment and gradient, and embedding securely in structure. Inlet end shall be surrounded by approved filter media or wrapped in geotextile to prevent clogging by soil particles. Outlet end shall be kept clean and unobstructed. Necessary holes or openings shall be formed in shuttering or masonry as required. All materials, labour, tools, and incidental works necessary to complete the weep hole system form part of this item.

4. General Workmanship

Work shall be executed by skilled labour under supervision. Pipes shall be fixed firmly to prevent displacement during concreting or backfilling. Proper slope shall be ensured. Mortar around pipe shall be compact and leakproof. Care shall be taken to avoid blockage. Damaged pipes shall not be used. Finished weep holes shall be clean, functional, and protected during construction.

5. Mode of Measurement and Payment

Measurement shall be made in **Number** (of A.C. pipe fixed as weep holes.

Length shall be measured along the centre line of pipe actually embedded.

No separate measurement for filter media, cutting, fixing, or sealing.

Rate shall include cost of A.C. pipes, filter media, fixing, cutting, sealing, labour, tools and plants, transportation, and all incidental charges.

Work shall be complete in all respects as approved by EIC.

Nothing extra shall be paid.

Item No. 34: Box cutting the road surface to proper slope, and chamber for making a base for road work including removing the excavated stuff and depositing on the road side as directed up to all lead & Lift.

MORT&H specifications for Box Cutting **as in section 300** (as mentioned below) shall be followed in connection with this item

Scope

This work shall consist of excavation, removal and disposal of materials necessary for the construction of roadway, side drains and waterways in accordance with requirements of these Specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and subgrade construction suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, with all leads and lifts, reuse of cut materials as may be deemed fit, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

Classification of Excavated Material

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 moorum, 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 moorum or stabilized soil requiring use of pick axe or shovel or both.
- iii) lime concrete, stone masonry and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
- iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

c) Hard Rock (requiring blasting)

This shall comprise :

- i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required,
- ii) reinforced cement concrete below ground level and in bridge/ROB/RUB/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 has to be carried out by chiselling, wedging or any other agreed method.

f) Marshy soil

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

Authority for Classification

The classification of excavation shall be decided by the Engineer and his decision shall be final and binding

on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

Construction Operations

Setting Out

After the site has been cleared as per Clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. Clause 109 shall be applicable for the setting out operations.

Stripping and Storing Topsoil

When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to specified depths and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired in accordance with Clause 305.3.3. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with approval of the Engineer.

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.

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.

Rock Excavation

Rock, when encountered in road excavation, shall be removed upto 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 also 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.

Where blasting is to be resorted to, the same shall be carried out as per Clause 302 and all precautions indicated therein observed.

Where presplitting is prescribed to be done for the establishment of a specified slope in rock excavation, the same shall be carried out as per Clause 303.

Marsh Excavation

The excavation of soil from marshes/swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of backfilling with materials like boulders, sand moorum, bricks bats, dismantled concrete as approved by the Engineer. The method and sequence of excavating and backfilling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits indicated on the drawings or as staked by the Engineer.

Excavation of Road Shoulders/Verge/Median for Widening of Pavement or Providing Treated Shoulders

In the works involving widening of existing pavements or providing paved shoulders, the existing shoulders/verge/median shall be removed to its full width and upto top of the subgrade. The subgrade material within 500 mm from the bottom of the pavement for the widened portion or paved shoulders shall be loosened and recompactd as per Clause 305. Any unsuitable material found in this portion shall be removed and replaced with the suitable material. While doing so, care shall be taken to see that no portion of the existing pavement designated for retention is loosened or disturbed. If the existing pavement gets disturbed or loosened, it shall be dismantled and cut to a regular shape with sides vertical and the disturbed/loosened portion removed completely and relaid as directed by the Engineer, at the cost of the Contractor.

Excavation for Surface/Sub-Surface Drains

Where the Contract provides for construction of surface/sub-surface drains, the same shall be done as per Clause 309. Excavation for these drains shall be carried out in proper sequence with other works as approved by the Engineer.

Slides

If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the Contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material from the slips, slides etc. shall conform to its condition at the time of removal and payment made accordingly regardless of its condition earlier.

Dewatering

If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to discharge the drained water into suitable outlets 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 to the original condition at his own cost or compensate for the damage.

Use and Disposal of Excavated Materials

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

Backfilling

Backfilling of masonry/concrete hume pipe or drain excavation shall be done with approved material with all loads and lifts after concrete/masonry/hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be backfilled to the original surface making due allowance for settlement, in layers not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as trench compactor, mechanical tamper, rammer or plate compactor as directed by the Engineer.

Plying of Construction Traffic

Construction traffic shall not use the cut formation and finished subgrade without the prior permission of the

Engineer. Any damage arising out of such use shall be made good by the Contractor at his own cost.

Preservation of Property

The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing roadside trees, drains, sewers, sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which, in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved from the Engineer. However, if any, of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition at his cost. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of the Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing prior notice to the effect.

Preparation of Cut Formation

The cut formation, which serves as a sub-grade, shall be prepared to receive the sub-base/base course as directed by the Engineer.

Where the material in the subgrade has a density less than specified in Table 300-1, the same shall be loosened to a depth of 500 mm and compacted in layers in accordance with the requirements of Clause 305 adding fresh material, if any required, to maintain the formation level as shown on the drawings. Any unsuitable material encountered in the subgrade level shall be removed as directed by the Engineer, replaced with suitable material and compacted in accordance with Clause 305.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base material as directed by the Engineer, laid and compacted in accordance with the respective Specifications for these materials. The unsuitable material shall be disposed of in accordance with Clause 301.3.11. After satisfying the density requirements, the cut formation shall be prepared to receive the sub-base/base course in accordance with Clauses 310 and 311.

Finishing Operations

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock (ordinary or hard) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Clause 902.

Where directed, the topsoil removed and conserved (Clauses 301.3.2 and 305.3.3) shall be spread over cut slopes, shoulders and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 100 mm.

Measurements for Payment

Excavation for roadway shall be measured by taking cross-sections at suitable intervals before the excavation starts (after clearing and grubbing/stripping etc. as the case may be) and after its completion and computing the volumes in cu.m by the method of average end areas for each class of material encountered. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits, the volumes shall be computed by other accepted methods.

At the option of the Engineer, the Contractor shall leave depth indicators during excavations of such shape and size and in such positions as directed so as to indicate the original ground level as accurately as possible. The Contractor shall see that these remain intact till the final measurements are taken.

For rock excavation, the overburden shall be removed first so that necessary cross-sections could be taken for measurement. Where cross-sectional measurements could not be taken due to irregular configuration or where the rock is admixed with other classes of materials, the volumes shall be computed on the basis of measurement of stacks of excavated rubble allowing a deduction of 35% therefrom. When volume is calculated on the basis of measurement of stacks of the excavated material other than rock, a deduction of 16% of stacked volume shall be allowed.

Works involved in the preparation of cut formation shall be measured in units indicated below:

i)	Loosening and recompacting the loosened material at subgradeCum
ii)	Loosening and removal of unsuitable material and replacing with suitable material and compacting to required densityCum
iii)	Preparing rocky subgrade	...Sq. m
iv)	Stripping including storing and reapplication of topsoil	...Cum

Rates

The Contract unit rates for the items of roadway and drain excavation shall be payment in full for carrying out the operations required for the individual items including full compensation for:

- i) setting out;
- ii) transporting the excavated materials for use or disposal with all leads and lifts by giving suitable credit towards the cost of re-usable material and salvage value of unusable material;
- iii) trimming bottoms and slopes of excavation;
- iv) dewatering;
- v) keeping the work free of water as per Clause 311;
- vi) arranging disposal sites; and
- vii) all labour, materials, tools, equipment., safety measures, testing and incidentals necessary to complete the work to Specifications. Where presplitting of rock is prescribed it shall be governed by Clause 303.5.

The Contract unit rate for loosening and recompacting the loosened materials at subgrade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

Clauses 301.9.1 and 305.8 shall apply as regards Contract unit rate for item of removal of unsuitable material and replacement with suitable material respectively.

The Contract unit rate for item of preparing rocky sub-grade as per Clause 301.6 shall be full compensation for providing, laying and compacting granular base material for correcting surface irregularities including all materials, labour and incidentals necessary to complete the work and all leads and lifts.

The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts and leads.

Also, following specifications shall be followed along with above,

1. The subgrade/sub base/base to receive the water bound macadam course shall be prepared to the specified grade and camber and made of dust and other extraneous materials. Any nets of soft places be corrected in on approved manner and rolled until firm.
2. Specification no 162 and 553 of P.W.D. Hand book volume II and the following additional specifications shall be applicable here.
3. After clearing the site ,the center lines, Necessary Levels , Bench mark will be given by the Contractor Through Total Station and check and verify by R&B (Division) Arvalli's Engineer in charge. . The contractor shall assume full responsibility for alignment, elevation and dimension of each and all parts of the work. Contractor shall supply laborers, materials, etc. required for setting out the reference marks and bench marks and shall maintain them as long as required for setting out reference marks and bench marks and shall maintain them as long as required and directed.
4. Cutting shall be done in proper grade & camber as per measurements given. Care must be taken the tall slopes are evenly and truly dressed. Cutting shall be done to the exact depth required and shall be as per format ion level in proper grade and camber. If extra depth of cutting is done due to negligence of contractor the same shall be refilled with approved quality of materials duly consolidated to the satisfaction of Engineer-in-charge (without extra cost). Box cutting for soling and metaling in required width, the depth shall be done. The final surface shall confirm to proper profile, camber and super elevation etc. as directed by the engineer. The Earthwork shall be paid on sectional measurements, cross sectional etc. taken.
5. No allowance or payments shall be made for materials excavated prior to the taking of level by the engineer.

6. The stuff received from the cutting shall be utilized for filling cuts and correcting side slopes of bank with all lead and lift as directed. Useful stuff shall be carefully stacked separately as directed.
7. The rate is inclusive of cutting in all soil and Murrum including removal of all shrubs, jungle cutting, cutting stuff in slopes, side drain bank, & including dismantling of RCC, Stone & Brick work etc. complete. This item also includes the clearing the sides and demarking the line as per requirement and cutting out the existing trees on the road side, no extra payment will be paid for at the time of preparing final bill, the road formation in embankment and cutting shall have perfect condition true to grade, camber and side slope duly dressed and damages due to rain cuts etc., during entire working period shall have to be done by the contractor. The work taken in length shall be completed in all respects viz. width, grades, camber, side drains, side slopes etc. and measurements for incomplete work shall not be taken otherwise.
8. The item also includes carrying out Road level with total station instrument and as directed. The item includes fixing the required points for execution of the work as and when needed and establishing bench mark as per GTS bench mark.
9. The measurement shall be taken as per cross section measurement to the cutting based on length, breadth, depth measured with tape at every 25 meters interval.

Item No.35 :- Earth work in embankment using selected soil and hard murrum, approved by engineer in charge, with contractor's own earth by all lead, and lift, including breaking clods dressing with all lead and lift including watering rolling and consolidation of subgrade in layers of 300 mm or as directed by engineer in charge, at OMC to required dry density including filling the depressions which occur during the process using power roller 8T to 10T.

MORT&H specifications as in section 305 & 900 (5th revision) shall be followed in connection with this item as below. All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

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

305.2 Materials and General Requirements

305.2.1 Physical Requirements

305.2.1.1 The materials used in embankments, subgrades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, reclaimed material from pavement, fly ash, pond ash, a mixture of these or any other material as 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; any soil that classifies as OL, OI, OH or Pt in accordance with IS:1498;
- c) Materials susceptible to spontaneous combustion;
- d) Materials in a frozen condition;
- e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 percent when tested as per IS:2720 – Part 40) shall not be used as a fill material. Where an expansive clay having "free swelling index" value less than 50 percent is used as a fill material, subgrade 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 SO₃) per litre when tested in accordance with BS:1377, Part 3, but using a 2:1 water-soil ratio shall not be deposited within 500 mm distance (or any other distance described in the Contract), of permanent works constructed out of concrete, cement bound materials or other cementitious material.

Materials with a total sulphate content (expressed as SO₃) exceeding 0.5 percent by mass, when tested in accordance with BS:1377, Part 3 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when 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 in such cases, however, shall not be more than two-thirds of the compacted layer thickness.

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

Table 300-1 : Density Requirements of Embankment and Sub-grade Materials

Sr. No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS:2720 (Part 8)
1)	Embankments up to 3 m height, not subjected to extensive flooding	Not less than 15.2 kN/cu.m
2)	Embankments exceeding 3 m height or embankments of any height subject to long periods of inundation	Not less than 16 kN/ cu.m
3)	Subgrade and earthen shoulders/verges/backfill	Not less than 17.5 kN/cu.m

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

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

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 acceptable materials becoming available from nearby roadway excavation under the same Contract.

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

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 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the

edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width of a minimum of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition. Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

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

305.2.2.3 Fly-Ash

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

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

305.2.2.4 Compaction Requirements

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

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)	Subgrade and earthen shoulders	Not less than 97%
2)	Embankment,	Not less than 95%
3)	Expansive Clays a) Subgrade and 500 mm portion just below the subgrade b) Remaining portion of embankment	Not Allowed 90-95%

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

- The values of maximum dry density and optimum moisture content obtained in accordance with IS:2720 (Part 8), appropriate for each of the fill materials he intends to use.
- A graph of dry 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 the desired density and in 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 for the damage at his own cost.

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

305.3.3 Stripping and Storing Topsoil

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. Top soil 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 in accordance with Clauses 305.3.5 and 305.3.6 so as to achieve minimum dry density as given in Table 300-2.

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

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

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of such material types (a) to (f) in 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 in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250 mm when vibratory roller/vibratory soil compactor is used and not more than 200 mm when 80-100 kN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

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

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content 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 percent above to 2 percent below the optimum moisture content determined in accordance with IS:2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

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

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

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 construction vehicles. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength of the material before it was damaged.

Embankments and unsupported fills shall not be constructed with steeper side slopes or to greater widths than those shown in the drawings, 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, cuttings, other fills and excavations steeper than 1 vertical to 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

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

305.3.6 Compaction

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

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

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

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

When density measurements reveal any soft areas in the embankment/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 using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage

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

305.3.8 Repairing of Damages Caused by Rain/Spillage of Water

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

the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9 Finishing Operations

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

The topsoil, removed and conserved earlier (Clauses 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 moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirements of Clause 308. When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4 Construction of Embankment and 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/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of light weight vibratory roller, double drum walk behind roller, vibratory plate compactor or vibratory tamper or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2 Earthwork for Embankment and Sub-Grade to be Placed Against Sloping Ground

Where an embankment/subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1 before placing the embankment/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 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 type and lies within 1 m of the new formation levels, it shall be scarified to a depth of 50 mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new sub-grade level is compacted to the desired density;
- ii) If the existing road surface is of bituminous type or cement concrete and lies within 1 m of the new formation level, the bituminous or cement concrete layer shall be removed completely;
- iii) If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be roughened after ensuring that the minimum thickness of 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 upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and 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 an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS:2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC:78. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of Table 300-2.

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

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

305.4.5 Construction of Embankment over Ground Incapable of Supporting Construction Equipment

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

305.4.6 Embankment Construction under Water and 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 be of GW, SW, GP, SP as per IS:1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. 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.

305.5 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 cost 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 Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 Sub-grade Strength

305.7.1 It shall be ensured prior to actual execution that the 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 subgrade shall be determined on

remoulded samples, compacted to the field density at the field moisture content and tested for soaked/unsoaked condition as specified in the Contract.

305.8 Measurements for Payment

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

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

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

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

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

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

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

305.8.8 Removal of unsuitable material at embankment/sub-grade foundation and replacement with suitable material shall be measured in cu.m.

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

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

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

305.9 Rates

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 suitable material or loosening and recompacting is involved;

iv) Scarifying or cutting continuous horizontal benches 300 mm wide on side 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 and compacting to Specification requirements;

vii) Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;

viii) Restricted working at sites of structures;

ix) Working on narrow width of embankment and sub-grade;

x) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and sub-grade site with all leads and lifts unless otherwise provided for in the Contract;

xi) All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications;

xii) Dewatering; and

xiii) Keeping the embankment/completed formation free of water as per Clause 311.

xiv) Transporting unsuitable excavated material for disposal with all leads and lifts.

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

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

305.9.4 Clauses 309.1.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material, respectively.

305.9.5 The Contract unit rate for scarifying existing granular/bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals, necessary to complete the work. This will also comprise of handling, giving credit towards salvage value and disposal of the dismantled materials with all leads and lifts or as otherwise

specified.

305.9.6 Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

305.9.7 The Contract unit rate for providing and laying filter material shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

305.9.8 The Contract unit rate for providing and compacting backfill material behind abutments and retaining walls shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

305.9.9 Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.

305.9.10 Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

For, Quality Control for Road Works (Clause 900), MORT&H Specifications shall be followed as mentioned above in general specifications.

With above, following specifications are also to be followed,

- 1 The land width on which the earthwork is to be done shall be cleared of all trees having a girth of 30 cm and less, loose stones, vegetation, bushes, stumps and all other objectionable materials. All the materials cleared will be the property of Government. Useful material shall be arranged in convenient stacks along the road boundary or as directed at places within 50 metres lead, and handed over to the department in convenient section. Unsuitable material shall be burnt or otherwise disposed off by the contractor at his own cost without causing any nuisance, inconvenience or damage to the works property or people in the neighbourhood. In all cases the materials shall be disposed off in a neat manner.
- 2 After clearing the site, the alignment of the road shall be properly set out true to line, curves, slopes, grades and sections as shown on the plan or directed by the engineer in charge. The contractor shall provide all labours and materials such as lime, strings, pegs, nails, bamboos, stone, mortar, concrete, etc. required for setting out, establishing bench marks and giving profiles. The contractor shall be responsible for maintaining the BMs profile alignments and other marks as long as they are required for the work in the opinion of the engineer in charge. If the contractor defaults in this respect they may be restored by the department at the cost of the contractor.
- 3 When an existing embankment is to be widened, continuous, horizontal benches, each at least 0.30 metre wide shall be cut into the existing slope for ensuring adequate bond with the fresh embankment of the embankment. The 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 type of hauling equipment.
- 4 The soil to be used for embankment shall be free from trees, stumps, roots, rubbish or any other objectionable materials. Only material considered suitable by the engineer in charge shall be used for the construction and that considered unsuitable other disposed off as directed by him. The selection of the materials to be used in the construction of embankment shall be made after soil surveys and investigations carried out by the department. The embankment shall consist of earth available from road side borrow pits on either side with all lead and all lifts.
- 5 Location, shape and size of borrow pits shall be as indicated by the engineer in charge. Pits shall not be dug continuously. Ridges of not less than 8 metres width should be left at interval not exceeding 300 metres. Small drain shall be cut through the ridges to facilitate drainage. The outer edge of borrow pits shall be so regulated that the bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of final section of the bank, the maximum depth in any case being limited to 1.5 metres. Also no pits shall be dug within 5 metres of the toe of the final section of the road embankment.
 - 5.1 No borrow pits shall be allowed at the following sites along the road.
 - (i) up to 30 metres on either side of CD works.
 - (ii) Up to 15 metres on either side of cart track crossing for which approaches are to be constructed.
 - 5.2 If there is top layer of black cotton or other objectionable soils, the same shall be removed and disposed off elsewhere and usable material found at lower level will only be used in the embankment.
- 6 The embankment shall be constructed in uniform layers not **exceeding 250 mm** in loose thickness. The soil shall be spread uniformly over the entire width of the embankment, unless otherwise directed by the engineer in charge. The consolidation including watering and rolling of earthwork shall be carried out by the department. The operation of laying the successive layer of earth shall have to be suitably. All clods of hard lumps of earth shall be broken to have maximum size of 15 cm when being placed in the embankment and a maximum size of 5 cm when being placed in the top 45 cms of the embankment. The work of next

layer shall be allowed only after the first layer below it has been thoroughly compacted.

7 Where an embankment is to be placed on sloping ground, the surface of the ground shall be benched in the steps of trenches or broken up in such a manner that the new material shall have perfect bond with the existing surface. Where the embankment is to be placed over an existing road surface, the surface shall be scarified to minimum depth of a 5 cm so as to provide ample bond between the old and new material. However when the embankment is to be placed over an old concrete pavement and lies within 1 metre of new sub grade level the pavement shall be broken up in pieces not to exceed 0.1 m and may be left under the new embankment. If the existing road surface is of granulate or bituminous type and lies within 1 mt. of the new sub grade level, the same shall be scarified to a depth of minimum 50 mm, so as to provide ample bond between the old and the new material.

8 To avoid interference with the construction of abutment, wing walls or return walls of culverts/bridge structure, the contractor shall at point to be determined by the engineer in charge, suspend work on embankments 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 interference or damage to the bridge work. Unless directed otherwise, the filling ground culverts, bridges and other structures up to a distance twice the height of embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given for 14 days, the embankment 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 in charge. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneous with the laying of fill material. The material used for the filter shall conform to the requirements for filter medium and will be aid extra in the relevant item.

9 The embankment shall be finished in conformity with the alignment, levels, cross sections and dimension shown on the plans or as directed by engineer in charge. Where the alignment of the road is in a curve, the top of the embankment shall be formed with the super elevation and the increased width shown on the drawings or as the engineer in charge may direct. Finishing operations shall include the work of shaping and dressing the shoulders, road bed and the side slopes to conform the cross section.

10 The earthwork measurements shall be paid on cross sectional measurements and computing the volumes of earthwork in cubic meters by average area method. The contractor shall sign day to day leveling work and also original cross section, longitudinal section, etc. in token of his acceptance. The working sections both longitudinal and cross of the ground shall be taken by the engineer in charge before the actual work is started. The contractor or his authorized representative shall attend day to day leveling work and sign with date the field book daily in token of his acceptance. If there is any disagreement the contractor shall inform of it in writing to the officer concerned with specific reference to the sections before starting further work. Once the work is started, no cognizance of any complaint will be taken. Merely not signing of level book shall not be deemed as disagreement. The executive engineer shall also verify leveling work to the extent of 5% before commencement of earthwork and on finalization. The contractor shall maintain the embankment by filling in ruts, rain cuts, depression due to shrinkage, etc. to proper formation and grade till this item is finally measured and accepted by the department. The measurements shall be taken on compacted earthwork. If the compaction as stipulated in Para above is not done by the department in that case shrinkage from such earthwork quantity shall be deducted as per norms i.e. 10% after monsoon and 15% before monsoon. However the contractor shall have to bear loss of quantity due to all settlements as well as other types of deformations etc., if any, that might have taken place at the time of taking the final measurement of this item.

11 The rate of earthwork includes, clearing jungles, dog-belling, fixing profiles, erecting necessary pillars for stones for bench marks for levelling purpose, excavating earth from borrow areas, breaking clods, conveying and spreading earth in layers with all lead and lift, finishing the entire embankment and incidentals necessary to complete the work to the specifications. The cutting stuff of cutting in ordinary soil, soft murrum, soft rock, hard murrum and hard rock shall be utilized in embankment construction under this item within the lead specified in the particular item. No payment shall be made under this item for the cutting stuff used in the embankment but labour for cutting will be paid as per specifications in the particular item, and only balance quantity of earthwork brought from borrow areas will be paid in this item.

12. The measurement shall be on the basis of cubic meter.

13. The rate for this item includes all materials, labour, plants and everything required to execute this item etc. complete and as directed by engineer in charge.

Sand filling shall commence after a period of 3 days of laying of bottom plug. Sand shall be clean & free from earth, clay clod, roots, boulder shingle, etc.

The sand to be used for filling shall be coarse, granular, clean, free from dust and deleterious matters obtained from a source as approved by the Engineer-in-charge. Sand between returns shall confirm to I.S. : 383.

Filling sand as per detailed drawing or as directed by the Engineer-in-charge.

Sand between returns and below raft foundations shall be filled in suitable layers not exceeding 20 cms. at a time and each layer shall be well compacted.

Unit rate includes the cost of material, labour and tools and plant to complete the work.

The measurement shall be in Cu. meter.

Item No.36 :- Carting of excavated material such as murrum, earth, kapachi, gravel, brickbats, kankar, debris, sand, dismantled material, including, Spreading , levelling loading, unloading, stacking etc. complete at non objectional place as directed by engineer in charge a) Lead up to 5 Km.

1. All the super earth etc. shall be carried away immediately from the site of work to a place within limit Distance as directed and ordered by the Engineer so as not to cause any inconvenience to the public traffic failing which in view of public safety and traffic convenience.
2. The R & B shall carry out the work by any other agency at the contractor's risk and cost. If the instructions are not complied within 7 days from the date of order or cart the surplus materials and clear the site, the said work shall be carried out by the R & B at the risk and cost of the contractor and no claim or dispute shall be entertained in this respect.
3. If the filing in the trenches after settlement of the earth filing in trenches will observed, the same shall be carried out by the contractor without asking any extra rate.
4. The contractor shall have to cart the surplus earth after the trenches will watered and refilled with the sand. The rate of carting shall be for carting of brickbats, metal, rubble, vegetation and garbage, if necessary to clear the road surface.
5. The Measurement of the item shall be in Cubic metre basis.
6. The rate includes labour, material, equipment etc. complete to the site as directed loading, unloading etc. completed.

Item No.37 :- Providing, laying and compacting natural gravel and sand (river bed material C.B.R. not less than 10%) below sub base course including carriage of materials spreading in uniform layer manually on prepared base and compacted with vibratory roller to achieve desired density including all materials, labour etc. complete.

1. Materials

- Material shall consist of natural gravel and sand obtained from approved river bed source.
- Material shall be clean, hard, durable, and free from clay lumps, organic matter, and deleterious substances.
- The soaked **CBR value shall not be less than 10%** when tested as per relevant IS/IRC specifications.
- Gradation shall be as approved by Engineer-in-Charge (EIC) to ensure proper compaction and stability.
- Water used for compaction shall be clean and free from harmful salts.

2. Scope of Work

The work shall consist of supplying, transporting, laying, spreading, watering, and compacting natural gravel and sand material below sub-base layer as shown in drawings or

directed by EIC. The prepared formation or subgrade shall be checked for line, level, camber, and density before laying material.

Material shall be spread in uniform layers of specified thickness without segregation. Required moisture content shall be maintained for effective compaction. Compaction shall be done using suitable vibratory rollers to achieve specified density. Surface shall be finished true to line, level, and cross fall. Any soft spots or irregularities shall be corrected. The work includes all labour, equipment, watering, and quality control necessary to complete the layer.

3. General Workmanship

Material shall be laid only on approved and prepared surface. Segregated or oversized materials shall be removed. Layer thickness before compaction shall be controlled to achieve required compacted thickness. Rolling shall proceed from edges towards centre or as directed. Adequate passes of roller shall be applied to obtain uniform compaction. Surface shall be smooth, dense, and free from ruts or depressions. Work shall not be carried out during heavy rain or unsuitable conditions.

4. Mode of Measurement and Payment

- Measurement shall be made in **Cubic Metres (Cu.M.)** of compacted material.
- Quantity shall be calculated based on compacted thickness and area covered.
- No separate measurement for watering, compaction, or handling.
- Rate shall include cost of material, carriage, spreading, watering, compaction, labour, tools and plants, and all incidental charges.
- Work shall be complete in all respects as per specification and approval of EIC.
- Nothing extra shall be paid.

Item No. 38 :- Construction of granular sub-base (Grade -I, Crushed B T Materials of 53 mm to 26.5 mm @ 35 %, 26.5 mm to 4.75 @ 45 %, below 2.36 mm @ 20 %) by providing close grade material, spreading uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve desire dencity, complete clauses as per 401. For Grading - I Material

401. GRANULAR SUB-BASE

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

401.2. Materials

The material to be used for the work shall be natural sand ,murrum ,gravel ,crushed stone, or combination thereof depending upon the grading required. Materials like crushed concrete ,brick metal and kankar may be allowed only with the specific approval of the engineer. sand. The material shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table 400 -1

While the grading in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding grading for the

corresponded materials for each of the three maximum particle sizes are given at Table 400-2. The grading to be adopted for a project shall be as specified in the Contract.

401.2.2. Physical requirements: The material shall have a 10 per cent fines value of 50 or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part 11). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 3, 83 FBR Grading II and III materials, the CBR shall be not less than 10 as per item description.

TABLE 400-10 GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Per cent by weight passing the IS sieve Grading III
75.0 mm	100
26.5 mm	55 -75
4.75 mm	10 -30
0.075 mm	<10
CBR Value (Minimum)	30

Note: The material passing 425 micron (0.425 mm) sieve for all this grading when tested according to IS: 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on - specimens remolded at field dry density and moisture content and any other tests for the quality" of materials, as may be necessary.

Construction Operations

Preparation of sub grade: Immediately prior to the laying of sub-base, the sub grade already finished to Clause 301(Pg. No-45) or 305(Pg. No-63) as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80 - 100 KN smooth wheeled roller.

Spreading and compacting: The sub-base material of grading specified in the Contract shall be spread on the prepared sub grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1(Pg. No-109), mixing shall be done mechanically by the mixing-place method.

Manual mixing shall be permitted only where the width of lying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotator or similar approved equipment capable of mixing the material to the desired degree, if so desired by the engineer; trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS: 2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added the material shall be processed by mechanical or other approved means like disc harrows, rotators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super-elevation and shall commence at 6 the edges and progress towards the centre for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or

depressions, which become apparent, corrected by removing or adding fresh material, the speed of the roller shall not exceed 5 km per hour.

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

Surface Finish and Quality Control of Work: The surface finish of construction shall conform to the requirements of Clause 902(Pg. No-417) of MORTH Specification.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900(Pg. No-415) of MORTH Specification.

Arrangements for Traffic: During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112(Pg. No-19) of MORTH Specification..

Measurements for Payment: Granular sub-base shall be measured as finished work in position in cubic metres. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

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(Pg. No-19) of MORTH Specification except for initial treatment to verges, shoulders and construction of diversions.
- (ii) Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts.
- (iii) All labour, tools, equipment and incidentals to complete the work to the Specifications.
- (iv) Carrying out the work in pavement widths of road where directed
- (v) Carrying out the required tests for quality control.

The payment shall be made on Cum basis.

For, Quality Control for Road Works (Clause 900), MORTH Specifications shall be followed as mentioned above in general specifications.

Item No. 39 : Providing and laying W.B.M. of M.C. metal of size 45 mm to 90 mm size including 0.27 Cu.m stone screening & 0.08 cum stone dust as filler including spreading watering & consolidation by Vibratory roller 80 KN to 100 KN static Weight. 100 mm thick compacted.

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 sub grade/ sub bases base or existing pavement, as the case may be and finished in accordance with the requirements of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

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

404-2. Materials

Coarse aggregates

Coarse aggregates shall be either crushed stone of Black trap type only. The aggregates shall conform to the physical requirements set forth in Table 400-6. The type and size range of the aggregate shall be specified in the Contract or shall be as, specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS : 2386 (Part 5).

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.

TABLE 400-6. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE COURSES

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

Aggregate may satisfy requirements of either of the two tests.

Aggregates like brick metal, kankar, laterite etc. 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 when the case of Crushed broken stone and crushed-slag.

Grading Requirement of Coarse Aggregates

The Coarse aggregates shall conform to one of the Grading given in Table 400-7 as specified, provided, however, the use of Grading No. 1 shall be restricted to sub-base course only.

TABLE 400-7. GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size Range	IS Sieve Designation	Per cent by weight passing
I.	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60

		45	mm	0-15
		22.4	mm	0-5
II.	63 mm to 45 mm	90	mm	100
		63	mm	90-100
		53	mm	25-75
		45	mm	0-15
		22.4	mm	0-5
III.	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

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 murrum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

Screenings shall conform to the grading set forth in Table 400 – 8. The consolidation details of quantity of screenings, required for various grades of stone aggregates are given in Table 400 – 9. The table also gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 100/75 mm.

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

TABLE 400 – 8. GRADING FOR SCREENINGS

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 mcn	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micn	15-35

TABLE 400 – 9. APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100 / 75 MM COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SUB-BASE / BASE COURSE FOR 10 M² AREA

Classification	Size Range	Compact thickness	Loose Qty.	Screenings	
				Stone screening	Crushable type such as murrum or gravel

				Grading classification and size	For WBM sub-base / base course (loose Qty)	Grading classification and size	Loose Qty.
Grading1	90 mm to 45 mm	100 mm	1.21 to 1.43 m ³	Type A 13.2 mm	0.27 to 0.30 m ³	Not Uniform	0.30 to 0.32 m ³
Grading2	63mm to 45 mm	75 mm	0.91 to 1.07m ³	Type A 13.2 mm	0.12 to 0.15 m ³	- do -	0.22 to 0.24 m ³
- do -	- do -	- do -	- do -	Type B 11.2 mm	0.20 to 0.22 m ³	- do -	- do -
Grading3	53mm to 22.4 mm	75 mm	- do -	- do -	0.18 to 0.21 m ³	- do -	- do -

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 quality of binding material where it is to be used will depend on the type of screening. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06 – 0.09 m³/10m² and 0.08 – 0.10 m³/10m² for 100 mm compacted thickness.

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

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

Construction Operations

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 lines and cross fall (camber) and made free oil dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by Sprinkling water. Any sub-base / base surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (leveling course).

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50

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

Spreading coarse aggregates:

The coarse aggregates shall be spread uniformly and evenly upon the prepared sub grade/sub-base/ base to profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading I and 75 mm for Grading 2 and 3 as specified in Clause 404.2.5. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment may be spread in one or more layers by any approved means so as to achieve the specified results.

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

The surface of the aggregate 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 drawings.

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

Rolling:

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 ton capacity or tandem or Vibratory not less of 8 to 10 ton static weight. The type of roller to be used shall be approved by the engineer based on trial run.

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

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the 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 and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired cross fall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

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

It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses as per Clause 407.4.1.

Application of screenings:

After the coarse aggregate has been rolled 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 Aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion & of hand shovels or by mechanical spreaders or directly from tipper with suitable grit spreading arrangement Tipper operating for spreading the screenings shall be so driven as not to disturb to 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 aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and booming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

Sprinkling of water and grouting :

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings Care shall be taken to see that the base or 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 can cause excessive water to flow down to the lime treated sub-base before it has picked up

enough strength (is still "Green") and thus cause damage to the sub-base layer. The layer of water bound macadam layer in such cases shall be done after the sub base attains adequate strength, as directed by the Engineer.

Setting and drying :

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

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

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.

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

Reconstruction of defective macadam:

The finished surface of water bound macadam shall conform to the tolerance 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 dyer the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re compacted. In no case shall depressions be filled up with screenings or binding materials.

Arrangement for Traffic

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

Mode of Measurement & payment

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

RATE

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed below.

- (i) Making arrangements for traffic to Clause 112 except verges, shoulders and construction of diversions;

- (ii) Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts,
- (iii) All labour, tools, equipment, plant incidental to complete Specifications
- (iv) Carrying out the work in part widths of the road where required
- (v) Carrying out the required tests for quality control.

Item No. 40 : Providing and laying W.B.M. of M.C. metal of size 45 mm to 63 mm size including 0.12 Cu.m stone screening & 0.08 cum stone dust as filler including spreading watering & consolidation by Vibratory roller 80 KN to 100 KN static Weight. 2 layer of 75 mm thick compacted.

The work shall be executed as per specification of **Item No. 39** except for the item is work of **Providing and laying W.B.M. of M.C. metal of size 45 mm to 63 mm size including 0.12 Cu.m stone screening & 0.08 cum stone dust as filler including spreading watering & consolidation by Vibratory roller 80 KN to 100 KN static Weight. 2 layer of 75 mm thick compacted.**

Mode of Measurement & payment

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

RATE

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed below.

- (i) Making arrangements for traffic to Clause 112 except verges, shoulders and construction of diversions;
- (ii) Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts,
- (iii) All labour, tools, equipment, plant incidental to complete Specifications
- (iv) Carrying out the work in part widths of the road where required
- (v) Carrying out the required tests for quality control.

Item No. 41 : Providing and laying bituminous grout base course 37.5mm thick using Emulsion for tackcoat at the rate of 4.00 kg/10 sqmt on WBM surface using B.T. Stone aggregate as per required gradation with the asphalt of VG-30 grade at the rate of 1.99% i.e. 19.90 Kg/M.T. by weight by mix including heating and mixing in drum mix plant, transporting the mix spreading the same by paver finisher and consolidation by vibratory roller including cost of all materials, fuels,

Scope

The work shall consist of construction, in two layers of compacted crushed aggregates premixed with a bituminous binder, to serve as base/binder course, laid immediately after mixing, on a base prepared previously in accordance with the requirement of these Specifications and in conformity with the lines, grades and cross sections shown on the drawing or as directed by the Engineer. Thickness of the course shall be **37.5mm** materials.

Materials

Bitumen: The bitumen shall be paving bitumen of suitable **viscosity grade VG-30** as per IS:73. The actual grade of bitumen to be used shall be decided by the Engineer appropriate to the region, traffic, rainfall and other environmental conditions. Guidelines on selection of the grade of bitumen are given in *Appendix-4*.

Viscosity Grade (VG) Bitumen Specification as per IS 73 : 2013

Characteristics	VG - 10	VG-20	VG-30	VG-40
Absolute Viscosity 60°C, poises, min	800	1600	2400	3200
Kinematic Viscosity 135°C CSI, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, % min	99.0	99.0	99.0	99.0
Penetration at 25°C	80-100	60-80	50-70	40-60
Softening point, C min	40	45	47	50
Test on residue from thin film oven test / RTFOT :				
(A) Viscosity ration at 60°C, max	4.0	4.0	4.0	4.0
(B) Ductility at 25°C, cm, min after thin film over test	75	50	40	25

Aggregates

The aggregates shall consist of crushed stone, crushed gravel/shingle or other stones. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall preferably be treated with anti-stripping agents of approved quality in suitable dose as per *Appendix-5*. The aggregates shall satisfy the physical requirements set forth in Table 500-3.

**TABLE 500-3. PHYSICAL REQUIREMENTS OF AGGREGATES FOR
BITUMINOUS GROUT**

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

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

** To determine this combined proportion, the flaky stone from representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particle be separated out from the remaining (non flaky) stone metal. Elongation index is weight of elongated particles divided by total non flaky particles. The value of flakiness index and elongation index so found are added up.

Proportioning of materials:

The bitumen content for premixing shall be **1.99 % (percent)** by weight of the total mix except when otherwise directed by the Engineer.

The maximum compacted thickness of a layer shall be **37.5mm**.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

AGGREGATE GRADING FOR BITUMINOUS GROUT

<u>IS Sieve</u> <u>Designation</u>	<u>Percent by weight passing the sieve</u>
53.0 mm	100
26.5 mm	75-100
22.4 mm	50-85
13.2 mm	20-40
5.6 mm	5-20
2.8 mm	0 – 5

Variation in proportioning of materials : The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content +0.3 per cent by weight of total mix shall however be permissible for individual

specimens taken for quality control tests vide Section 900.

Construction Operations:

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

Preparation of base : This work shall consist of preparing an existing granular or black topped surface bituminous course. The work shall be performed on such widths and lengths as shown in application drawing or as directed by the Engineer. The existing surface shall be firm and clean and treated with prime or tack coat as shown on the drawings as otherwise stated in the contract.

Materials:

For scarifying and re-laying the granular surface: The materials used shall be coarse aggregates salvaged from scarification of the existing granular base course supplemented by fresh coarse aggregates and screenings so that aggregates and screening thus supplemented correspond to Clause 404. Water Bound Macadam or Clause 406. Wet Mix Macadam, as the case may be.

For patching potholes and sealing cracks : Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with Clauses 3004.2 and 3004.3 or as directed by the Engineer.

For Profile Corrective Course : A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings, or as indicated in the Contract Documents. The profile corrective course shall be laid to tolerances and densities as specified for wearing course if a single layer, or base course, if it is to be covered with a wearing course layer.

Profile corrective course and its application: The type of material for use as a profile corrective course shall be as shown on the drawing. If it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/strengthening course. However, if provided as a separate layer, it may be of the same specification as the layer over which it is to be laid or intermediate between underlying layers, as shown on the Drawing.

Surface Levels:

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

Bituminous material shall not be applied to a wet surface or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than

10DC. Where the tack coat consists of emulsion the surface shall be slightly damp, but not wet. Where the tack coat is of cut back bitumen the surface shall be dry.

Construction Equipment:

The tack coat distributor shall be self propelled or towed bitumen pressure sprayer, quipped for spraying the material uniformly at a specified rate. Hand spraying of small areas inaccessible to the distributor or in narrow strips shall be sprayed with a pressure and sprayer or as directed by the Engineer 503.4.2 of MORTH specification. 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 and 902 as appropriate. 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.

Application of tack coat:

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in TABLE 500-2 of MORTH specification. The normal range of spraying.

TABLE 500-2 RATE OF APPLICATION OF TACK COAT:

The emulsion asphalt at the rate of 4.00 kg per 10 sq.m. shall be used for tack coat temperature for a bituminous emulsion shall be 20°C to 70°C and for a cut back 50°C to 80°C if RC-70/MC-70 IS used. Where geosynthetic IS proposed for use, the provisions of Clauses 703.3.2, and 703.4.4 of MORTH specification shall apply. The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray ban and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Where the material to receive an overlay is a freshly laid bituminous layer, that has not been subjected to traffic, or contaminated by dust, a tack coat is not mandatory where the overlay is completed within two days.

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 pant or vehicles shall be allowed on the tack coat other than those essential for the construction.

Quality Control of Work :

TOLERANCES IN SURFACE LEVELS

1. Sub grade	+	20mm 25mm
2. Sub-base 4 - 10 mm		
(a) Flexible pavement	-	20mm

(b)	Concrete pavement	+	6mm
	[Dry clean concrete or Rolled concrete]	-	10mm
3.	Base - course for flexible pavement	+	6mm
(a)	Bituminous course	-	6mm
(b)	Other than bituminous	+	10mm
(i)	Machine laid	-	10mm
(ii)	Manually laid	+	15mm
			15 mm
4.	Wearing course for flexible pavement		
(a)	Machine laid	+	6mm
			6mm
(b)	Manually laid	+	10mm
			10mm
5.	Cement concrete pavement	+	5mm
		-	6mm

TACK COAT :

Scope:

This work shall consist of the application of a single coat of high viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Engineer.

Materials:

The binder used for tack coat shall be bitumen emulsion complying with IS:8887 of a type and grade as specified in the Section 500 of MORTH specification Contract or as directed by the Engineer. The use of cut back bitumen as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

Weather and Seasonal Limitations:

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

Specification: The rate shall cover the provision of tack coat at 0.40 kg per square meter with provision that the variation in actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

Preparation and transport of mix:

Bituminous grout mix shall be prepared in a drum mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates.

The plant shall be drum mix type. The plant shall have coordinated set of essential units capable of producing uniform mix within the job mix formula such as laid down in Appendix 'A'.

(a) In case of drum mix plant, the cold feed system shall have variable speed conveyors/ or

other suitable devices for regulating the accurate proportion of aggregate in to an even flood flow automatically from a control operation/Control Cabin.

(b) **Bitumen Control Unit:** Capable of measuring/metering and spraying required quantity of bitumen at specified temperature with automatic synchronization of bitumen and aggregate feed.

(c) **Filler System :** A fines feeder system suitable to receive bagged or bulk supply of filler materials and its incorporation to the mix in the correct quantity shall be necessary auxiliary.

(d) **Dust Control :** A suitable built in Dust Control Equipment for the dryer to contain the exhaust of fine dust in the atmosphere for environmental control wherever so specified by the Engineer.

(e) Suitable auxiliary Bitumen Boiler of Adequate capacity with self heating arrangement and temperature control device. The boiler should be fitted with temperature indicating instruments.

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

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

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

Spreading: The mix transferred from the tipper at site to the paver shall be spread immediately by means of self-propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix true to the specified lines, grades and cross sections. The paver finisher shall have the following essential features:

- (a) Loading hoppers and suitable distributing mechanism.
- (b) All drives having hydrostatic drive/control.
- (c) The machine shall have a hydraulically extendable screed the appropriate width requirement.
- (d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.
- (e) The paver shall be equipped with necessary control mechanism so as to

ensure that the finished surface is free from surface blemishes.

- (f) The paver shall be fitted with an electronic sensing device for automatic leveling and profile control within the specified tolerances.
- (g) The screed shall have the internal heating arrangement.
- (h) The paver shall be capable of laying either 2.5 to 4.0 m width or 4.0 to 7.0 m width as stipulated in the Contract.
- (i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation.

However, in restricted locations and in narrow widths where the available plant cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of the mix at the time of laying shall be in the range of 120°C to 160°C. In multi-layer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the top-most layer shall be at the lane line of the pavement.

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

Compaction: After the spreading of mix, rolling shall be done by 80 to 100 kN vibratory roller. Rolling shall start as soon as possible after the material has been spread deploying a set of rollers as the rolling is to be completed in limited time frame. The roller shall move at a speed not more than 5 km/h. Rolling shall be done with care to avoid unduly roughening of the pavement surface.

Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or break-down rolling shall be done with 80-100 kN static weight smooth wheel roller (3 wheels or tandem) as soon as it is possible to roll the mix without cracking the surface or having the mix pick up on the roller wheels. The second or intermediate rolling shall follow the break-down rolling with vibratory roller of 80 to 100 kN static weight or

pneumatic tyred roller of 150 to 250 kN weight, with minimum 7 wheels and minimum tyre pressure of 0.7 MPa as closely as possible to the paver and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while material is still workable enough for removal of roller marks with 60 - 80 kN tandem roller. During the final rolling, vibratory system shall be switched off. The joints and edges shall be rolled with a 80 to 100 kN static roller.

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 mix material. The rolling shall then be continued till the entire surface has been rolled to 95 per cent of the average laboratory density (obtained from Marshall specimens compacted as defined in Table 500-10), there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. The roller wheel shall be kept damp if necessary to avoid bituminous material from sticking to the wheels and being picked up. In no case shall fuel, lubricating oil used for this purpose, nor excessive water poured on the wheels.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 100°C.

Roller(s) shall not stand on newly laid material while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous grout laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approximate binder before the new mix is placed against it.

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.

The built-up spray grout shall be provided with next 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.

Arrangement for Traffic:

During the period of construction, arrangement of traffic shall be done to Clause 112 of MORTH Specification.

Passage of Traffic along a part of the Existing Carriageway under Improvement:

For widening/strengthening existing carriageway where part width of the existing carriageway is proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consist of providing at least 150 mm thick granular base course covered with bituminous surface

dressings in a width of at least 1.5 m and the surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the Engineer. The continuous length in which such work shall be carried out, would be limited normally to 500 m at a place. However, where work is allowed by the Engineer in longer stretches passing places at least 20 m long with additional paved width of 2.5 m shall be provided at every 0.5 km interval.

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

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

MEASUREMENTS FOR PAYMENT:

The payment shall be made on the **tonnage basis** of the weight of mix of aggregates and bitumen. For this purpose, the contractor shall have to install a weight bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty and weight of loaded dumper will be recorded in bound and numbered register on plant site. Department will be free to get some loaded dumpers test checked at other weight bridge. Weight bridge will be periodically got calibrated and verified from weight and measure authorities.

For the purpose of application of tack coat, if the theoretical area as per sanctioned estimate for basis of tonne differs with the actual area of work done in the field, the reduction in or addition to payment shall have to be exceeded respectively.

Weight of mix materials will be done in presence of responsible person, not less than the rank : of supervisor of department and the measurement shall be recorded by the Deputy Engineer or Assistant Engineer or Addl. Asst. Engineer. If so authorized, record of each dumper will be maintained separately in bound and numbered register, which will be maintained by the departmental representative and signed by the contractor. Proper gate pass system shall be established for the vehicles coming to the plant site and out going from the plant site. The location of the kilometer, hectometer and meter in which individual dumper are unloaded shall be recorded carefully.

RATE :

The contract unit rate for the work shall be payment in full for carrying out the required operations including full compensation for

- (i) Making arrangements for traffic to Clause 112 of MORTH specification except or initial treatment to verge, shoulders and construction of diversion.
- (ii) Preparation of base except for laying of profile corrective course but including filling of

potholes.

- (iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lift.
- (iv) All labour, tools, equipment, plant including installation of drum mix plant, power supply units and all machineries, incidental to complete the work to the specifications.
- (v) Carrying out the work in part widths of the road where directed.
- (vi) Carrying out all tests for control of quality.

Item No. 42 :Providing and laying 37.5 mm thick compacted bituminous macadam with B.T. Aggregate as per M.O.R.T & H Gradation and Asphalt VG-30 @ 4 Kg/10 Sq Mt and 2.50 Kg/10 sq Mt on existing B.T. Surface for tack coat & Asphalt grade VG-30 for mixing @ 34.00 Kg/M.T. ie 3.40% of total mix weight of the including heating the aggregates and Aphal by continues baching of drum mix plant and spreading the same by paver finisher and consolidation with vibratory roller 80 KN to 100 KN Static weight including providing all materials, Equipments, tools and plants, oil, kerosene, firewood, laboar charges etc. comp. using contractor's own machineries drum mix plant and paver finisher etc complete.

504.1. Scope

The work shall consist of construction, in a single course, of compacted crushed aggregates premixed with a bituminous binder, to serve as base/binder course, laid immediately after mixing, on a base prepared previously in accordance with the requirement of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawing or as directed by the Engineer.

504.2. Materials

504.2.1. Bitumen: The bitumen shall be paving bitumen of suitable viscosity grade **VG-30 (60/70)** as per IS: 73. The actual grade of bitumen to be used shall be decided by the Engineer appropriate to the region, traffic, rainfall and other environmental conditions. Guidelines on selection of the grade of bitumen are given in *Appendix - 4*.

Viscosity Grade (VG) Bitumen Specification as per IS 73 : 2006

Characteristics	VG - 10	VG-20	VG-30	VG-40
Absolute Viscosity 60°C, poises, min	800	1600	2400	3200
Kinematic Viscosity 135°C CSI, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, % min	99.0	99.0	99.0	99.0
Penetration at 25°C	80-100	60-80	50-70	40-60
Softening point, C min	40	45	47	50

Test on residue from thin film oven test / RTFOT :				
(A) Viscosity ration at 60°C, max	4.0	4.0	4.0	4.0
(B) Ductility at 25°C, cm, min after thin film over test	75	50	40	25

➤ **Silane Nanotechnology**

It is an innovative asphalt additive and gives chemical bonding and 100 % coating of bitumen on aggregate and wider temperature zone for compaction are achieved. It is added to the bitumen, to get full association and molecular mixing with bitumen. Co-inject it to the truck at the bitumen terminal while loading or unloading at the storage tank the bitumen. Do not add it on the top of a filled truck. Use an injection system to co-inject it while the truck off loads the bitumen into the storage tank.

Or if the plant is capable of excellent metering system to deliver small quantity accurately with static mixers, then it can be co-injected while being pumped into the mixing chamber during HMA production. Do not add it directly into the storage tank, or into the bitumen tanker containing bitumen, it will not disperse quickly enough.

Alternatively it can be added slowly in 15 minutes while circulating into bituminous tank.

It should be added at the rate of 0.1 % of weight of asphalt.

➤ **Silane Nanotechnology (For Bitumen Emulsion Application, IRC approved) :-**

This tack coat is water resistant, faster setting, tack free and chemically bonds two bituminous layers.

- **CSS1**

The tack coat shall have bitumen emulsion, complying with RS-1 as per IS 8887 (slow setting) of a type and grade as specified in the Contractor as directed by the Engineer. It is mixed with silane water solution and sprayed on the surface. It should be stable to cement addition as per BIS standard IS: 8887:2004 to ensure it will meet the stability requirement.

- **Water:-**

It should be taken from potable water source.

- **Application:-**

The bituminous surface shall be clean and made dust free.

Preparing and applying of water soluble silane nanotechnology (For bitumen emulsion application) with cationic bitumen emulsion RS-1 as per IS 8887 CSS1 and water (<1000 ppm TDS) in the ratio of 1.4 kg silane: 100 kg cationic bitumen emulsion RS-1 : 200 liter water. Take 1.4 kg of silane nanotechnology and add in 200 liter water while filling water in tanker/drum and then add 100 kg cationic bitumen emulsion RS-1 under circulation. Mix the solution completely. Spray the solution at the rate of 0.4 liter per sqm on the existing bituminous / non bituminous surface with mechanical sprayer.

Check quality of bitumen emulsion before bulk use.

504.2.2. Aggregates

504.2.2.1. The aggregates shall consist of crushed stone, crushed gravel/single or other stones. They shall be clean, strong, durable of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. If crushed shingle/gravel is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall preferably be treated with anti-stripping agents of approved quality in suitable dose as per Appendix-5. The aggregates shall satisfy the physical requirements set forth in Table 500-3.

**TABLE 500-3
PHYSICAL REQUIREMENTS OF AGGREGATES FOR
BITUMINOUS MACADAM**

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

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

Note : If crushed slag is used, Clause 404.2.3 shall apply.

504.2.2. The aggregate for bituminous macadam shall conform to one of the two grading in Table 500-4, depending on the compacted thickness; the actual grading shall be as specified in the Contract.

504.2.3. Proportioning of materials: The bitumen content for premixing shall be **3.4 percent** by weight of the total mix except when otherwise directed by the Engineer.

**TABLE 500 - 4
COMPOSITION OF BITUMINOUS MACADAM**

Mix designation Nominal aggregate size layer thickness	Grading 1 40 mm 80-100 mm	Grading 2 19 mm 50-75 mm
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IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight	3.1 – 3.4	3.40%
Bitumen grade	35 to 90	VG-30 (60/70)

Notes: 1. Appropriate bitumen contents for conditions in cooler areas of India may be up to 0.5% higher subject to the approval of the Engineer.

The maximum compacted thickness of a layer shall be **37.5 mm**.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

504.2.4. Variation in proportioning of material: The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content ± 0.3 per cent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests vide Section 900.

504.3. Construction Operations

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

504.3.2. Preparation and transport of mix: Bituminous macadam mix shall be prepared in a drum mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates.

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

A - General

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

- (b) Cold aggregate feed system with minimum 4 bins having belt conveyor arrangement for initial proportioning of aggregates from each bin in the required quantities.
In order to have free flow of fines from the bin, it is advisable to have vibrator fitted on bin to intermittently shake it.
- (c) Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyor for measuring the flow of aggregates.
- (d) Dryer unit with burner capable of heating the aggregate to the required temperature without any visible unburnt fuel or carbon residue on the aggregate and reducing the moisture content of the aggregate to the specified minimum.
- (e) The plant shall be fitted with suitable type of thermometric instruments at appropriate places so as to indicate or record/register the temperature of heated aggregate, bitumen and mix.
- (f) Bitumen supply unit capable of heating, measuring/metering and spraying of bitumen at specified temperature with automatic synchronisation of bitumen and aggregate feed in the required proportion.
- (g) A filler system suitable to receive bagged or bulk supply of filler material and its incorporation to the mix in the correct quantity wherever required.
- (h) A suitable built-in dust control system for the dryer to contain/recycle permissible fines into the mix. It should be capable of preventing the exhaust of fine dust into atmosphere for environmental control wherever so specified by the Engineer.
- (i) The plant should have centralised control panel/cabin capable of presetting, controlling / synchronizing all operations starting from feeding of cold aggregates to the discharge of the drum mix to ensure proper quality of mix. It should have indicators for any malfunctioning in the operation.

Every drum mix plant should be equipped with siren or horn so that the operator may use the same before starting the plant every time in the interest of safety of staff.

B - For Batch Type Plant

- (i) Gradation control unit having minimum four deck vibratory screens for accurate sizing of hot aggregate and storing them in separate bins. This unit should be fully covered to reduce the maintenance cost and for better environmental condition.
- (ii) Proper arrangement for accurate weighing of each size of hot aggregate from the control panel before mixing.
- (iii) Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of the mineral aggregate with binder.

C - For Continuous Type Plant

- (i) Gradation control unit having vibratory screens for accurate sizing of hot aggregate and storing them in separate bins. This unit should be fully covered to reduce the

maintenance cost and for better environmental condition.

- (ii) There should be appropriate arrangement for regulating and volumetric control of the flow of hot aggregate, from each bin to achieve the required proportioning.
- (iii) Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of the mineral aggregate with binder.

D - For Drum Mix Plant

- (i) It is a prerequisite that only properly screened and graded materials are fed to the bins. If required, a vibratory screening unit shall be installed at the plant site to ensure the same.

A primary 4-deck vibratory screening unit shall be installed before the multiple bin cold feed system for screening the aggregates and grading the same.

- (ii) Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyer for measuring the flow of aggregate.
- (iii) There should be arrangement to measure moisture content of the aggregate(s) so that moisture correction may be applied for working out requirements of binder and filler.

The temperature of binder at the time of mixing shall be in the range of 150⁰C -to 163⁰ C and that of the aggregate in the range of 155⁰C - 163⁰C. provided that the difference in temperature between the binder and aggregate at no time exceeds 14⁰C.

Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly, and the discharge temperature of mix shall be between 130⁰C to 160⁰C.

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

➤ SCOPE :

This work shall consist of preparing an existing granular or black-topped surface bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean, and treated with prime or Tack coat as shown on the drawings as otherwise stated in the contract.

➤ MATERIALS :

For scarifying and re-laying the granular surface : The materials used shall be coarse aggregates salvaged from scarification of the existing granular base course supplemented by fresh coarse aggregates and screenings so that aggregates and screening thus

supplemented correspond to Clause 404.

For patching potholes and sealing cracks : Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with Clauses 3004.2 and 3004.3 or as directed by the Engineer.

For Profile Corrective Course : A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings, or as indicated in the Contract Documents. The profile corrective course shall be laid to tolerances and densities as specified for wearing course if a single layer, or base course, if it is to be covered with a wearing course layer.

Profile corrective course and its application : The type of material for use as a profile corrective course shall be as shown on the drawing or as directed by the Engineer. Where it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/strengthening course. However, if provided as a separate layer, it may be of the same specification and details given in the contract drawings.

Surface Levels :

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

TABLE 900-1

TOLERANCES IN SURFACE LEVELS

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

➤ Preparation and transport of mix :

Bituminous macadam shall be prepared in a drum mix plant of adequate capacity and

capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. The plant shall be drum mix type. The plant shall have coordinated set of essential units capable of producing uniform mix within the job mix formula such as laid down in Appendix 'A'.

- (a) In case of drum mix plant, the cold feed system shall have variable speed conveyors/ or other suitable devices for regulating the accurate proportion of aggregate in to an even flood flow automatically from a control operation/Control Cabin.
- (b) **Bitumen Control Unit :**
Capable of measuring/metering and spraying required quantity of bitumen at specified temperature with automatic synchronization of bitumen and aggregate feed.
- (c) **Filler System :** A fines feeder system suitable to receive bagged or bulk supply of filler materials and its incorporation to the mix in the correct quantity shall be necessary auxiliary.
- (d) **Dust Control :** A suitable built in Dust Control Equipment for the dryer to contain the exhaust of fine dust in the atmosphere for environmental control wherever so specified by the Engineer.
- (e) Suitable auxiliary Bitumen Boiler of Adequate capacity with self heating arrangement and temperature control device. The boiler should be fitted with temperature indicating instruments.

The temperature of binder at the time of mixing shall be in range of 150 Degree C to 163 degree and that of the aggregate in the range of 155 degree C - 163 degree C provided that the difference in temperature between the binder and aggregate at no time exceeds 14 Degree C. Rate of asphalt of **VG-30 (60/70)** grade in mixing is 3.40% per 1 MT of total mix i.e. 34 kg per 1 MT of total mix.

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

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

➤ **Spreading :** The mix transferred from the tipper at site to the paver shall be spread immediately by means of self-propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix true to the specified lines, grades and cross sections. The paver finisher shall have the following essential features :

- (a) Loading hoppers and suitable distributing mechanism.

- (b) All drives having hydrostatic drive/control.
- (c) The machine shall have a hydraulically extendable screed the appropriate width requirement.
- (d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.
- (e) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.
- (f) The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within the specified tolerances.
- (g) The screed shall have the internal heating arrangement.
- (h) The paver shall be capable of laying either 2.5 to 4.0 m width or 4.0 to 7.0 m width as stipulated in the Contract.
- (i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation.

However, in restricted locations and in narrow widths where the available plant cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of the mix at the time of laying shall be in the range of 123 degree C to 160 degree C. In multi-layer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the top-most layer shall be at the lane line of the pavement.

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

➤ **Compaction** : After the spreading of mix, rolling shall be done by 80 to 100 kN **vibratory roller**. Rolling shall start as soon as possible after the material has been spread deploying a set of rollers as the rolling is to be completed in limited time frame. The roller shall move at a speed not more than 5 km/h. Rolling shall be done with care to avoid unduly roughening of the pavement surface.

Rolling of the longitudinal joints shall be done immediately behind the paving

operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or break-down rolling shall be done with 80-100 kN static weight smooth wheel roller (3 wheels or tandem) as soon as it is possible to roll the mix without cracking the surface or having the mix pick up on the roller wheels. The second or intermediate rolling shall follow the break-down rolling with vibratory roller of 80 to 100 kN static weight or pneumatic tyred roller of 150 to 250 kN weight, with minimum 7 wheels and minimum tyre pressure of 0.7 MPa as closely as possible to the paver and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while material is still workable enough for removal of roller marks with 60 - 80 kN tandem roller. During the final rolling, vibratory system shall be switched off. The joints and edges shall be rolled with a 80 to 100 kN static roller.

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 mix material. The rolling shall then be continued till the entire surface has been rolled to 95 per cent of the average laboratory density (obtained from Marshall specimens compacted as defined in Table 500-10), there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. The roller wheel shall be kept damp if necessary to avoid bituminous material from sticking to the wheels and being picked up. In no case shall fuel, lubricating oil be used for this purpose, nor excessive water poured on the wheels.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 100°C.

Roller(s) shall not stand on newly laid material while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous grout laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approximate binder before the new mix is placed against it.

➤ **Joints**

Where longitudinal joints are made in pre-mixed bituminous materials, the materials shall be fully compacted and the joint made flush in one of the following ways; only method (iii) shall be used for transverse joints:

(i) by heating the joints with an approved joint heater when the adjacent width is being laid, but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of material, to within the specify range of minimum rolling temperature and maximum temperature at any stage for the material, for a width not less than 75 mm. The

Contractor shall have equipments available, for in the event of heater break down, to form joints by method.

(ii) by using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.

(iii) by cutting back the exposed joint for a distance equal to the specified layer thickness to a vertical face, discarding all material and coating the vertical face completely with 60/70 viscosity grade hot bitumen, or cold-applied bitumen or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.

All joints shall, be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, which ever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

➤ **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.

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be 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.

➤ **Arrangement for Traffic :**

During the period of construction, arrangement of traffic shall be done to Clause 112.

➤ **Passage of Traffic along a part of the Existing Carriageway under improvement :**

For widening/strengthening existing carriageway where part width of the existing carriageway is proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consist of providing at least 150 mm thick granular base course covered with bituminous surface dressing in a width of at least 1.5 m and the surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the Engineer. The continuous length in which such work shall be carried out, would be limited normally to 500 m at a place. However, where work is allowed by the Engineer in longer stretches passing places at least 20 m long with additional paved width of 2.5 m shall be provided at every 0.5 km interval.

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

part of the existing carriageway, stipulations as in para above shall apply.

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

➤ **MEASUREMENTS FOR PAYMENT :**

The payment shall be made on the **tonnage basis** of the weight of mix of aggregates and bitumen. For this purpose, the contractor shall have to install a weight bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty and weight of loaded dumper will be recorded in bound and numbered register on plant site. Department will be free to get some loaded dumpers test checked at other weight bridge. Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

➤ **RATE**

The contract unit rate for the work 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 verge, shoulders and construction of diversions;
- (ii) Preparation of base except for laying of profile corrective course but including filling of potholes;
- (iii) Providing all materials to be incorporated in the work including arrangement for stockyards, all royalties, fees, rents where necessary and all leads and lifts;
- (iv) All labour, tools, equipment, plant including installation of drum mix plant, power supply units and all machineries, incidental to complete the work to the Specifications;
- (v) Carrying out the work in pan widths of the road where directed,
- (vi) Carrying out all tests for control of quality and
- (vii) The rate shall cover the provision of bitumen at **3.40 percent** of weight of total mix, with the provision that the variation of quantity of bitumen will be assessed and the payment adjusted as per the rate of bitumen quoted.

Item No. 43 :- Providing and laying Bituminous Seal Coat with stone chips 6 to 10 mm size 0.18 Cum/10sqmt i.e. using 0.66 cmt Agg per M.T. mix using Asphalt VG-30 @ of 4.50% of mix including heating the asphalt and aggregate by continuous batching drum mix plant and paver finisher and consolidating by vibratory roller including providing equipment, tools, plant, firewood, oil, kerosene, labour charge etc, using the contractors own machinery and plant.

1. DESCRIPTION

The work shall consist of construction of premix seal coat as wearing course on a previously prepared base to the requirement of these specification.

2. MATERIALS

2.1 Binder: The binder shall be straight run bitumen of viscosity grade **VG-30** satisfying the requirement of IS:73. The actual grade of the binder to be used shall be decided by the Engineer-in-charge and it shall have to be brought by contractor to the site at his own cost

unless otherwise specified in schedule 'A'.

Viscosity Grade (VG) Bitumen Specification as per IS 73 : 2013

Characteristics	VG - 10	VG-20	VG-30	VG-40
Absolute Viscosity 60°C, poises, min	800	1600	2400	3200
Kinematic Viscosity 135°C CSI, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, % min	99.0	99.0	99.0	99.0
Penetration at 25°C	80-100	60-80	50-70	40-60
Softening point, C min	40	45	47	50
Test on residue from thin film oven test / RTFOT :				
(A) Viscosity ration at 60°C, max	4.0	4.0	4.0	4.0
(B) Ductility at 25°C, cm, min after thin film over test	75	50	40	25

2.2 Coarse aggregates: The coarse aggregate shall consist of crushed stone or crushed gravel.

These shall be clean, durable, of cubical shape, free disintegrated pieces, organic or other deleterious matter and adherent coatings. The aggregates shall preferably be hydrophobic and of low porosity and shall satisfy the physical requirements set forth in Table given in Item No. 18 Para 2. Except that the upper limit for water absorption value shall be one percent.

2.3 Fine aggregates; The fine aggregates shall consist of crusher run screenings, natural sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substances.

2-4 Filter: The filler, where required, shall be an insert material the whole of which passes 600 micron sieve at least 90 percent passing 150 micron sieve and not less than 70 percent passing 75 micron sieve. The filler shall be cement, stone dust, hydrated lime, fly ash and other non-plastic mineral matter approved by the Engineer-in-charge.

2.5 Aggregate gradation : The mineral aggregates, including mineral filler shall be so graded or combined as to conform to gradings set forth in tables below:

Table : Aggregate gradation Pre-Mix Seal Coat

Sieve Designation	Percentage by wt passing through Sieve	
	For type 'A'	For Type 'B'
12.5 mm	-	100
10 mm	100	70-100
4.75 mm	40-85	20-40
2.35	5-20	5-20
75micron	0 - 4	0 - 4

2.6 Proportioning of materials : The binder content for premixing shall be 45.00 kg per M.T. (4.5% by weight) for mixing aggregate.

The quantities of aggregates shall be sufficient to yield the specified thickness after compaction. The contractor shall get the job-'mix formula for the mix approved by the Engineer-in-charge before starting the work.

2.7 Variation in Proportioning of material : The Contractor shall have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix. A variation in binder content of ± 0.3 percent by weight of total mix shall, however be permissible in individual specimen taken for quality control tests vide MOST Specification Section 900.

3. CONSTRUCTION OPERATIONS

3.1 Weather and seasonal limitation : Premix seal coat shall not be laid during rainy weather or when the base course is damp or wet.

3.2 Preparation of base : The base on which premix seal coat is to be laid shall be prepared shaped and conditioned to the specified, lines, grade and cross section in accordance with MOST Specification Clause 601 as directed by the Engineer-in-charge. The surface shall be thoroughly swept" and scraped clean and free of dust and foreign matter.

3.3 Tack coat (if applied) : Application of binder : Binder shall be rapid setting emulsion shall be used and approved by the Engineer-in-charge and sprayed on the base at the rate specified hereafter. The rate of spread in terms of straight run emulsion shall be 2.5 kg per 10 square metre area for an existing bitumen treated surface. The binder shall be applied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.4 Preparation of the mix : Drum mix plant of adequate capacity and capable of producing a proper and uniform quality shall be used for preparing the mix. The plant should be continuous type having a co-ordinated set of essential units such as dryer for heating the aggregates, device for feeding by weight or volume the required quantities of aggregates, a binder heating and control unit for metering out the correct quantity of heated binder together with a paddle mixer for intimately mixing of the binder and aggregates. For details regarding Drum mix plant the Annexure 'A' may be referred.

The temperature of-binder at the time of mixing shall be in the range of 150° C - 177° C and aggregates in the range of 150° C -163° C provided also that at no time shall the difference in temperature of the aggregates and the binder exceed 14° C.

Mixing shall be throughout to ensure that a homogeneous mixture is obtained in which all the particles of the mineral aggregates are coated uniformly.

The mix shall be transported from the mixing .plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in the transit if so directed by the Engineer-in-charge.

3.5 Spreading : The mix, transported from the drum mix plant to the site, shall be spread by means of self propelled mechanical paver with suitable screens capable of spreading, tamping and finishing the mix, true to specified grade, line and cross sections. The temperature of mix at the time of laying shall be in the range of 121° C -163°C.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150 mm from those in the binder course. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.6 Rolling : Immediately after the spreading of mix, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not exceeding 5 km per hour. The initial or break-down rolling shall be with 8-12 tonne three wheeled rollers and the surface finished by final rolling with vibratory rollers or suitable pneumatic rollers. Rolling temperature shall not be less than 100°C in any case the rolling shall be completed the temperature of mix falls about 80° C.

The roller wheels shall be kept damp to prevent the mix adhering to them but in no case shall fuel lubricating oil be used for this purpose. Rolling shall commence longitudinally from the edge and progress towards the centre except that at super elevated portions, it shall progress from the lower to upper edges parallel to the centre line of the pavement. The roller should proceed on the fresh material with rear or fixed wheel leading so as to minimize the pushing of the mix and each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass Rolling shall continue until the entire surface has been rolled to compaction and all the roller marks eliminated.

4. OPENING TO TRAFFIC

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

5. SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction shall conform to the requirements of most specification Clause 901. Control on the quality of material and works shall be exercised by the Engineer-in-charge in accordance with MOST Specification Clause 902.

6. ARRANGEMENT FOR TRAFFIC

The provision of MORTH Specification Clause 105 shall apply as regards the flow to traffic during construction.

7. MEASUREMENT FOR PAYMENT

The payment shall be made on the **tonnage basis** of the weight of mix of aggregates and bitumen. For this purpose the contractor shall have to install a weigh bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty dumper and weight of loaded dumper will be recorded in bound and numbered register on plant side.

Department will be free to get some loaded dumper test checked at other weigh bridge. Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

For the purpose of application of tack coat if the theoretical area as per sanctioned estimate for basis of tonne differs with the actual area of work done in the field, then the reduction in or addition to payment shall have to be effected to the contractor on proportionate basis depending upon the area reduced or exceeded respectively.

Weigh of mix materials will be done in presence of responsible person, not less than the rank of supervisor of Department, Deputy Executive Engineer or Assistant Engineer or Addl. Assistant Engineer if so authorized.

Record of each dumper will be maintained separately in bound and numbered register which will be maintained by the departmental representatives and signed by the contractor. Proper gate pass system shall be established for the vehicles coming to the plant site and out going from the plant site. The location of the kilometer, hectometer in which individual dumper are unloaded will be recorded carefully.

8. RATE

The Contract unit rate for seal coat shall be for payment for carrying out the required operations including full compensation for all components listed in MORTH Specification Clause 503.7.

Item No.44 :- Supplying and fixing road sign board of MS Plates and angle iron including painting, lettering, etc. complete including excavation, etc. complete as per IRC type design - Reflective Type.

1. Materials

- Sign board plate shall be **Mild Steel (MS) sheet** of required thickness conforming to IRC standards.
- Supporting frame and posts shall be MS angle sections of specified size, straight and free from defects.
- Reflective sheeting shall be high-intensity or engineering grade retro-reflective sheeting conforming to IRC:67 and MoRTH specifications.
- Paint for back side and structural steel shall be primer and two coats of enamel paint of approved shade.
- Lettering, symbols, arrows, and borders shall be as per IRC code for road signs.
- Concrete for foundation shall be of specified grade (generally M-15 or as directed).

2. Scope of Work

The work shall consist of supplying, fabricating, transporting, and erecting reflective type road sign boards of approved size, shape, and design as per IRC type design and drawings or as directed by the Engineer-in-Charge (EIC). MS plates shall be cut to shape, edges smoothed, and welded or riveted to angle iron frame. Structural steel components shall be cleaned, primed, and painted before fixing.

Reflective sheeting shall be fixed on the front face of sign board with approved adhesive.

Lettering, symbols, legends, and markings shall be applied as per IRC standards. Excavation for foundation of sign posts shall be done to required depth. Posts shall be erected true to line and plumb, and foundation pits shall be filled with concrete and properly compacted. The sign board shall be fixed firmly to withstand wind loads. The site shall be restored after installation.

3. General Workmanship

Fabrication shall be done neatly with proper welding and finishing. Surfaces shall be free from rust, oil, or scale before painting. Reflective sheeting shall be applied smoothly without wrinkles or air bubbles. Signs shall be aligned correctly and positioned for clear visibility. All edges shall be properly sealed. Work shall conform to IRC/MoRTH specifications.

4. Mode of Measurement and Payment

- Measurement shall be made in **Number (Nos.)** of sign boards supplied and fixed.
- No separate measurement for excavation, foundation concrete, painting, lettering, or fittings.
- Rate shall include cost of MS plate, angle iron, reflective sheeting, painting, lettering, excavation, foundation concrete, erection, labour, tools and plants, transportation, and all incidental charges.
- Work shall be complete in all respects and approved by EIC.
- Nothing extra shall be paid.

Item No.45 : Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beads as per IRC:35-2015.the finished surface to be level , uniform and free from streaks and holes. Zebra patta/bump patta lane /center line/edge line/cut patta.The white color marking should provide liminance coefficinet on cemend road shall be min 130 mcd/m2/lux and asphalt road shall be min 100mcd/m2/lux during the service life during the day time.the marking should meet the performancecriteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section -15 of IRC 35-2015.warranty for retro reflectivity shall be two year

803.4 Hot Applied Thermoplastic Road Marking

803.4.1 Thermoplastic Material

803.4.1.1 General

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

803.4.1.2 Requirements :

i) **Composition:** The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated

in Table 800-9.

Table 800-9 : Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30–30	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 reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.6.4.

803.4.2.2 The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in Clause 803.4.2.3.

803.4.2.3 Specific Requirements

a) **Gradation :** The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

Table 800-10 : Gradation 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

803.6.8 Measurements for Payment

803.6.8.1 The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

803.6.8.2 In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

803.6.9 Rate

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.

All relevant provisions as have been included in the respective IRC and IS specifications are also

applicable.

1.7 **SPECIAL TERMS AND CONDITIONS FOR THERMOPLAST PAINT WORK:**

- (1) Agency should carry out the such type of work by only of thermoplastic paint laying machine (power driven only) with temperature controller and automatic mixing arrangement of glass beads in required proportion.
- (2) After completion of the laying of thermoplastic paint work, four years guarantee for durability and reflectivity as per M.O.R.T.H. specification for road and bridge works clause 803 should be given by the bidder in the writing.
- (3) **Guarantee security deposit shall be retained @ 10% of the cost of the item of thermoplast paint from the R.A. bills, which will be released after expiry of guarantee period.**
- (4) Agency who carry out the such type of work shall have an experience of carrying out similar type of work.
- (5) Test certificates as per M.O.R.T.H. specification for road and bridge works clause 803.3.2.2 (vi) should be furnished of reputed laboratory before.

Item No.46 :- Providing and laying Double Walled Corrugated Pipes (DWC) of Polyethene conforming to IS-14930-II of 90mm O.D. with fittings and necessary connecting accessories of same material at required depth for laying cable into crash barrier etc. complete as per specification and as directed by engineer incharge.

1. Materials

- Pipe shall be **Double Walled Corrugated (DWC) HDPE/PE pipe of 90 mm outer diameter** conforming to **IS 14930 (Part II)**.
- Pipe shall have corrugated outer wall and smooth inner wall, suitable for underground cable ducting.
- Couplers, bends, sockets, end caps, and other fittings shall be of same material and make as pipe.
- Rubber rings or approved jointing accessories shall be used to ensure tight joints.
- Marker tape or warning tape shall be provided where specified.

2. Scope of Work

The work shall consist of supplying, laying, and fixing DWC polyethylene pipes of 90 mm OD at required depth for laying of cables in crash barrier zone, footpath, or other specified locations as per drawings or directions of the Engineer-in-Charge (EIC). Trenches shall be excavated to required width and depth, and bed shall be prepared with sand cushioning where specified.

Pipes shall be laid true to line, level, and gradient without kinks. Jointing shall be done using approved couplers ensuring proper alignment and continuity. Necessary bends, junctions, and sleeves shall be provided. Pipes passing through structures shall be properly protected. After laying, trench shall be backfilled with selected soil or sand and compacted in layers. Surface shall be restored to original condition.

3. General Workmanship

Work shall be executed by skilled workers under supervision. Pipes shall be handled carefully to avoid damage. Joints shall be clean, properly aligned, and secure. No cracked or damaged pipe shall be used. Adequate cover depth shall be ensured. Finished duct line shall be continuous and free from blockage.

4. Mode of Measurement and Payment

- Measurement shall be made in **Running Metres (R.M.)** of DWC pipe laid.
- Length shall be measured along centre line of pipe including fittings.
- No separate measurement for trenching, sand bed, backfilling, or fittings unless specified separately.
- Rate shall include cost of pipes, fittings, jointing materials, laying, fixing, labour, tools and plants, transportation, and incidental works.
- Work shall be complete in all respects and approved by EIC.
- Nothing extra shall be paid.

Item No. 47:- Cat eye/Road stud/ RPM: Supplying of Twin Shanks Raised pavement markers made of polycarbonate and ABS moulded body and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635kgs.tested in accordance to ASTM D 4280 type H and complying to specifications of category A of MORTH circular No RW/NH/33023/10-97-DO III Dt 11.06.1997. The height,width and length shall not exceed 20 mm,130 mm and 130mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35+/-5 degree. The strength of detachment of the integrated cylindrical shanks,(of diameter not less than 19+/-2 mm and the height not less than 30+/-2 mm) from the body is to be a minimum value of 500 kgf. Fixing will be by drilling hole on the road for the shanks to go inside, without nails and using epoxy based adhesive as per manufacturers recommendation and color of the marker should be as per the IRC 35-2015 and as directed by engineer-in-charge.

Relevant specifications given in IS/IRC codes for above work shall be applicable to this item.

804 REFLECTIVE PAVEMENT MARKERS (ROAD STUDS) AND SOLAR POWERED ROAD MARKERS (SOLAR STUDS)

804.1 Scope

The work shall cover the providing and fixing of reflective pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the Contract.

804.2 Material

804.2.1 Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13,635 kg tested in accordance with ASTM D 4280.

804.2.2 Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of methyl methacrylate conforming to ASTM D 788 or equivalent.

804.3 Design

The slope or retro-reflecting surface shall preferably be $35 \pm 5^\circ$ to base and the area of each retro-reflecting surface shall not be less than 13.0 sq.cm.

804.4 Optical Performance

804.4.1 Unidirectional and Bi-directional Studs

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L.). not less than that given in Tables 800-13 or 800-14 as appropriate.

804.4.2 Omni-directional Studs

Each Omni-directional stud shall have a C.I.L. of not less than 2 mcd/lx.

Table 800-13 : Minimum C.I.L. Values for Category 'A' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L & R	0.3°	220	110	44
0° U 10° L & R	0.5°	120	60	24

Table 800-14 : Minimum C.I.L. Values for Category 'B' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 6° L & R	0.3°	20	10	4
0° U 10° L & R	0.5°	15	7.5	3

Note :

- 1) The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.
- 2) The stud incorporating one or more corner cube reflectors shall be included in Category 'A'. The stud incorporating one or more bi-convex reflectors shall be included in Category 'B'.

804.5 Tests

804.5.1 Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS:873-Part 4: 1973.

804.5.2 Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L. at any one position of measurement is less than the values specified in Tables 800-13 or 800-14 provided that

- i) the value is not less than 80 percent of the specified minimum, and
- ii) the average of the left and right measurements for the specific angle is greater than the specified minimum.

804.6 Solar Powered Road Markers (Solar Studs)

The solar studs shall be made of Aluminium alloy and poly carbonate material which shall be absolutely weather resistant and strong enough to support a load of 13,635 kg tested in accordance with ASTM D4280. Its colour may be white, red, yellow, green or blue or combination as directed by the Engineer. Its water resistance shall meet the requirements of IP 65 in accordance with IS:12063:1987 Category 2 for protection against water ingress. The dimensions of solar studs shall not be less than 100 mm x 100 mm x 10 mm. It shall have super bright LEDs so as to provide long visibility from a distance of more than 800 m. Its flashing rate shall not be less than 1 Hz. Its should be able to give the prescribed performance in the temperature range of -40°C to +55°C. Its life shall be not less than 3 years.

804.7 Fixing of Reflective Markers

804.7.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portions of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10 mm and shall not exceed 20 mm. and its width shall not exceed 130 mm. The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured, the outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.

804.7.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure

recommended by the manufacturer. No nails shall be used to affix the marker so that they do not pose safety hazard on the roads. Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing until the surfacing has been opened to traffic for a period of not less than 14 hours. The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the of the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place. For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

804.7.3 Warranty and Durability

The contractor shall submit a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel, to the Engineer. In addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer, at his own cost.

804.8 Measurement for Payment

The measurement of reflective road markers/solar powered road studs shall be in **numbers of different types of markers supplied and fixed.**

804.9 Rate

The contract unit rate for reflective road markers/solar powered road studs 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 specification complete as per approved drawings or as directed by the Engineer.

Item No. 48 A : 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 phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ;reflectorised with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm /65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per theinstruction 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. Aarranty for 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.

MORT&H specifications as mentioned below and as in section 800 (Pg. No-325) (Fifth Revision, April-2013) shall be followed in connection with this item. All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.

801 TRAFFIC SIGNS

801.1 Scope

The work shall consist of the 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 aluminium sheet, aluminium composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium 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 (LDPE) between two thick skins/sheets of aluminium with overall thickness and 3 mm or 4 mm (as specified in the Contract), and aluminium skin of thickness 0.5 mm and 0.3 mm respectively on both sides. The mechanical proportion of ACM and that of aluminium 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)

S. No.	Description	Specification	
		Standard Test	Acceptable Value
A	Mechanical Properties of ACM		
1)	Peel off strength with retro reflective sheeting (Drum Peel Test)	ASTM D903	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 Sheetting

801.3.2.1 High Intensity Grade (Type III)

This high intensity retro reflective sheetting 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 unmetallised 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 D:4956-09) as indicated in **Table 800-2**.

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

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-lx-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 sheetting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheetting shall retain at least 80 percent of its original retro-reflectance.

801.3.3 High Intensity Micro-Prismatic Grade Sheetting (HIP) (Type IV)

This sheetting shall be of high intensity retro-reflective sheetting made of micro-prismatic retro-reflective element material coated with pressure sensitive adhesive. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM D:4956-09) as indicated in **Table 800-3**.

Table 800-3 : Acceptable Minimum Co-efficient of Retro-Reflection for High Intensity Micro-Prismatic Grade Sheetting (Type IV)
(Candelas Per Lux Per Square Metre)

Observation	Entrance	White	Yellow	Orange	Green	Red	Blue	Brown
0.1 ^{0B}	-4 ⁰	500	380	200	70	90	42	25
0.1 ^{0B}	+30 ⁰	240	175	94	32	42	20	12
0.2 ⁰	-4 ⁰	360	270	145	50	65	30	18
0.2 ⁰	+30 ⁰	170	135	68	25	30	14	8.5
0.5 ⁰	-4 ⁰	150	110	60	21	27	13	7.5
0.5 ⁰	+30 ⁰	72	54	28	10	13	6	3.5

A Minimum Coefficient of Retro reflection (RA) cd/fc/ft² (cd-lx-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 sheetting shall show not less than 90 percent of the values of retro reflection indicated in above Table . At the end of 7 years, the sheetting shall retain at least 80 percent of its original retro-reflectance.

801.3.4 Prismatic Grade Sheetting

801.3.4.1 Prismatic Grade Sheetting (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	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow/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	92	69	35

A Minimum Coefficient of Retro reflection (R^A) cd/fc/ft² (cd-lx-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	Entrance	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	115
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
1.0°	-4°	80	60	30	8.0	16	3.6	64	48	24
1.0°	+30°	45	34	17	4.5	9.0	2.0	36	27	14

A Minimum Coefficient of Retro reflection (R^A) cd/fc/ft² (cd-lx-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-reflection (determined in accordance with ASTM E 810) as indicated in Table 800-6.

**Table 800-6 : Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade
Sheeting Type A (Type XI) (Candelas Per Lux per Square Metre)**

Observation	Entrance Angle	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	660	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	17	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
1.0°	-4°	120	90	42	12	18	5.0	4.0	96	72	36
1.0°	+30°	45	34	16	5.0	7.0	2.0	1.0	36	27	14

A Minimum Coefficient of Retro-reflection (RA) cd/fo/ft² (cd-lx-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 sheeting 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 specifications.

801.3.6 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all 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 5 mm. Where screen printing with transparent colours 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 sheeting in the manner specified by the manufacturer.

801.3.7 Messages/Borders

The messages (legends, letters, 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 materials and in a manner specified by the sheeting manufacturer. 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 sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 percent of the values of corresponding colour in Tables 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 Colour 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 250 mm side bands, alternately black and white. The lowest band next to the ground shall be in black.

801.3.8.3 The colour 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 800-7 : 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	0.393	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	0.735	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 colours 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/Prohibitory 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 and State 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 aluminium backing or materials as per Clause 801.2.5, pre-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.

801.3.10 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 Sight Distance/ Clear Visibility Distance (m)	Maximum Distance from Centre 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-height, the width, the heights are indicated in Table IV (a) of the Annexure-4 of IRC:67 to facilitate the design of the informative 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 messages 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 all 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-reflective 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/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 Measurement for Payment

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

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 furnishing of necessary test certificates, warranty and incidentals to complete the work in accordance with these Specifications.

Item No.48 B :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 Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with 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 warranty for 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by Contractor. (A) Class - C Type - 11 Retro Reflective Sheeting

The sign board shall conform to IRC-67-2012 and nineth schedule of the motor vehicle Act. It shall be providing and fixed as directed by the Engineer in charge.

1.2 Traffic Signs having retro-reflective sheeting :

1.2.1 General Requirements :

The retro-reflective sheetings used on the sign shall consist of white or coloured sheeting having a smooth outer surface which has the property of retro reflective over its entire surface. It shall be weather resistance and show colour fastness. It shall be new and unused and shall shown no evidence of cracking scaling pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained form a reputed laboratory by the manufacture of the sheeting. The reflective sheeting shall be either or Engineering Grade material with enclosed lens or of high intensity grade with encapsulated lens/ micro prismatic type. The type of sheeting to be used would depend upon the type functional hierchy and importance of

the road.

High Intensity Grade Sheeting :

Encapsulated Lens Type :

This sheeting shall be of encapsulated lens type consisting of spherical glass lens elements, adhered to a synthetic resin and encapsulated by a flexible, transparent water proof plastic having a smooth surface. The retro reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E:810) as indicated in Table 800-1.

TABLE 800-1

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+ 30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90% of the values of retro reflectance indicated in Table 800-1. At the end of 10 years, the sheeting shall retain at least 75% of its original retro-reflectance.

1.3.3 Engineering Grade Sheeting :

This sheeting shall be of enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical, resulting in a non-exposed lens optical reflecting systems. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard E-810) as indicated in Table 800-2.

TABLE 800-2

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR ENGINEERING GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+ 30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	14.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

1.1.2.3 When totally wet, the sheeting shall not show less than 90% of the values of retro-reflectance indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50% of its original retro reflective.

1.1.3 **Messages / Borders** : The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs. Screen-printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.

1.1.4 For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 800-1(a), 800-1(b) and 800-2 as applicable.

1.1.5 Cut out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per Clause 801.3.2 of 801.3.3 as applicable) except those in black which shall be of non-reflective sheeting.

1.1.6 **Colour** : Unless otherwise specified, the general colour scheme shall be as stipulated in IS:5 "Colour for Ready Mixed Paints".

Blue	IS	Colour No.166 : French Blue
Red	IS	Colour No.537 : Signal Red
Green	IS	Colour No.284 : India Green
Orange	IS	Colour No.591 : Deep Orange

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

1.1.7 **Adhesives** : The sheeting shall either have a pressure sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The sheeting shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

1.1.8 **Refurbishment**: Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminium backing pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for type of material used for the sign and should thoroughly bond with that material.

Alternatively, the aluminium blank shall be recycled to a finished condition and new sheeting's put on in an approved manner.

1.1.9 Fabrication :

1.1.9.1 Surface to be reflectorised shall be prepared to receive the retro-reflective sheeting. The smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

1.1.9.2 Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure sensitive adhesive shall be overlapped not less than 5 mm. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

1.1.10 **Warranty Durability :** For each lot of sheetings procured, the contractor shall obtain from the manufacturer a 10 years warranty for satisfactory field performance including stipulated retro-reflectance of the sheetings of high intensity grade and a 5 years warranty for the engineering grade and submit the same to the Engineer. In addition, a 10 years and a five years warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut-out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and passed on to the Engineer. The contractor / supplier shall also furnish a certification that the signs and materials supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty.

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values Tables 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH weatherometer AASHTO Designation M 268).

1.2 Installation :

1.2.1 Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or

displacement by vandalism. Normally signs with an area upto 0.9 sq.m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanised iron (G.I.). Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

1.2.2 All components of signs and supports, other than the reflective portion and G.I. Posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

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

1.3 **Measurements for Payment :**

The measurement for standard cautionary, mandatory and information sign shall be in number of different types of signs supplied and fixed as per above details and specifications. Direction and place identification signs, also shall be measured in numbers of different type of sign supplied and fixed.

1.4 **Rate :**

The contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

➤ **SPECIAL TERMS AND CONDITIONS OF CONTRACT FOR SIGN BOARDS**

- 1 Warranty certificate for 10 years for respective grades of signs from the sheeting manufacturer should be attached with the bid.
- 2 A certificate of authorization from the sheeting manufacturer shall be submitted with the bid.
- 3 The responsibility for handling, upkeep and safety of the boards lies with the contractor until the completion of work and final payment are released.
- 4 The contract is valid for three months from the date of work order. The required quantity has to be supplied and fixed as and when intimated by the Division.
- 5 The measurement for payment will be done only after fulfilling condition up to the satisfaction of Executive Engineer. The 100% quantity of supply and fixing will be checked by Deputy Executive Engineer and at least 10% quantity of supply and fixing will be checked by the Executive Engineer to ensure quality and workmanship, before passing for payments.
- 6 The contractor will have to ensure how he is going to arrange repair or replacement of defective boards after intimation from the Division.

Item No. 48 C : 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 Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per theinstruction of engineer in charge. The fixing at site shall be 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 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting,

The relevant specification of **Item No. 48A** shall be followed for the execution for the work is **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 Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per theinstruction of engineer in charge. The fixing at site shall be 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 10 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-C Type-11 Retro Reflective sheeting.**

Measurements for Payment :

The measurement for standard cautionary, mandatory and information sign shall be in number of different types of signs supplied and fixed as per above details and specifications.

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. 48 D : Flexible Median Marker : Providing and fixing of flexible median marker that are made of tough,high impact resistant,injection-molded,thermoplastic body with property of flexibility to provide high durability.The dimension of flexible median marker should not exceed 18.4 cm in height (including shank height),12.5cm in width,0.65cm in thickness and shank depth shall be 3.4cm the body structure shall be rounded at all its corners and edges.The plastic used for molding the flexible median marker should survive impact load of 5kg continuously for 750 times at room temperature.The logo of the manufacturer shall be embossed on either side of the body in the injection molding process.The median marker shall have flame like shaped body with,fluorescent yellow color retro-reflective sheeting of size not less than 90 cm square,with fully reflective micro prismatic cube corners as its retro-reflective elements as per IRC 67 2012 and ASTM D4956-09 type XI specifications reflectivity values.The retro-reflective sheeting shall be one or both sides of the flexible median marker and shall be edge protected with no exposed edges which will prevent edge lifting, vandalism, sheeting damage, etc.The flexible median marker shall be fixed by a combination of epoxy adhesive and grouting as recommended by manufacturer and engineer in charge.

The Median Marker shall have flame like shaped body with, fluorescent yellow color retro-reflective sheeting of size not less than 90 Cm square, with fully reflective micro prismatic cube corners as its retro-reflective elements as per IRC:67-2012 and ASTM:D4956-09 type XI specifications reflectivity values. The retro-reflective sheeting shall be one or both sides of the Flexible Median Marker and shall be edge protected with no exposed edges which will prevent edge lifting, vandalism, sheeting damage, etc.

The Flexible Median Marker shall be fixed by a combination of epoxy adhesive and grouting as recommended by manufacturer and Engineer in charge

The measurement shall be in number.

The rate for this item includes cost of all materials, labour, plants and everything required to execute this item etc. complete and maintain till completion of the work and as directed by engineer in charge.

Item No.48 E : Providing and Fixing of NJ Reflector made up of 2mm Aluminium of size 100 x 100mm duly pasted with Reflective sheeting of Florescent yellow Type -11 Fixed to the Bridge wall/ Parapet with Nails.

. Description:

The reflector Marker is made from 2mm Aluminum of size 100 x 100mm duly pasted with Reflective sheeting of Florescent yellow Type -11. The fluorescent yellow reflective sheeting in the reflector helps to highlight the medians and increase the visibility during the night.

The product should have edge sealed Reflective sheeting for vandal proof from pilling off the sheeting for longer durability and service life.

A. Color: The color of the retro-reflective element shall be Florescent Yellow.

B. Material:

Aluminum: Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminum alloy conforming to IS 736 - Material Designation 24345 or 19000

C. Dimensions:

Height: The marker height shall be min 80mm

Width: The marker width shall be 100mm

Body Thickness: min 2mm

2. RETROREFLECTIVE SHEETING

The Marker shall have rectangular shaped fluorescent yellow colored retro-reflective sheeting, conforming to ASTM D4956 -09 type XI specifications, on its surfaces.

The retro-reflective sheeting shall be on both sides of the Marker and shall be edge protected with no exposed edges which will prevent edge lifting, vandalism, sheeting damage, etc. The edge of sheeting should not come out easily by putting nails, sharp objects etc.

The retro-reflective sheeting shall be made of retro-reflective elements that are optically stable, non-metallized, fully retro-reflective, micro-prismatic cube-corners.

Color (daytime)

The retro-reflective sheeting used in the Median Marker shall be of fluorescent yellow color.

The chromaticity coordinates (x,y) of the retro-reflective sheeting shall conform to Table II

Colour	1	1	2	2	3	3	4	4
	X	Y	X	Y	X	Y	X	Y
Fluorescent Yellow	.479	0.520	0.446	.0483	0.512	0.421	0.557	0.442

Fluorescence

The minimum total daytime luminance for the fluorescent yellow colored retro-reflective sheeting, measured in terms of luminance factor (YT %), shall be as per the below Table III.

Table III: Daytime Luminance Color

Colour	Minimum Total Luminance Factor (YT %)
Fluorescent Yellow	45%

Conformance to standard chromaticity (x, y) and luminance factor (Y %) requirements shall be determined by instrumental method in accordance with ASTM E 991.

Coefficients of Retro-reflection (Ra)

The retro-reflective sheeting used in the Median marker shall conform to ASTM D4956 Type XI specifications.

The minimum coefficients of retro-reflection for the retro-reflective sheeting, expressed in candelas per lux per square meter (cd/lux/m²), shall be as per Table IV

TABLE IV

Minimum Initial Coefficient of Retro-reflection (Ra) for retro-reflective sheeting used in Median Marker (cd/lux/m²) (Confirming to ASTM D4956 type XI specifications)

Observation Angle2 (°)	Entrance Angle3 (°)	Fluorescent Yellow
0.2	-4 350	- 350
0.2	+30 130	130
0.5	-4 250	-250
0.5	+30 90	90
1.0	-4 72	-72
1.0	+30 27	27

Observation Angle – The angle between the illumination axis and the observation axis.

3Entrance Angle – The angle from the illumination axis to the retro-reflector axis. The retro-reflector axis is

an axis perpendicular to the retro-reflective surface.

Conformance to coefficient of retro-reflection requirements shall be determined by instrumental method in accordance with ASTM E-810 "Test Method for Coefficient of Retro-reflection of Retro-reflective Sheeting", and per E-810 the values of 0° and 90° rotation are averaged to determine the Ra.

Outdoor weathering performance:

The fluorescent yellow colored retro-reflective sheeting used in the Marker shall have excellent weathering performance.

It shall retain at least 70% of the values of its initial coefficient of retro-reflection as specified in Table IV and the minimum total luminance as specified in Table III when subjected to outdoor weathering for 3 years as per ASTM D4956 and IRC-67-2012 clause 6.7 and shall show no appreciable cracking, blistering or dimensional change

3. Installation

The Marker shall be fixed by a combination of epoxy adhesive and grouting/Drilling on concrete wall or properly constructed solid medians. The Combination of proper grouting (Drill) Epoxy would help for better application and epoxy giving proper support.

4. Measurements for Payment

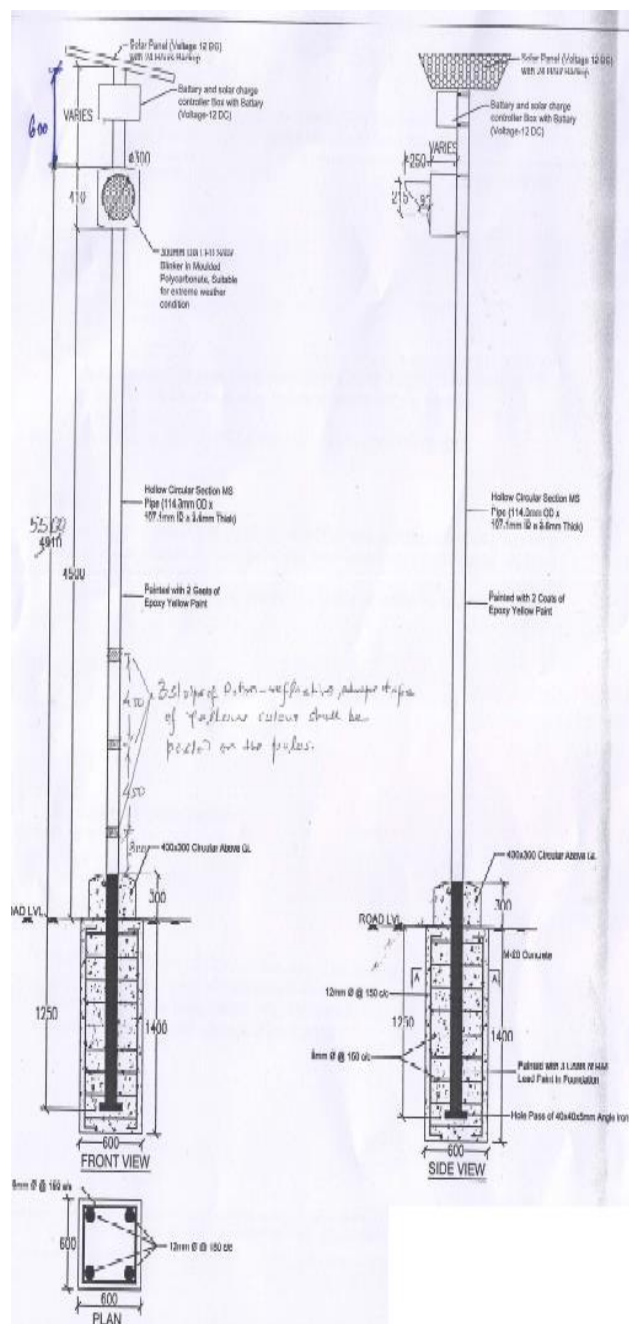
The payment shall be made on a per Number basis.

5. Rate

The Contract unit rate shall be payment in full for the cost of application, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

Item No. 48 F : Blinkers : Providing & fixing solar power road traffic flasher / blinker (24 hour operations) having 300 mm round light source, cluster of high intensity ultra bright LED visibility greater than 500mtr red or amber or as required. Flashing duty cycle 50% operation for 24 hours located 3.0mtr above the ground level on post of 80NB MS Post, design in line with IS 7537-1974 specification of road traffic signals Solar model 12V, 20WP/124, 40W, Battery 12V 60Ah/12 V 110 AH. Operating temperature 0 to 50 C, Humidity 93% EH (NC) complete with Installation.

Providing & fixing solar power road traffic flasher / blinker shall be carried out as per Drawing and as directed by engineer In charge . The Blinkers shall be as per item description & drawings. Blinker shall be fixed on site in consultant with engineer In charge to facilitate general public.



TECHNICAL SPECIFICATION

LED PANEL LIGHT

300 mm dia in Moulded Polycarbonate Signal Head with In-Built Blinker unit with 140 nos LED, Flashing rate: 50-60 pair Min., Colour Amber with wave length 580 ± 5 nm, Working Voltage = 12 DC, Power consumption less than 5 watt per lamp, Lamp intensity more than 260 cd, Ambient temperature should be $(-4^{\circ}\text{C}$ to $(+60^{\circ}\text{C}$, LED viewing angle 23° . Flashing shall continue from dusk to dawn or similar light intensity in day during adverse weather conditions.

SOLAR SYSTEM

Which can take load of Blinker for 24 hours back-up with solar module Working Voltage- 12 VDC ICE certified

BATTERY

Working Voltage 12 DC, 3 days Autonomy, Maintenance Free, Solar charge Controller with cabinet for keeping battery & charge controller, Controller cabinet, Vandal Resistant

POST FOR ERECTION

100 NB HOLLOW CIRCULAR SECTION AS PER IS SPECIFICATION IS : 1161

FOUNDATION

600mm Dia x (300mm Above GL + 1400mm Below GL)
Grade of Concrete = M20

➤ Material

The solar traffic flasher shall be an integrated, self-contained unit suitable for **24-hour operation**. The light unit shall consist of a **300 mm diameter circular LED signal module** fitted with a cluster of **high-intensity, ultra-bright LEDs** capable of visibility from a minimum distance of **500 metres** under normal atmospheric conditions. The emitted colour shall be **Red or Amber** as specified by the Engineer-in-Charge (EIC).

The housing shall be weatherproof, dustproof and suitable for outdoor road conditions with UV-stabilized polycarbonate front lens and corrosion-resistant body. The unit shall conform to the functional requirements of **IS 7537:1974** (Road Traffic Signals) or latest revision.

The solar power system shall consist of:

- Solar Panel: **12V, 20 Wp or 40 Wp** crystalline solar module
- Battery: **12V, 60 Ah or 110 Ah** maintenance-free rechargeable battery
- Charge Controller: Inbuilt automatic controller with overcharge and deep discharge protection

The system shall be designed to operate in temperature range **0°C to 50°C** and humidity up to **93%**

RH (non-condensing).

➤ Construction

- a. The pole shall be 8'-0" in length to provide a solar blinkers mounted on a steel circular hollow pole of standard specification for diversion should fulfill road safety norms of constant output light and 40-50 flashes per minute minimum, even used in, 3 m high fitted with solar panel and light and fixed firmly in concrete foundation.
- The pole shall be a hollow, truncated cone of suitable wall thickness and taper. The taper shall be regular from top to bottom (any section shall be circular).
- The pole surface shall be smooth and uniform in texture and black in color. The pole color shall be added to the resin and transmitted throughout the pole and base to be one solid color.
- The reinforcing glass shall be a commercial grade of "E" glass fibers in continuous filament and woven filaments, or a combination of same. The glass fibers shall be treated with a coupling agent compatible with the resin used.
- The surfacing layer shall be a commercial grade of "C" glass with suitable coupling agent or may be an organic veil compatible with the resin used. The resin shall be thermosetting type.
- The surface layer shall be high in resin content, at least 80% by weight, to assure long life without glass "blooming." The resin shall be a thermosetting-type and shall contain ultra-violet inhibitors and pigment throughout.
- The surface may be painted with an ultra-violet resistant paint. However, the paint may not be a substitute for complete ultra-violet inhibition in the resin used, nor for the surfacing layer.
- The poles shall be furnished with a hand hole and removable, lockable cover and seal. The hand hole shall be located in the decorative base of the pole and shall have minimum dimensions of 3" at the top, 6 ½" at the bottom and be 8" high. The cover shall have the same color and texture as the pole and be equipped with a vandal resistant fastener.
- The pole shall be provided with either a galvanized steel or cast aluminum shoe which is permanently attached to the bottom of the pole. The shoe shall be adhesively bonded to the pole and shall also be mechanically locked to the pole in such a manner that it cannot come loose even if the adhesive bond fails. The shoe shall be slotted to accommodate four 5/8" anchor bolts on the circle variable minimum from 8" diameter to 12" diameter. The pole shall be supplied with 4 - 5/8" x 18" anchor bolts.
- b. The Fiberglass Reinforced Plastic pole shall be Main Street Lighting RTM-Series FF- 802-BK, Shakespeare AP17-8FS011
- c. All components shall be installed in true alignment and firmly secured. Electrical connections shall be properly insulated and protected from moisture ingress. The flasher shall operate with **50% flashing duty cycle** continuously for 24 hours. The system shall be tested after installation for proper charging, battery backup, and flashing performance.
- d. Any defective component during installation or testing shall be replaced by the contractor at no extra cost. Installation shall not damage surrounding structures or roadway.

➤ Installation

The poles shall be placed on the diversion with sufficient care to preserve the exterior finish of the pole and the surface of the foundation. The pole shall be plumbed and tightened as shown on the drawings and indicated in the field by the engineer.

The luminaries shall be installed on the poles as shown on the drawings and indicated in the field by the engineer. Orientation and leveling of the units shall be so as to provide for uniform vertical appearance, maximum lighting efficiency and ease of maintenance as directed by the engineer.

➤ Mode of Measurement

Unit rate includes the cost of materials, labour and tools and plant to complete the work. The payment shall be made on **No.** basis for completed item.

base/sub-base reinforcement having minimum tensile strength 30kN/m in the longitudinal and transverse direction, with 10.5kN/m and 21kN/m tensile strength at 2% and 5% strain respectively in the longitudinal and transverse direction, junction efficiency not less than 95% and with 38mm X 38mm mesh opening.

1. Materials

- Geogrid shall be **Uni-axial or Bi-axial extruded high modulus polypropylene geogrid** conforming to MoRTH specifications.
- Minimum ultimate tensile strength shall be **30 kN/m** in both longitudinal and transverse directions.
- Tensile strength at 2% strain shall be **10.5 kN/m** and at 5% strain shall be **21 kN/m** in both directions.
- Junction efficiency shall not be less than **95%**.
- Aperture size shall be approximately **38 mm × 38 mm**.
- Material shall be resistant to biological degradation, chemicals, and environmental effects.
- Manufacturer's test certificates shall be submitted and approved by Engineer-in-Charge (EIC).

2. Scope of Work

The work shall consist of supplying, laying, positioning, and fixing geogrid over prepared subgrade/sub-base surface for reinforcement of pavement layers as shown in drawings or directed by EIC. The underlying surface shall be level, free from sharp objects, and approved prior to placement.

Geogrid shall be rolled out in the direction specified, stretched to remove wrinkles, and laid flat. Overlaps shall be provided as per specification, typically 300–500 mm or as directed. Adjacent panels shall be joined or pinned using approved fasteners where required. Care shall be taken to prevent damage during spreading of overlying material. Aggregate shall be placed carefully over geogrid without direct trafficking on exposed grid.

3. General Workmanship

Installation shall be carried out by trained personnel. Geogrid shall not be dragged over rough surfaces. Torn or damaged portions shall be replaced. Overlaps shall be maintained correctly. No vehicle movement shall be allowed directly over uncovered geogrid. Work shall conform to MoRTH and manufacturer's installation guidelines.

4. Mode of Measurement and Payment

- Measurement shall be made in **Square Metres (Sq.M.)** of geogrid laid.
- Measurement shall be based on net area covered including overlaps.
- No separate measurement for cutting, lapping, fastening, or wastage.
- Rate shall include cost of geogrid, laying, overlapping, fastening, labour, tools and plants, transportation, and all incidental charges.

- Work shall be complete in all respects and approved by EIC.
- Nothing extra shall be paid.

Item No.50 :- Providing the Diversion by proper means i.e. In proper grade, camber and approach etc. for easy passing of traffic incl. Providing necessary sign board, making etc. as per instructions of Engineer in charge and maintaining the same during the period of work up to completion of work.

1. Scope of Work

This item includes **planning, design, construction, operation and maintenance** of temporary traffic diversion required for safe movement of vehicular and pedestrian traffic during execution of bridge / approach road works.

2. Diversion Road Formation

- The diversion shall be constructed with **approved earth / moorum / GSB / WMM / metal** or other approved material depending on site conditions.
- The diversion road shall have:
 - Proper **longitudinal gradient**
 - Adequate **camber / cross fall** for drainage
 - Sufficient **carriageway width and shoulders** as directed
- Side slopes, embankments and approaches shall be properly shaped and compacted.
- Adequate drainage arrangements shall be provided to avoid water stagnation.

3. Compaction & Riding Quality

- All layers shall be compacted using appropriate rollers or compactors to achieve stable and trafficable surface.
- The riding surface shall be reasonably smooth, free from potholes, loose material and undulations.

4. Traffic Safety Arrangements

The contractor shall provide and maintain the following, as per **IRC / MoRTH guidelines** and directions of the Engineer-in-Charge:

- Advance caution boards indicating:
 - “Road Under Construction”
 - “Diversion Ahead”
 - Speed restriction signs
- Direction and information sign boards
- Barricades, cones, drums and safety tapes
- Reflective studs, reflectors and cat eyes
- Solar blinkers / warning lamps for night visibility

- Flagmen / traffic marshals at critical locations
-

5. Maintenance During Construction Period

- The diversion shall be **maintained in good condition at all times**, including:
 - Filling potholes
 - Regrading and recompaction
 - Removal of loose material
 - Dust suppression by watering, if required
 - During monsoon, special care shall be taken to maintain camber, drainage and surface condition.
-

6. Safety & Responsibility

- The contractor shall be solely responsible for:
 - Safety of road users and pedestrians
 - Any accident, damage or inconvenience caused due to improper diversion or inadequate safety measures
 - All statutory safety requirements shall be strictly followed.
-

7. Removal of Diversion

- After completion of the main work or when directed, the diversion shall be:
 - Properly dismantled
 - Temporary materials removed
 - Site restored to original condition or as directed
-

8. Mode of Measurement

- The work shall be measured as **Rmt.**, unless otherwise specified in the BOQ.
-

9. Mode of Payment

- The accepted lump sum rate shall include:
 - Construction of diversion
 - Traffic management and safety measures
 - Maintenance during entire construction period
 - Removal of diversion and site restoration
 - **No separate payment** shall be made for sign boards, barricading, maintenance, lighting, flagmen or repairs.
-

10. Specifications & Standards

- The work shall conform to:
 - **MoRTH Specifications**

- IRC:SP-55, IRC:67, IRC:SP-84
- Relevant **R&B Department guidelines**
- Any deviation shall be only with prior approval of the Engineer-in-Charge.

Item No. 51 : Providing and fixing guard stone as per I.R.C. type design including white washing etc. complete.(ii) Fixing in C.C. 1:5:10

The guard stone shall be approved quality as per I.R.C. type design including necessary reinforcement and of 20 x 15 cm. size and its length shall not be less than 75 cms. The top portion shall be rounded. The top 38 cms. shall be chillesled dressed on all sides. The size, shape and dimensions of the guard stone shall be exact and shall be neatly dressed and finished.

Fixing in C.C. 1:5:10

The Guard stone 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 good brick bats. Rate includes all labour and curing etc. necessary for concrete.

Unit rate of guard stone includes the cost of all materials, labours, tools, fixing & white washing as directed by the Engineer-in-charge.

In case of Deep/Causeway the guard stone shall be fixed in masonry of head wall as directed by Engineer-in-charge.

Measurement shall be taken and paid on **Number** basis.

Item No. 52 :- Supplying and fixing reinforced concrete heavy duty nonpressure 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 daimeters.(vii) 1200mm dia.

1. This shall consist of furnishing and installing ISI standard Vertical Cast R.C.C. pipes of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.
2. ISI standard Vertical Cast R.C.C. pipes shall be of **NP3** Class manufactured by vertical vibrated casting technology for culverts conforming to the requirements of IS : **458-1991** and shall be of **1200mm** dia. as specified in the item. Each consignment of

cement concrete pipes shall be inspected, if necessary and approved by the Engineer-in-charge either at the place of manufacture or at the site before their incorporation in the works.

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

Production of such certificate will not however relieve the Contractor from his responsibility of supplying pipes of required standard and will have to bear the loss or damage caused to the work on account of defects found subsequently during execution. It will also be necessary to purchase these pipes from manufacturer having standard equipments for carrying out various tests as per IS : **458-1991** at his factory.

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

We _____

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

Satisfy the requirement of IS:458.

Date: _____

Place: _____

Manufacturer's Sign _____

3. **Vertical vibrated pipe over spun pipes** shall be dry cast process. Zero slump, concrete is used. Hence it ensures maximum strength due to extremely low water cement ratio. It is multi Amplitude, multi directional vibration under pressure. Steam curing - concrete achieves 80% to 90% strength within 48 hours. Much better joints to ensure complete water tightness. Very smooth finish inside but rough finish outside. Heavier walled pipe providing increased cover and longer design life.
4. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to minimum of **1200 mm**. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with spigot and socket / rubber ring joint type carrying heavy traffic as per IS **458-1991** specification. Any pipe found defective or damaged during laying

shall be removed at there cost of Contractor.

5. The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diametre of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to from a self centering joint with a joining space 13 cm wide. The joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.
6. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in **linear metres**.
7. The rate for the pipes shall include the cost of pipe including loading, unloading, handing, storing laying in position and joining complete.

The payment shall be made on **Rmt** Basis.

Item No. 53 :- Providing and laying Pitching on slopes laid over prepared filtermedia including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications. A. Stone/ Boulder.

Materials:

- (1) The specification, and Material for panel which is in CC 1:3:6 shall be followed as per Item No. -7
- (2) Rubble
- (3) Materials for pitching.

The pitching material shall consist of the most durable rock fragments of approved quality selected for the purpose. The stones shall be used from the approved quarries and shall be subject to through inspection and approval by the Engineer-In-Charge. The quality of individual stones shall be hard, dense, sound and resistant to abrasion and shall be free from cracks, seams, shale partings, conglomerate, bands and other defects that would tend to increase unduly their susceptibility to destruction by water and weathering action. The shape of the individual stones shall be angular. Stones having thickness less than 33% of their maximum dimensions shall not be used for pitching. Rubble when immersed in water for 24 hours shall not absorb water by more than 5 percent of their dry weight when tested in accordance with IS:1125- 1974. the length of rubble shall not exceed three times its height and the breadth on base shall not be greater than three fourth of the thickness of pitching and in any case not less than 15 cm. Minimum crushing strength of rubble shall not be less than 105 kg./sq.cm.

(a) Size of Rubble / Stone:

No stone/rubble shall be less than 0.021 cum (3/4 cu.ft.) in size. At least 15% of stones to be used for pitching shall have depth equal to the thickness of pitching (30 cm) No stones shall have any dimensions less than 20 cm. (2) Cement, sand and water shall be as specified in Section 6, clause 6.3.3 to 6.3.5.

(b) Stone Cutting:

The compacted embankment, the slope of which is to be protected with stone pitching, shall be trimmed to the lines and slopes as prescribed on the drawings, or as directed by the Engineer-In-charge from time to time. The earth obtained from this trimming shall be laid on top of the embankment if required or as directed by the Engineer-In-charge.

(c) Thickness of Pitching: Pitching shall be hand placed on slope of the embankment. The thickness of pitching shall be as indicated on the drawing. The thickness shall be measured perpendicular to the slope of the embankment.

(d) Method of Placing: Before laying the pitching on sides of the banks, the receiving surface shall be trimmed to the required slopes and profiles put by means of lines and pegs at regular intervals. Depressions shall be filled up and thoroughly compacted. Pitching shall be started from the end and built in course upwards. Stone shall be placed by derrick or by hand and so placed that the largest dimensions are perpendicular to the face of the slope. The larger stones shall be placed in the bottom course and for use as headers for subsequent course.

(e) All interstices between adjacent stones shall be filled with spauls of proper size and wedged in with hammer to ensure tight packing. The joints shall not be more than 35 mm thick but shall be sufficiently thick to prevent stone to stone contact and shall be completely filled with 1:5 cement mortar (1 Cement : 5 sand)

(f) For laying of pucca rubble pitching in cement mortar 1:5 (1 Cement: 5 sand) relevant specifications shall apply.

(g) For racking out joints & joint pointing is cement Mortar 1:3 (1 Cement: 3 sand) relevant specifications of item no. 54 shall be applying.

Measurement and Payment :

Measurement for payment shall made on the basis of square metre of the completed works. The unit rate is inclusive of trimming the earth surface to the required profile, slopes and grade and / or preparing levels strips at suitable interval as directed to have uniform base, cost of cement mortar etc. as per above specification. It shall include construction of rubble pitching, line and level as per drawings.