SABARMATI RIVER FRONT DEVELOPMENT

Sabarmati River Front Development Corporation Limited

2nd Floor, Riverfront House,
B/h H. K. Arts College,
Between Gandhi Bridge and Nehru Bridge,
Pujya Pramukh Swami Marg (River Front Road – West)
Ahmedabad - 380 009

BID DOCUMENT

CONSTRUCTION OF ROAD WITH INFRASTRUCTURE SERVICES LIKE ELECTRICAL, STORM WATER DRAINAGE AND HORTICULTURE WORKS FROM SADAR BAZAR TO INDIRA BRIDGE ON THE EAST BANK AND RAILWAY BRIDGE TO INDIRA BRIDGE ON THE WEST BANK OF RIVER SABARMATI

Contract Package: SRFDCL

VOLUME- 02

IV) Technical Specification

SECTION IV

TECHNICAL SPECIFICATIONS

SUB SECTION 4.1
TECHNICAL SPECIFICATION
FOR
CIVIL WORKS

GENERAL

The specifications to be followed for this work are the specification for road & bridges are published by the MORTH for relevant Items. This specification shall be supplemented by the technical specification as given here under in this document and also the provision in the relevant IRC & IS codes.

In case of any discrepancy or contradiction if any in the provision of above specification the order of the precedence shall be followed.

1. MORTH
2. IRC Provisions
3. Technical Specification in this Volume
4. IS Provisions
5. Sound Engineering Practice
6. Manufacture specification for special items

All work shall be carried out in confirmation with the above specifications. These specifications broadly cover all major aspects of the work involved. Minor details may not be specified here however if these are necessary for completion of work the contractor shall execute such minor items without any additions to the costs.

All work shall be executed in accordance with good engineering practices.

The Contractor shall remain responsible for workmen's compensation if any, when such case occurs, the contractor shall arrange for red lamps at night and fencing etc. shall be responsible for any damage of life and or property if any happen, during the execution of work. In case of dispute for unseen or overlooked items, the decision of Engineer in charge shall be final. The Contractor shall have to give site clean of all rubbish on completion of work and handover the bridge with final finishing as directed. All the rejected materials shall be removed from site within 24 hours by Contractor at his risk and cost.

The Contractor shall have to make his own arrangement for water required for the work.

If in the interest of SRFDCL, it is necessary to change either any site or the design of the proposed work the Contractor shall carry out the works and he will be paid at the rates quoted by him and no claim for extra for subsequent changes made, entertained.

The cubical contents of the cement bag shall be taken as per actual weight of bag and the Contractor shall have to prepare the concrete mixes using weigh batches.

Contractor will be fully responsible for compliance of the various provisions under Contract Labour Act, 1970 and the Rules framed there under.

Contractor is requested to procure their quarry materials required for construction work through legal sources i.e. only from the quarry lease holders permit holders or middleman who satisfies the contractor as to the legality of the source of purchase by him of these materials.

GENERAL DETAILS

All work shall be carried out in confirmation with these specifications. In general, provisions of Indian Standard, Indian Road Congress codes and 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 shall be read in conjunction with the various other documents forming the contract, tender specifications, BOQ, contract drawings and other related documents.

Measurement and payments

a) The methods of measurement and payment shall be as described under various items and in Price Bid. Where specific definitions are not given, the methods described in MORTH will be followed. Should there be any detail of construction of materials which has not been referred to in the specifications or in Price Bid 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 Price Bid.

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.

SPECIFICATION FOR CIVIL WORKS

1. The specification for various items of work shall be same as specified for such items in the MORTH SPECIFICATIONS FOR ROAD AND BRIDGE WORKS, latest published prior to 1 month before issue of tender.

2. The inclusions and exclusions from quoted rates are specified in the details of each item of work in the specifications and the Bill of Quantities. In case there is no specific mention of a particular detail, the mode of specification as prescribed in MORTH SPECIFICATIONS for such an item shall be followed.

3. In the event of contradiction between the MORTH specifications referred to above and this Contract document, the provisions of this Contract document shall prevail.

Applicable Standards
For
Civil Work

Section: A - Applicable Standards for Civil work

1	Conversion factors	IS:786
2	Method of measurement of building works	IS:1200
3	Code of practice for measurement of civil engineering works	IS:3385
4	Materials and workmanship for earthwork and excavation	IS:1200 (PART I)
5	Safety code for blasting and related drilling operations	IS:4081
6	Safety code for excavation work	IS:3764
7	Moisture content in sand for filling	IS:2720
8	Determination of moisture content	IS:2720 (PART II)
9	Determination of moisture content & dry density relation using light compaction	IS: 2720 (PART VIII)
10	Determination of dry density of soils in-place by the sand replacement method	IS:2720(PART XXVIII)
11	Determination of dry density of soils in-place by the core cutter method	IS:2720 (PART XXIX)
12	Anti termite treatment	IS:6313(PART I TO III)
13	Construction water	IS:456
14	Methods of sampling and test (physical and chemical water used in industry)	IS:3025
15	Ordinary (33 grade)/low heat Portland cement	IS:269
16	Ordinary Portland cement (43 grade)	IS:8112
17	Ordinary Portland cement (53 grade)	IS:12269
18	White Portland cement	IS:8042-E
19	Portland pozzolana cement	IS:1489
20	Rapid hardening Portland cement	IS:8041, IS:269
21	Portland (blast furnace) slag cement	IS:455
22	Hydrophobic cement	IS:8043
23	High alumina cement	IS:6452
24	Super sulphated cement	IS:6909
25	Oil well cement	IS:8229E
26	Standard for testing of cement	IS:650
27	Methods of physical tests for hydraulic cement	IS:4031
28	Specification for standard sand for testing of cement	IS:650
29	Coarse and fine aggregates for concrete	IS:383, IS:515
30	Gradation of coarse aggregates	IS:383(TABLEII)
31	Gradation of fine aggregates	IS:383 (TABLE III)
32	All-in aggregates	IS:383 (TABLE IV)
33	Method of tests for aggregates for concrete	IS:2386(PART I TO VIII)
34	Methods of determination the maximum qty. of deleterious materials in aggregate	IS:2386 (PART II)
35	Limiting values of the maximum quantities of deleterious materials in aggregate	IS:383 (TABLE I)
36	Flakiness index of aggregates	IS:2396 (PART I), IS:5640
37	Moisture content test for aggregates	IS:2386 (PART III)
38	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.	IS:432 (PART I & II)
39	Specification for plain hard drawn steel wire fabric for cement concrete	IS:1566

40	Specification for cold twisted steel bars for concrete reinforcement	IS:1786
41	Specifications for hot rolled mild steel and medium tensile steel deformed bars	IS:1139, IS:1739
42	Code of practice for bending and fixing of bars for concrete reinforcement	IS:2502
43	Mild steel binding wire	IS:280
44	Code of practice for welding of mild steel bars used for RCC	IS:2751
45	Code of practice for plain and reinforced concrete	IS:456
46	Code of practice for general construction of plain and RCC for dams	IS:457
47	Testing of reinforced cement concrete	IS:516
48	Method of tests for strength of concrete	IS:516
49	Methods of sampling & analysis of concrete	IS:1199
50	Code of practice for concrete structures for storage of liquids	IS:3370 (PART I TO IV)
51	Code of practice for composite construction	IS:3935
52	Code of practice for construction of reinforced concrete shell roof	IS:2204
53	Criteria for the design of RCC shell structures and folded plates	IS:2210
54	Specification for batch type concrete mixers	IS:1791
55	Specification for portable swing weigh batchers for concrete	IS:2722
56	Specification for roller pan mixer	IS:2438
57	Specification for concrete vibrators immersion type	IS:2505
58	Specification for screed board concrete vibrators	IS:2506
59	Specification for concrete vibrating tables	IS:222
60	Specification for pan vibrators	IS:3366
61	Specification for form vibrators for concrete	IS:4656
62	Code of practice for use of immersion vibrators for consolidated concrete	IS:3558
63	Air entraining agent	ASTM:6260
64	Criteria for design and construction of precast concrete trusses	IS:3201
65	Prestressed concrete	IS:1343
66	Specification for high tensile steel bars used in code of practice for pre-stressed concrete	IS:2090
67	Specification for plain hard drawn steel wire for pre-stressed concrete	IS:1785 (PART I)
68	Specification for plywood for concrete	
69	Shuttering work	IS:4990
70	Code of practice for steel tubular scaffolding	IS:4014 (PART I & II)
71	Specification for steel scaffolding	IS:2750
72	Safety code for scaffolds and ladders	IS:3696
73	Common burnt clay building bricks	IS:1077
74	Classification of burnt clay bricks	IS:3102
75	Burnt clay building bricks, heavy duty	IS:2180
76	Burnt clay facing bricks	IS:2691, IS:1077
77	Method of sampling and testing clay building bricks	IS:3495 (PART I - IV)
78	Mortar for brick work	IS:2250
79	Code of practice for brick work	IS:2221
80	Masonry works	IS:3466
81	Structural safety etc. Of building masonry walls	IS:1905
82	Load bearing hollow concrete blocks	IS:2185
83	Lime - cement - cinder hollow concrete blocks	IS:5498

84	Lime - cement - cinder solid blocks	IS:3115
85	Code of practice for construction of stone masonry	IS:1597 (PART I)
86	Stone tests	IS:1124
87	Code of practice for design and installation of joints in buildings	IS:3414
88	Joint sealing compound	IS:834
89	Pre-moulded bituminous joint filler	IS:1838
90	Timber door, window and ventilator frames	IS:4021
91	Material & workmanship for wood work	IS:883, IS:4021
92	Wooden flush door shutters (solid core type)	IS:2202 (PART I)
93	Timber panelled and glazed shutters	IS:1003 (PART I & II)
94	Method of tests for wooden flush doors, type tests	IS:4020
95	Plywood & tests	IS:303
96	General tests for wood work	IS:1659
97	Red lead for wood knot	IS:103
98	Oil type wood preservative	IS:218
99	Particle board	IS:3087
100	Transparent sheet glass for glazing & framing purposes	IS:1761
101	Resin bonded fiber glass	IS:3144
102	Putty for glazing	IS:420
103	Steel door frames	IS:4351
104	Steel window	IS:1361
105	Steel doors	IS:1038
106	Steel ventilators	IS:1081
107	Rolling shutters	IS:6248
108	Primer for steel doors, windows & ventilators	IS:102
109	Aluminium alloy for door/window frames	Dsgn Hea-WPO IS:733
110	Sections	IS:1948
111	Anodizing	BS:1616
112	Hydraulic lime & storage	IS:712
113	General tests for lime	IS:6932 (PART I TO X)
114	Field tests for lime	IS:1624
115	Lime mortar preparation	IS:1625
116	Slacked lime	IS:1639
117	Surkhi	IS:1344
118	Code of practice for application of lime plaster finish	IS:2394
119	Rough cast plaster	IS:1661(CLAUSE-165)
120	Specification for integral cement water proofing compounds	IS:2645
121	Water proofing asphalt/maxphalt	IS:702
122	Bitumen saturated layer	IS:1322
123	Bitumen felt	IS:1322
124	Bitumen	IS:702
125	Code of practice for laying and finishing of cement concrete flooring tiles	IS:1443
126	Material & workmanship for flooring	IS:1197, IS:1344
127	Code of practice for laying in situ terrazzo floor finish	IS:2114
128	Code of practice for laying in-situ cement concrete flooring	IS:2571
129	Mosaic tiles	IS:1237
130	Glazed earthenware tiles	IS:777
131	Marble chips & marble mosaic terrazzo	IS:2114

132	Plain cement tiles & tests	IS:1237
133	Marble mosaic tiles	IS:1237
134	Marble slab	IS:1130
135	PVC flooring tiles & sheets	IS:3461, IS:3462
136	Broken marble mosaic tiles	IS:1257
137	Oxy-chloride	IS:658
138	Magnesium chloride	IS:657
139	C.I. grid tiles	IS:210
140	Pigment for terrazzo flooring	IS:459
141	Rivets	IS:1148
142	Electrodes for welding	IS:814
143	Code of practice for use of electric arc welding for general construction in steel	IS:813
144	Tests for welding works	IS:1181
145	Welding works	IS:816
146	Bolts and nuts	IS:1367
147	Tests for bolts and nuts	IS:1608
148	Structural steel sections & tests	IS:226
149	Structural steel plates	IS:2062
150	Defects in structural steel	IS:229
151	Dimension & properties of steel section	IS:808
152	Structural steel work	IS:226, IS:4948
154	Expanded metal steel sheet	IS:412
155	Mild steel wire gauze jali	IS:280
156	Welding procedure & edge preparation	IS:823
157	Washers	IS:2016
158	Storage of welding wire & electrodes	IS:816
159	Primer to structural surface for bolts	IS:2074
160	Chequered plates	IS:3502
161	Code of practice for painting of ferrous metal in building and allied finishes	IS:1477 (PART I & II)
162	Distemper and dry color	IS:427
163	Code of practice for painting concrete, masonry and plaster surfaces	IS:2395
164	Distemper and oil emulsion	IS:428
165	Enamel paints	IS:2933
170	Coat of zinc chromate	IS:104
171	French spirit polish	IS:348
172	GI sheets	IS:227
173	Ac sheets	IS:459
174	Ac sheet fixing	IS:730
175	Mangalore pattern tiles	IS:654
176	Fiber glass reinforced polyester	IS:4154
177	Galvanized steel for barbed wire	IS:278
178	Insulation of hot water pipes, tanks & heat exchanger	BS:476
179	GI pipes & MS tubes	IS:1239 (PART I)
180	Screw down bib cocks & stop cocks	IS:781
181	Vitreous sanitary fixtures(general)	IS:2556 (PART I)
182	Gun metal wheel, globe, check, gate & non return valves	IS:778

183	Wash basin	IS:2556 (PART IV), IS:771
184	European W.C.	IS:2556, IS:771
185	Solid plastic seat & cover	IS:2548
186	Orissa pan W.C.	IS:2556 (PART III)
187	Squatting pans & traps	IS:2556 (PART III)
188	Indian W.C. (wash down W.C.)	IS:2556 (PART II), IS:771
189	Urinals	IS:2556 (PART VI)
190	Half round channels	IS:2556 (PART VII)
191	Specific requirements of siphonic wash down W.C.	IS:2556 (PART VIII)
192	Ss sink/C.I./flushing tank brackets	IS:775
193	C.I. siphonic flushing cistern	IS:774
194	Lead pipes	IS:404 (PART I)
195	Sand cast pipes & fittings	IS:1729
196	C.I. spun soil pipes & fittings	IS:3939
197	Gully trap	IS:651
198	Glazed stone ware pipes & fittings	IS:651
199	High pressure/crydon ball valve	IS:1703
200	C.I. sluice valve	IS:780
201	Capstan head	IS:1795
202	Malleable iron fittings	IS:1879 (PART I TO X)
203	C.I. pipes	IS:1536, IS:1537
204	Molten (pig)lead	IS:782
205	C.I. manhole frames & covers	IS:1726
206	Concrete pipes	IS:458
207	Threads for screwed pipes	IS:554
208	Lead jointing	IS:718
209	Carbon steel for pipes	IS:9161
210	Low level ceramic cistern	IS:774
211	Bowl pattern flat back urinals	IS:2556 (PART IV)
212	Showers	IS:2064
213	Heavy C.I. pipes	IS:1729
214	Concrete mix design	IS:10262
215	Code of practice for construction of floor and roof with joists and filler blocks	IS:6061 (PART I)
216	Code of practice for construction of light weight concrete block masonry	IS:6042
217	Specification for load bearing light weight concrete blocks	IS:3590
218	Code of practice for construction of hollow concrete block masonry	IS:2572
219	Specification for concrete masonry units (hollow and solid concrete blocks)	IS:2185 (PART I)
220	Chemical composition of ordinary Portland cement	IS:4032
221	Sulphate resistant cement	BS:4027 & ASTMC-150 TYPE II
222	Specifications for circular hollow sections	IS:1161
223	Properties of rectangular & square hollow sections	IS:4923
224	Cold formed welded & seamless carbon steel structural tubing	ASTMA 500
225	Cold but not formed welded & seamless carbon steel structural tubing	ASTMA 501

226	Hot formed welded & seamless high strength low alloy tubing	ASTMA 618
227	Hot rolled structural steel hollow section	BS:4848/
228	(Part 1) Code of Practice for design and construction of pile foundation concrete piles cast-in-situ bored piles.	IS: 2911
229	Recommendation for detailing of Reinforcement in Reinforced Concrete Works.	IS: 5525
230	Guidelines for dewatering during construction	IS: 9759 : 1981

Note: For the reference of all Codes and Standards, the latest version of the above specified Standards shall be followed, Wherever, such Standards are not specified for the construction materials, equipment and method, the relevant Indian Standard Codes of Practice shall be followed, in the absence of Indian Standards corresponding British Standard Codes of Practice or relevant American Standards shall be followed.

List of Approved Makes
For
Civil Work

Section B - List of Approved Make for Civil Works

Sr. No.	Material / Item	Make
1	Cement OPC	UltraTech, ACC, Ambuja, J.K Laxmi, Wonder, Sanghi, Hathi, Siddhi, Binani
2	Cement - White	J.K. White, Birla White
3	Admixture for Concrete	Fosroc, BASF, Sika, Mapei, STP Limited, MYK Arment, Chryso India, CAC, Fairmate, Pidilite
4	Reinforcement Steel: Main Producers only	TATA, SAIL, RINL (VIZAG)
5	Coarse Aggregates (machine cut) - 6mm to 40mm sizes (Hard black trap stone)	Approved quarry from Sevalia, Bayad, Vadagam & Vatrak
6	Stone /Rubbles & Gravels (Hard black trap stone)	Approved quarry from Sevalia, Bayad, Vadagam & Vatrak
7	Concrete Curing Compound	Sika, Fosroc, Mapei, MYK Arment, Pidilite, STP Limited
8	Filler board	Supreme, STP Limited, Duraflex
9	Polysulphide Sealant/ PU sealant	Mapei, Sika, Fosroc, Pidilite, Bostik, STP Limited, Cico
10	Shuttering plywood	Greenply, Archidply, Duroply, Century, Greenlam
11	FRP shuttering	Technos-n-plastos
12	Mold release agent	Fosroc, Pidilite, BASF, Sika
13	Core cutting	Hilti, Fischer, Wuerth
14	PVC pipe	Prince, Astral, Supreme
	WATERPROOFING WORK	
15	Coal tar epoxy	Fosroc, BASF, Sika, Mapei, STP Limited, Asian, Burger
16	PVC Water stop/Water bar	Jyoti Polyvinyl, Kanta Polymers / Hitech Rubber Industries, Fosroc, Sika
	PLASTER WORK	
17	Water Proofing compound	Fosroc, Sika, Mapei, Pidilite, STP Limited, Chryso India, Asian, Berger
	PAINTING WORK	
18	Paint - Enamel	Asian, Dulux, Berger Paints, Nerolac, MRF, Nippon, Indigo
19	Paint - Acrylic Emulsion (Exterior) and Primer	Asian Paints, Akzo Nobel (Dulux), Jotun, Berger, Nerolac, Birla Opus, Indigo, Nippon

20	Paint - PU & epoxy paint, and primer	Asian PPG, ICI, Berger, Jotun, MRF, Akzo Nobel (ICI Dulux), Nippon, Nerolac
21	Water & Stain repellent coating	Killick Guard Speciality Products Limited, Konstruktion Chemie, Dow corning, Wacker, Akemi, MYK Laticrete, Ardex Endura, Saint Gobain-Weber
	METAL WORK	
22	Structure Steel & Hollow Section - Producers only	SAIL, TATA (TISCO), RINL, Jindal Steel & Power (JSPL), APL Apollo tube, JSW
23	Steel (MS) rolled section & plate	TATA, Jindal, SAIL, RINL
24	Anchor Fastener, Rebar, Chemical/ Mechanical fastener, Expandable fasteners	Hilti, Fischer, Wuerth, Mungo, AFT, Axel India, ITW, Power, Split, Trixel, Kilmas, Buildex
25	Non shrink cementitious precision (anchoring) grout	Fosroc, Sika, Mapei, Pidilite, BASF, MYK Arment, Ultratech, Ardex Endura, STP Limited
26	Polyester Powder coating/ PVDF Coating	Jotun, AkzoNobel (Internpon), Asian PPG
	EXTERNAL DEVELOPMENT WORK	
27	Precast Paver block	Vyara, Winner conmat, Super, Basant Betons
28	Precast Kerb	Vyara, Winner conmat, Super, PSP Projects & Proactive Con Pvt Ltd
29	Precast Concrete elements (light pole cover, base of dustbin, bollard, saucer drain, coping and other elements)	Vyara, Winner conmat, Super, PSP Projects & Proactive Con Pvt Ltd, Artocrete, Fuji, Sachi
30	Tiles/ Stone fixing Adhesive (Only High performance, polymer modified, non-slip adhesive)	Ardex Endura, MYK Laticrete, KeraKoll, Saint Gobain - Webar, Roff, Mapei, Fosroc, Pidilite, Samrock
31	Epoxy Grout/ Cementitious Grout for Flooring	Ardex Endura, MYK- Latricrete, KeraKoll, Saint Gobain-Weber, Mapei, Roff, Ultratech
32	Terrazzo	Vyara, Bharat Tile, Artocrete.
33	FRP Recessed Manhole cover	Thermodrain, Strong Drain, Amrock, Fibrocast, HIMALAYA
34	Precast Perforated Drain Cover	PSP Projects & Proactive Con Pvt Ltd, Vyara, ACE Infracon, Fuji

35	FRC Heavy Duty (HD35) Man hole cover with frame	ACE Infracon, Vyara, PSP Projects & Proactive Con Pvt Ltd, Shilp, HIMALAYA
36	Safety equipment	Frontier, 3M India Ltd, Protector, Ananta Inc
37	Road marking paint	Kataline, Asian, Berger, STP Limited
38	Bitumen	IOCL, BPCL, HPCL
39	ACP sheet for signage	Alstone, Viva, Eurobond, Aludecor, Alucobond, Alstrong
40	Signage	Cosign, Vista
41	Vinyl Sticker and lamination for signage	3M

NOTE:

i All materials and products shall conform to the relevant standards (IS, EN, BS, ASTM, ISO, AS/NZS) and shall be of approved make and design.

ii The Architect shall give the approval of a manufacturer only after a review of the sample/ mock-up. In case the same is not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer then an equivalent approved make shall be used with the approval of Architect. The complete system and installation shall also be in conformity with applicable Codes & Standards and Tender specifications.

iii Architect and Engineer-in-charge reserves the right to choose any of the approved as per this list.

iv In case of products not indicated in this list, the name of the manufacturer shall be given by the Architect and Engineer-in-charge.

Cement Consumption

Section C - Cement Consumption

No.	Item	Ratio/ Grade	Consumption per Unit	
A.	**CEMENT CONCRETE (OPC 53 grade Cement)**			
	BBCC (Volumetric)	1:5:10	2.60	Bags/m^3.
		1:4:8	3.40	Bags/m^3.
	PCC (Volumetric)	1:6:12	2.30	Bags/m^3.
		1:5:10	2.60	Bags/m^3.
		1:4:8	3.40	Bags/m^3.
		1:3:6	4.30	Bags/m^3.
	PCC (Controlled concrete)	M7.5	3.40	Bags/ m^3.
	PCC (Controlled concrete)	M10	4.70	Bags/m^3
	PCC (Controlled concrete)	M15	5.50	Bags/ m^3.
	RCC (Controlled concrete Minimum cement content as per IS - 456:2000)	M15	5.70 (285 Kg)	Bags/m^3.
		M20	6.0 (300 Kg)	Bags/m^3.
		M25	6.5 (325 Kg)	Bags/m^3.
		M30	7.0 (350 Kg)	Bags/m^3.
		M35	7.5 (375 Kg)	Bags/m^3.
B.	**MORTARS**			
	Cement and Sand mortar			
		1:1	20.4	Bags/m^3.
		1:2	13.6	Bags/m^3.
		1:3	10.2	Bags/m^3.
		1:4	7.60	Bags/m^3.
		1:5	6.2	Bags/m^3.
		1:6	5.0	Bags/m^3.
		1:8	3.83	Bags/m^3.
C.	**MASONRY WORK**			
	Brickwork in Cement sand mortar **(Conventional)**			
		1:3	2.55	Bags/m3.
		1:4	1.90	Bags/m3.
		1:5	1.56	Bags/m^3.
		1:6	1.27	Bags/m^3.
		1:8	0.95	Bags/m^3.
	Stone masonry, Coursed			

		1:3	3.06	Bags/m^3.
		1:4	2.28	Bags/m^3.
		1:6	1.50	Bags/m^3.
		1:8	1.18	Bags/m^3.
	Stone masonry Uncoursed			Bags/m^3.
		1:5	2.04	Bags/m^3.
		1:6	1.65	Bags/m^3.
	Half Brick work **(Conventional)**	1:3	0.29	Bags/m^2.
		1:4	0.21	Bags/m^2.
		1:5	0.17	Bags/m^2.
D.	**PLASTERING**			
	10 mm. thick plaster in Cement mortar, on ceiling & soffit of stair, chajjas etc.			
		1:3	0.12	Bags/m^2.
		1:4	0.1	Bags/m^2.
	15 mm. thick single coat plaster in on walls			
		1:3	0.17	Bags/m^2.
		1:4	0.13	Bags/m^2.
	20 mm. thick plaster in Cement mortar, on unfair side of brick in single coat			
		1:3	0.23	Bags/m^2.
		1:4	0.17	Bags/m^2.
	20 mm. thick plaster in Cement mortar, on unfair side of brick in double coat (First coat 15mm in 1:4 and second coat of 5mm in 1:3)		0.18	Bags/m^2.
	20 mm. thick Sand Face plaster (First coat 15mm in 1:4 and second coat of 5mm in 1:2)		0.22	Bags/m^2.
	15 mm. thick Water Proof plaster in 1:3 Cement mortar		0.21	Bags/m^2.
	Neat Cement finishing		0.044	Bags/m^2.
E.	**POINTING**			
	Flush, Grooved or Struck in Cement Brick masonry			
		1:1	0.092	Bags/m^2.
		1:2	0.046	Bags/m^2.
		1:3	0.03	Bags/m^2.
		1:4	0.023	Bags/m^2.
	Flush, Grooved or Struck in Cement Random Stone masonry			
		1:3	0.023	Bags/m^2.
F.	**FLOORING**			

	Precast Mosaic Tiles of 40mm thk. in cement mortar 1:6		0.30	Bags/m².
	20mm thk. Green Kotah/Granite Stone in flooring, skirting & dado of 50mm thk. in cement mortar 1:6		0.50	Bags/m².
	20 mm thick. Green Kotah/ Granite Stone in Risers and Treads		0.50	Bags/m².
	20 mm thick. Double Polished Kotah/Granite Stone		0.50	Bags/m².
	25mm thick. Rough Kotah, Dholpur, Red Mandana, Bansipahadpur stone etc. in flooring, skirting & dado of 50mm thk. in cement mortar 1:6		0.50	Bags/m².
	Glazed Tiles, Ceramic tiles, vitrified tiles flooring in 25 mm thick. Bedding of C:M 1:6		0.20	Bags/m².
	Glazed Tiles, Ceramic tiles, vitrified tiles dado in C:M 1:1		0.20	Bags/m².
	China mosaic with 25 mm bedding mortar in C:M 1:6		0.22	Bags/m².
	18-20mm Marble, Granite, Jesalmer Slab with avg. 50mm bedding mortar in cement mortar 1:6		0.50	Bags/m².
	I.P.S.	40 mm. thick	0.35	Bags/m².
		50 mm. thick	0.40	Bags/m².
		75mm. thick	0.55	Bags/m².
	115mm water proofing plaster		0.40	Bags/m².
	Brick-on-edge		0.12	Bags/m².
	Wet stone cladding in C:M 1:2		0.2	Bags/m².
	Chemical water proofing 3 coats		0.05	Bags/m².
	Sandwich platform		0.5	Bags/m².
G.	**MISCELLANEOUS**			
	Filling Zaris with			
	C.M.	1:3	5.0	Bags/ 100 m.
	C.C	1:2:4	3.2	Bags/100 m.
H.	**ROADWORK**			
	Precast exposed Curbs M20	1:2:4	35	Bags/100 m.
I.	**SANITARY WORK**			
	R.C.C Hume pipes jointed with Cement mortar 1:1			
		600 mm. dia.	6.4	Bags/100 m.
		450 mm. dia.	4.8	Bags/100 m.
		300 mm. dia.	2.2	Bags/100 m.
		230 mm. dia.	1.8	Bags/100 m.
		150 mm. dia.	1.2	Bags/100 m.
		100 mm. dia.	1.0	Bags/100 m.

SW pipes jointed with Cement mortar 1:1			
	300 mm. dia.	12.94	Bags/100 m.
	230 mm. dia.	9.74	Bags/100 m.
	150 mm. dia.	6.56	Bags/100 m.
	100 mm. dia.	4.34	Bags/100 m.
Fixing wall hung type WC		0.1	Bag/no.
Fixing Urinal/s.		0.2	Bag/no.
Half Round Channel 100 mm.		15.86	Bags/100 m.
Fixing 100 mm. dia. SW Gully Trap		0.5	Bag/no.

Note: For the items not covered in above list, CPWD co-efficient shall be followed or proportionate from CPWD co-efficient, or actual consumption shall be checked in the beginning, during execution of item in consultation with EIC.

Material Specifications - Civil Works

Section D - MATERIALS SPECIFICATIONS – CIVIL WORKS

In the Technical specification document wherever "CPWD specifications" is mentioned, the same shall be considered as technical specifications from "CPWD specifications, volume 1 & 2 – 2009 published by DIRECTOR GENERAL OF WORKS, CPWD, NIRMAN BHAWAN, NEW DELHI". The Explanatory Notes and comments mentioned in the above referred book shall be ignored and shall not be considered as part of technical specifications.

1. In the specifications, "as directed" / "Approved" shall be taken to mean "as directed" / "approved" by the Architect and Engineer-in-charge.

2. Wherever a reference to any Indian Standard appears in the specifications, it shall be taken to mean as a reference to the latest edition of the same in force on the date of agreement.

3. In "Mode of Measurement" in the specifications wherever a dispute arises in the absence of specific mention of a particular point or aspect, the provisions on these particular points, or aspects in the relevant Indian Standards shall be referred to.

4. All measurements and computations, unless otherwise specified, shall be carried out nearest to the following limits:

   Length, width and depth (height) – 0.01 Metre.
   Areas – 0.01 Sq.Mt.
   Cubic Contents – 0.01 Cu.Mt.

5. The distance which constitutes lead shall be determined along the shortest practical route and not necessarily the route actually taken. The decision of the Engineer – in – charge in this regard shall be taken as final.

6. Where no lead is specified, it shall mean "all leads"

7. Lift shall be measured from Ground Level.

8. Reference to specifications of materials as made in the detailed specifications of the items of work is in the form of a designation containing the number of the specifications of the material and prefix "M" e.g. "M-5"

9. Approval to the samples of various materials given by the Engineer – in – charge shall not absolve the contractor from the responsibility of replacing defective material brought on site or materials used in the work found defective at a later date. The contractor shall have no claim to any payment or compensation whatsoever on account of any such materials being rejected by the Engineer – in – charge.

10. The contract rate of the item of work shall be for the work completed in all respects.

11. No collection of materials shall be made before it is not approved from the Engineer-in-charge.

12. Collection of approved materials shall be done at site of work in a systematic manner. Materials shall be stored in such a manner as to prevent damage, deterioration or intrusion of foreign

matter and to ensure the preservation of their quality and fitness for the work.

13. Materials, if and when rejected by the Engineer-in-charge, shall be immediately removed from the site of work.

14. No materials shall be stored prior to, during and after execution of a structure in such a way as to cause or lead to damage or overloading of the various components of the structure.

15. All works shall be carried out in a workmanlike manner as per the best technique for the particular item.

16. All tools, templates, machinery and equipment for correct execution of the work as well as for checking lines, levels, alignment of the works during execution shall be kept in sufficient numbers and in good working condition on the site of the work.

17. The mode, procedure and manner of execution shall be such that it does not cause damage or over loading of the various components of the structure during execution or after completion of the structure.

18. Special modes of construction not adopted in general engineering practice, if proposed to be adopted by the contractor, shall be considered only if the contractor provides satisfactory evidence that such special mode of construction is safe, sound and helps in speedy construction and completion of work to the required strength and quality. Acceptance of the same by the Engineer-in-charge shall not, however, absolve the contractor of the responsibility of any adverse effects and consequences of adopting the same in the course of execution of completion of the work.

19. All installations pertaining to water supply and fixtures thereof as well as drainage lines and sanitary fittings shall be deemed to be completed only after giving satisfactory tests by the contractors.

20. The contractor shall be responsible for observing the rules and regulations imposed under “Minor Minerals Act” and such other laws and rules prescribed by Government from time to time.

21. All necessary safety measures and precaution (including those laid down in the various relevant Indian Standards), shall be taken to ensure the safety of men, materials and machinery on the works as also of the work itself.

22. Contractor shall submit the test reports for every material carried out at recognized laboratory technical institute or laboratory. Many certificates for such test shall not be considered. The testing charges of all materials shall be borne by the Contractor.

23. Approval to any of the executed items for the work does not in any way relieve the contractor of his responsibility for the correctness, soundness and strength of the structure as per the drawings and specifications

24. Contractor shall set up testing laboratory on site. Laboratory shall be equipped with minimum following equipments / instruments.

- Beaker-Measuring Cylinder

- Flakiness Index
- Elongation Index
- Aggregate Impact Value
- Oven
- Slump Cone
- Concrete cube testing Machine
- Concrete Test Cubes
- Vicat Apparatus
- 90 micron Sieve
- Mortar Cube Mould
- Plate Vibrator
- Micrometer Screw
- Varner Callipers
- Thermometer
- 5 kg- Weigh Scale /Balance
- Electronics Balance – 20 kg
- 300 kg- Weigh Scale /Balance
- Core cutter set
- Mortar Mixture
- Casagrande Apparatus
- Welding gauge
- Dye penetration material-set
- Pycnometer
- Proctor mould
- GI tray/ Ceramic tray
- Distilled Water
- Wire basket
- PH meter
- TDS meter
- IS 1852
- Electronic vernier
- Welding gauge
- Theodolite
- Auto Level/ Staff

25. In case of any discrepancy or contradiction if any in the provision of above specification the order of the precedence shall be followed.

Technical Specification in this Volume
IS Provisions
MORTH and CPWD Specification
IRC Provisions
Sound Engineering Practice
Manufacture specification for special items

26. 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.

M-1 Water

1.1 CPWD specifications clause no. 3.1.1 shall be followed.
1.2 CPWD specifications chapter 3 Mortars - List of Mandatory Tests shall be followed.

M-2 Lime

2.1 CPWD specifications clause no. 3.1.3 shall be followed.

M-3 Cement

3.1 CPWD specifications clause no. 3.1.2 shall be followed.
3.2 CPWD specifications chapter 3 Mortars - List of Mandatory Tests shall be followed.

3.2.1 Reduction of strength of cement with passage of time
Reduction of strength at 28 days of concrete made from fresh and stored cement

Sr. No.	Storage Period of Cement	Strength Reduction
1.	Fresh	NIL
2.	3 months old	20%
3.	6 months old	30%
4.	12 months old	40%
5.	24 months old	50%

3.3 Stored cement can be used only upto the 3 months from the date of manufacture. After 3 months cement is to be used after prior permission of the consultant.

M-4 White Cement

4.1 The white cement shall conform to IS: 8042-E.

M-5 Coloured Cement

5.1 Coloured cement shall be with white or grey Portland cement mixed with pigments as specified in the item of the work.

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

5.3 The pigment shall have the property such that it is neither affected by the cement nor detrimental to it.

M-6 Sand

6.1 CPWD specifications clause no. 3.1.4 shall be followed.
6.2 CPWD specifications chapter 3 Mortars - List of Mandatory Tests shall be followed.

M-7 Stone Dust

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

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

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

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

M-8 Stone Grit

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

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

IS Sieve Designation	% passing Through sieve	IS Sieve Designation	% by weight passing through sieve
12.50 mm.	100%	4.75 mm.	0-20%
10.00 mm.	85-100%	2.36 mm.	0- 5%

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

8.4 The necessary tests for grit shall be carried out as per the requirements of IS: 2386 (Parts I to VIII), as per instructions of the Engineer-in-charge and Architect. The necessity of test will be decided by the Engineer-in-charge and Architect.

M-9 Cinder

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

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

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

IS Sieve Designation	% Passing	IS Designation	% Passing
20 mm.	100	4.75mm	70
10 mm.	86	2. 36 mm	52

9.4 Density of cinder shall be 900 Kg / cum or as approved by structural consultant.

9.5 Material shall be non-hazardous and suitable as per relevant IS code.

M-10 Lime mortar

10.1 CPWD specifications clause no. 3.2.1 shall be followed for lime mortar instead of cement mortar.

M-11 Cement Mortar

11.1 CPWD specifications clause no. 3.2.1 shall be followed.

M-12 Coarse Aggregate

12.1 CPWD specifications clause no. 4.1.1 shall be followed.

M-13 Murrum

13.1 Murrum or the selected earth shall be brought from outside, as indicated in the item. The selected earth shall be good yellow soil and shall be got approved from the Engineer-in-charge. In no case, Black cotton soil or similar expansive and shrinkable soil shall be used. It shall be clean and free from all rubbish and perishable materials, stones, or brick bats. The clods shall be broken to a size of 50 mm. or less. It shall be of good binding quality and of approved quality obtained from approved pots/quarries of disintegrated rocks which contain silicones materials and natural mixture of clay of cal carious origin. Contractor shall make his own arrangement, at his own cost, for land for borrowing selected earth. The staking of the material shall be done as directed by Engineer-in-charge, in such a way as not to interfere with any constructional activities and in proper stacks.

M-14 Stone

14.1 The stone shall be of specified variety such as Granite/ Trap Stone/ Quartz or any other type of good hard stones.
The stones shall be obtained only from the approved quarry and shall be hard, sound, durable and free from defects like cavities, cracks, sand holes, flaws, injurious veins, patches of loose or soft materials etc. and weathered portions and other structural defects or imperfections tending to affect their soundness and strength. The stone with round surface shall not be used. The percentage of water absorption shall not be more than 5% of dry weight, when tested in accordance with IS:1124. The minimum crushing strength of the stone shall be 200 Kg/cm^2. Unless otherwise specified.

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

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

M-15 Brick Bat coba

15.1 Brick Aggregate shall be obtained by breaking well burnt or over burnt dense bricks / brickbats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil, vegetable matter and other deleterious substances such aggregate should not contain more than one percent of sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete and 20% when used in lime concrete. It shall conform to IS : 306 – 1983 unless otherwise specified.

M-16 Chemical Admixture

16.1 CPWD specifications clause no. 4.1.2 shall be followed.

M-17 Steel for reinforcement

17.1 CPWD specifications clause no. 5.1.3 shall be followed except chairs, separators etc. will be measured and paid under this item.

M-18 Annealed/GI Binding Wire

18.1 The Annealed/GI wire shall be of 16 gauge (1.63 mm), 18 gauge (1.22mm) or 20 gauge (1 mm) or as specified in the item conforming to relevant latest IS.

18.2 It shall be free from rust, oil paint, grease, loose mill scale or any other desirable coating which may prevent adhesion of cement mortar.

M-19 Polyurethane Foam Filler

19.1 Polyurethane from filler shall be Capcell HD-100 of Supreme or equivalent. It should comply with ASTM–D-3575/ Highway clause 1015/ BS-5628 Part-3. It should be semi-rigid, UV resistant, high performance laminated closed cell polyethylene foam joint filler in sheet form.

19.2 The density of polyurethane shall be 100Kgs/ cum. The water absorption should be 0.08% max. The operating temperature of foam filler should be between -40 c to +100 c.

19.3 It should be bitumen free and chemical resistant. It should possess excellent recovery after compression.

19.4 If gap of expansion joint should be more than 50mm, use two board of required thickness joint with adhesive by manufacturer only.

M-20 Polysulphide Sealant

20.1 The polysulphide sealant shall be of Sika, Fosroc, Mccoy Soudal, Pidilite or equivalent as approved by the architect or engineer-in-charge. It shall conform to relevant IS codes.

20.2 It shall be a two-component polysulphide sealant. The mix ratio of both the parts should be as per manufacture's specification. It should not contain chloride or other corrosive substance.

20.3 It shall be pourable or gun grade.

20.4 It shall be used for sealing joints in water retaining structures, buildings, roofs, external walls, cladding, concrete highways, airport runways, bridges, parking and cargo areas and buildings. It shall have excellent adhesion to wide range of building materials like Aluminium, Stainless Steel, Glass, Concrete, Marble, Stone, Brick, Masonry block, Plaster, Ceramic and quarry tiles, Timber etc.

20.5 It should accommodate continuous and pronounced cyclic movements. Material should be low in shrinkage, UV resistance, water resistant to bio-degradation. It should be water resistant to occasional spillage of dilute acids, alkalis, petrol, aviation fuels, diesel, kerosene, lubricating oils etc. It should be non-toxic.

20.6 The density of the material should be 1.58 ± 0.03 Kg / ltr. The pot life should be more than 2 hrs. at 30ºC. Shore A hardness should be 16 to 22 after complete curing. Movement accommodation should be 25% for butt joints and 50% for lap joints. Joint size should be 5 to 50 mm. and depth to width ratio should be 1:2 (min). For joints with skew movement the ratio shall be 1:1

M-21 Expansion Joints – Copper Strips & Hold Fasts

21.1 The item provided for expansion joints in RCC frame structure, for internal joint as well as for exposed joints, with the use of necessary copper strip and holdfasts.

21.2 Copper sheet shall be 1.25 mm. thick and 125 mm width and shall be of U shape in the middle. Copper strip shall have holdfast of 3 mm. diameter copper rod 25 cm long soldered on the strip at intervals of about 30 cm. or as shown in the drawing or as directed. The width of each flange (horizontal side), to be embedded in the concrete work shall be 25 mm. Depth of `U' to be provided in the expansion joint, in the copper plate shall be of 25 mm.

M-22 Shuttering Material

All shuttering materials which are in contact with concrete surfaces, used material brought from other projects shall not be permitted.

M-22A Timber / Wooden Planks

22A.1 Timber / wooden planks and timber bracing, scaffolding shall conform to IS: 883. The shuttering shall be either of wooden planking of 30 mm. minimum thickness with or without steel lining or steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical ballies properly cross braced together, so as to make the centering rigid. In place of ballie props, brick work of adequate section built in mud mortar may be used to support the arch after approval of EIC.

22A.2 The form work shall be sufficiently strong and shall have camber, so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration, live load of men working over it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout

22A.3 If at any stage of work, during or after placing concrete in the structure, the form work sag or bulge out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and got approved from the Engineer-in-charge and Architect, before the reinforcement bars are placed in position.

22A.4 The props shall consist of ballies having 100 mm. minimum diameter, measured at mid length and 80 mm. at thin end and shall be placed as per design requirement. These shall rest squarely on wooden sole plate 40 mm. thick and minimum bearing area of 0.10 m^2. laid on sufficiently hard base.

22A.5 Double wedges shall further be provided between the sole plate and the wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.

22A.6 The timber used in shuttering shall not be so dry as to absorb water from concrete and swell or bulge nor so green or wet as to shrink after erection. The timber shall be properly sawn and planned on the sides and surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted.

22A.7 As far as possible, clamp and ties shall be used to hold the forms together and use of nails and spikes shall be avoided.

22A.8 The surface of timber shuttering that would come on contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Alternatively coat of raw linseed oil or oil of approved manufacture may be applied in place of soap solution. In case of steel shuttering, either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances, black or burnt oil shall be permitted.

22A.9 The shuttering for beams and slabs shall have camber of 4 mm. per meter (1 in 250) as per structural drawing or as directed by engineer-in-charge, so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50 of the project length structural drawing or as directed by engineer-in-charge.

M-22B Concrete Shuttering Plywood (laminated or non laminated)

22B.1 Plywood shall conform to IS 4990. It shall be made from strong and selected hard-woods. It shall be bonded with high quality Phenol Formaldehyde synthetic resin adhesive, hot pressed and then shall be further treated with a permanent type of preservative by vacuum-cum-pressure impregnation.

22B.2 Due to the bonding with Phenol Formaldehyde, it shall be moisture and weather proof. The use of selected hard-woods renders hard and wear-resistant faces and thereby it shall be reusable several times. It shall be highly resistant to rot, termites and other wood inhabiting insects. Due to complete penetration of the preservative, it shall be exceedingly durable.

22B.3 It shall have high impact strength and therefore shall be used successfully in place of timber planks and steel sheets. It shall protect the concrete from rapid temperature changes and shall provide optimum conditions for setting of the concrete. As it shall possess remarkable design flexibility, it shall be ideal for curved formwork.

22B.4 Besides it shall be used as centering, shuttering and formwork of concrete columns, beams, slabs, walls, tanks, bridges, fly-overs, silos etc. It shall also be used for structural applications like external walling, roofing, flooring, curtain walls, work-site offices, in cabins of trucks, rail coaches etc.

M-22C Steel Shuttering and Steel Plates

22C.1 Steel shuttering plates shall conform to IS 8500, IS 2062, and IS 1977. Steel sheeting and steel plates should be free from crimps, twists, offsets, warps, etc. Their surface should be neat, clean and smooth. Before placing concrete, steel forms shall be thoroughly cleaned off of all rust, dust and loose materials. Colourless oil or grease of approved quality shall be applied before placing steel.

22C.2 The size of rolled steel sections, tubular steel section used for framing and bracing of steel plates should be sufficient to withstand the weight of concrete without forming crimps, twists, offsets, warps, etc. in the steel plates. Also, the gauge of steel sheeting used should not be less than 2 mm.

22C.3 Minimum two bracing angles should be provided along with angle framing while making the steel plates. It should be riveted for non-exposed concrete or welded for exposed concrete finished concrete. Minimum two rivets should be provided at all Four Corners and at junction of angle framing and bracing.

22C.4 If the plates are to be welded, steel sheet and angle framing/bracing should be welded from sides and at back. Welding on sides should be buffed to make the sides smooth. Also, intermittent welding should be done to keep steel sheet and angle framing/bracing in one plane

M-23 Brick

23.1 CPWD Technical specifications clause no. 6.1 shall be followed

M-24 Bricks for exposed work

24.1 Bricks for exposed work shall be first class brick conventional bricks with size of 228 X 107 X 75 mm. Bricks are to be laid such that ten layers of brick laid in mortar shall form masonry of 1 m. height.

24.2 The weight of the bricks should be 3 Kgs water absorption for each brick shall not more than 12% of the total weight of the brick.

24.3 These bricks are manufactured from good quality plastic earth, which is free from saline deposits. They are of good uniform colour. They are well burnt, giving a hard ringing sound when two bricks are struck together.

24.4 They should have straight edges and even surfaces. They are free from cracks, flows, nodules of free lime wrap age and organic matter.

24.5 The bricks shall have plane rectangular faces with parallel sides and sharp straight right-angled edges. Bricks should have uniform colour and even texture.

24.6 When immersed in water for an hour, they do not absorb water more than 1/6th of their weight. On drying, these bricks do not show any sign of efflorescence.

24.7 Average Compressive strength of the bricks shall be more than 65 Kg / cm² either wire cut or hand moulded as directed by the Architect or engineer-in-charge.

24.8 Unless otherwise specified machine moulded bricks shall be used. Selected hand moulded hand bricks are to be used if it is specified. As far as possible total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and corners shall not be used.

M-25 Calcium Silicate Bricks

25.1 The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape. Bricks shall be free from visible cracks, warpage, organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely grounded sand siliceous rock and lime. In addition, a limited quantity of fly ash conforming to IS 3812 may be used in the mix. These bricks are also known as Fly Ash Sand Lime bricks in the construction industry.

25.2 The bricks shall be machine moulded and have smooth rectangular faces with sharp corners and shall be uniform in size, colour and shape. The size of bricks shall be 228 mm x 110 mm x 72 mm or as approved by the Architect. The compressive strength of bricks shall be minimum 150 kg/$m^{2.}$ and the bricks shall have very high strength to weight ratio. The bricks shall have very good resistant capacity to atmospheric conditions, optimum building properties in relation to heat insulation, sound insulation, absorption of water and fire protection.

25.3 Calcium silicate products shall conform to the appropriate IS standards and there shall be no change required in civil application techniques while using such products in the place of traditional clay bricks.

M-26 Glass Brick

26.1 It shall be KIG Indonesia or equivalent as approved by the Architect and Engineer-in-Charge.

26.2 It shall be free from any defects like, cracks, air bubbles, uneven surface, breaks etc. During handling and laying, its edges shall not be damaged. All edges and corners of all faces shall be sharp and well shaped. It shall be of size and colour as specified in the item or as approved by the Architect. The glass bricks shall be of uniform size and tolerance of +2 mm. shall only be allowed in dimensions of glass brick. Spots of colour other than that of bricks or in bricks shall not be allowed. The weight of each brick shall be about 2.75 kg.

26.3 The transmission of direct light through brick shall not be less than 40%. The glass brick shall have good thermal insulation. It shall be sound proof and vibration absorber having adequate compressive strength. If bricks with groove or projections shall be used, the groove or projections shall be uniform and regular in size & shape.

M-27 Cement Concrete Hollow Block

27.1 Hollow concrete blocks shall be of size such that they can be bonded with brick masonry, if necessary. The blocks are generally referred by their nominal sizes which include the block and an allowance for joints. The block shall have one or more large holes or cavities which either pass through the block or do not effectively pass through (in case of closed cavity) and shall have the total solid material between 50 to 75% of the total volume of the block, calculated from the overall dimensions. In case of solid blocks, the solid material shall not be less than 75% of the total volume of the block.

27.2 The shell thickness of the blocks shall be not less than 65 mm., in any part, however based on the strength requirements, the thickness can be varied between 20 mm. to 50 mm., as follows:

Nominal block face width.	Shell thickness minimum.	Web thickness minimum.
100 or less	25	25
Over 100 to 150	25	25
Over 150 to 200	30	25
Over 200	35	30

All the above dimensions are in mm.

27.3 The volume of concrete shall not be less than half the gross volume of the block. The total width of the cavities shall not be less than 2/3rd of the overall thickness of the block. The maximum variation in the length of the blocks shall not be more than $\pm$ 5 mm. and maximum variation in height and width shall not be more than $\pm$ 3 mm.

27.4 Hollow blocks are manufactured by special machines. Casting is done in a single operation. Concrete shall be thoroughly compacted in the moulds with blunt end steel rods or vibrators or by using vibrating tables. Ordinary concrete mix 1:2:4 of very low water/cement ratio is used and shall be mixed as described in the section no. 2.00 of plain and reinforced concrete. Additives or admixtures shall be used such as a) Accelerating, water-reducing and air-entraining admixtures, b) Water-proofing agents, etc. High compressive strength and very dry consistency enables to remove the blocks for curing, immediately after casting. In case of manual compaction, the mixture shall be placed into the mould, in layers of about 50 to 75 mm. and each layer is thoroughly tamped until the whole mould is filled up and struck off level with a trowel. In case of mechanical compaction, the mould shall be filled up to overflow, vibrated or mechanically tamped and struck off level. Steel wire may be embedded in each block while casting. Rapid hardening cement may be used. After demoulding, the blocks shall be protected until they are sufficiently hardened to permit handling without damage. The blocks shall be thoroughly cured for atleast 14 days and shall be dried out for a period of 4 weeks, before placing. They shall be stacked with voids horizontal to facilitate thorough passage of air. The blocks shall be allowed to complete their initial shrinkage before placing. Water absorption shall not be more than 10% by mass.

27.5 Hollow blocks have better thermal properties than solid blocks. Further hollow blocks made from light weight concrete have still better insulation against heat. They shall conform to the following three grades:

Grade A - They shall be used as load bearing units and shall have a min. block density of 1500 Kg/m^3. They shall possess min. average compressive strength of 35, 45, 55 and 70 Kg/cm^2. respectively, for its sub-category, at 28 days.

Grade B - They shall be used as load bearing units and shall have block density less than 1500 Kg/m^3. but not less than 1000 Kg/m^3. They shall possess min. average compressive strength of 20, 30 and 50 Kg/cm^2. respectively, for its sub-category, at 28 days.

Grade C - They shall be used as non-load bearing units and shall have block density less than 1500 Kg/m^3. but not less than 1000 Kg/m^3. They shall possess min. average compressive strength of 15 Kg/cm^2. at 28 days.

Grade D - Solid Concrete Blocks - They shall be used as load bearing units and shall have block density not less than 1800 Kg/m^3. They shall possess min. average compressive strength of 75 to 100 Kg/cm^2. respectively, for its sub-category, at 28 days.

27.6 They shall have a variety of surface textures ranging from very fine close texture to a coarse open texture, by proper selection, grading and proportioning of the aggregates. Further the texture shall be developed by treating the surface while the units are still green. Colour shall be rendered by adding non-fading mineral pigments.

27.7 Well made units shall not require plaster, in case of unimportant buildings. Two or three coats of cement paint shall be sufficient to render the masonry resistant to rain water. However, if plaster is intended, the

unit shall have a sufficiently rough surface to afford good key to the plaster. Water-proofing admixtures shall be used in the plaster.

M-28 Cement concrete Solid Block

28.1 A block shall be considered to be solid if the solid material is more than 75% of the total volume of the block calculated from over all dimensions.

28.2 The size other than those specified in the item description may be used with the approval of the Architect and engineer-in-charge.

28.3 The blocks may be machine made. The concrete mix the mixing of concrete, the manufacturing of blocks, curing and drying shall be accordance with para-6 to 10 of IS: 2185-1967.

28.4 Faces of blocks shall be flat and rectangular. Surface finish shall be render smooth or plastered with CM 1:3 (1 cement: 3 coarse sand) as directed. The payment for the rendering shall be included in this item.

28.5 The average compressive strength of 8 blocks, when determined in the manner described in IS: 2185-1967, shall not be less than 50 Kg/cm^2 of gross area. The lowest strength of an individual block shall not be less than 75% of average compressive strength of the 8 blocks.

28.6 Concrete blocks shall be stored and stacked properly in such a way to avoid any contact with moisture at site. They shall be stock plied on planks or other supports free from contact with ground and covered to protect against wetting.

M-29 Stone (For Rubble Masonry)

29.1 CPWD specifications clause no. 7.1.1, 7.1.2 shall be followed.

M-30 Perlite Aggregate

30.1 The Perlite shall be from Amol Dicalite or equivalent as approved by the Architect and Engineer-in-charge.

30.2 Perlite shall conform to ASTM C-332-61.

30.2 Perlite is naturally occurring siliceous volcanic rock, which when heated in excess of 870 C expands four to twenty times its original volume and its transformed into lightweight glass like particles containing countless sealed cells. This unique structure accounts for its superior insulating characteristic.

30.3 It is light weight aggregate which when combined with Portland cement and water produces an ultra light concrete that is used for insulating roof decks, lightweight floor fills, insulating structural rock decks, curtain wall systems and for variety of permanent insulating applications.

30.4 It shall have sintering temperature and melting point about $2300^{O}F$ and $2400^{O}F$, respectively. The specific heat and specific gravity of minerals shall be 0.2 and 2.6 respectively. The mineral should possess pH value of 7.0 and cation exchange rate 90 to 100 milli equivalent per 100 grams. The thermal conductivity K shall be 0.43-0.45 Btu.

30.5 The mineral should be incombustible and capable to withstand temperature upto $1100^{O}C$ to give effective insulation. It shall be insoluble and inert to organic solvents having cold crushing strength at least 250 Psi. The air contraction at maximum service temperature shall be less than 1%.

M-31 Water Proofing Compound

31.1 The water proofing compound shall conform to IS 2645-latest version. It should be chloride free, corrosion inhibitor, Hydrophoper and water reducer. It shall be compatible with all types of cement. It should be able to reduce water absorption and dampness. It shall be highly water-tight against water

head pressure. It shall be able to reduce efflorescence, salt petering, and fungus growth. It shall be of approved make as approved by Architect.

31.2 It should be non-flammable, non-toxic and eco-friendly. It should be able to reduce shrinkage. It should be able to increase plastic workability.

M-32 Ex-foliated Vermiculite

32.1 Ex-foliated Vermiculite should be of approved make as directed by the engineer-in-charge.

32.2 Ex-foliated Vermiculite shall be 100% natural, non-fibrous, light weight material. It can be used for thermal insulation, acoustic treatment and fire resistance.

32.2 Vermiculite shall be formed by hydration of certain basaltic material. Vermiculite shall be natural mineral that expands with the application of heat.

32.3 It shall be possible to reduce the heat transfer. Heat energy can be transferred by conduction, convection, radiation. The material shall be such that it should maintain acceptable temperature throughout the building and makes the building well-insulated as per manufacture's specification.

32.4 It shall be hydrated laminar natural mineral having, Aluminum-Iron, Magnesium Silicates as content and shall consist of thin flat flakes, containing innumerable microscopic voids and layers. It shall have physical properties like chemical inertness, light weight, fire and rot proofness, porosity, non-abrasive nature, flakiness etc.

32.5 It shall have centering temperature and melting point about 1260ºC and 2400^{O}F, respectively. The specific heat and specific gravity of minerals shall be 0.2 and 2.6, respectively. The mineral should possess pH value of 7.0 and cat ion exchange rate 90 to 100 milli equivalent per 100 grams. The thermal conductivity K shall be 0.43-0.45 Btu. It shall have bulk density 6 Kg.c.ft.

32.6 It shall be mixed with cement in 6:1 ratio by volume and requisite water or as per manufacture's specification.

32.6 The mineral should be incombustible and capable to withstand temperature upto 1100^{O}C to give effective insulation. It shall be insoluble and inert to organic solvents having cold crushing strength at least 250 Psi. The air contraction at maximum service temperature shall be less than 1%.

M-33 Precast Terrazzo Tile

33.1 Terrazzo tile shall generally conform to IS: 1237. Unless otherwise specified tiles shall be supplied with initial grinding and grouting of wearing layer. The size of the tiles shall be as per the drawing. Half tiles for use with full tiles shall be such as to make two half tiles when joined together, match with the dimensions for the full tile.

33.2 Tolerance on length and breadth shall be as per plus or minus one millimeter and tolerance on thickness shall be plus 5 mm. The range of the dimensions in any one delivery shall not exceed 1 mm on length and breadth and 3 mm on thickness.

33.3 The tiles shall be manufactured in a factory under pressure process subjected to hydraulic pressure of not less than 140 kg per square centimeter shall be given the intial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of the wearing layer may be rounded.

33.4 The proportion of cement to aggregate in the backing of tiles shall be not leaner by 1:3 by weight. Where colouring material is used in wearing layer, it shall not exceed 10 percent by weight of cement used in the mix.

33.5 The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips from the smallest upto 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for size of marble chips varying from the smallest upto 20 mm.

M-34 Chequered Tile

34.1 The size of the tiles shall be as shown in the drawing or as required Architect or engineer-in-charge.

34.2 The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.

34.3 The overall thickness of the tile shall not be less than 22 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not less than 3 mm. The chequered tile shall be terrazzo or cement tile as specified in the description of item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm.

34.4 The terrazzo tiles shall be given the first grinding with machine before delivery to site.

34.5 The tiles shall conform to the specifications for plain cement concrete or terrazzo tiles in respect to the method of the manufacture and the mix of the backing and wearing layers.

M-35 Ceramic Tile

35.1 The tiles shall be of approved make and shall generally conform to IS: 777. They shall be flat and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as indicated in Appendix of IS: 777.

35.2 The size of the tiles shall be square or rectangular as shown in the drawing or as required Architect or engineer-in-charge.

35.3 The thickness of the tiles shall be 6 to 9 mm depending upon the size and manufacture. The length of all four sides shall be measured correct to 0.1 mm and average length breadth shall not vary more than $\pm$ 0.8 mm from specified dimension. The variation of individual dimension from average value of length/breadth shall not exceed $\pm$ 0.5 mm. Tolerance in thickness shall be $\pm$ .5 mm.

35.4 The top surface of the tiles shall be glazed and glaze shall be either glossy, mat or as specified. The underside of the tiles shall not have glaze more than 5 percent of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable shall be permissible only upto 50 percent of the surface area of the edges.

35.5 They shall be extremely strong, breaking strength of the tile shall be 350 kg/ cm2. They shall offer good abrasion resistant i.e. can withstand upto 5000 grindings. They shall be scratch resistance, their hardness on the Moh's scale shall be 6.8 to 7. They shall be resistant to all acids and alkalies except hydrofluoric acid. In addition, they shall be bacteria free and fire proof, as they are fired at @ 11600C. They shall have very high acoustic damping factor and their specific gravity shall be 0.12, making them good insulators. Their resistance to thermal shocks shall be upto 10 cycles and their co-efficient of linear thermal expansion shall be 9 from ambient temperature to 1000C.

35.6 Ceramic tile for Industrial purposes, shall have a hardness of 8.6 on the Moh's scale and shall be non-skid, hard wearing, long lasting and acid and alkali resistant. They shall adequately meet the IS : 4457.

35.7 In Rectified ceramic tile sizing and squaring is done in tile.

M-36 Vitrified Tile

36.1 Vitrified floor tiles shall be of approved make, as approved by the Architect and Engineer-in-charge. They shall conform to the relevant IS Codes. (IS15633 & IS13612)

36.2 They shall be monolithic and available in smooth, mirror-polished and anti-skid finishes. They shall have a size tolerance of + 0.5%, in length and width and + 5% in thickness. Allowable warpage shall be + 0.2%. Allowable squareness wedging shall be + 0.5%. Their water absorption rate shall be less than 0.5%. They shall offer hard-working and hard-wearing floors for homes, public buildings, apartments and airports. The tiles shall be of ASTM or DIN standards.

36.3 They shall be extremely strong, breaking strength of the tile being 1600 Kg/cm2, flexural strength 3500 Kg/cm2. and bonding strength of 2500 Kg/cm2. They shall offer abrasion resistance to < 175 mm3. They shall be scratch resistance; their hardness on the Moh's scale shall be min. 7. They shall be able to resist thermal shock upto 10 cycles and shall have a density of greater than 2 gm/cc. They shall have greater than .4 co-efficient of friction for polished/unpolished surfaces.

M-37 Cement based Polymer Adhesive

37.1 Tile adhesive complies with the BS: 5980 with latest edition. The adhesive shall be polymer modified cement-based adhesive. The adhesive should be able to fixing tiles, natural stones in exterior and interior use including swimming pool.

37.2 Adhesive should be able to improve adhesion, reduce water permeability and widen application. It should be able to fixing upto 6 mm thickness.

37.3 It should possess low shrinkage and should be flexible to accommodate physical and thermal movements.

37.4 It should be able to use for indoor and outdoor application.

M-38 Grouts

M-38A Cementitious grout

38A.1 The grout shall be of high quality, water resistant, cement-based powder grout for grouting ceramic tile, vitrified tile, industrial tile, stone etc.

38A.2 It should be available in all colours to match the tile colour. It should have high strength for maximum load bearing. It should be non shrink, non-bleeding and non segregating at fluid consistency.

38A.3 It should not contain any chlorides and or additives which may contribute the corrosion of the structure.

38A.4 It should be weather resistant, non cracking, non shrinking. The compressive strength, linear shrinkage, tensile strength and flexural strength should be according to the IS codes.

M-38B Epoxy Grout

38B.1 It should be hygienic, hard wearing, impervious, epoxy resin based ceramic tile grout with a high degree of resistance to chemical attack, abrasion and impact.

38B.2 The grout should not transfer taints to food stuffs and should not permit the entry of bacteria or dirt and easily maintained in a sterile condition.

38B.3 It should be available in all colours to match the colour of the tile colour. It should attain very good early strength. It should possess good chemical resistance to acid, alkalies etc.

38B.4 It should possess good tensile and flexural strength and it has a very good dynamic load resistance.

M-39 Floor Hardener

39.1 CPWD specifications clause no. 11.3.1 shall be followed.

39.2 The Concrete floor hardener shall be of best quality and from manufacturer like Ironite, BASF, MYK or equivalent, as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the EIC. It shall conform to the relevant IS Code.

39.3 It shall be applied on the concrete floors when concrete is green. It should be applied as per the manufacture's specification. Floor hardener makes the permanently hardened concrete floor, with increased abrasion resistance, increased surface density, and increased resistance to chemical attack and to eliminate dust accumulation. Precautions shall be taken while using the product, to avoid contact with eyes and open wounds and to work in good ventilation. After application, the affected parts shall be washed copiously.

M-40 Polypropylene Fibres

40.1 Polypropylene fibres shall conform to ASTM C 1116 Type III 4.1.6. Polypropylene fibres should be of NINA concrete or equivalent as approved by engineer-in-charge. Polypropylene fibres should inhibit and controls the formation of cracking in the concrete.

40.2 It should reinforce the concrete against impact forces, shattering forces. It should make the concrete abrasion resistance and should reinforce the concrete against water migration.

40.3 It should provide the concrete better durability. It should be able to reduce the plastic shrinkage and settlement cracking.

40.4 It should protect rebar from corrosion and should prevent explosive spoiling of concrete due to fire.

M-41 Marble Chips

41.1 The marble chips shall be of approved quality and shade. It shall be hard, sound, dense, and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering.

41.2 The marble chips to be used should be as per the grading as decided by the Architect.

41.3 The marble chips shall be machine crushed if not specified in the item description. They shall be free from foreign matter, dust etc. The marble chips shall conform to IS : 2114.

M-42 China Mosaic

42.1 China mosaic shall be from broken pieces of white glazed tile. The size of the broken pieces of white glazed tiles shall not be more than 12-20mm.Triangular china mosaic pieces shall not be used. Rectangular or square pieces shall only be used. The broken pieces shall be soaked in water for 24 hr before using for the execution.

M-43 Rough Kota Stone

43.1 The kota stones shall be of selected quality, hard, even, sound, dense and homogeneous in texture free from cracks, decay and weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of colour as indicated in the drawings or as instructed by engineer-in-charge.

43.2 The slabs shall have the top (exposed) face rough before being brought to the site, unless otherwise specified. The slabs shall conform to the size required. Before starting of the work the contractor shall get the samples of the slabs approved by engineer-in-charge.

43.3 Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth and so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

43.4 The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the description of the item. Tolerance of ± 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

M-44 Polished Kota Stone

44.1 Polished kota stone shall have same specifications as Rough Kota stone, except as mentioned below.

44.2 The stones shall have machine polished surface. When brought on site, the stone shall be single polished or double polished, depending upon its use. Single polished kota stone shall have single face of the stone polished whereas, double polished kota stone shall have both the faces polished. The stones for paving shall generally be single polished. The stones to be used for dado, skirting, sink, veneering, sills, steps, etc., where machine polishing after the stones are fixed in situ is not possible, shall be polished more than once for the desired finish, before fixing.

44.3 When brought at site, the colour of the stone shall be fairly uniform. It shall be ensured that the stones to be used in a particular work, shall not differ much in shade or tint, from the approved sample.

M-45 Marble Stone

45.1 Marble shall be hard, sound, dense and homogeneous in texture with crystalline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

45.2 Marbles are metamorphic rocks capable of taking polish, formed from the re-crystallization of lime stones or dolomitic lime stones and are distinguished from limestone by even visibly crystalline nature and nonflag by stratification. The surface shall be machine polished to an even and perfect plane surface and edges machine cut, true and square. The rear face shall be rough to provide key for the mortar.

45.3 Marble slabs are to be laid as per pattern of engineer-in-charge. The slab shall not be thinner than the specified thickness, at its thinnest part. A few specimens of the finished slab to be used, shall be deposited by the Contractor in the office, for reference.

45.4 Except as above marble slab shall conform to IS: 1130.

M-46 Dholpur Stone

46.1 Dholpur sand stone shall be of best quality, as approved by the Architect and Engineer-in-charge. The stone slab shall be hard, even, sound, durable and tough free from cracks, decay and weathering.

46.2 The size of the slab shall be as specified in the item or detailed drawing or as approved by the Architect and Engineer-in-charge. The thickness of the stone shall be as specified in the item of work with the permissible tolerance of + 2 mm.

46.3 The stones shall have machine polished surface. When brought on site, the stone shall be rough, single polished or double polished, depending upon its use and as specified in the item or detailed drawing. The stones for paving shall generally be single polished. The stones to be used for sills, steps, brackets, coping, facias, bands, pillars, fabricated railings, jali work etc., where machine polishing after the stones are fixed in situ, is not possible, shall be double polished or as required.

46.4 All angles and edges of the stone slab shall be fine chiselled or polished, as specified in the item of work and all the four edges shall be machine cut. All angles and edges of the face of the stone slab shall be true and plane.

46.5 The sample of stone shall be got approved by the Engineer-in-charge and Architect, for a particular work. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint, from the approved sample. No white, black or any other colour spots shall be there. Cheetah or tiger skinned stones shall not be allowed under any case.

M-47 Granite Stone

47.1 Granite shall be of approved color and quality. It shall be got approved by the Engineer-in-charge and Architect, prior to procurement. The stone shall be hard, even, sound and regular in shape and generally uniform in color. It shall be without any soft veins, cracks or flaws.

47.2 The thickness of the stone shall be as specified in the item.

47.3 All exposed faces shall be double polished to render truly smooth and even reflecting surface. The exposed edges and corners shall be rounded off, as directed. The exposed edges shall be machine cut and shall have uniform thickness.

M-48 Red Mandana Stone

48.1 Red mandana stone shall be of best quality, as approved by the Architect and Engineer-in-charge. The stone shall be without any veins, cracks and flaws. The stone shall be even, sound and durable, regular in shape and of uniform colour.

48.2 The size of the stone shall be as specified in the item or detailed drawing or as approved by the Architect and Engineer-in-charge. The thickness of the stone shall be as specified in the item of work, with the permissible tolerance of + 2 mm.

48.3 The stones shall have machine polished surface. When brought on site, the stone shall be rough, single polished or double polished, depending upon its use and as specified in the item or detailed drawing. The stones for paving shall generally be single polished.

48.4 All angles and edges of the stone shall be fine chiselled or polished, as specified in the item of work and all the four edges shall be machine cut. All angles and edges of the face of the stone shall be true and plane.

48.5 The sample of stone shall be got approved by the Engineer-in-charge and Architect. It shall be ensured that the stones to be used shall not differ much in shade or tint, from the approved sample

M-49 Jaisalmer Yellow Stone

49.1 Jaisalmer stone shall be of best quality, as approved by the Architect and Engineer-in-charge. The stone shall be without any veins, cracks and flaws. The stone shall be even, sound and durable, regular in shape and of uniform colour.

49.2 The size of the stone shall be as specified in the item or detailed drawing or as approved by the Architect and Engineer-in-charge. The thickness of the stone shall be as specified in the item of work, with the permissible tolerance of + 2 mm.

49.3 The stones shall have machine polished surface. When brought on site, the stone shall be rough, single polished or double polished, depending upon its use and as specified in the item or detailed drawing. The stones for paving shall generally be single polished.

49.4 All angles and edges of the stone shall be fine chiselled or polished, as specified in the item of work and all the four edges shall be machine cut. All angles and edges of the face of the stone shall be true and plane.

49.5 The sample of stone shall be got approved by the Engineer-in-charge and Architect, for a particular work. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint, from the approved sample. No white, black or any other colour spots shall be there. Cheetah or tiger skinned stones shall not be allowed under any case.

M-50 Cobble Stone

50.1 Cobble stones shall be of best quality, as approved by the Architect and Engineer-in-charge and shall be obtained from reliable source. The make will be approved by the Architect and the source of supply shall not be changed without prior approval of the Architect. The stone shall be without any veins, cracks and flaws. The cobbler stones shall be even, sound, durable and regular in shape and of uniform colour

50.2 The size of the cobbler stone shall be as specified in the items or detailed drawing or as approved by the Architect and Engineer-in-charge. The thickness of the stone shall be as specified in the item of work, with permissible tolerance of + 2 mm.

50.3 The stone shall have machine polished surface. When brought on site the stone shall be single polished or double polished, depending upon its use and as specified in the item or detailed drawing. The cobbler stones to be used for walkways, roadways, parking, floors, docks, roofs, public squares etc., where machine polishing after the fixing of stones, is not possible, the stones to be fixed shall be double polished or polished more than once, as required. All angles and edges of the cobbler stone shall be true and plane.

M-51 Precast Cement Concrete Tile

51.1 The plain cement tiles shall be of general-purpose type. Cement used in the manufacture of the tiles shall conform to relevant IS code. Pigments are not used in this tile.

51.2 The tiles shall be manufactured from a mixture of cement and natural aggregates, using pressure process. During the manufacture, the tiles shall be subjected to a pressure of not less than 140 Kg/cm2. The proportion of cement to aggregate, in the backing of the tiles shall be not less than 1:3 by weight. The wearing face though the tiles are of plain cement, shall be provided with stone chips of 1 to 2 mm. size. The proportion of cement to aggregate, in the wearing layer of the tiles shall be three parts of cement to one part chips, by weight. The minimum thickness of wearing layer shall be 3 mm. The colour and texture of the wearing layer shall be uniform throughout its face and thickness. On removal from mould, the tiles shall be kept in moist condition, continuously atleast for 7 days and subsequently, if necessary, for such long period, as would ensure their conformity to requirements of IS : 1237, regarding strength, resistance to wear and water absorption.

51.3 The wearing face of the tiles shall be plane, free from projections, depressions and cracks and shall be reasonably parallel to the backing of the tile. All angles shall be right angles and all edges shall be sharp and true.

51.4 The tiles shall generally be square in shape, with a size specified in the item. The thickness of the tiles shall be 25 mm. Tolerance of length and breadth shall be + 1 mm. Tolerance of thickness shall be + 5 mm.

51.5 The tiles shall satisfy the test as regards transverse strength, resistance to wear and water absorption as per IS : 1237

Testing Standards :

A. Water Absorption :
Sampling :
6 tiles out of every 3000 tiles are taken for testing.
Results :
Absorption permissible, shall be at the most 10%.

B. Transverse strength test :
Sampling :
12 tiles out of every 3000 tiles are taken for testing.
Results :

When wet :- 80 Kg/cm2.
When dry :- 120 Kg/cm2.

C. Abrasion test :

Sampling :
6 tiles out of every 3000 tiles are taken for testing.
Results :
Average abrasion shall not be more than 3.5 mm.

M-52 Interlocking Paver Block

52.1 The Paver block shall conform to IS 1237:1980. The variation in length of any side shall not exceed + 2 mm. The variation in thickness shall not be more than + 3 mm.

52.2 The average abrasion value of the same shall not be more than 2.00mm & for individual it shall not vary more than 2.5mm.

52.3 The water absorption shall not be more than 5%. The compressive strength of the tile shall be as per item description.

M-53 PVC (Poly Vinyl Chloride Sheet/Tile)

53.1 PVC sheets/tiles for PVC/ Vinyl floor covering shall be of approved make as approved by the Architect and Engineer-in-charge. It may be in form of sheets or tiles or rolls as specified. It shall consist a thoroughly blended composition of thermoplastic binder, filler and pigments. The thermoplastic binder shall consist substantially of one or both the following.

a) Vinyl Chloride Polymer
b) Vinyl Chloride Copolymer

The polymetric material shall be compounded with suitable plasticizers and stabilizers.

53.2 The preferred thickness of PVC tiles for normal floor covering shall be 1.5 to 4 mm. Dimensional stability shall be 0.3% The thickness of the PVC sheets shall be measured with micrometer or Ratechet type or a dial guage graduated to .02 mm. The micrometer shall have flat bearing surfaces of at least 6.5 mm diameter at both contact points. For sheets and rolls the thickness of the specimen shall be measured at twenty scattered points.

53.3 The width of rolls shall be as per manufacture's specification and length shall not be less than 20 meters. The measurement shall be carried out with a traveling microscope or suitable scale graduated to .02 mm. Each tile shall be measured for length and width at the three quarter point in each direction

53.4 The following tolerance shall be allowed

a)	Thickness	-	± 0.15 mm
b)	Width		
	i) 300 mm square tile		± 0.2 mm
	ii) 600 mm square tile		± 0.4 mm
	iii) 900 mm square tile		± 0.6 mm
	iv) Sheets and rolls		± 0.1 percent

53.5 It shall offer colour fastness to daylight as per the relevant IS : 3462. Allowance for curling shall be 0.6 mm. It shall be flexible and shall not break, crack or show any signs of failure.

53.6 It shall offer above average resistance to mild and diluted acids, alkalies, soaps and detergents. It shall have high abrasion resistance. At normal temperature, it shall develop an indent of 0.15 mm., after one minute and 0.20 mm., after ten minutes. It shall offer insulation resistance as per the IS : 2259. It shall have a sound reduction factor of 3db for 2 mm. thickness and 2db for 1.5 mm. thickness. It shall have self extinguishing property and water absorption at room temperature for 24 hrs. shall be 0.1%.

53.7 It shall be available in various designs and shall be recommended for floors and walls, in homes, institutions, commercial establishments, clinics and hospitals.

M-54 Linoleum

54.1 Linoleum shall conform to IS : 653. Linoleum shall be of thickness as specified in the description of item. Linoleum shall be of either plain, moire jaspe or marble type or a combination of the above types as shown in the drawing or as per direction of engineer-in-charge.

54.2 Linoleum shall be stored in a clean, dry and well ventilated place without exposure to direct sunlight.

54.3 The contractor shall get approve the samples by the architect or engineer-in-charge.

54.5 Linoleum used shall be of a thickness adequate for the conditions of surface and situation. The following thickness generally shall be used are

a) For Public buildings, cinemas, restaurants, ships and the like - 6 to 6.7 mm
b) For offices, shops and the like depending upon the intensity of traffic - 3.2 to 4.5 mm
c) For residential house - 3.2 mm

M-55 Acid Resistant tile

55.1 Acid and Alkali resistant tiles should be able to withstand most corrosive of chemicals without as much as stain on acid resistant tile.

55.2 The tiles should be perfect for the floors of chemical, petrochemical, oil, pharmaceutical, food and textile industries.

55.3 The tiles should be of approved make. The sample of the tiles should be approved by the Architect before procurement and the after laying of sample tile same should be approved by the Architect before laying of all the tiles.

55.4 The tiles should cater the specifications as per IS 4457. It should be heavy duty as per the project's requirement.

55.5 It shall have a very high load bearing capacity with cold crushing strength as 1500 Kg/cm^2. and shall withstand a load of 3000 Kg/cm^2 in the compression strength test. The tiles shall have extremely low porosity because of their monolithic body structure. The water absorption shall be less than 1% and the tiles shall remain free of stains due to lubricants, oils, grease etc. The tiles shall be non-glazed and anti-skid, having a matt finish. They shall be available in special ribbed surface, also. The tiles shall be tough, have high surface hardness, 9 on the Moh's scale and shall offer extremely high resistance to wear and abrasion. They offer good resistance to acids and when tested, the loss of weight shall be around 0.25%

M-56 Blended Marble tile / slab

56.1 Marble tile / slab is an engineered wood or composite marble is aesthetically like natural marble.

56.2 It shall be composed of 80% to 95% of finest grains of quality selected marble aggregates, bonded together with 4% to 8% special resins, along with palette of colourants. It shall therefore offer a wide range of colour compared to natural marble. It shall be manufactured so, that its design goes right through the tile, insuring lasting designs.

56.3 It shall be available in pre-cut, pre-polished, chamfered and grooved upto sizes of 600 mm. x 600 mm. Sizes upto 2400 mm. x 1200 mm. shall also be supplied. It shall have indispensable mechanical strength,

Test	Dry	Wet
Compressive strength in Kg/cm^2.	1340	1317
Flexural strength in Kg/cm^2.	308	453
Modulus of Rupture in Kg/cm^2.	462	453

It shall offer flexibility, high wear resistance, impact resistance and on testing shall be 1.5 kgcm/cm., hardness on the Moh's scale shall be 3 to 4, abrasive wear index shall be 22 and total water absorption shall be around 0.13%. It shall not be easily affected by the freeze and thawing cycling.

56.4 It shall be non-porous and shall be used in all types of weather. It shall be used for internal and external surfaces. It shall be easily cut with a normal hand cutting machine, if required and shall be laid in the same manner as natural marble stone.

M-57 Glass Mosaic Tile

57.1 Glass mosaic tile shall be of approved make as directed by Architect. They shall confirm to relevant IS codes.

57.2 Tiles shall be water proof, weather proof and chemical proof. Tile should be resistant to thermal shocks. They should retain their original colour and were not cracked or damaged during in any way during construction.

57.3 They shall be available in the form of sheet pasted on paper for easy-fixing. They shall be non-slippery, non-porous, non-sensitive and non-conductive. They should offer good resistance to temperature changes, chemical effects, impact and pressure and surface abrasion. They shall be weatherproof and 100% fire proof. They shall be light weight and could be fixed on any surface and in any shape. They shall be available in all colours and shall be permanent in colour. They shall be antistatic and easy to clean.

57.4 For the properties mentioned below it shall conform to mentioned code.

1. Chemical Resistance - EN 122 / ISO 10545: Part 13
2. Colour Resistance to fading - DIN 51094
3. Water Absorption - ISO 10545: Part 13
4. Thermal Shock Resistance - ISO 10545: Part 9

M-58 Rubber Tile

58.1 The rubber tile shall be of approved make such as REPHOUSE, Nora or equivalent.

58.2 The tiles should be manufactured by polymerically rubber and cork particles.

58.3 Rubber tiles should have premium acoustical underlay which provides optimum sound and vibration resonance absorption as well as excellent thermal insulation properties.

58.4 It should be environmentally safe and is not health hazardous. It should exhibit excellent dynamic properties and should remain permanently elastic.

58.5 It should have excellent sound absorption and thermal insulation properties.

58.6 It should be available in a variety of thickness, widths, density and multi build up layers to suit most construction needs.

M-59A Solid Wood Flooring

59A.1 Solid wood represents a homogeneous construction of wood. Solid wood should be seasoned well and pre finished with minimum 7 coats of formaldehyde-free acrylic lacquer.

59A.2 The lacquer used for polishing shall be UV-cured so that it does not get dusty, stain or scratch easily.

59A.3 It shall be available in oil and lacquer both type of polish

M-59B Engineered Wood Flooring

59B.1 Engineered hardwood flooring shall be robust flooring comprised of 4 layers or as per manufacture's specification.

59B.2 Top layer shall be of 5 coats of hard-wearing lacquer above the genuine wood surface layer. Below the genuine wood surface layer middle layer of plywood or particle board shall be there. At bottom stabilizing layer shall be there as per manufacture's specification.

59B.3 It shall be available in oil and lacquer both type of polish.

59B.4 The lacquer used for polishing shall be minimum 5 coats of UV curved formaldehyde free lacquer

M-59C Laminated Wood Flooring

59C.1 Laminated flooring shall be available in 8 mm to 12 mm thickness. Laminated wood floor is made up of three layers. Bottom layer is stabilizing layer made up of special paper, middle layer or core layer made of HDF board, top most layer made of decorative and overlay in melamine resin.

59C.2 The decorative paper is what it gives the laminate flooring its individual appearance. Three layers shall be pressed with direct pressure laminate process in which decorative covering layer and stabilizing layer are pressed together onto the core layer made of HDF board.

M-60 Structural Steel

60.1 CPWD specification clause no. 10.1.1 shall be followed.

M-61 Rolling Shutters

61.1 The rolling shutters shall conform to IS: 6248. Rolling shutters shall be supplied of specified type, with accessories. The size of the rolling shutters shall be as specified in the drawings. The shutters shall be constructed with interlocking lath sections formed from cold rolled steel strips not less than 0.9 mm. thick and 80 mm. wide, for shutters upto 3.5 m. width and not less than 1.25 mm. thick and 80 mm. wide, for shutters 3.5 m. in width and above, unless otherwise specified.

61.2 Guide channels shall be of mild steel, deep channel section and roll pressed or built-up (fabricated), with joint less construction. The thickness of the sheet used shall not be less than 3.15 mm.

61.3 Hood covers shall be made of MS sheets, not less than 0.90 mm. thick. For shutters having width of 3.5 m. and above, the thickness of MS sheet for the hood cover shall be not less than 1.25 mm.

61.4 The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong MS or malleable CI brackets. The brackets shall be fixed on or under the lintel as specified with rawlplugs and screws bolts, etc.

61.5 The rolling shutters shall be of self rolling upto 8 m2. clear area, without ball bearing and upto 12 m2. Clear area, with ball bearing. If the rolling shutters are of large area, then gear operated type shutters shall be used as per approved manufacturer's specifications.

61.6 The locking arrangement shall be provided at the bottom of shutter at both ends. The shutters shall be opened from outside.

61.7 The shutters shall be completed with door suspension shafts, locking arrangements, pulling hooks, handles and other accessories.

M-62 Welded steel wire fabric

62.1 Welded steel wire fabric for general purpose shall be manufactured from cold drawn steel wire "as drawn" or galvanized steel conforming to IS: 226 or as specified in the item with longitudinal and transverse wire securely connected at every intersection by a process of electrical resistance welding and conforming to IS: 4948. It shall be fabricated and finished in workmanlike manner and shall be free from injurious defects and shall be dust proof. The type of mesh shall be oblong or square, as directed in the item description. The mesh sizes and sizes of wire for square as well as oblong, welded steel wire fabric shall be as directed. The steel wire fabric in panels shall be in one whole piece, in each panel, as far as stock sizes permit.

M-63 Expanded Metal Sheets

63.1 The expanded metal sheets shall be free from flaws, joints, broken strands, laminations and other harmful surface defects. Expanded metal steel sheet shall conform to IS 42 except the blank sheets need not be with guaranteed mechanical properties. The size of the expanded metal and dimensions of strands (width and thickness) shall be as specified. The tolerance on nominal weight of the expanded metal sheets shall be ± 10%.

63.2 Expanded metal in panels shall be in one whole piece, in each panel as far as stock size permit. The expanded metal sheets shall be coated with suitable protective coating to prevent corrosion

M-64 Oil Bound Washable Distemper

64.1 CPWD specification clause no. 13.19.1 shall be followed.

64.2 Oil Emulsion (Oil Bound Washable Distemper (IS: 428) of approved brand and manufacture shall be used. The primer used for distemper shall be of same make as paint. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for day's work shall be prepared.

64.3 The ready mixed paints shall only be used. However, if ready mixed paint of specified shade of tint is not available white ready mixed paint with approved stainer shall be allowed. In such a case contractor shall ensure that the shade of the paint so allowed shall be uniform.

64.4 All the paints shall meet following requirements
a) Paint shall not show excessive setting in a freshly opened full can and shall easily be re-dispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, levering, caking or colour separation and shall be free from lumps and skins.
b) The paint as received shall brush easily, possess good levelling properties and show no running or sagging tendencies.
c) The paint shall dry to a smooth uniform finish free from roughness grit, unevenness and other imperfections.

64.5 The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and engineer-in-charge. Empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the engineer-in-charge.

M-65 Water Bound Distemper

65.1 It shall be from Asian, Berger or equivalent as approved by Architect. It shall conform to relevant IS codes.

65.2 It can be in powder form or liquid form as per the manufacture's specification. If it is in powder form it can be prepared by adding warm water in the proportion recommended by the manufacture.

65.3 It shall be applied by the conventional distemper brush to all plastered surface. It shall be applied by the conventional distemper brush to all plastered walls, ceilings and woodwork. Priming coat shall be applied before applying the paint.

M-66 Plastic Emulsion Paint

66.1 Plastic emulsion paint shall conform to IS: 5411 of approved brand and manufacture and of the required shade shall be used.

66.2 The plastic emulsion paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These paints are to be used on internal surfaces except wooden and steel.

M-67 Cement Paint

67.1 The cement paint shall be (conforming to IS: 5410) of approved brand and manufacture.

67.2 The cement paint shall be brought to the site of work by the contractor in its original container in sealed condition. The material shall be brought by the contractor at a time in adequate to suffice for the whole work or atleast for a fortnight's work. The material shall be kept in joint custody of Architect and engineer-in-charge. Empty tins shall not be removed from the the site of work, till this item of work has been completed and passed by the engineer-in-charge.

67.3 It shall be manufactured from selected range of raw materials and a special cement, so the it shall be suitable for both indoors and outdoors. It shall be suitably used on concrete renderings, cement/sand renderings, cement/lime/sand renderings, asbestos sheets, fiber boards, brickwork, etc. It shall offer matt finish. It shall require no primer and shall be water thinnable. It shall offer a covering capacity as per manufacture's specification, depending on the surface and shade used. It shall preferably not be applied under direct sunlight to avoid patchy effect.

M-68 Textured wall finish

68.1 It shall be of acrylic polymer based texture of Jotun, Sherwin Williams / Asian / NITCO / ICI / Berger as approved by Architect or engineer in charge. It shall conform to relevant IS codes. Thickness and finish shall be as per manufacturer's specification.

68.2 It shall be of two components, or one component as specified by the Architect or engineer-in-charge. It shall be apply by trained and approved applicators. The single coat shall be 1.5 mm thick as specified in the item description. It shall be weather and fade resistant, water and damp resistant, durable and highly washable. It shall be acid and alkali resistant, high abrasion resistant, non-toxic and shall be capable to taking any shape. It can be applied on wide variety of surface like cement mortar, plywood, plaster board, AC sheet, Asbestos board, gypsum plaster or any other materials, to get homogenous layer.

68.3 It shall be water thinnable to avoid water contamination, incombustible and flexible. It shall be good fire resistant, anti-fungal, good impact resistant having adhesion strength more than 8 kg./cm^2. There shall not be any development of hair line cracks and no peeling off shall occur, after the maximum drying time of 4 hours and curing period of 2 days.

M-69 Silicone paint

69.1 It shall be of the best quality like Wacker, GE Silicone, Pidilite, Dow Corning or equivalent, as approved by the Architect and Engineer-in-charge. It shall conform to the relevant IS Codes.

69.2 It shall be prepared by mixing Silicone and Epoxy. It shall be applied on dry as well as damp surfaces. It shall be non-toxic and odourless, so shall be suitable for drinking water structures also. It shall render the surface impervious to water and shall prevent water penetration. It itself shall penetrate into the structure and shall form a strong film on the pores of the structure surface, making the surface water-tight, non-toxic and erosion free.

69.3 It shall be water thinnable. Before use, the hardener of the Siliconate Epoxy shall be mixed with resin and thinned with water, in the proportions described by the manufacturer. It shall be applied with a suitable spray gun with a fine nozzle. An overlap of 25 to 30 cm. shall be preferred. It shall be semitransparent but on drying it shall become transparent.

M-70 Synthetic Enamel Paint

70.1 Synthetic Enamel paint shall conform to IS : 2933. It shall be from Nerolac, Berger, Asian Paints or equivalent. It shall offer variety of finishes like Glossy, Semi-glossy, Pearl lustre and Matt finish.

70.2 It shall be applied either by brush, roll or spray. It shall have a covering capacity of as specified by the manufacture, depending on the surface to be painted. It shall be used both on metal and wood surfaces.

70.3 It shall have a viscosity of application of 30 to 40 seconds, if brush or rollers are used and 20 to 25 seconds, if spraying is done. The drying time shall however vary with the ambient temperature and humidity.

M-71 Acrylic Paint

71.1 It shall be from Asian Paints, ICI, Berger, Nerolac or equivalent as approved by the Architect. It shall conform to the relevant IS Codes.

71.2 It shall be used on both interiors and exteriors on all different types of plaster, wooden surfaces, stone, brickwork, asbestos cement sheets, hard and soft boards, etc. as specified in the drawing. It shall render rich smooth finish and shall provide a tough film that forms a suitable protection against all elements.

71.3 It shall be water thin able. On interior surface it shall be applied after one coat of cement primer and in case of exterior surface it shall be applied on waterproof cement coating. On a new but highly absorbent surface, a thin coat of the paint shall be applied by adding two parts of water by volume to two parts of Acrylic Emulsion by volume. On previously painted surfaces, one coat of the acrylic paint shall be applied by thinning four parts of the emulsion with one or two parts of water. It shall be applied by brush, roller or spray. It shall have a covering capacity as per manufacture's specification, depending on the surface and shade used. It can be washed to remove the day-to-day dirt, after the surface has been painted, minimum for a month. It should be non-flammable. For the best performance of paint proper washing and cleaning of all algal and fungal growth at regular intervals at six months is required.

M-72 French Polish

72.1 Pure Shellac conforming to IS : 16 varying from pale orange to lemon yellow colour free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of Shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade.

72.2 Ready made polish conforming to IS : 348 can also be used. The French polish so prepared shall Conform to IS : 348.

M-73 Lacquer Polish

73.1.1 Lacquer polish of ASIAN or TARALAC with thinner of same company shall be used.

73.1.2

73.1.3 Surfaces to be polished shall be properly grinned with sandpaper and all grains of the wood shall be filled by sealer coat over that multiple layers of approved company's Laquar to be applied up to hot water resistance.

M-74 Wax Polish

74.1 The Wax polish of required tint and shade shall be prepared with the below mentioned ingredients and other necessary materials.
(a) 2 parts Bees wax conforming to IS: 1504-196
(b) 1.5 parts boiled linseed oil conforming to IS : 75
(c) 1 part of Turpentine conforming to IS: 83
(d) 0.5 part Varnish conforming to IS: 337

74.2 Pure bees wax free paraffin or stearine adulterants shall be used. The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and entire mixture shall be well stirred.

M-75 Melamine Polish

75.1 The melamine polish shall be of best quality and make such as Asian Paints or equivalent, as approved by the Architect and Engineer-in-charge. It shall be transparent or opaque, as specified by the Architect or engineer-in-charge.

75.2 It shall give silken, smooth finish. The Melamine polish shall have shade and shine, either satin or glossy, as approved by the Architect. It shall be two component polish consisting of a base and hardener. It shall be capable of protecting wood from moisture, heat, cold, scratches, stains, cigarette burns etc. It shall have excellent covering capacity. It shall be applicable to all wooden surface of every shape. It shall be applied using brush or spray gun. It shall require lesser time to dry and there shall be no cracks or pealing off of the polish. There shall not be any undulation on the finished surface nor cracks at joints. It shall be of any desired shade as approved by the Architect. It shall have excellent colour, shall be free flowing and shall have good levelling properties. It shall be durable and flexible to absorb cracks. It shall have resistant to scrubs, light rays, heat etc. complete as per architect or engineer-in-charge.

M-76 Polyurethane paint

76.1 It shall be from Asian, ICI, Jotun or equivalent as approved by the Architect.

76.1.1 It shall be a three coat application. It can be done either by using a brush, spray or a roller. It shall be available in variety of decorative finishes i.e. in almost all shades and in glossy and matt finishes. It shall offer the following properties

(a) Adhesion to concrete / metal surface
(b) Sealing effect against heavy rain
(c) Good Water vapor diffusion
(d) Weather resistance, color stability, gloss retention and chalk resistance
(e) Resistance to disinfectants, chemical, fire, radiation, acid gases, abrasion and wear
(f) Low soil adhesion
(g) Scratch and Mar resistance
(h) Have long life and excellent gloss

76.2 It shall absorb UV radiation and shall be easily cleaned of radioactive contamination. The ultraviolet part of the solar radiation shall not affect the coating and thereby shall be long lasting

M-77 Powder Paints

77.1 Powder paints shall of superior quality such as Asian, Nerolac or equivalent, as approved by the Architect and Engineer-in-charge. It shall conform to the relevant IS specifications.

77.2 Powder coatings should be a blend of resins, curing agent and pigments which are melt mixed (extruded) and pulverized into finely divided particles. It should be solvent free.

77.3 It shall be available in the following types:

Epoxy Powder
It is practical coatings for pipes, water and gas valves, steel furniture and indoor appliances. It is suited for surface subjected to high stress and chemical effects.

Epoxy polyester powder
This is a system for economical operation with a high degree of chemical resistance. The manufacturers of household appliances, automobile parts, shelving systems, electrical cabinets and steel furniture use it

Pure Polyester Powder
This is best suited for articles such as aluminum extrusion, which are exposed to exterior environment. This powder has excellent U.V. resistance.

Polyurethane powder
Polyurethane gives excellent flow & Finish and protects the surface from Ultra Violet rays.

M-78 Mangalore Pattern Roof Tiles

78.1 The Mangalore pattern tiles shall conform to IS : 654 for Class AA or Class A type, as specified in the item. The tiles are to be made from clay, place it in a mould and cut to the measurement. Sample is to be got approved from Architect. Necessary tests are to be carried out as per IS code.

M-79 Aluminum Sheets

79.1 It shall be of the best quality and from reputed manufacturer like Jindal, Hindalco or equivalent, as approved by the Architect and Engineer-in-charge. It shall conform to IS: 1254, in all respects. The aluminum alloys used in the manufacture of the sheets shall conform to IS: 737.

79.2 The sheets shall be extremely light with high-strength-to weight ratio. having a density of about 2.70 gms/cm^3. It is corrosion resistant in almost any kind of environment. Even in highly-corrosive industrial environments, it should be resistant to fumes and vapours of organic compounds and to chemicals like ammonia, carbon-dioxide and acids like hydrochloric acid, nitric acid and sulphuric acid. This corrosion-resistant property gives the metal a long life and keeps it looking good throughout its life The sheets shall be non-fragile and shall be exceptionally durable. As aluminum reflects a high proportion of the radiant heat, the sheets provide excellent insulation when used for cladding/roofing. The sheets shall be non-combustible, non-flammable and non-sparking. As aluminum is elastic, the sheets shall offer high resistance to denting and shall be shatter-proof. Co-efficient of linear expansion of aluminum is 0.000024 per ^oC and therefore the lateral expansion of the sheets shall be readily accommodated in the corrugations. The sheets shall offer no health hazard and shall be totally hygienic. Aluminium is a good conductor of heat, its high reflectivity of radiant heat and light (75 to 80 per cent when new, 60 per cent after several years) keeps the interiors of an aluminium building from five to eight degree celsius cooler in summer while its low emission rate cuts heat loss during winter.

79.3 It shall be available in trapezoidal and rounded corrugations and shall be extensively used for various Industrial buildings, Warehouses, Aircraft hangers, Power plants, Storage sheds, Bunk houses etc. It shall be innovatively used as interior partitions, wall panels, false ceiling etc.

M-79B Aluminium Section

79b.1 Aluminum sections used for fixed/ openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.
The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows.
Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in- Charge and nothing extra shall be paid on this account.

79b.2 Anodising
Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

79b.3 Powder Coating

79b.3.1 *Material:* The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

79b.3.2 *Pre-treatment:* Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-in-Charge. The metal surface after the conversion coating pre-treatment and prior to the application of the coating shall be free from dust or powdery deposits.

79b.3.3 *Process:* The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

79b.3.4 *Thickness:* The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

79b.3.5 *Performance Requirements for the Finish*
(i) *Surface appearance:* The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

(ii) *Adhesion:* When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

79b.3.6 *Protection of Powder Coated / Anodizing Finish :* It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

M-80 PVC Sheet

80.1 PVC sheet should be of Finolex or equivalent as sample approved by Architect and engineer-in-charge. PVC sheet should be corrosion resistant and chemical resistant. It should resists actions against chemicals like mineral acids, alkalis, plating solutions, pickling solutions, paper making chemicals, most inorganic compounds, alcohols, aliphatic hydrocarbons, glycols, amines and phenols in both liquid and vapour form.

80.2 It should be hygienic, virtually maintenance free, UV resistant, highly flexible so that it can be bent perpendicular or parallel to corrugation. It should be light weight than it can be easily handled and transported.

80.3 It should possess excellent thermal insulation and rust proof to make it ideal for coastal region.

80.4 It should be fire retardant. It should be as per the sample approved by engineer-in-charge. It should be such type that it can be used in heavy industries, factories and warehouses, agricultural and food processing industries and for coastal construction

M-81 Fibre Glass

81.1 It shall be of the best quality such as Glass poll, Malibu or equivalent, as approved by the Architect and Engineer-in-charge. It shall conform to BSS : 4154.

81.2 It shall be a combination of glass fibre mat and polyester resin, suitably modified to resist ultraviolet degradation. It shall disperse light rays, allowing uniform diffused light penetration. It shall absorb the heat rays and so helps to save electricity. It shall be available in (1) Clear grade - where light transmission shall be 87% to 90%. (2) Natural white/green/blue/yellow/red - where light transmission shall be 60% to 70%. It shall be available in lengths of 1.5 m. to 3 m. The width shall be equivalent to that of asbestos/galvanized and aluminium corrugated sheets. It shall have a thickness of 1.2 mm. with a tolerance of $\pm$ 0.2 mm

81.3 It shall have a coefficient of linear expansion of .000012 per ^{o}C. Its heat distortation temperature shall be approximately 75□C. It shall have thermal conductivity of 0.22 Kcal/mh^{O}C. It shall have impact strength of 14.5 Ft, hardness of 40 - 50 Barcol and Brinell 26. It shall have a tensile strength of 600 - 800 Kg/cm^2 and compressive strength of 1200 - 1400 Kg/cm^2. On soaking for 24 hrs, at 25^{O}C, its water absorption shall be 0.24%. It shall have effective resistance to most chemicals except strong acids.

81.4 It shall be suitably used for industrial and residential roof coverings, where light transmission is desired. It shall also be used to cover swimming pools, gardens and terraces, if desired. It shall be normally self cleaning type but when used in industrial areas, it shall be cleaned with water and soap.

M-82 Polycarbonate Sheet

82.1 Polycarbonate sheets for versatile glazing shall of the best quality such as GE, Lexan or equivalent, as approved by the Architect and Engineer-in-charge. It shall meet all the requirements of BS: 6262. For impact performance, it shall meet the BS: 6206 requirements and for anti-bandit requirements, it shall conform to BS: 5544.

82.2 It shall be as transparent as glass, but shall have half its weight. It shall be tough and yet flexible. It shall have strong impact strength and shall offer thermal and sound insulation. It shall resist the effects of weather, shall be unbreakable and shall provide protection against forced intrusion. It shall be used for roof glazing, door and window glazing as well as privacy glazing, on many different types of buildings. As light weight, it shall be feasible to use it on wider spans. It promotes natural light and shall impart an impression of spaciousness.

82.3 It shall have tensile strength greater than 70 N/mm^2. Its flexural modulus shall be 2500 N/mm^2. and flexural yield strength shall be 100 N/mm^2. It shall have impact strength (falling dart) greater than 200 Nm. It shall have indentation hardness - H358 10 of 98 N/mm^2. and H358 60 of 93 N/mm^2. Its coefficient of linear expansion shall be 0.00067 per ^oC and thermal conductivity shall be 0.21 W/m.K. It shall have a specific gravity of 1.2 gm/cc. and water absorption @ 24 hrs. 23^OC shall be 10 mg. Its elongation at break shall be greater than 100%. It shall have a higher coefficient of thermal expansion. It shall allow light transmission of between 82% and 90%, depending on the thickness of the sheet. It shall not transmit UV radiation upto 385 Nm. It shall resist the effect of chemicals. It shall have self-extinguishing, low flame spread characteristics and low fire propagation indices.

M-83A Corrugated GI Sheet

83.1.1 CPWD specification clause no. 12.1.1, 12.1.2 shall be followed.

M-83B Pre painted (colour coated) galvanize sheet:

83.1B PPGL sheet shall be of tata colour bond or equivalent and as per manufacturer's specification.

M-84 Deleted

M-85 Teak Wood

85.1 CPWD specification clause no. 9.1 and 9.2 is to be followed.

M-86 Plywood

86.1 The plywood for general purpose shall conform IS : 303.
Plywood is made by cementing together thin boards or sheets of wood into panels. There are always an odd number of layers, 3,5,7,9 ply etc. The plies are placed so that grain of each layer is at right angles to the grain in the adjacent layer.

86.2 The chief advantages of plywood over a single board of the same thickness is that, plywood offers more uniform strength, along its length and width and also offers greater resistance to cracking and splitting with change in moisture content.

86.3 Usually synthetic resins are used for gluing, phenolic resins are usually cured in a hot press which compresses and simultaneously heats the plies between hot plates, which maintain a temperature of 90^0C to 140^0C and a pressure of 11 to 14 Kg/cm^2, on the wood. The time of heating may be anything from 2 to 60 minutes depending upon the thickness.

86.4 When water glues are used the wood absorbs so much water that the finished plywood must be dried carefully. When synthetic resins are used as adhesive, the finished plywood must be exposed to an atmosphere of controlled humidity until the proper amount of moisture has been absorbed.

86.5 According to IS : 303, the plywood for general purpose shall be of the grades namely BWR, WWR and CWR, depending upon the adhesives used for bonding the veneers, and it will be further classified into six types namely AA, AB, AC, BB, BC and CC based on the quality of the two faces, each face being of three kinds namely, A,B and C. After pressing, the finished plywood should be reconditioned to moisture content not less than 8% and not more than 16%.

86.6 Thickness of plywood boards: Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be ± 10% for boards upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plys in plywood boards shall be as per Table:

Thickness in mm	No of ply	Thickness in mm	No of ply
3,4,5,6	3	12,15,16,19	9
5,6,8,9	5	19,22,25	11
9,12,15,16	7		(Above 11 Ply as ordered)

Types of plywood :

M-86A Water Proof (Weather Proof) Plywood :

86A.1 The plywood shall be of approved make and as approved by the Architect and Engineer-in-charge. It shall conform to IS : 710 and to the relevant Defence and Navy specifications.

86A.2 Plywood shall be made from veneers of hard wood timbers and bonded with high quality BWP type Phenol Formaldehyde Synthetic Resin Adhesive and hot pressed at high temperature and pressure, and further treated with a fixed type of preservative by vacuum-cum-pressure impregnation, to produce thin boards or sheets of wood panels. There are always an odd number of layers. The plies shall be placed, so that, grain of each layer is at right angles to the grain in the adjacent layer.

86A.3 Plywood shall be waterproof, weather proof, boilproof, and highly durable even against strenuous vulnerable uses. It shall resist the attack of termites, cockroaches, wood burrowers, fungus, mould, rot, decay and other wood destroying insects and marine organisms.

86A.4 The tensile strength of the plywood shall be minimum 600 kg/cm$^{2.}$ and bending strength above 400 kg/cm^2. The swelling of plywood in water should be almost negligible. Specific gravity of plywood should be 0.7 to 0.75, having screw and nail holding strength normal to face, atleast 250 kg. and 60 kg., respectively.

86A.5 The moisture content shall be less than 10% and the plywood shall have high fire resistance and shall be free from any cracks, wraps, split etc., and shall have uniform strength all over the panel surface. It shall be used for marine structures, leather tanning tables, wall panelling, and underlayment for kitchen and other furniture, subjected to heat and moisture.

M-86B Commercial Ply:

86B.1 The plywood shall of approved make, as approved by the Architect and Engineer-in-charge. It shall conform to IS 303.

86B.2 Plywood shall be made from hard wood timbers, finished with selected species of timber, suitable for veneers and bonded with strictly controlled and evenly spread adhesives.

86B.3 It shall be smooth and strong and shall be free from warping, cupping and twisting.

M-86C Prelaminated - Standard and Veneered:

86C.1 **Decorative Plywood**

86C.1.1 It shall be obtained from manufacturer as approved by the Architect and Engineer-in-charge. It shall conform to relevant IS Code.

86C.1.2 Plywood shall be made from hard wood timbers, finished with selected species of timber, suitable for veneers and bonded with strictly controlled and evenly spread adhesives. It shall be smooth and strong and shall be free from warping, cupping and twisting.

86C.2 **Decorative Veneers**

86C.2.1 Decorative veneered plywood shall be manufactured using veneers of the best quality timbers like Teak, Rosewood, Walnut, Laurel, White Cedar and many others.

86C.2.2 They shall be available in flitch form as well as in lay-on form, in sizes suitable to the furniture industry. They shall be available either flat or quarter sliced, varying in thickness from 0.2 mm. to 1.5 mm. Lengths shall vary upto 4 m.

M-86D Block Boards

86D.1 They shall be manufactured from well-selected and seasoned hardwood timbers, used in sturdy construction. They shall be usually bonded with Urea Formaldehyde, however against specific requirements, Phenol Formaldehyde bonded boards shall also be available.

86D.2 They shall be strong, weather and water proof and shall be ideally used for high quality furniture and exterior applications.

M-87 Glass

87.1 All glass shall be of the best quality, free from specks, bubbles, smokes, veins, air holes, blisters, and other defects. The kind of glass to be used shall be as mentioned in the item or specification or in the special provisions or as shown in detailed drawings. Thickness of the glass panels shall be uniform. The specifications for different kinds of glass shall be as under:

87.2 **Sheet Glass**

87.2.1 In absence of any specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 7.5 Kg/m^2. for panes upto 600 mm. x 600 mm.

87.2.2 For panes larger than 600 mm. x 600 mm and upto 800 mm. x 800 mm., the glass weighing not less than 8.75 Kg/m^2. shall be used. For bigger panes upto 900 mm. x 900 mm., glass weighing not less than 11.25 Kg/m^2. shall be used.

87.2.3 Sheet glass shall be patent flattened glass of best quality and for glazing and framing purposes shall conform to IS : 1761. Sheet glass of the specified colours shall be used, if so shown on the detailed drawings or so specified for important buildings and for panes with any dimensions over 900 mm., plate glass of specified thickness shall be used.

87.3 **Plate Glass**

87.3.1 When plate glass is specified, it shall be `Polished patent plate glass' of best quality. It shall have both the surface ground flat and parallel and polished to obtain clear undisturbed vision and reflection. The plate glass shall be of thickness mentioned in the item or as shown in the detailed drawing or as specified. In absence of any specified thickness, the thickness of plate glass to be supplied shall be 6 mm. and a tolerance of 0.20 mm. shall be admissible.

87.4 **Obscured Glass**

87.4.1 This type of glass transmits light so that vision is partially or almost completely obscured. Glass shall be plain rolled, figure, ribbed or fluted, or frosted, as may be specified or as required. The thickness and type of glass shall be as per details on drawings or as specified or as directed.

87.5 **Wired Glass**

87.5.1 Glass shall be with wire netting embedded in a sheet of plate glass. Electrically welded 13 mm. Georgian square mesh shall be used. Thickness of glass shall not be less than 6 mm. Wired glass shall be of the type and thickness as specified.

87.6 **Double Glazed units**

87.6.1 Double glazed unit shall comprise of two glasses of appropriate thickness and absolutely machine-cleaned on both sides, with an air gap of 12 mm .in-between. The space between the two glasses is kept totally dry, avoiding any condensation by sealing the space with elastomeric sealant. Thus in all, it is an insulating glass unit of around 20mm. thickness.

87.6.2 It shall be suitably used for any kind of Doors and Windows, in all areas of work and residences. It shall be absolutely and clearly transparent, giving the following advantages:

1) Total light penetration, but with dust and heat insulation.
2) Noise insulation.
3) 25% saving in electricity due to heat insulation.
4) Crystal clear transparency.

M-88 PVC Water stops

88.1 The PVC waterstop shall be of approved make, as approved by the Architect and Engineer-in-charge.

88.2 It shall have optimum resilience, high elasticity & stretch strength, immune to corrosion, excellent weather resistance. They shall be manufactured to safeguard against hydrostatic pressure, water seepage, expansion or contraction of joints and to take care of any deflection or displacement arising due to change in temperature or settlement of foundation to eliminate danger of cracks.

88.3 They shall be effective in tropical climate having high mechanical strength, good ageing, longer life, shall be unaffected by acids, alkalis, metal salts and other chemicals. It shall not be hazardous and shall have fire retardant properties. It shall absorb less water than rubber, shall work as water tight seal but shall allow safe passage of seepage water and shall withstand high hydrostatic pressure. It shall be easily welded and can be installed easily, having high tensile strength and shall be capable of bearing heavy shocks arising due to turbines, earthquakes, floods etc.

88.4 It shall withstand a minimum hydrostatic pressure of 30 m. high column of water.

88.5 The selection criteria of waterstop depends upon the hydrostatic pressure, however the following points should be kept in mind :

1) Where substantial expansion/contraction of joints takes place, Dumb Bell type shall be used.
2) Where a firm grip in concrete is desired, serrated types should be used.
3) The overall width of the waterstop should not be greater than the thickness of concrete.
4) The distance from the face of the concrete to the waterstop must not be less than half the width of the waterstop.
5) The width of the waterstop must be at least 6 times the largest aggregate used for satisfactory compaction.

88.6 The prior approval of selected size and type of waterstop shall be taken from the Architect and Engineer-in-charge, before use.

M-89 Admixtures for Mass Concrete and Mortar

M-89A Joint Sealant :

89A.1 The sealant shall be of approved make, as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the Architect. It shall conform to the relevant IS Code.

89A.2 It shall be a two component polysulphide rubber joint sealant, based on a low molecular weight polymer. It should not contain chlorides or other corrosive substances.

89A.3 It shall be used for sealing joints in water retaining structures, roofs, external walls, cladding, floors, partitions, ceilings etc. It shall have excellent property to adhere most of building materials like Aluminium, Stainless Steel, Glass, Concrete, Marble, Stone, Brick, Masonry block, Plaster, Ceramic and quarry tiles, Timber etc. The modulus of elasticity of the sealant shall be less than 0.16 MPa, $\pm$10% at 100% elongation. The shore "A" hardness of the sealant shall be 22$\pm$3 @ 25^{O}C. The operating temperature range for the sealant shall be -25^{O}C to 800C. The permanent dynamic movement capability of the sealant shall be $\pm$25%. The tensile strength of the sealant shall not be less than 0.4 MPa. The optimum width/depth ratio shall be 2:1. The Sp.gr. of the sealant shall be 1.6 kg/lit. The sealant should be capable to resist attack of water, sunlight, oxidation, corrosive fumes, oils, petrol, diluted acids and alkalis, salt spray, aliphatic and aromatic solvents and shall not contain tar or bituminous ingredients.

89A.4 It shall posses the properties like 550% elongation at break, non-toxicity when fully cured, no staining and shrinkage less than 1%. The trafficable strength shall be achieved within 24 hours and full at 7 days (at 25^{O}C & 250% RH). It shall possess excellent coverage capacity and more strength at low dry temperatures.

M-89B Abrasion Resistant Industrial Flooring Aggregate :

89B.1 The flooring aggregate, shall be of best quality and from manufacturer like CICO or equivalent, as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the Architect. It shall conform to the relevant IS Code.

89B.2 The flooring aggregate shall be a factory processed and specially graded non-oxidising, non-magnetic and chemically inert metallic flooring aggregate, free from oil and grease.

89B.3 It shall be used as a surface hardener to concrete floors. It is recommended for Factory floors, Warehouses, Hangers, Car parks and such other areas, subjected to heavy vehicular traffic. It shall also be used on open and continuously wet surfaces. The flooring aggregate shall build in wear resistance and shall produce high abrasion resistant floor surface. It shall impart extreme surface density and shall offer resistance to oil and water penetration. It shall provide a non-rusting floor surface which is easy to maintain.

89B.4 It shall be used with cement in the ratio, as per the manufacturer's instructions and spread evenly on the surface to be treated, at the rate depending on the type of floor. The flooring aggregate shall be spread when the surface of the concrete floor is still fresh, i.e. as soon as the surface water has evaporated and then trawled, in stages, to bring about an uniform and smooth finish.

M-89C Concrete Hardener and Dustproofer :

89C.1 The Concrete hardener and dustproofer, shall be of best quality and from manufacturer like CICO or equivalent, as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the Architect. It shall conform to the relevant IS Code.

89C.2 It shall have a specific gravity of 1.18 and shall be applied on concrete floors, at the rate of atleast 25 lit.s per 100 $m^{2.}$ per coat. A total of three coats shall be applied for permanently hardened concrete floor, with increased abrasion resistance, increased surface density, increased resistance to chemical attack and to eliminate dust accumulation. Drying time of 4-6 hours for each coat shall be allowed before the floor is put to use or is applied with another coat of the product. Precautions shall be taken while using the product, to avoid contact with eyes and open wounds and to work in good ventilation. After application, the affected parts shall be washed copiously. It shall not be stored for a period of more than 2 months before use.

M-89D Water Repellent Coating :

89D.1 The Water repellent coating, shall be of approved make and as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the Architect. It shall conform to the relevant IS Code.

89D.2 Water repellent coatings for exterior exposed surfaces shall be acrylic resin based, having a Flash point of approx. 40^0C and specific gravity of 0.95.

89D.3 It shall be suitably used for concrete, brick, stone and plastered surfaces preventing moisture penetration and thus any damage to the interiors. It shall be quick acting, long lasting, invisible i.e. colourless so as to maintain the original colour of the surface treated. It shall impart sealing characteristics so that the treated surface becomes stain and dust free. The coating itself shall not darken or turn yellow with age.

M-89E Accelerating, Water Reducing Admixture and Plasticiser:

89E.1 The Accelerating, Water reducing admixture and plasticiser, shall be of approved make, as approved by the Architect and Engineer-in-charge. The prior approval for the source shall be taken from the Architect. It shall conform to the relevant IS Code.

89E.2 It shall be in liquid state with a specific gravity of 1.30 and complying with ASTM C-494 Type E, IS: 9103 & IS: 2645. It shall accelerate the setting and hardening of the concrete mix, thereby achieving higher early age strength. It shall reduce the water content of the concrete without affecting its workability. It is useful for pre-cast/pre-stressed works, structural concrete works, floors, roads, runways, paving etc. It shall be used at the rate instructed by the manufacturer, with cement, depending on the amount of acceleration of hardening required. It should be compatible to all types of cement.

M-89F Retarding, Water Reducing Admixture and Plasticiser:

89F.1 The Retarding, water reducing admixture and plasticiser, shall be of best quality and from approved make, as approved by the Engineer-in-charge. It shall conform to the relevant IS Code.

89F.2 It shall be in liquid state with a specific gravity of 1.22 and complying with ASTM C-494 Type B & D, IS : 9103, CRD-C87 Type B & D, BS 5075 Part 1. It shall be added to the concrete mix during the mixing process, at the same time as the water or the aggregates. No extension of normal mixing time is necessary. It shall extend the period of time as to placing the concrete and compacting, i.e., delay the initial and final setting time. It shall help to spread the heat of hydration over a longer period. It shall give a highly workable concrete with a low W/C ratio. It shall be used at the rate instructed by the manufacturer, with cement, depending on the amount of acceleration of hardening required. It should be compatible to all types of cement.

M-89G Water & Weather Proof Compound:

89G.1 The water & weather proof integral cement admixture shall be of best quality and from approved make, as approved by the Engineer-in-charge. It shall conform to the relevant IS Code.

89G.2 It shall be used as an excellent cement admixture in all types of concrete/plaster mortars, pointing mortars, masonry works, guniting works and pressure grouting works. It shall improve resistance of concrete surfaces to weathering and chemical attack. It shall be non-toxic so as to use for waterproofing water tanks, reservoirs, bio-gas tank, leaking ceiling, basements, tunnels, lift wells etc.

89G.3 It shall be mixed to concrete or plaster mortar, while mixing. First, water is added and then the admixture, at the rate instructed by the manufacturer. For use of the admixture, precaution shall be taken to use clean materials for preparation of mortar.

M-90 Sand Stone Grills/ Baluster:

90.1 Sample shall be approved by the Architect and Engineer-in-charge.

90.2 It shall be made from best quality either Bansipahadpur or as specified in item having uniform colour (no other colour spot shall be allowed) and texture. The sand stone shall be even, sound, durable and free from any veins, cracks and flaws. The thickness of the stone used shall be as specified in item of work with the permissible tolerance of $\pm$2 mm.

90.3 The sandstone grills shall be produced by fine chiselling. All edges, faces and angles of fine hand chiselled grills, columns, baluster shall be smooth finished.

M-91 Polyurethane Foam Insulation:

91.1 Polyurethane foam shall be of approved make, as approved by the Architect and Engineer-in-charge. It shall conform to the relevant IS Code.

91.2 It shall have high strength to weight ratio alongwith excellent thermal insulation and acoustic absorption. It shall be based on the exothermic, catalytic reaction of polyisocynates with polyol molecules containing hydroxyl groups in the presence of blowing agent. It shall be perfectly homogenous and having uniform characteristics like perfect adhesion to metal surfaces, higher insulation capacity, maximum resistance and lightness. It shall be perfect non-hygroscopic, completely water proof having dimensional stability, optimum thermal insulation, fire retardancy.

91.3 It shall be of low foam density, not more than 40 Kg/m^3. The thermal conductivity shall be 0.02 Kcal/m hr ^{O}C. The compressive strength shall not be less than 2.5 Kg/$cm^{2.}$ and 1.2 Kg/$cm^{2.}$, in direction parallel to rise and perpendicular to rise respectively. The close cell content of the foam shall be 90 to 95% and it shall be workable within the temperature range of -150^{O}C to +80^{O}C. The water vapour permeability shall be 2.0 perms/in.

M-92 Fibreglass Reinforced Plastics (FRP)

92.1 Fibreglass Reinforced Plastic shall be of approved make, as approved by the Architect and Engineer-in-charge. It shall conform to relevant IS Code.

92.2 It shall be either unidirectional reinforced or sheet moulded or filament wound epoxy to match the purpose of work and item of tender. It shall have versatile chemical inertness, electrical resistance and mechanical strength, ease of processibility, repeatability and predictability. It shall have desirable characteristics like light weight, high strength, stiffness, toughness, thermal insulation properties, superior weather resistance, complete elasticity, fatigue, creep, resistance to corrosion, rot, swelling, insects, fungus etc.

92.3 There shall be no yield point beyond which buckling or denting of the FRP occurs, to reduce the possibility of irritating damages for minor stresses or impacts. The density, flexural strength and flexural modules shall not be less than 1.5 mg/m^3., 1000 MPa and 40x10^3 MPa, respectively. It shall have minimum tensile strength, tensile modulus and compressive strength of 1000 MPa, 40x10^3 MPa and 250 MPa, respectively. The FRP shall have thermal conductivity about 0.2 w/m^{O}C. Thermal coefficient of expansion shall be less than 10x10^{-6} per ^{O}K.

92.4 The minimum glass content shall be 60%. The weight index for stiffness and tensile strength at yield shall not be less than 0.6 and 0.9 respectively. No damage should be there while testing at impact energy of 8 joules. The level of translucency should be greater than 80% of diffused transmission that of direct light. It shall provide superior aesthetic value with incorporated colour. It shall be good fire retardant, durable and impermeable to water.

M-93 Fly ash

CPWD specifications clause no. 3.1.5 shall be followed.

M-94 Plaster of Paris

94.1 Plaster of Paris is manufactured from heating gypsum at 120ºC - 160º C. When plaster of Paris is mixed in water it rehydrates and form dense matrix of gypsum crystal.

94.2 Chemical formula of POP shall be CaSO4, ½ H2O.

94.3 Plaster of Paris shall be stored at dry place. Once the mix is prepared, it shall be applied within half an hour or the final setting whichever is earlier. Set material and wastage cannot be used.

EARTH WORK & CARRIAGE OF MATERIAL

Note:
1) The method of excavation shall be approved by the Engineer in charge before execution.
2) Excavation shall be carried out very carefully without damaging existing structures and surrounding if any.
3) If required, the contractor shall provide stabilization by any means to protect the foundation of the existing structure and building without any extra cost.
4) Rate shall include dewatering work (pumping out and removing slush) while execution in underwater condition if required.

Item No. 1
Excavation for all kinds of soil
Earthwork in excavation for all kind of soil by any means including getting out the excavated soil, sorting and stacking of useful material, dressing of the sides, ramming of bottom, and disposal of surplus excavated earth for all lead within the site area at non objectionable place and lift up to 1.5 mt depth, including dewatering and working in or under water and /or liquid mud, including pumping out water/slush as required etc complete as directed by engineer-in-charge. In case of excavation for pipe, cable, any services trenches, making base for road work, pavement works walkway, etc, proper slop and camber by any means shall be maintain and dressing of the sides shall be made as per requirement and as directed by engineer-in-charge.

AND

Item No. 2
Excavation for all kinds of soil
Earthwork in excavation for all kind of soil by any means including getting out the excavated soil, sorting and stacking of useful material, dressing of the sides, ramming of the bottom, and disposal of surplus excavated earth for all lead within the site area at non objectionable place and lift from 1.5 mt to 3.0 mt depth, including dewatering and working in or under water and /or liquid mud, including pumping out water/slush as required etc complete as directed by engineer-in-charge. In case of excavation for pipe, cable, any services trenches, making base for road work, pavement works walkway, etc, proper slop and camber by any means shall be maintain and dressing of the sides shall be made as per requirement and as directed by engineer-in-charge.

AND

Item No. 3
Excavation for all kinds of soil
Earthwork in excavation for all kind of soil by any means including getting out the excavated soil, sorting and stacking of useful material, dressing of the sides, ramming of the bottom, and disposal of surplus excavated earth for all lead within the site area at non objectionable place and lift from 3.0 mt to 5.0 mt depth, including dewatering and working in or under water and /or liquid mud, including pumping out water/slush as required etc complete as directed by engineer-in-charge. In case of excavation for pipe, cable, any services trenches, making base for road work, pavement works walkway, etc, proper slop and camber by any means shall be maintain and dressing of the sides shall be made as per requirement and as directed by engineer-in-charge.

1.0 General

1.1 CPWD specifications clause no. 2.0, 2.1, 2.2, 2.3 shall be followed.

2.0 Site Clearance

2.1 CPWD specifications clause no. 2.4 shall be followed except nothing extra will be paid for removing, diverting existing structures and services and providing fencing for the any archaeological monuments within or adjacent to the area.

3.0 Setting out and making profiles

3.1 CPWD specifications clause no. 2.5 shall be followed.

4.0 Excavation

4.1 CPWD specifications clause no. 2.7, 2.9 shall be followed up to any width (not restricted to 1.5m) and any area (not restricted to 10 sqm) on plan.

4.2 The Contractor shall do the necessary shoring and strutting or shall provide necessary slopes to a safe angle or steps as required or directed at his own cost. No extra payment shall be made for such precautionary measures taken by contractor.

4.3 The Contractor shall at his own expense and without extra charge make provision of supporting all utility services, lighting the trenches, separating and stacking serviceable materials neatly, shoring, timbering, strutting, bailing out water either sub-soil or rainwater, including pumping at any stage of the work. Trenches shall be kept free of water while masonry or concrete works are in progress and till the Architect and Engineer-in-charge considers it necessary, i.e. till the concrete is sufficiently set.

4.4 Maximum of 1 Horizontal: 1 Vertical slope shall be allowed and paid.

5.0 Disposal of the excavated stuff

5.1 The excavated stuff of the selected type shall be used in filling the trenches and plinth or levelling the ground in layers, including ramming and watering etc. complete as directed by the engineer-in-charge.

5.2 The Contractor has to dispose the surplus excavated earth within the site area at non objectionable place.

5.3 The lead is the shortest practical route and not necessarily the route actually taken. The decision of Engineer-In charge shall be final.

6.0 Mode of Measurement and Payment

6.1 CPWD specifications clause no. 2.11, 2.12.1 (a to f) shall be followed.

6.2 Plan area of base PCC as per structural drawing shall be measured for payment (unless otherwise specified). The contractor shall quote the rate for excavation with additional quantity for surrounding working space (which shall not be paid).

6.3 The rate shall also include necessary shoring & strutting, getting out the excavated soil, sorting and stacking of useful material, dressing of the sides, ramming of bottom, watering, dewatering and working in or under water and/or liquid mud, including pumping out water/slush as required, compacting and disposal of surplus excavated earth for all lead at non objectionable place within the site area as directed by engineer in charge.

Item No. 4

Filling available excavated earth (excluding rock)

Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations, plot filling, etc. in layers not exceeding 20cm in depth, with optimum moisture content to give at least 95% of the maximum dry density (proctor density) including watering, ramming and compacting by any means, including transportation, loading, unloading, screening, passes etc. all complete for all lead (from anywhere from the campus area) and lift and as directed by the Engineer-in-charge.

1.0 Workmanship

1.1 The earth to be used for filling shall be free from rock, boulder, salts, organic or other foreign matter. All clods of earth shall be broken.

1.2 As soon as the work in foundation has been completed and measured, the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc., and filled with earth in layers not exceeding 20 cm. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is

laid. The earth shall be rammed with iron rammers where feasible and with the but ends of crow-bars, where rammer cannot be used.

1.3 The plinth shall be similarly filled with earth in layers not exceeding 20 cm. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

1.4 The finished level of filling shall be kept to shape intended to be given to floor.

1.5 The excavated stuff of the selected type shall be allowed to be used in filling the trenches, plinth, sides of foundations, plot etc. Black cotton soil shall not be used for filling the trenches, plinth, sides of foundations, plot etc.

2.0 Mode of Measurements & Payment

2.1 The payment shall be made for filling in trenches, plinth, sides of foundations, plot etc. No deduction shall be made for shrinkage or voids, if consolidated as instructed above.

2.2 The rate shall be for a unit of one cubic meter.

Item No. 5

Embankment construction with selected approved materials from river at OMC to min. 95% standard proctor density by using vibratory roller for compaction. The rate includes excavation/ dragging, banking, spreading of the material in max. 300mm layers, watering, rolling & compacting the same as per the specifications, drawings and as directed by the Engineer-in-charge with all lead and all lift.

1. General

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.

2 Materials and General Requirements

2.1 Physical Requirements

2.1.1 The materials used in embankments, subgrades, earthen shoulders and miscellaneous backfills shall be soil, murrum, 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.

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 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.

2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as S03) 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 S03) 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.

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.

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

S.R. 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/cum
2)	Embankments exceeding 3 m height or embankments of any height subject to long periods of inundation	Not less than 16 KN / cum
3)	Subgrade and earthen shoulders/verges/backfill	Not less than 17.5 KN /cum

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.

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.

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

2.2 General Requirements

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.

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 horizontals 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.

2.2.3 Compaction Requirements

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

i) 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.

ii) 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.

3. Construction Operations

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.

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 4.6 shall apply.

3.3 Stripping and Storing Topsoil

When so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding

150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily subjected to traffic either before stripping or when in a stockpile. Stockpiles shall not be surcharged, or otherwise loaded and multiple handling shall be kept to a minimum.

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 3.5 and 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 up to a level 0.5 m below the sub-grade level, watered and compacted in layers in accordance with Clauses 3.5 and 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 2.1.1 at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

3.5 Spreading Material in Layers and Bringing to Appropriate Moisture Content

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.

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 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 sub-grade.

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 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.

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 considered.

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.

3.7 Drainage

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

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 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.

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 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.

4. Construction of Embankment and Sub-grade under Special Conditions

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 shell be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

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 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.

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.

4.4 Embankment and Sub-Grade around Structures

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

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

The material used for backfilling 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.

4.5 Construction of Embankment over Ground Incapable of Supporting Construction Equipment

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geo synthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper

ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 3.

4.6 Embankment Construction under Water and Waterlogged Areas

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.

4.6.2 Embankment Construction in Waterlogged and Marshy Areas

The work shall be done as per IRC: 34.

4.7 Earthwork for High Embankment

The material for high embankment construction shall conform to Clause 2.1.7. In the case of high embankments (more than 6 m), the Contractor shall normally use fly ash in conformity with Clause 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.

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.

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.

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.

7. Sub-grade Strength

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.

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.

8. Measurements for Payment

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.

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

8.4 Construction of embankment under water shall be measured in cum.

8.5 Construction of high embankment with specified material and in specified manner shall be measured in cum.

8.6 Stripping including storing and reapplication of topsoil shall be measured in cum.

8.7 Work involving loosening and recompacting of ground supporting embankment/sub-grade shall be measured in cum.

8.8 Removal of unsuitable material at embankment/sub-grade foundation and replacement with suitable material shall be measured in cum.

9.0 Rates

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 re compacting 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.

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.

9.3 Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and re compacting the embankment/sub-grade foundation.

9.4 Clauses 309.1.1 and 8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material, respectively.

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.

9.6 Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

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.

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.

9.9 Clause 4.6 shall apply as regards Contract unit rate for construction of embankment under water.

9.10 Clause 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.

Item No. 6
Embankment construction with selected approved good soil from any source outside the site area at OMC to min. 95% proctor density by using vibratory roller for compaction. The rate includes royalty charges for material, transportation to site, laying in max. 300 mm layers, watering, rolling & compacting the same as per the specifications, drawings and as directed by

the Engineer-in-charge with all lead and lift.
Specifications of item No 5 shall be followed except that filling shall be done with selected approved good soil from any source at OMC to min. 95% proctor density by using vibratory roller for compaction. The rate includes royalty charges for material, transportation to site, laying in max. 300 mm layers, watering, rolling & compacting the same as per the specifications, drawings and as directed by the Engineer-in-charge with all lead and lift.

The rate shall be for a unit of one **cum**.

Item No. 7
Bitumen Cutting
Labour charge of cutting in bituminous pavement before fixing kerb stone. Cutting to be done with heavy duty tandem cutting machine consist of diamond blade. Minimum cutting depth shall be 20 cm from the finished level. Cutting shall be perfectly in line. The width and depth of the removal of asphalt towards kerb stone shall be as directed by engineer in charge. Bitumen shall be carefully removed so that the cutting edge towards the road shall not be disturbed. Bitumen and other debris shall be disposed for all lead and lift at non objectional place and as per the direction of the engineer in charge. Surroundings shall be cleaned up to the satisfaction of engineer in charge.

Cutting of Bituminous pavement for fixing of Kerb stone.

1.0 Workmanship

1.1 Marking shall be carried out to demarcate the exact location of the kerb stone to be fixed.

1.2 Cutting of the bituminous pavement shall be carried out by mechanical cutter only. The cutter engaged shall be having a diamond blade.

1.3 The minimum cutting depth is of 20 cm from the finished level.

1.4 All the debris generated shall be cleared and transported to a safe place as directed by Engineer-In-Charge.

1.5 Bitumen shall be removed without damaging the road edge. If damaged, then the edge has to be cut and removed and redone.

1.6 Surrounding shall be cleared and cleaned to the satisfaction of Engineer-In-Charge.

2.0 Mode of Measurement

The rate shall be for a unit of one Sqm.

Item No. 8
Boring holes in all kinds of soil (for cast in situ piles) and getting out the soil and disposal of the surplus excavated soil as directed for depth upto 5 m. within all lead and lift for 300 mm dia and double under reaming inside the bore hole including dewatering and working in or under water and /or liquid mud, including pumping out water/slush as required etc complete as per the drawing and as instructed by Engineer in charge. The rate of concrete and steel reinforcement shall be paid in relevant tender items.

1.0 Workmanship

MORT&H fifth revision specifications as in section 1100 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.

2.0 Mode of Measurement

The rate shall include all required plant & machineries, polymer slurry, disposal of excavated material with all leads & lifts, mobilization demobilization, remobilization if required, transportation of required plant and machineries, etc. Method of boring shall be as per IS 2911-Part 1 - Section -II.

The rate shall be for a unit of one Rmt.

Item No. 10
Clearing and grubbing of top soil, cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 100 mm in thickness, rubbish etc. and disposal of cleared materials. stacking of useful material with all lead and lift as per MORT&H specification.

1.1 Scope
This work shall consist of cutting, removing, and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, rubbish, top organic soil, etc. 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 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.

1.2 Preservation of Property/ Amenities
Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers, and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own cost, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

1.3 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 tired 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.

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.

1.4 Disposal of Materials
All materials arising from clearing and grubbing operations shall be taken over and shall be disposed off by the Contractor at suitable disposal sites with all leads and lifts. The disposal shall be in accordance with local, State and Central regulations.

1.5 Measurements for Payment

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of **hectares**. Cutting of trees of any girth and removal of their stumps, including removal of stumps of any 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 after clearing and grubbing shall be the base level for computation of earthwork for embankment.

1.6 Rates

1.6.1 The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, and incidentals necessary to complete the work.

PLAIN & REINFORCEMENT CEMENT CONCRETE WORK

Note -
1) All types of shuttering shall be designed by the contractor and submitted to the Engineer in charge along with design calculations (if required) and approved by the Engineer in charge. However, the Stability and compatibility of shuttering shall be the responsibility of the contractor. Shuttering shall be executed as per the approved shop drawing. No extra payment shall be made for the above.
2) Rate shall be inclusive of dewatering work (pumping out and removing slush) while execution in underwater conditions. The contractor shall not claim for dewatering if required.
3) Rate shall be inclusive of providing grooves, drip moulds, pockets, cut-outs, etc., and co-ordination of insert sleeves, insert plate (cost of insert sleeves/ plate shall be paid separately), encasing if any wherever required while casting for all level all height.
4) If required, concrete batching and mixing plant of minimum 60 cum/hr capacity shall be set up by contractor.
5) Mould release agent of approved make shall be used at every repeatation on formwork material.
6) Shuttering shall be compatible with self-compacting concrete (SCC) work, wherever required.
7) Shuttering shall be compatible with heavy/bulky RCC elements, wherever required.

Item No. 11
Concrete (PCC) of grade - M15
Providing and laying in position Controlled cement concrete /Ready mix concrete/ batch mix concrete of cement concrete (PCC) of grade - M15 cement concrete work, using cement content as per approved design mix (Min cementitious level as per latest IS 456 shall be maintained) manufactured in fully automatic batching plant and transported to the site of work in transit mixer for all lead having a continuous agitated mixer, for reinforced cement concrete work including pumping from transit mixer to site of laying; cost of admixtures in recommended proportions as per IS: 9103 to accelerate, retard the setting of concrete, improve workability without impairing strength and durability; finishing, compacting, vibrating, curing, dewatering (if required), etc, including the cost of form work and removal of formwork, dewatering (if required), etc. complete for all level, all height/ depth and for all lead and lift and as directed by the Engineer.

1.0 Material
1.1 Water
1.1.1 Water shall conform to M-1.

1.1.2 Cement
1.2.1 Cement shall conform to M-3.

1.2 Coarse Sand
1.3.1 Sand shall conform to M-6.

1.4 Coarse Aggregate
1.4.1 Coarse Aggregate shall conform to M-12.

2.0 Workmanship
2.1 CPWD specifications clause no. 4.2 to 4.2.14 shall be followed.

2.2 General
2.2.1 Before commencing the concreting, the depth and width of the excavated foundation shall be checked as per the drawing. The bed of foundation trenches shall be cleared off of all loose materials, levelled, watered and rammed, as directed by engineer-in-charge.

3.0 Mode of Measurement and Payment
3.1 CPWD specifications clause no. 4.2.15.1 to 4.2.15.5 and 4.2.15.7 shall be followed.

3.3 The rate includes the cost of material, labour, tools and plant required for mixing, placing in position vibrating and compacting, finishing, curing, form work and removal of formwork, dewatering (if required) as directed by engineer-in-charge of specified strength, for all floors, all shapes at any height and level, and in any position.

The rate shall be for a unit of one **Cum**.

Item No. 12
Providing and laying in position Fair Finish Controlled cement concrete /Ready mix concrete/ batch mix concrete of specified grade for reinforced cement concrete work, using cement content as per approved design mix (Min cementitious level as per latest IS 456 shall be maintained) manufactured in fully automatic batching plant and transported to the site of work in transit mixer for all lead having a continuous agitated mixer, for reinforced cement concrete work including pumping from transit mixer to site of laying; Pouring by tower crane or boom placer or any other means where required, cost of admixtures in recommended proportions as per IS: 9103 to accelerate, retard the setting of concrete, improve workability without impairing strength and durability; finishing, compacting, vibrating, curing, dewatering (if required), the Formwork/shuttering/scafolding etc for any RCC Element and removal of formwork etc, excluding the cost of the reinforcement, etc complete for all elements, all floors, all level, any heights/ depths, any lead and lift as directed by Engineer In charge.
Rate shall be inclusive of shuttering and centering/ formwork (shuttering plate made of welded smooth finish plate of min 3mm thick MS plate, thickness of formwork shall be such that no bulging or deformation of concrete element occurs) for fair finish concrete with or without pattern, lift charges, scaffolding, staging, propping etc and tie rod assembly of PVC cone and coil on both side of the concrete walls, filling the same with non shrink grout or polymer mortar and excluding cost of steel reinforcement. Full height shuttering with single pour system shall be followed wherever required. Contractor shall prepare shuttering drawing as per the shuttering pattern given by architect. All concrete work shall be with finish (without any honey comb) up to the satisfaction of the engineer incharge. Contractor shall use mould release agent of approved make before use of shuttering material every time. The Contractor shall get prior approval for the reuse of the shuttering material for repetition from the Engineer-in-charge
A sample of each element shall be prepared with and without shuttering pattern at location as per instruction of Architect and SRFDCL Engineer in charge for review and approval before mass execution. In case of Exposed finish concrete work, Extra rate for exposed finish shuttering shall be paid in relevant tender item, However, Finishing of exposed concrete shall be up to the satisfaction of the architect and the SRFDCL Engineer in charge.
Item No. 12.1 - Concrete of M 25 grade
Item No. 12.2 - Concrete of M 30 grade

1.0 Materials
1.1 Water
1.1.1 Water shall conform to M-1.

1.2 Cement
1.2.1 Cement shall conform to M-3.
1.3 Coarse Sand
1.3.1 Sand shall conform to M-6.
1.4 Coarse Aggregate
1.4.1 Coarse Aggregate shall conform to M-12.

2.0 Workmanship
2.1 CPWD specifications of item no. 5.4.1, 5.4.2, 5.4.3, 5.4.4, 5.4.5, 5.4.6 shall be followed. The relevant CPWD specifications clause no. 4.2.1 to 4.2.14 shall be followed.

2.2 Before quoting the rate, contractor shall confirm the exposure condition for the design of concrete. Mix design shall be carried out for environmental exposure condition as given in IS 456: 2000, page no. 18

table 3.

2.3 All concrete work shall have fair finish concrete surface without any pattern unless otherwise specified.

2.4 For concrete element specified in the drawing fair finish steel shuttering made out of MS sheet not less than 14 gauge/ laminated plywood and supporting frame work shall be of steel. Proper care shall be taken in MS shuttering at the time of concreting during monsoon to achieve rust free concrete surface. The concrete surface shall be rendered if required to give fair finish.

For other concrete shuttering material shall be as follows:

- Columns: Moulds from marine ply with wooden battens or MS steel plates
- Straight walls / Curved wall in plan: Marine plywood with wooden battens of Acro make or equivalent makes plates and soldiers.
- Beam: Bottom - timber / steel plates, Sides - Steel plates / marine ply with battens

2.5 The concrete shall be designed as per relevant IS code- IS 10262 and SP 23, with or without chemical admixture to provide the grade of concrete having required workability and characteristic strength as per IS 456:2000. The proportion of cement, sand and coarse aggregates shall be determined by weight. The weight batch machine shall be used for maintaining proper control over the proportion of aggregates as per mix design. The design mix shall be got approved by Engineer in-charge before starting the concrete work. The minimum cement content shall depend on the exposure condition of the concrete. The minimum cement content given in table (IS 456:2000, table 5) shall be adopted irrespective of whether the contractor achieves the desired strength with less quantity of cement. The strength requirements of different grades of concrete shall be as under:

Grade of Concrete	Compressive strength of 15 cm. cubes in N/mm$^{2.}$ at 7 and 28 days conducted in accordance with IS : 516 : 1959		
	At 7 days	At 28 days	Max size of agg. In mm
M-10	7	10	20
M-15	10	15	20
M-20	13.5	20	20
M-25	17	25	20
M-30	21	30	20
M-35	24	35	20
M-40	28	40	20

In all cases, the 28 days compressive strength specified in above table be the criteria for acceptance or rejection of the concrete.

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

2.7 The Contractor shall take necessary care to avoid sand streaks, air holes, honey combining etc., on finished concrete surface.

2.8 Proportioning

2.8.1 The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work and the supply of properly graded aggregate of uniform quality can be maintained till the completion of work. Grading of aggregate shall be controlled by obtaining the coarse aggregate, in different sizes and blending them in the right proportions as required. Aggregate of different sizes shall be stocked in separate stockpiles. The required quantity of material shall be stockpiled several hours, preferably a day before use. The grading of coarse and fine aggregate shall be checked as frequently as possible, the 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 the preliminary tests.

2.8.2 In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the maker's weight per bag a reasonable number of bags shall be weighed separately, to check the net weight, where cement is weighed 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 clean and serviceable condition. Their accuracy shall be periodically checked and calibrated in standard laboratory.

2.8.3 It is most important to keep the specified water cement ratio constant and at its correct value. 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: 2386 (Part III) shall be referred. Suitable adjustments shall also be made in the weights of aggregates due to variation in their moisture content.

2.8.4 The minimum cement content for the various mixes shall be as per IS – 456:2000 (Table -5, Page - 20).

2.8.5 All RCC works shall be carried out as per the detailed drawings and direction of Architects and Engineer-in-charge. The concrete shall be placed at all heights, levels and for all shapes.

3.0 Mode of Measurement and Payment

3.1 The relevant specifications of item no. 5.4.11.1, 5.4.11.4, 5.4.11.5, 5.4.12, 5.4.13 shall be followed. The rate shall be included or exclude the cost of centering and shuttering will be as specified in the item description.

3.2 The rate shall be for a unit of one **cum**.

3.3 The rate shall be inclusive of chemical admixture like plasticizer etc. as directed by the engineer-in-charge. No extra payment shall be paid for.

Item No. 13
Providing and laying in position Exposed Finish controlled cement concrete manufactured in fully automatic batch mixed plant of specified/ required capacity (batch mix plant shall be installed by contractor on site) for reinforced cement concrete work as per design mix of specified grade using graded black trap stone aggregates of maximum 20mm nominal (down graded) size including fine aggregates conforming to latest IS 383 with minimum cement content (without fly ash) for durability (followed as per IS-456 and technical specification) shall be followed as per approved design mix for all elements of any shape and size, at all places and heights/ depths including transporting by transit mixer for any lead having continuous agitated mixer, laying of concrete to site by any means like pumping, tower crane or boom placer etc., vibrating, finishing and curing etc. and including admixtures in recommended proportions as per IS 9103 to accelerate, retard setting of concrete, to improve workability without impairing strength and durability as per direction of Engineer-in-charge. Rate shall be inclusive of providing grooves, drip moulds, ghisis, pockets, cutouts etc. and labour for insert sleeves if any wherever required while casting.
Rate shall be inclusive of shuttering and centering/ formwork (shuttering plate made of welded smooth finish plate of min 3mm thick MS plate, thickness of formwork shall be such that no bulging or deformation of concrete element occurs) for exposed finish concrete with pattern, lift charges, scaffolding, staging, propping etc and tie rod assembly of PVC cone and coil on both side of the concrete walls, filling the same with non shrink grout or polymer mortar and excluding cost of steel reinforcement. Full height shuttering with single pour system shall be followed. Contractor to prepare shuttering drawing as per the shuttering pattern given by

architect. All concrete work shall be exposed finish (without any honey comb). Contractor shall use mould release agent of approved make before use of shuttering material every time.
A sample of each element shall be prepared with and without shuttering pattern at location as per instruction of Architect and SRFDCL Engineer in charge for review and approval before mass execution.
Contractor may use 18mm laminated ply at some specific place, after taking prior written permission from Architect in charge and SRFDCL before using the ply.
Item No. 13.1 - Concrete of M 25 grade
Item No. 13.2 - Concrete of M 30 grade

Specifications of item no. 13 & 14 shall be followed in addition to that following specifications shall also be followed for exposed RCC work.

Formwork for Exposed concrete surface:

All vertical members for formwork shall be of steel like Acro props, H frame etc. Care shall be taken to set all formwork in perfect line, level (or in required camber or slope as specified) and plumb. Formwork propping shall be strong, rigid, and sturdy. The formwork shall be as per pattern & design shown in drawings. Formwork shall be done accurately and precisely to achieve neat, clean, and smooth concrete surface, in line, level and plumb. Clinks, twists, offsets, warps, riveting etc. in plates or forms shall not be allowed. Before placing concrete, forms shall be thoroughly cleaned off all rust, dust and loose materials. Mould release agent as per the Architect / Engineer in charge shall be applied on sheathing before placing the reinforcement steel. Also, the formwork material will be plate of min 3mm thick MS plate and 18mm laminated ply at some specific place, after taking prior written permission from Architect in charge and SRFDCL before using the ply. All exposed concrete surfaces should have uniform colour and texture. After de-shuttering, all concrete surfaces shall be properly rendered with sandpaper or emery stone. The sample of the exposed concrete shall be got approved by the architect or engineer in charge.

For walls and columns, the sheathing plates shall be bolted with special nuts and bolts- spring coils and PVC cone spacer. No through bolts shall be allowed.

For all kind of exposed concrete work only one brand (to be approved by the Engineer-in-charge) of cement shall be used.

The rate shall be for unit of **Cum**.

Item No. 14
Providing and fixing Thermo-Mechanically Treated bars (Fe 550 D) Reinforcement for R.C.C. work including transporting to the work site, straightening, cutting, bending, cranking, fabricating to required shape, placing/ lowering in position by suitable method, and tying / binding the system (with GI wire) all complete for all leads and lifts, all levels, all floors, all heights/ depth, etc complete and as directed by the Engineer in charge.
Measurement will be made on the length basis and converted into weight by using standard co-efficient (rolling margin's and wastage shall not be paid). No separate payment shall be made for laps, chairs, pins, lifting hooks, spacers, and binding wire.

1. Material
1.1 Reinforcement
1.1 Reinforcement shall conform to M-17.

1.2 Binding Wire
1.2 Binding Wire shall conform to M-18.

2. Workmanship
2.1 CPWD Technical specifications clause no. 5.3.1 and 5.3.2 is to be followed.

2.2 The type of reinforcement shall be as per the item description. The contractor shall submit the test certificate from steel manufacturer as and when required. The test results shall be verified, if required in any reputed laboratory.

2.3 Bar bending schedule shall be made by the contractor before starting the work. The payment shall be done based on quantity worked out in bar bending schedule. The bar bending schedule shall be prepared as per SP 34.

2.4 All the reinforcement bars shall be accurately placed in exact position shown on the drawings and shall be securely held in position with 18 gauge annealed/GI binding wire as approved by Engineer-in charge. The rebars shall be placed with stay blocks or metal chair spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars shall not be allowed to sag between supports nor displaced during concreting or any other operations of the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports shall not extend to the surface of concrete, except where shown on drawing. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing shall not allow. Pieces of broken stone or brick and wooden blocks shall not be used. Layers of bars shall be separated by spacer bars at 1m c/c , Precast cover blocks in cement mortar 1:2 (1cement : 2 coarse sand) about 4 X 4 cm square section or 4 cm dia round section or PVC cover blocks shall be used to maintain the cover of the concrete members as directed by Engineer In charge or Architect. Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To prevent reinforcement from corrosion, concrete cover shall be provided as indicated on drawing. All the bars projecting from concrete and to which other bars are to be spliced and which are likely to be exposed for a period exceeding 10 days shall be protected by a thick coat of neat cement grout.

2.5 Bars crossing each other where required shall be secured by 18-gauge GI binding wires (annealed) of size not less than 1 mm., in such manner than they do not slip over each other at the time of fixing and concreting.

2.6 As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed. Where directed and practicable overlapping bars shall not touch each other, but be kept apart by 25 mm. or 1.25 times the maximum size of the coarse aggregate, whichever is greater by concrete between them. Where not feasible, overlapping bars shall be bound with annealed wires not less than 1 mm. thick, twisted tight. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending movement is maximum in beam and slab.

2.7 Whenever indicated on the drawings or desired by the Architect and Engineer-in-charge, bars shall be joined by couplings which shall have a cross section sufficient to transmit the full stresses of bars. The ends of the bars that are joined by coupling shall be upset for sufficient length so that the effective cross sectional the base of threads is not less than normal cross section of the bar. Threads shall be standard threads. Steel coupling shall conform to IS : 226.

2.8 When permitted or specified on the drawings, joints of reinforcement bars shall be welded with appropriate welding rod as per the instructions given by Structural Engineer. The type of welding, size of fillet etc shall be as approved by Structural Engineer. Welded joints shall preferably be located at points when steel will not be subject to more than 75 % of the maximum permissible stresses and welds so staggered that any one section not more than 20 % of the rods are welded. Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work shall be accepted. Suitable means shall be provided for holding bars securely in position during welding. It shall be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S electrodes used for welding shall conform to IS: 814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed. Welding shall be done by electric arc process as per IS : 816 and IS : 823.

2.9 At the time of concreting, a bar fitter shall remain at site to keep the reinforcement in position.

2.10 Rolling margin shall be checked for each lot of steel received at site. This rolling margin shall be considered for reconciliation of steel at the end of the project or after the end of each month as per the decision of engineer -in charge.

3.0 Mode of Measurement and Payment

3.1 Reinforcement shall be measured in length including overlaps, separately for different diameters as actually used in the work. Where welding or coupling is resorted to in place of lap joints, such joints shall be measured for payment as equivalent length of overlap as per design requirement. From the length so measured, the weight of reinforcement shall be calculated in kg by using standard IS co-efficient. Length shall include hooks at the ends. The wastage of steel and binding wires shall not be measured and paid extra. The rolling margin of steel shall not be paid extra.
Measurement will be made on the length basis and converted into weight by using standard co-efficient (rolling margin's and wastage shall not be paid). No separate payment shall be made for laps, chairs, pins, lifting hooks, spacers, and binding wire.

3.1 The rate for reinforcement shall include the cost of labour and material required for all operations described above like cleaning of reinforcement bars, straightening, cutting, hooking, bending, binding, welding placing in position etc. as per the drawing or directed by the engineer-in-charge Rate shall also include the cost of annealed (with two strands) binding wires, devices like chairs, pins, spacer bars, cover blocks of PVC or cement mortar etc. for keeping reinforcement in position.

3.2 The rate shall be for a unit of **KG**.

Item No. 15

Providing and fixing premoulded compressible, high performance closed cell, bitumen free expansion joint filler board (Cap cell HD 100 of Supreme or equivalent) of 25mm thickness in black color, conforming to MORTH specification (clause 1015), having minimum density 95 Kg/Cum, non Staining with less than 0.08% water absorption & compression recovery of 93% minimum as per specifications including cutting to required size and shape, placing in position, maintaining in position while formwork and concreting at all levels/ all floors/ all heights, etc. complete, as per drawings/ specification and as directed by Engineer in Charge.

1.0 Material

1.1 Polyurethane form filler shall be Cap cell HD-100 of approved make. It shall comply with ASTM–D-3575/ Highway clause 1015/ BS-5628 Part-3. It shall be semi-rigid; UV resistant, high performance laminated closed cell polyethylene foam joint filler in sheet form.

1.2 The density of polyurethane shall be 95 Kgs/ cum. The water absorption shall be less than 0.08%. The operating temperature of foam filler shall be between - 40 c to +100 c.

1.3 It shall be bitumen free and chemical resistant. It shall possess excellent recovery after compression.

1.4 If gap of expansion joint shall be more than 50mm, use two board of required thickness joint with adhesive by manufacturers only.

1.5 If gap width is more than 50mm, contractor shall use joint sheet as per required dimension and direction by Engineer-in-charge. Sheet shall be jointed with compatible adhesive as recommended by manufacturer. Both items shall be paid in relevant agreement items**.**

2.0 Workmanship

2.1 The Cap cell HD 100 board shall be cut neatly with all edges even and to the size required (size of the structure at the expansion joint). The concrete surfaces must be clean, dry, and free of dirt, grease, oil, or other contaminants that would interfere with proper adhesion. It shall be placed resting on the existing structure at the joint before the structure adjoining to the joint is constructed. The board shall be snugly filled the gap in between the expansion joint. The board shall be provided 40mm recessed on the exposed side, to accommodate backup polyurethane rod of required diameter and polysulphide sealant (if required). At the time of concreting, the recessed 40mm gap shall be filled with the cap cell HD board

with a both side adhesive tape to keep it in position. The same shall be removed until the gap is sealed with the polysulphide sealant/ treated with other material.

3.0 Mode of Measurement and payment

3.1 The item will be measured and paid in sqm as per the actual area done. Wastage will not be paid for.

Item No. 16
Polysulphide sealant
Providing and filling the expansion joints, with polysulphide sealant with the application of primer including scraping/removing the expansion filler materials from the joints, cleaning, repairing the edges with epoxy mortar of approved color and make, placing backup material (polyethylene backer rod), fixing of abro masking tapes on the edges to protect the adjoining surface, at all levels/ all floors/all height etc. complete as directed by the Engineer-in-charge. The Polysulphide sealant shall conform to BS-4254:1983 and ASTM C920, and be resistant to water, diluted alkalis, cement grout, water-dispersed detergents, etc. The Contractor shall furnish a performance guarantee of 10 years against leakage, and debonding from the edges. Size of expansion joint upto 25 mm width x 12 mm depth.

1.0 Materials:

PU sealant with primer, epoxy mortar of approved colour and make, backup material (polyethylene baker rod), abro masking tapes etc.

2.0 Workmanship:

Filling the expansion joints, with exterior grade one component PU sealant with application of primer including scraping/ removing the expansion filler materials from joints, cleaning, repairing of the edges with epoxy mortar of approved colour and make, placing of backup material (polyethylene baker rod), fixing of abro masking tapes on the edges to prevent the adjoining surface, at all levels/ all floors / all height etc. complete as directed by Engineer-in-charge.

3.0 Mode of Measurement and payment:

The contractor shall furnish a performance guarantee of 5 years against leakage, de-bonding from the edges**.** The rate shall be for a unit of one Rmt.

Item No. 17
PVC pipe sleeves
Providing in position rigid PVC pipe sleeves of 6Kg/cm2 and length as per design for following diameters for services wherever pipes pass through walls/ slabs/ beam before concreting for all floors/ all levels/ all heights. All pipes shall be accurately cut to the required sizes, laid as per drawing, kept in the position while laying reinforcement and shuttering, sleeves shall not get displaced while concreting, and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid clogging while concreting. The rate shall be inclusive of the removal of sleeves before waterproofing or grouting. The location of the sleeve shall be approved by the Engineer-in-charge.
PVC sleeve - Beyond 110mm and Up to 200 mm Diameter.

1.0 Materials and Workmanship:

The PVC pipe of approved make shall confirm to CPWD material specification. Before pouring the concrete PVC pipe sleeves are placed in between the reinforcement as per drawing. Pipe sleeves shall be 50mm larger diameter than pipes, which are passing through. All pipes shall be accurately cut the required sizes and reinforcement bars shall be kept in position before placing of sleeves. Open ends of the pipes shall be closed with thermocol or gunny bags to avoid entrance of foreign matters. Care shall be taken that sleeves remain in position while concreting. To Vertical sleeves shall finish 50mm above finish floor level. Wherever pipes pass through walls, slab and circular space filled with fireproof materials like putty, fire seals etc. shall be paid separately.

2.0 Mode of Measurement and payment:

The rate shall be for a unit of one Rmt. No wastage shall be paid.

Measurement shall be taken up to two decimals. (Minimum 0.01 m)

Item No. 18
Providing and fixing 110 mm dia PVC pipe having capacity of 6 Kg/cm2 with ISI mark of required length as shown in the structure drawing wherever pipes pass through walls as weep hole before concreting for all level/ all depth/ height. All pipes shall be accurately cut to the required sizes, laid as per drawing, kept in the position while laying reinforcement and shuttering, sleeves shall not get displaced while concreting, and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid clogging while concreting. At one side of pipe, SS 304 mesh shall be placed to protect filled soil. Rate shall be inclusive of pipe and SS 304 mesh. Item shall not be used for diaphragm wall construction. Actual installed length of pipe shall be measured for payment.
PVC Sleeve – Upto 110 mm Diameter

1.0 Materials

1.1 PVC pipe shall be of approved make.

2.0 Workmanship

2.1 Preparation - The joint surfaces must be thoroughly dry, clean, and all the dirt, laitance, oil or grease, rust, scale and protective lacquers from metal surfaces should be cleaned before positioning a bond breaker or back up tape.

2.2 **Supply and Handling -** Joint filler must be checked for tight packing so that no gaps or voids exist at the base of the sealing slot.

2.3 **Installation -** A thin coat of primer should be applied on the concrete surfaces and allowed to dry "tack free" before sealing. The mixed polysulphide sealant must be applied after the evaporation of the solvent but before the primer film has completely reacted. After 3 hours the surface should be re primed before the application of sealant. The sealant should be thoroughly mixed with a paddle stirrer for a full five numbers (at 300 - 500spm). The mix should be applied by a Gun to the joint and should be tooled to a smooth finish. These joints should be flush and unpainted.

2.4 The deposit at the rate of 50% of the cost of this item from the running and final bills shall be recovered and retained for the first one year after completion of the work and 10% shall be retained for the balance of defects liability period and shall be refunded only after the completion of the defects liability period.

3.0 Measurement for Payment

3.1 The sealant Joint shall be measured in **running meters.**

3.2 The contract unit rate shall include the cost of materials, labour, equipment, and other incidental charges for fixing the sealant in position.

WATERPROOFING WORK

Note:-
1) All waterproofing treatment/work shall be executed through an approved water-proofing agency of an approved manufacturer. The Contractor shall submit technical data sheets for each product that will be used for execution.
2) The Contractor shall submit a methodology statement with all relevant details in illustrative sketch form and get them approved by the Engineer-in-charge.
3) A written guarantee/bond on non-judicial stamp paper (tri-party) shall be submitted by the main Contractor and provided by the principal manufacturer and applicator, who has carried out the work. The guarantee/bond shall be for a period of ten years from the certified date of completion of the overall work. The guarantee shall be for a composite warranty against

leakages/seepage/dampness and for the satisfactory performance of the entire waterproofing system.
4) Waterproofing shall be executed under the supervision of the technical team of the manufacturer. Waterproofing shall be tested and approved by the Engineer-in-charge before proceeding with subsequent activities.
5) The Contractor shall repair the concrete elements by injection grouting of suitable non-shrink grout and other suitable methods in case of defective concreting of retaining walls, water tanks, slabs, beams, etc., for which no extra costs shall be payable.
6) Rate shall be inclusive of surface preparation, repairing, injection grouting, saw cutting of construction joints and filling with patch repair mortar, making polymer mortar/Polymer CC fillets at horizontal as well as vertical corners, etc complete. The rate shall be inclusive of testing of elements and the system before and after waterproofing application.
7) Rate shall be inclusive of dewatering work (pumping out and removing slush) while execution in under water conditions.
8) The latest technical system/product shall be adopted at the time of execution.

Item No. 19
Providing and applying Coal tar extended epoxy resin coating of approved make in two coats having 250 micron DFT on RCC surface as per following steps and as per manufacturer's specifications with coverage recommended 3.0 – 4.0 Sqm/ litre for two coat application to achieve approx. 250 +/- 10 micron DFT:
1) Proper surface preparation, remove dirt, rust, oil, grease, cement slurry from wall surface. Thoroughly clean the concrete surface with wire brush/ compressed air etc
2) Carry out cementitious injection grouting at construction joints and at leakage points using plasticised expansive grout admixture,
3) Treatment of construction joints using polymer modified mortar,
4) Filling pipe cutouts using non shrink cementitious grout,
5) Mixing base and hardener component of coal tar extended epoxy resin coating, apply first coat using suitable brush or roller, allow the first coat to dry
6) Application of second coat in perpendicular direction to first coat as per manufacturer's specification.
Coal tar epoxy shall be having 100% solid contents by weight, specific gravity - min 1.24, Water absorption <0.01 % (ASTM D 570), Bond Strength: min 1 N/mm2 (BS 1881 Pt 207), Water Permeability: nil at @ 2 bars pressure over 3 months.
Actual applied area of coal tar epoxy shall be measured for payment.

1.0 GENERAL

INTENT

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

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.

SUBMITTAL

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.

2.0 PRODUCTS

Coating for Application on RCC Retaining wall surface
System Design – Epoxy Tar Based Coating
The coating shall be corrosion resistant coal tar epoxy coating with minimum of 100% solids content. The dry film thickness shall not be less than 250 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.

3.0 EXECUTION

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.

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.

CONRETE 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.

APPLICATION OF COATING
- Conform 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.

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

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.

4.0 Mode of Measurement & Payment:

The rate includes cost of all materials and labour required to carry the works for all floor all height as per the above specifications.

Sample shall be approved by Engineer-in-charge before execution.
Actual applied area of coal tar epoxy shall be measured and paid.

The rate shall be for a unit of one Sqm.

Item No. 20
Providing and placing in position 225 mm wide x 12mm thick PVC water stops (made of 100% virgin polymer material and ROHS non - hazardous standard product) conforming to IS:12200 for construction/ expansion joints between two RCC members as shown in the structure drawings and fixed to the reinforcement with GI binding wire before pouring concrete etc. complete and as directed by engineer in charge. Rate shall also include fixing arrangement in stop end pipe/ plate. Item shall not be executed for diaphragm wall work.

1.0 General

Polyvinyl chloride (PVC) water stops shall normally have a centre bulb of minimum 12 mm inside diameter and 25 mm outside diameter. It shall be 225 mm in width and shall have minimum of two or three longitudinal ribs on each side of the bulb evenly distributed between the bulb and the edge of the water stops. Each rib shall be 6.33 mm high and the rib adjacent to the centre bulb shall have web thickness 12.5 mm and the rib adjacent to the edge shall have a web thickness of 10 mm. For this purpose, the contractor shall submit to the Engineer-in-charge, for approval, four sets of drawings showing details of the water stops, including dimensions, shapes and details of intersections and splices between water stops of the same size and of different sizes. Fabrication and procurement of materials shall be made only after the approval of the drawings by the Engineer -in-charge. Any fabrication or procurement of materials performed prior to approval of the drawings shall be at the Contractor's risk.

The Engineer-in-charge shall have the right to ask the contractor to make any changes in the drawings, which may be necessary to make the finished installation conforming to the requirements and intent of these specifications without additional cost to the Corporation. Approval by the Engineer -in charge to the Contractor's drawings shall not re leave the contractor of his obligation to meet all the requirements at these specifications or of the responsibility for the correctness of the Contractor's drawings.

One set of the above drawings will be returned to the Contractor either approved, disapproved, or conditionally approved and these shall be resubmitted for approval, if so directed.

The water stops shall be dense, homogeneous and free from holes and other imperfections. The water stops shall meet the material and test requirements given hereinafter. The cross section of the water stops shall be uniform along its length and the thickness shall be symmetrical transversely. Tolerance for the dimensions given above shall be plus 5 mm in width, plus 2 mm in thickness and plus 1 mm for other dimensions.

Certified copies of the laboratory test reports on the physical properties of the PVC water stops and a certificate stating that PVC water stops as furnished meeting with all other requirements of those specifications, be obtained by the Contractor from the manufacturer of the PVC water stops shall submit to the Engineer-in-charge with the test report of the PVC water stop carried out by the Contractor. Three samples of PVC water stops of 25 to 30 cm length shall be obtained by the Contractor from the supplier and shall be submitted to the Engineer-in-charge. These samples shall be furnished at least 60 days prior to embedment of any water stops in the structure.

The Contractor shall arrange to obtain the water stops from the suppliers in rolls securely packed, containing a single length of not less than 12 linear meters and having inside diameter of not less than 0.3 meter.

2.0 Materials

The PVC water stops shall be fabricated by an extrusion process from the elastomeric plastic compound, the basic resin of which shall be virgin Polyvinyl chloride. No reclaimed Polyvinyl Chloride shall be used.

The compound shall contain any additional resin, plasticizers inhibitors or other materials, needed to ensure that the finished product shall have the following physical characteristics as per the CWC specification for PVC seal.

1. Tensile strength Kg/cm2 116 minimum
2. Ultimate elongation % 300 minimum
3. Tear Resistance Kg/cm2 49 minimum
4. Stiffness in flexure Kg/cm2 24.6 minimum
5. Accelerated extraction

(a) Tensile strength minimum-105 kg/cm2
(b) Ultimate elongation minimum-250%

6. When tested in accordance with the effect of alkali test as described in the following paragraphs, the material shall not show an increase in weight of more than 0.25 percent or a loss in weight of more than 0.1 percent or loss in weight of more than 0.10 after 7 days, or more than 0.40 percent increase in weight or more than 0.30 percent loss in weight after 28 days. After 28 days immersion the dimensions of the sample shall not differ from those of the original sample by more than 1.0 percent. After 7 days immersion, the Durometer hardness reading of sample shall not differ by more than plus or minus 5 from the reading on the original sample.
7. When tested in accordance with the cold bend test described in the following paragraph, the material shall show no signs of cracking or chipping.
8. PVC water stop confirming to IS –12200 of standard make is only acceptable.

3.0 Inspection and Tests

All water stops shall be subject to laboratory tests before transport. Samples of the finished water stops and material for tests shall be furnished to the Engineer -in-charge. All tests shall be made by and at the expense of the contractor.

Samples for laboratory tests to determine physical properties of the compound shall be taken in accordance with the random process to obtain following number of tests units from each lot received.

Size of lot received	Number of tests.
45 Meters	1
45 to 90 Meters	2
90 to 450 Meters	4
450 to 900 Meters	8
Over 900 Meters	Additional one test for every 100 m

Laboratory tests to determine physical properties of the water stops required to be furnished under these specifications shall be performed on test specimens cut from test units taken from the finished products. The contractor shall furnish the specimens at his cost for test at places as directed.

Test shall be made in accordance with the following methods.
i) Tensile strength ASTM designation D 638
ii) Elongation ASTM Designation D 638
iii) Durometer hardness ASTM Designation D 2240 (Type A)
iv) Accelerated extraction.
v) Effect of alkali
vi) Cold bend test
vii) Impact resistance.

4.0 Installation

Location and embedment of the PVC water stops shall be as shown on the drawings, with approximately one half of the width of the water stops embedded in the concrete on each side of the joint. In order to eliminate faulty installation that may result in leakage, care shall be taken that the water stops are correctly positioned and secured during installation. All water stops shall be installed so as to form a continuous watertight diaphragm in the joint, unless otherwise shown. Adequate provision shall be made to completely protect the water stops during the progress of the work.

Additional vibration, over and above that used for adjacent concrete placement, shall be carried out to ensure complete embedment of the water stop in the concrete. Larger pieces of aggregate near the water stop shall be removed by hand during embedment to assure complete contract between the water stop and the surrounding concrete. Splices in the continuity or at the intersections of junctions of PVC water stops shall be performed by heat-sealing the adjacent surface in accordance with the Manufacturer's recommendations. A thermostatically controlled electric heat source shall be used to make all splices. The correct temperature at which splices should be made will differ with the material compounds but should be sufficient to melt. All splices shall be neat with the ends of the joined water stops in true alignment. A meter box guide and portable saw shall be provided and used to cut the ends to be joined to ensure good alignment and contract between joined surfaces. After splicing, a remoulding iron with rubs and corrugations to match the pattern of the water stop shall be used to reform the ribs at the splices. The continuity of the characteristics members of the cross sections of the water stop design (ribs, tubular centre axis, protrusions, and the like) shall be maintained across the splices.

Where splices are required between water stops of different size, the splices shall be made as recommended by the manufacturer of the water stops and drawings showing the details of the splices shall be submitted to the Dept. for approval, as required in paragraph "General" above.

Prior to embedment, the edges of the water stops shall be secured to looped wire in the end bulbs to improve the Concrete bond as shown on the drawings. The bars shall conform to the provisions of section 5 "Reinforcement Steel fabrication and erection". The manner in which the water stop is secured to the reinforcing bars shall be subject to approval.

5.0 Measurement and Payment

Measurement for payment, for furnishing and placing PVC water stops shall be made based on linear **meter** measured along the centre line of the water stop with no allowance for lap at splices and intersection. The contractor unit rate includes complete item of PVC water stop. The payment shall be made at the rate quoted for the item with no allowance floor lap at splices and intersection. The unit price shall include making splices and intersections and of furnishing all labour, equipment, and materials, required for installing the water stops and protecting the water stops from damage during the progress of the work. The unit rate shall also include the cost of preparing and submitting the drawings, producing samples for approval of the Engineer-in-charge and costs of all incidental work needed to complete the work as per the specifications.

MASONRY WORK

Item No. 21
Providing and laying Brick masonry works using common burnt clay bricks confirming to IS 1077-1992 having Compressive strength not less than 35 kg/Sq.cm in cement mortar 1:5 (1 cement: 5 coarse sand) in any shape, any thickness including finishing, curing, scaffolding racking / flush jointing, etc. complete for all level, all depth/height, as per drawing and as directed by Engineer in Charge.

1.0 Material

1.1 Water

CPWD specifications clause no. 3.1.1 shall be followed.
CPWD specifications chapter 3 Mortars - List of Mandatory Tests shall be followed.

1.2 Cement Mortar

1.2.1 CPWD specifications clause no. 3.2.1 shall be followed.

1.3 Brick

1.3.1 CPWD Technical specifications clause no. 6.1 shall be followed

2.0 Workmanship

2.1 Proportion

2.1.1 The proportion of the cement mortar shall be as specified in item and conform to relevant IS standards.

2.2 Soaking of Brick

2.2.1 The bricks required for masonry shall be thoroughly wetted with clean water for about 24 hours before use or as directed. The cessation of bubbles, when the bricks are wetted with water is an indication of thorough wetting of bricks.

2.3 Laying

2.3.1 Bricks shall be laid in English bond unless directed otherwise. Half or cut bricks shall not be used except when necessary to complete the bond; closer and in such case it shall be cut to required size and used near the ends of walls.

2.3.2 In a day brick work shall not be laid more than 1m or 10 courses in height.

2.3.3 The frames of doors, windows, cupboards, etc. shall be housed into the brick work at the correct location and level, as directed while executing the masonry work. The heavy steel doors, windows frames, etc. shall be built in with brick work, but for ordinary steel doors and windows, required opening for frames, hold-fasts, etc. shall be left in the wall and frames shall be embedded later on in order to avoid damage to the frames.

2.4 Joints

2.4.1 Bricks shall be so laid that all joints are quite flush with mortar. Thickness of joints shall not exceed 12 mm. The face joints shall be raked out as directed by raking tools daily, during the progress of work, when the mortar is still green so as to provide key for plaster or pointing to be done, subsequently.

2.4.2 At the end of day's work or on holidays the top of unfinished masonry shall be kept wet. If the mortar becomes dry, white or powdery, for want of curing, work shall be pulled down and re-built at Contractor's expense.

2.5 Curing

2.5.1 Fresh work shall be protected from rain suitably. Masonry work shall be kept moist on all the faces for

minimum period of 7 days. The top of masonry work shall be kept well wetted at the end of the day's work.

2.6 Scaffolding

2.6.1 Necessary scaffolding shall be provided by the Contractor. The supports of the scaffolding shall be sound and strong, tied together with horizontal pieces over which the scaffolding planks shall be fixed. Normally simple scaffolding only shall be allowed. In this case horizontal pieces of the scaffolding shall rest in the holes, made in the header course only. The Contractor is responsible for providing and maintaining sufficiently strong scaffolding to withstand all loads likely to come upon it.

2.6.2 No through holes shall be left in brickwork to support the scaffolding. In case the holes are left in the brickwork, it shall be filled with 1:4:8 PCC.

2.7 Preparation of foundation bed

2.7.1 If the foundation is to be laid directly on the excavated bed, the bed shall be levelled, cleared off all loose materials, cleaned and wetted before starting masonry work. If masonry is to be laid on concrete footing, the top of concrete shall be roughened, cleaned and moistened. The Contractor shall obtain approval of the Engineer-in-charge for the foundation bed, before foundation masonry is started. When pucca flooring is to be provided flush with the top of the plinth, the inside of the plinth wall shall be lowered down having an offset of the same thickness of the flooring with respect to the outside plinth wall top or as directed.

3.0 Mode of Measurement and Payment

3.1 Brickwork shall be measured in cubic meter unless otherwise specified. Dimensions shall be measured correct to the nearest to 0.01m. Areas shall be calculated to the nearest 0.01 sqm and cubic contents shall be worked out to the nearest 0.01 cum. Half brick wall thick shall be measured separately in sqm stating the thickness.

3.2 The measurement shall be taken for the brick masonry fully completed in foundation up to plinth or above plinth for all levels, heights, shapes and locations as per the item description. Battered, tapered and curved portions shall be measured net as walls.

3.3 No deduction shall be made from the quantity of brick work, nor shall any extra payment be made for embedding in masonry or making holes in respect of following items

(1) End of joists beams, posts, girders, rafters, purlins, trusses, corbel, steps etc. where cross sectional area does not exceed 0.1 m^2.
(2) Architectural openings in walls, parapet, and compound walls, not exceeding 0.1 m^2 area.
(3) Wall plates and bed plates, bearing of slabs, chhajjas and the like whose thickness does not exceed 10 cm. and the bearing does not extend to the full thickness of wall.
(4) Drainage holes, recesses for cement concrete blocks to embed hold fasts for doors, windows etc., forming toothings, grooves etc. and providing cramps for holding stone lining.
(5) Iron fixtures, pipes upto 300 mm. dia. holdfasts and doors and windows built into masonry and sanitary and water supply pipes, etc., for concealed electrical wiring and any other fixtures or inserts.
(6) Forming chases of section not exceeding 350 cm^2 in cross section or 50 cm in girth.

3.4 Apertures for fire places shall not be deducted nor shall extra labour required to make splaying of jambs, throating and making arches over the aperture be paid for separately. The rate shall include for work of any shape e.g. pillars of any size and shape, curved or tapered walls, drip courses, projections, parapets, load bearing walls, sills, ottas, steps, tank walls, platforms and counter walls, ducts, channels and architectural moldings like corbelling, pattas, etc.

3.5 The rate shall be for a unit of one cum.

PLASTER WORK

Item No. 22
12-15 mm thick plaster
Providing and laying 12 to15 mm thick single coat mala cement plaster on masonry work/ concrete work in cement mortar (1 Cement : 3 coarse sand) finished with trowel including making grooves, forming pattas, scaffolding, curing, hacking properly RCC surface etc. complete for all level, all shape, all heights and as directed by Engineer in Charge.

1.0 Material
1.1 Water
1.1.1 Water shall conform to M-1.

1.2 Cement Mortar
1.2.1 Cement Mortar shall conform to M-11.

2.0 Workmanship
2.1 Scaffolding
2.1.1 CPWD specifications clause no. 13.1.1 is to be followed.
2.1.2 Wooden ballies, bamboo, planks, trestles and other Steel scaffolding shall be sound. These shall be properly examined before erection and use. Stage scaffolding shall be provided for ceiling plaster, which shall be independent of the walls. The sample shall be approved by engineer-in-charge before starting the work.

2.2 Preparation of Surface
2.2.1 CPWD specifications clause no. 13.1.2 is to be followed.

2.2.2 All putlog holes in brickwork and junction between concrete and brickwork shall be properly filled in advance with concrete. Joints in brick work shall be raked about 10 mm if not raked during the masonry work and concrete surface shall be hacked to provide grip to the plaster. Hacking of concrete should be done after immediate the deshuttering the concrete. Projecting burrs of mortars formed due to gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brush/coir brush to remove dirt, dust etc., and the surface thoroughly washed with clean water to remove efflorescence, grease and oil etc., and shall be kept wet for a minimum of two hours before application of plaster.

2.2.3 For external plaster the plastering operation shall be started from the top floor and carried downwards. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready and the temporary supporting ceiling resting on the wall of the floor have been removed. Ceiling plaster shall be completed before starting plaster to walls.

2.3 Application of plaster and finish of plaster
2.3.1 CPWD specifications clause no. 13.1.4, 13.1.7 shall be followed.

2.3.2 Cement mortar shall be used within half an hour after addition of water. Any mortar or plaster which is partially set shall be rejected and removed from the site.

2.3.3 Each coat shall be kept damp continuously till the next coat is applied or for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking of walls shall be avoided and only as much water as can be readily absorbed shall be used, excessive evaporation on the sunny or windward side of building in hot air or dry weather shall be prevented by hanging mats or gunny bags on the outside of the plaster and by keeping them wet.

2.3.4 CPWD specifications clause no. 13.2 is to be followed for floating coat of neat cement.

2.4 Thickness
2.4.1 CPWD specifications clause no. 13.1.5 shall be followed except the thickness of the plaster shall be as per the item description. **Thickness of plaster shall be thickness with minimum 12 mm, at any point on the surface.**

2.5 Curing

2.5.1 CPWD specifications clause no. 13.1.6 shall be followed.

2.6 Precautions

2.6.1 CPWD specifications clause no. 13.1.8 shall be followed.

3.0 Mode of Measurement and Payment

3.1 CPWD specifications clause no. 13.1.9.1, 13.1.9.3, 13.9.5, 13.9.6, 13.1.9.7, 13.1.9.9 shall be followed except the plaster on moulded cornices and coves in curved shape not paid separately measured and paid as per actual area in Sqm.

3.2 Soffits of the stairs even folded stair also shall be measured as plastering on the ceilings.

3.3 The rates shall include for work at any height, position, shape and floor and for all necessary scaffolding, etc. as may be required. The rates shall also include for hacking and/or bush hammering to form key for plaster and for spatter dash treatment as specified as directed by engineer in charge.

The rates shall also include for all work in narrow width, rounded angles, chamfered external angles, drip moulds, grooves and for making good after all trades.

The rate shall also include for groove with cement finish upto 10 mm. x 10 mm to be formed in plaster at junction two different materials (skirting and plaster, dado and plaster, RCC and brickwork, around door window etc.) without any extra charge.

The rate shall be for a unit of one **sqm**.

Item No. 23
12 to 15 mm thick water proof Plaster
Providing and laying 12 to 15 mm thick water proof single coat smooth / wired finish cement plaster on sides of masonry work / block work / RCC work, in any shape, in CM 1:3 (1 cement : 3 fine sand) and water proofing compound of approved make in proportions recommended by the manufacturer, finishing the surface wired finish/ smooth finish with a floating coat of neat cement slurry for all floors, all height including hacking to RCC surface, scaffolding, curing etc. complete as directed by engineer-in-charge.

1.0 Material

1.1 Relevant Technical specifications of item no. 22 shall be followed.

1.2 The water proofing compound of approved make shall conform to IS 2645-latest version. It should be chloride free, corrosion inhibitor, Hydrophoper and water reducer. It shall be compatible with all types of cement. It should be able to reduce water absorption and dampness. It shall be highly water-tight against water head pressure. It shall be able to reduce effloresce, salt petering, and fungus growth. It shall be of approved make as approved by Engineer in charge.

1.3 It should be non-flammable, non-toxic and eco-friendly. It should be able to reduce shrinkage. It should be able to increase plastic workability.

2.0 Workmanship

1.1 Relevant technical specifications of item no. 22 shall be followed except thickness of the plaster will be 12 to 15 mm and water proofing material of approved make shall be added to the cement in recommended proportions by manufacture and as approved by the engineer-in-charge.

3.0 Mode of measurement and payment:

3.1 The payment shall be made for 12-25 mm. thick waterproof plaster work as per the relevant specifications of item no. 22. The rate shall include the waterproofing material as per manufacture's specification.

3.2 The rate shall be for a unit of one sqm for plaster work using water proofing material.

PAINT WORK

Note:-
1) All adhesives, sealants & paint shall be water based, with low VOC with acceptable VOC content as per Green Building Norms requirements and lead free.
2) Paint shall be applied after thoroughly brushing the surfaces, free from mortar dropping and other foreign matter, preparing the surface even and sand papered smooth etc, after applying every coat of putty and primer complete.
3) Contractor shall furnish warranty paper, wherever applicable.
4) If necessary more coats shall be applied till the surface presents a uniform appearance without any extra cost.
5) Paint shall be applied with any means (i.e. brush, roller, spray etc)
6) Contractor shall prepare sample of minimum three shades as suggested by engineer in charge for approval.
7) The rate shall be applicable for all floor, all level, all height by any means of scaffolding.

Item No. 24
Acrylic emulsion paint with primer - Exterior grade
Providing and applying 100% Acrylic Smooth exterior paint with exterior primer of Two or more coats of paint including required number of priming coat of exterior primer as per manufacturer's specification of approved make and shade, having VOC (Volatile Organic Compound) content less than 50 grams/ litre of required shade over any surface etc complete for all floors all heights all levels. Exterior paint and primer shall have minimum 7 years warranty.

1.0 Material
1.1 Acrylic paint

1.1.1 It shall be from approved makes list. It shall conform to the relevant IS Codes.

1.1.2 It shall be used on both interiors and exteriors on all different types of plaster, wooden surfaces, stone, brickwork, asbestos cement sheets, hard and soft boards, etc. as specified in the drawing. It shall render rich smooth finish and shall provide a tough film that forms a suitable protection against all elements.

1.1.3 It shall be water thin able. On interior surface it shall be applied after one coat of cement primer and in case of exterior surface it shall be applied on waterproof cement coating. On a new but highly absorbent surface, a thin coat of the paint shall be applied by adding two parts of water by volume to two parts of Acrylic Emulsion by volume. On previously painted surfaces, one coat of the acrylic paint shall be applied by thinning four parts of the emulsion with one or two parts of water. It shall be applied by brush, roller or spray. It shall have a covering capacity as per manufacture’s specification, depending on the surface and shade used. It can be washed to remove the day-to-day dirt, after the surface has been painted, minimum for a month. It should be non-flammable. For the best performance of paint proper washing and cleaning of all algal and fungal growth at regular intervals at six months is required.

2.0 Workmanship
2.1 General

2.1.1 The materials required for work of painting work shall be obtained directly from approved manufacturers or approved dealer and brought to the site in maker's drums, cage etc. with seal unbroken.

2.1.2 All materials not in actual use shall be kept properly protected, lid of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of water to prevent formation of skin. The materials, which have become stale 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 paint shall be stirred thoroughly in its container before pouring into small containers.

2.1.3 If for any reasons, thinning is necessary, water shall be added as per supplier’s instructions.

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 parts of 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 Scaffolding

2.2.1 Where scaffolding is required, it shall be erected in such a way that as far as possible, no part of scaffolding shall rest against the surface to be distempered. A properly secured strong and well tied suspended platform (Zoola) may be used for distempering. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the walls and floors. For distempering to ceiling, proper stage scaffolding shall be erected where necessary and the floor area shall be covered with plastic so that the flooring is not spoilt.

2.3 Preparation of surface

2.3.1 CPWD specifications clause no. 13.19.2 shall be followed.

2.3.2 The surface spoiled by smoke soot shall be scrapped with steel wire brushes or steel scrapers or shall be rubbed with over burnt surkhi or brick bats. The surface shall be then broomed to remove all dust and dirt and shall be washed with clean water.

2.3.3 Oil or grease spots, algae or other foreign materials shall be removed by suitable chemical and vigorous brush. If the surface is cleaned with water than it should be allowed to dry before application of paint. In no case the finishing shall be allowed on damp course.

2.3.4 All unsound portion of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the masonry joints properly. Such portions shall be wetted and allowed to dry. Any crevice, at any level shall be cleaned and filled with the plaster mortar and cured as above.

2.3.5 All unnecessary nails shall be removed; the holes, cracks, patches etc. shall be made good with material similar in composition to the surface to be prepared.

2.3.6 New plaster surface shall be allowed to dry for atleast 2 months before applications of paint and primer.

2.3.7 The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with IS: 2395 (Part-1)-1966.

2.3.8 All unnecessary nails, hooks etc. shall be removed. Pitting in plaster shall be made good with plaster again and papered with a fine grade sandpaper and made smooth. A coat of paint shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of paint is applied. The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with IS : 2395 (Part-1)-1966. Before applying paint, any unevenness shall be made good by applying putty made out of plaster of paris mixed with water, on entire surface, including filling up the undulation and then sand papering the same after it has dried.

2.4 Application

2.4.1 Before pouring into small containers for use of applying, the paint shall be stirred thoroughly in its container. Also, the paint shall be continuously stirred in the smaller container, so that its consistency is kept uniform.

2.4.2 The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and 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 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. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.

2.4.3 On the newly plastered surface, the first coat shall be applied with 100% dilution or exterior grade primer,

second and third coat shall be applied with 40 % dilution or as per the supplier's instructions The second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking of the brush being used.

2.5 Precautions

2.5.1 Old brushes if they are to be used with emulsions paints, shall be completely dried of turpentine or oil paint by washing in warm soap water. Brushes shall be quickly washed in water immediately after use and shall be kept immersed in water during break periods to prevent the paint from hardening on the brush.

2.5.2 In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

2.5.3 Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

2.5.4 Washing of surfaces treated with emulsion paint shall not be done within 3 to 4 weeks of application.

2.6 Protective measures

2.6.1 The surface of doors, windows, ventilators, floors, furniture etc. and such other parts of the building not to be white/colour washed shall be protected from being splashed upon. Such surfaces shall be cleaned of with white/colour wash splashed, if any, immediately after completing the painting, at no extra cost

3.0 Mode of measurement and payment

3.1 Length and breadth shall be measured correct to a cm and area shall be calculated in sqm correct to two places of a decimal.

3.2 Priming coat of exterior primer, scraping of surface spoiled by smoke soot, removal of oil and grease spots, treatment for infection of efflorescence, mould, moss, fungi, algae and lichen and patch repairs to plaster shall be included in this item for which nothing extra shall be paid for.

3.3 All the work shall be measured net in this item as in place subject to the following limits unless otherwise stated herein after

(a) Dimensions shall be measured to the nearest 0.01 m.
(b) Area in individual items shall be worked out to the nearest 0.01 m^2.
All work shall be measured in m^2. No deductions shall be made for ends of joints, beams, posts etc. and openings, not exceeding 0.5 m^2. each and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings nor for finish around ends of joints, beams posts etc.

3.4 Deductions of opening exceeding 0.5 m^2 but not exceeding 3.0 $m^{2,}$ each shall be made as follows and net addition shall be made for reveals, jambs, soffits etc. of these opening

(a) When both the faces of walls are provided with same finish, deductions shall be made for one face only.
(b) When each face of is provided with different finish, deduction shall be made for that side of frame for doors, windows etc. on which width of reveal is less than that of the other side but no deduction shall be made on the other side. Where the width of reveals on the both the faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of finish.
(c) When only one face of wall is treated and the other face is not treated, full deductions shall be made if the width of the reveal on treated side is less than that on untreated side but if the width of the reveal is equal or more than that on untreated side neither deductions nor additions to be made for reveals, jambs, soffits, sills etc

3.5 In case of opening of area exceeding 3.0 $m^{2,}$ each, deduction shall be made for actual size of the openings and jambs, sills and soffits shall be measured and paid separately.

3.6 No deductions shall be made for attachments such as casings, conduits, pipes, electric wiring and the like.

3.7 Corrugated surfaces shall be measured flat as fixed and not girth. The quantities measured shall be increased by the following percentage and the resultant shall be included with the general areas:

(a) Corrugated steel sheets	14%
(b) Corrugated A.C. Sheets	20%
(c) Semi corrugated A.C. Sheets	10%
(d) Nainital pattern roof (Plain sheeting with rolls)	10%
(e) Nainital pattern roof (with corrugated sheets)	25%
(f) Sand faced Plaster / textured plaster / Smooth or mala plaster ----------	0%

3.8 Cornices and other wall features, when they are picked out in a different finish/colour shall be girthed and included in the general area.

3.8.1 Item includes removing nails, making good holes, cracks, patches with materials similar in composition of distemper.

3.9 **Rate**

3.9.1 The rate includes cost of all materials, labors, scaffolding, protective measures etc. involved in all the operations described above, carried out at all floor heights in any position at all levels. This shall also include conveyance, delivery, handling, unloading, storing work etc. as directed by engineer in charge.

3.9.2 The rate shall be for a unit of one sqm.

Item No. 25

Stain-repellent transparent coating - For exposed concrete work

Providing and applying (solvent/ water based), low VOC, breathable and biodegradable, water, oil, and stain-repellent transparent fluorocarbon-based coating with anti-graffiti properties (suitable product according to natural stone, exposed concrete work) of approved make having fluoro carbon-based nanotechnology at all heights & leads and wherever instructed by Engineer-In-Charge. The treatment shall be in two coats wet-on-wet or as recommended by the approved manufacturer including preparation of surfaces by cleaning, curing, protecting, scaffolding, etc complete. The rate includes the cost of all materials, their application by specialized applicators by spray coating with an airless sprayer, cleaning the substrate of all laitance, construction dust, contaminants, scaffolding, labour, etc., all complete and at all levels, leads and heights as per particular specification & directions of Engineer-in-Charge. Guarantee Bond in the prescribed proforma shall be executed by the contractor for the satisfactory performance of the application for 5 years. The look and feel of the natural stone surface, and exposed concrete shall not be affected by coating.

1.0 Materials

1.1 Silicone Paint

Silicone Paint shall be of approved make.

2.0 Workmanship

2.1 The silicone paint shall be diluted with water or solvent (benzene or toluene) based in proportion as per manufacturer's specifications.

2.2 Before applying the surfaces should be thoroughly cleaned of dust, dirt, concrete slurry or any other foreign material etc. as directed by Engineer-in-charge.

2.3 The treatment shall be in two coats wet-on-wet or as recommended by approved manufacturer. Its application by specialized applicators by spray coating with airless sprayer. The sample shall be approved by Architect before execution.

2.4 Unless otherwise specified silicone paint shall be executed through approved specialized agency. Contractor shall furnish a guarantee of 5 years on stamp paper to the employer directly and the tender rate shall be inclusive of the same which is also to be signed by the specialized agency. However, soul responsibility shall be of main contractor for any leakages.

2.5 Copy of work order mentioning the rate issued to the specialized agency shall be attached with guarantee bond.
A guarantee bond on appropriate stamp paper, shall be given by the Contractor to the Client in the manner form prescribed below
FORM OF GUARANTEE BOND
"I/We .....(Contractor) hereby guarantee that work will remain unaffected and will not be in any way damaged by water or any other humid conditions, for a period of 5 years after completion of the work of Silicone painting as per the terms and conditions of the contract and Contractor hereby indemnifies and agrees to save the Client from any loss and or damage that might be caused on account of exposure to water and hereby Guarantees to make good any loss or damages suffered by the Client and further guarantee to redo the affected work without claiming any extra cost."
This guarantee shall remain in force for a period of 5 years from the completion of the work under the contract and it shall remain binding to the Contractor for period of 5 years.

3.0 Mode of Measurements and Payment.

3.1 The rate shall be for a unit of one Sqm.

METAL WORK

Note -
1. Contractor shall prepare shop drawing base on concept design/ drawing for any type of fabrication work and get approved. Contractor shall prepare mock-up/ prototype (as suggested) as per approved shop drawing for approval. Work shall be carried out as per approved shop drawing, approved mock-up/ prototype and as suggested by Engineer in charge.
2. Rate shall be for all floor, all level all height.
3. The rate shall include cost of all types of fasteners (ETA approved) to be used for fixing.
4. Structural stability shall be responsibility of contractor for all kind of metal work.
5. All elements shall be factory fabricated and finished, only final finishing to be made on site with all precautions.
6. Contractor shall coordinate all services work (cut-outs and provisions) in metal work. All cut-out and services provisions shall be finished at factory/ work shop.
7. contractor shall provide PVC/ nylon separator, where two different metals connect to avoid galvanic reactions.

Item No. 26
Structural steel work - Fabrication works - with paint
Providing, fabricating, assembling, hoisting, erecting and fixing in position structural steel work at all heights/ all levels/ all shapes & sizes with all leads & lifts using any type of MS section like rolled steel sections, hollow sections, plates, chequered plates, bar, sheet, rod, threaded bolt, railing etc. all confirming to latest relevant IS codes for the metal elements i.e. window grill, transom bar, bright bar in wooden door - window frame, railings, gates, grills, bracings, foundation plate & bolt, support at truss system, truss, purlin, rafter ,cleat, platforms, brackets, fencing pole, platform, trench cover, flag fixing sleeve pole, garbage box, signage pole, service elements, Jali, clamp, logo, metal dustbin as per design intent etc. including straightening, cutting, bending, profile cutting, embosing, bolting and welding, eatching (if required) the members all as per structural drawings and as per detailed specifications (for materials & workmanship) including profile cutting, smooth grinding, machining of edges/ faces, necessary welding (electric arc welding) for required weld lengths and sizes, machine drilling of holes for joining/ anchoring/bolting, necessary arrangements of templates to keep the foundation bolts in position dry sanding, degreasing (wet cleaning) & preparation of rust-free surface manually or mechanically, metal putty to make the surface even and smooth, necessary scaffolding/ staging, anchor fasteners,extra for bending elements for fixing etc complete. Incase of Metal dustbin, openable MS Shutter shall be with invisible self-closing hinge of required capacity and locking arrangement inside the shutter as per design intent. Contractor shall prepare mock-up of any element wherever required as directed by the Engineer-in-charge.
Contractor shop/ fabrication prepare shop drawing and get approved. The fabrication work shall start only after approval of the fabrication drawings. Fabrication shall be in a perfect Architectural workmanship manner and as provided in Section V & VI of IS 800 & IS 7215. Contractor shall responsible against stability, safety etc all complete
The rate shall include for applying (on all surfaces of MS member) two or more coats PU paint (DFT min 40 micron per coat) of approved make and shade over two coat (DFT min 50 micron per coat) of anti corrosive epoxy base primer for PU paint, as per manufacturer's specification, anchor fastener etc all complete.

1.0 Material
1.1 Structural steel
1.1.1 Structural Steel shall conform to M-60.

2.0 Workmanship

2.1 Laying out and Preparation of Surface
2.1.1 CPWD specifications clause no. 10.3.1 shall be followed.

2.1.2 Surfaces which are to be welded together shall be free from loose mill scale, rust paint, grease or foreign matters. A coating of linseed oil shall be permitted.

2.2 Fabrication

2.2.1 CPWD specifications clause no. 10.3.2, 10.4.2.1, 10.4.2.2, 10.4.2.3 10.4.2.4, 10.4.2.5, 10.4.2.6 shall be followed.

2.3 Erection

2.3.1 CPWD specifications clause no. 10.3.3, 10.4.2.7 shall be followed. Grouting shall be done with cement mortar 1:3 (1 cement: 3 coarse sand) or non shrink free flow cement grout of approved make as per manufacture's specification as directed by engineer-in-charge.

2.4 Precautions

2.4.1 CPWD specifications clause no. 10.4.2.3 shall be followed.

2.4.2 The following points shall be borne in mind during the process of welding

(a) Welds shall be made in flat position wherever practicable.
(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.
(c) The segments of welding shall be such that where possible, the members which offer the greatest resistance to compression are welded first.
(d) Proper care shall be taken while welding, for shrinkage and distortions, as the drawing dimensions are the finished dimensions of the structure.
(e) Cutting of plates shall be profile cut.
(f) Welding rod shall be of Ishab Corporation or equivalent.
(g) The drilling is to be done with drill or magnetic drill.

2.4.3 The defective welds which shall be considered harmful to the strength shall cut out and rewelded.

2.4.4 Finished welds and adjacent part shall be protected with clean boiled linseed oil and after all stag has been removed welds and adjacent parts shall be painted after the same are approved.

2.4.5 All the members shall be thoroughly cleaned of rust, cakes, dust etc. and given a priming coat of zinc chromate red oxide before fixing them in position. All fabricated members shall be suitably packed to be protected from any damage while transportation, if any.

2.4.6 Grinding to the finished level is to be done, if directed by Engineer in charge. All exposed weld shall be ground smooth. Welds which have not been ground shall be scrubbed with a 10% solution of Hydrochloric acid which shall be washed of with water before painting unless alkali resistant paint is used.

2.4.7 The following checking and inspection shall be carried out before, during and after erection :
- Damages during transportation
- Accuracy of alignment of structures
- Erection according to drawings and relevant specifications
- Progress and workmanship

2.5 Painting

2.5.1 CPWD specification clause no. 10.2.2 shall be followed except paint shall be as per Item description.
2.5.2 First priming coat of zinc chromate yellow oxide is to be applied on the fresh steel arrived at site.
2.5.3 Once the cutting, fabrication, grinding work gets completed second coat of primer and first coat of enamel paint is to be applied on the priming coat.
2.5.4 After paint has been already dried erection is done as specified in the item or as directed by engineer-in-charge.
2.5.5 After the erection final coat or second coat of paint is to be applied on the structural steel.

2.6 1 coat of epoxy primer of 50-to-60-micron DFT (dry film thickness), 2 top coats of Metal PU Paint of having DFT 40 to 50 micron of approved shade of ICI or equivalent paint is to be applied.

2.7 Unless otherwise specified proprietary treatment shall be executed through approved specialized water proofing agency. Contractor shall furnish a guarantee of 5 years on stamp paper to the employer directly and the tender rate shall be inclusive of the same which is also to be signed by the specialized agency. However, soul responsibility shall be of main contractor for any damages to paint.

2.8 Copy of work order mentioning the rate issued to the specialized agency shall be attached with guaranteed bond.

2.9 A guarantee bond on appropriately stamp paper shall be given by the contractor to the client in the manner form prescribed below:

FORM OF GUARANTEE BOND

"I/We .....(Contractor) hereby guarantee that work will remain unaffected and will not be in any way damaged by water or any other form of weather condition, for a period of 5 years after completion of the work of painting as per the terms and conditions of the contract and the Contractor hereby indemnifies and agrees to save the Client from any loss and or damage that might be caused on account of water and or other similar form of weather conditions and hereby guarantees to make good any loss or damage suffered by the Client and further guarantees to redo the affected work without claiming any extra cost."

2.10 This guarantee shall remain in force for a period of 5 years from the completion of the work under the contract and it shall remain binding to the Contractor for period of 5 years.

3.0 Mode of Measurement and Payment

3.1 For Riveted and bolted sections CPWD specification clause no. 10.3.5, 10.3.6, 10.4.3 shall be followed except in case of skew cut if the balance material is used at other place, same shall be deducted from quantity of skew cut i.e. **Used wastage from skew cuts shall be deducted from it's quantity and shall not be paid in skew cut.**

3.2 The weight of steel plates, sections and strips shall be taken from relevant IS Codes, based on 7.85 kg/m² for every mm. sheet thickness, if steel is supplied by the Contractor, otherwise, the weight shall be calculated on the actual weight basis on which steel is supplied to the Contractor by the Client. If the steel is supplied by the client, testing & checking as per relevant IS code, recording and intimation of quality of steel (to client and consultant) shall be sole responsibility of the contractor.

3.3 For forged steel and steel castings, weight shall be calculated on the basis of 7850 kg/m3.

3.4 Rolling Margin and wastage shall not be considered when weight is determined by standard weight on the basis of IS codes.

3.5 The rate includes cost of all material, labor involved in all operations as described above like erection, hoisting, scaffolding, painting as specified in item description, safety measures and sundry required for proper completion of the item of work, at all heights, all shapes and all places. This shall also include conveyance and delivery, handling, loading, unloading and storing etc. required for completion the item described above including necessary wastage involved.

3.7 The rate shall be for an unit of one Kg.

Item No. 27

Extra charges for providing hot dip galvanizing work conforming to IS 4759/2629/2633 with a zinc coating of 610 GSM thickness on any type of MS sections for various elements, for all locations, heights, and levels as per the drawings and as instructed by the Engineer-in-Charge. The rate includes surface preparation by shot blasting or acid washing prior to hot dip galvanizing, as well as all necessary labour, tools, and machinery (sample to be approved). The weight of the steel sections before galvanization shall be measured for payment without considering any wastage. A sample and mock-up shall be prepared for approval by the Engineer-in-Charge before mass execution.

1.0 Scope

This specification covers the general requirements of hot dip galvanizing for fabricated M.S. sections-plates, foundation bolts including cleaning of any paint, grease, rust, scale, acid or alkali or such other foreign matters.

2.0 Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable.

(i) IS: 4759-20.79: Specification for Hot Dip Zinc Coatings on Structural Steel and other allied Products.
(ii) IS: 209-20.79: Specification for zinc.
(iii) IS: 2629-20.66: Recommended Practice for Hot Dip Galvanizing of Iron and Steel.
(iv) IS: 6158-20.71: Recommended Practice for Safe-guarding against Embrittlement of Hot Dip Galvanized Iron & Steel Product.
(v) IS: 2633-20.72: Method of Testing Uniformity of Coating on Zinc Coated Articles.
(vi) IS: 6745-20.72: Method for Determination of weight of Zinc Coating on Zinc coated iron and steel articles (with amendment No. 1).
(vii) ASTM A-123: Spec. for Zinc (Hot Galvanized) Coatings on (20.78) Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strips.

3.0 General Requirements

QUALITY OF ZINC: Zinc conforming to at least grade Zn 99.95 specified in IS: 209-20.79 shall be used for the purpose of galvanizing.

BASE METAL: The steels and castings shall be in accordance with clause 2 of IS: 6158-20.71. Where steel is supplied by the fabricator, it is the responsibility of the fabricator to select suitable steel which shall withstand normal galvanizing operation without embrittlement.

The edges of tightly contacting surfaces shall be completely sealed by welding. The residue of coated electrodes shall be removed, prior to pickling, by brushing, chipping or sand blasting.

SURFACE PREPARATION: Surface shall be cleaned and prepared as per clause 4 of IS: 2629-20.66. Malleable iron castings shall be shot and grit blasted before galvanizing.

GALVANISING: The members shall be galvanized in accordance with the practice contained in the IS: 2629-20.66 unless otherwise specified in the succeeding paragraphs.

4.0 Coating Requirements

MASS OF ZINC COATING: Minimum average mass of zinc coating on different kinds of articles shall be as under:

a)	Fabricated steel Thickness less than 2 mm but not less than 1.2 mm	340 gm/sqm
	Thickness 2 mm and above	750 gm/sqm
b)	Fasteners Up to nominal size M10	270 gm/sqm
	Over M10	300 gm/sqm

Note: Articles galvanized with 1000 g/m² zinc coatings shall be identified by a band of green paint by the galvanizer.

FREEDOM FROM DEFECTS: The zinc coatings shall be uniform, adherent, reasonably smooth, and free from imperfections such as flux ash and dross inclusions, bare patches, black spots, pimples,

lumpiness and runs, rust stains, bulky white deposits and blisters, etc. These terms have been defined in IS: 2629-20.66 (duly amended wherever necessary).

STEEL EMBRITTLEMENT: The design of the product and the selection of steel, wherever steel is to be supplied by fabricator, for its suitability to withstand normal galvanizing operations without embrittlement or the method of fabrication shall be the responsibility of the fabricator. Recommended precautions to properly design, fabricate and prepare the material for galvanizing to prevent embrittlement shall be as per IS: 6158-20.71.

5.0 Tests

TYPE TESTS

(a) Visual Inspection
(b) Adhesion of coating
(c) Uniformity of coating
d) Mass of zinc coating

Each test shall be conducted on three samples.

ACCEPTANCE TESTS

(a) Visual Inspection
(b) Adhesion of coating
(c) Uniformity of coating
(d) Mass of zinc coating

ROUTINE TESTS

(a) Visual Inspection

Scale of Sampling and criteria for conformity

LOT: All the material of the same type in a coating bath whose characteristics are intended to be uniform shall be grouped together to constitute a lot.
A lot shall not consist of more than one shift's production or 100 nos. whichever is lower.

Sample shall be taken from each bath and tested for conformity of coating. Where the galvanizing is done without the presence of Purchaser, the manufacturer may prepare lots consisting of the articles of the same type and material and galvanized in the same bath. If there is more than one bath, separate lots shall be prepared for each bath.

6.0 SCALE OF SAMPLING:

Samples in accordance with TABLE 1 shall be taken, at random, from each lot for tests.

TABLE 1: Scale of Sampling

Lot size	Sample size	Permissible no. of defective units
Up to 25	3	0
26-50	5	0
51-100	8	0
101 and above	13	1

For materials of inconvenient lengths and from which it is not possible to cut a specimen for coating characteristic tests, two test pieces of same cross section and not less than 90 cm length shall be galvanized in the same bath.

The samples selected in accordance with Table 1 above shall be subjected to the visual inspection.

If any sample fails to conform to the requirement, the lot shall be rejected. The galvaniser, however, may segregate the good pieces of the lot and submit them once again for inspection.

If the lot inspected for visual inspection, passes the test, 3 samples for coating characteristics shall be taken from the samples, which were subjected to the visual tests.

Each of the 3 samples shall be subjected to test for adhesion, uniformity, and mass of zinc coating. Shall any sample fail in any test, six more samples shall be taken from the lot and all the 3 tests repeated. Shall any sample fail in the retest, the lot shall be rejected. If it is not possible to take six samples for the test, the lot shall be rejected.

The material in a lot which has been rejected may be stripped and re-galvanized and submitted for inspection and tests.

7.0 TEST METHODS

VISUAL INSPECTION: The material shall be inspected visually to observe that it is smooth, reasonably bright, continuous and free from such imperfections as flux/ash/dross inclusions, bare patches, black spots, pimples, lumpiness runs, rust stains, bulky white deposits and blisters. The stains of flux, usually white in color, shall not be regarded as flux intrusions.

8.0 ADHESION OF GALVANISED COATING:

Coating shall withstand the knife tests as prescribed in IS: 2629-20.66. When cut or pried into, such as with a stout knife applied with considerable pressure, in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating; and it shall not be possible to peel any portion of the coating so as to expose iron or steel underneath.

On articles fabricated from angles, channels, beams and rolled sections of 8 mm or more thickness, the adhesion may, alternatively, be tested by pivoted hammer tests as per IS : 2629-20.66. This test is not suitable for curved and round surfaces.

9.0 UNIFORMITY OF GALVANISED COATING:

On small articles, which can be conveniently handled the uniformity of the coating shall be determined by Preece Test in accordance with IS: 2633-20.66 by dipping the whole article in the copper sulphate solution. For sheets, strips and other fabricated articles a 10 cm x 10 cm specimen may be cut for tests. For tubes, 100 mm long piece shall be cut from each end of the product, after discarding 300 mm length from the end. The article shall withstand 5 dips of one minute each.

For long articles, measurement of coating thickness at a number of places by magnetic method shall be taken as a uniformity test.

Note: The Preece Test is primarily meant for articles where surface is mechanically scrapped or wiped after dip in the galvanizing baths etc

10.0 MASS OF GALVANISED COATING:

The average mass of galvanized coating shall be determined by any one of the following methods as agreed between the purchaser and the galvaniser before the tests.

Mass before and after galvanizing: The mass of coating may be determined by weighing the article before and after galvanizing, subtracting the first mass from the second and dividing the result by the coated surface area. The first mass shall be determined after pickling, rinsing and drying; and the second after cooling to the ambient temperature.

Stripping method: In case of materials galvanized without purchasers' inspection, average mass of coating shall be determined by stripping the entire article in accordance with IS: 6745-20.72. If the surface area of the entire article cannot be measured easily or if the article is inconveniently large, a specimen of 100 sqcm area may be cut from each of the three samples and stripped.

Magnetic thickness gauge method:
For large products such as poles, towers, structural shape and castings the average weight of the coating shall be determined by a magnetic thickness gauge.

Before making the measurement the gauge shall be calibrated by measuring the thickness of zinc coating on a test panel and comparing the measured value with the value obtained by stripping method on the same piece.

For castings etc. at least 5 readings may be taken at convenient locations nearly in the centre. Thickness, in micro-meters, when multiplied by 7.047 would give the average mass of zinc coating (g/m^2). Three articles in each lot of up to 100 shall be tested in this manner.

11.0 RECTIFICATION OF DAMAGE

Normally all fabrication work in the case of galvanized articles shall be completed prior to galvanizing. If, for any reason, fabrication such as cutting, drilling or welding has to be undertaken after galvanizing, protection of metal exposed as a result of fabrication and rectification of damaged galvanized areas shall be done in accordance with either the following methods or any other method approved by the Purchaser.

USE OF ZINC BASED SOLDERS: The surface to be protected, or the surface where galvanizing has been damaged, shall be cleaned and any oxides removed with a weak acid solution and a wire brush. The surface shall be thoroughly washed with water to make it free from any traces of acid. The cleaned area shall be heated with a welding torch and rubbed with white salammoniac. A piece of zinc stick or rod 5-10 mm diameter of high purity shall be melted on this area and spread out with a heated piece of salammoniac. The areas shall then be washed down by water and lightly wire brushed. The workmanship shall be such that the finished surface is smooth and non-porous.

USE OF ZINC RICH PAINTS: The damaged surface after cleaning shall be painted with two or more coats of zinc rich primer followed by a finishing coat of a zinc rich paint as per the painting schedule recommended by the manufacturers. It is to be ensured that the dry film thickness of zinc rich primer shall not be less than the average thickness of the galvanized coating. The complete painting system i.e. zinc rich primer with the finishing zinc rich paint for this purpose shall be produced from a source of repute and approved by the Purchaser.

12.0 DEFECTS, THEIR CAUSES AND REMEDIAL MEASURES

Defects	Causes	Recommended actions	Ground for rejection
	Paint grease or oil residues	Check cleaning practices	
Bare spots	Scale or rust residues	Check pickling practices	Yes, if bare spots are bigger than 8 mm dia. or 8 mm diagonal.
	Residual welding slag	Blast-clean wells; avoid coated rods	
	Breakdown of preflux coating	Check preflux and drying conditions	
	Aluminium content of bath too high	Regulate aluminium additions	
	Rolling defects in basic	Check steel supply	

Defects	Causes	Recommended actions	Ground for rejection
	steel		
	Article in contact during galvanizing.	Keep articles separated.	
General	Analysis or original surface condition of steel	Check steel supply.	
roughness	Over-pickling	Reduce pickling use inhibitor	No
	High galvanizing temperature or long immersion time or both	Adjust galvanizing conditions.	
Pimples	Entrapped dross particles	Avoid agitation of dross layer; check carryover of pickle salt.	No, unless dross contamination is heavy
Lumpiness and runs (uneven	Withdrawal speed too high	Remove work slowly	No.
	Cold galvanizing bath.	Increase temperature.	
	Delayed run-off from seams, joints, bolt holes, etc.	Remove work slowly.	
drainage)	Article in contact during withdrawal.		
	Stale flux burnt on during dipping.	Refresh or renew flux blanket.	Yes.
Flux inclusions	Surface residues on steel.	Check steel preparation.	
	Flux picked up from top of bath.	Skim before withdrawal.	
	Ash burnt on during dipping.	Skim bath before dipping.	Yes, if in gross lumps.
Ash inclusion	Ash picked up from top of bath.	Skim before withdrawal.	
Black spots	Includes flux particles from flux ‘dusting’.	Confine fluxing to top of bath.	Yes.
	Dirt smuts, splash marks.	Check storage conditions.	No.
Dull grey coating (all alloy, no free	Steel composition (high silicon, phosphorous or carbon) severe cold work.	Check steel supply for composition order to adjust for galvanizing.	No.
Zinc).	Slow cooling after galvanising.	Avoid hot stacking quench.	
	Release of absorbed hydro-gen during solidification of coating.	Avoid over pickling; use inhibitor.	
	Weeping of acid etc. from seams and folds.	Check product design and fabrication.	
Rust stains	Storage near rusty material.	Check storage condition.	No.
Bulky white deposit (wet storage stain,	Confinement of close packed articles under damp conditions.	Storage dry well-ventilated conditions, separate articles with spacer.	No.

Defects	Causes	Recommended actions	Ground for rejection
White rust).	Packing of articles while damp.	Dry before packing; include desic cant.	
	Expansion of entrapped hydrogen and moisture in flaws.	Check steel quality	Yes, if general.
Blisters	Driving off of hydrogen absorbed during pickling.	Use shot blast instead of pickle; check steel supply.	
	Improper malleabilising (for malleable iron castings only)	Check malleabilising practice.	
Tiny blisters	Effect sometimes observed on quenched work notably malleable castings. May be caused by gas evolved from the work resulting from absorbed hydrogen or break-down of combined carbon near surface.	Use shot blast instead of pickle. Check malleabilising treatment. Shall have no combined carbon near surface of casting.	Yes, if blistering is generally wide spread.

13.0 STRIPPING METHOD (Extracted from IS: 6745-20.72)

Cleaning of test piece: The test pieces shall be washed with solvent naphtha, trichloro ethylene or any other suitable organic solvent, then with alcohol and finally dried thoroughly.

Stripping Solutions:

Dissolve 20 g of antimony trioxide (Sb_2O_3) or 32 g of antimony trichloride ($SbCl_3$) in 1000 ml of concentrated hydrochloric acid (specific gravity 1.1).

Immediately before tests, prepare the stripping solution by adding 5 ml of the solution, 1 to 100 ml of concentrated hydrochloric acid (specific gravity 1.16). Mix well.

Procedure – Weigh the cleaned test specimen whose mass is less than 200 g nearest to 0.01 g; for test piece whose mass is between 300 to 1000 g to the nearest 0.1 g; and for test specimen of over 1000 g to the nearest 0.5 g. After weighing immerse each test piece singly in test solution and allow to remain there until the violent evolution of hydrogen and only a few bubbles are being evolved. This requires about 15 to 30 seconds.

The mass of zinc coating (in g/m²) of surface may be calculated as per the following formula:

$$M = \frac{M1 - M2}{A} \times 10^6$$

Where,
M = mass of zinc coating, in g/m², of surface, M1 = original mass, in g, of test piece, M2 = mass in g, of stripped test piece, and A = coated area of the test piece, in mm².

14.0 Mode of Measurement:

Sample MS elements with hot dip galvanized finish must be approved before mass execution. Mock-ups for each element should be prepared by the contractor and approved by the architects before mass execution works begin.
Architect reserves right to reject part or all work of sub standard or not in confirmation to sample approved as per mock up.

The rate includes cost of all materials and labour required to carry the works for all floor all height as per the above specifications. Any deviations from approved samples/mock-ups must be rectified promptly at the contractor's expense.

The rate shall include preparing the surface by shot blasting/ acid washing prior to hot dip galvanizing, labour, tools, machinery etc complete.

The rate shall be for a unit of kg.

EXTERNAL DEVELOPMENT WORK

Note -
1) Stones shall be free from cracks, lines, stains, white spots of efflorescence and even in shade for all kind of stone work.
2) Stones shall be selected and sorted for uniform colour, figure and thickness and approved by Engineer in charge prior to procurement.
3) Stone shall be from same lot and/ or source (stone quarry) for same kind of work and as approved by Engineer in charge.
4) Contractor shall apply Stone Impregnation primer/ sealer coat on back side and all edges (after cutting and finishing of the stone as per size) of stones of approved make. Stone Impregnation primer/ sealer coat shall be of water based with pH value 7 to 10 in minimum two coat as per manufacturer's specification and as directed by Engineer in charge. No extra shall be paid for the same.
5) Contractor shall prepare and submit shop drawing for all kind of stone work with sub base/ framing work/ fixing arrangement/ joinery with all required fasteners and get approval from Engineer in charge.
6) Mock up/ sample shall be prepared as per approved shop drawing and get approved by Engineer in charge before execution of work.
7) All adhesives and sealants shall be with low VOC and lead free with acceptable VOC content as per Green Building requirements.
8) Stone work shall be carried out for all floor, all level, all height, all places including loading, unloading, stacking, transporting, hoisting, erecting by any means (mechanical or manual).
9) All type of stones shall be cut to size with help of with water jet cutting/ laser cut/ CNC machine according to the design and shape for best workmanship as per shop drawing.
10) Granite shall be mirror polished/ flame finished/ sand blasted/ river wash finish or other as per specified.
11) All type of stone/ stone elements shall be factory cut and factory finished. Finish on any stone shall be as per satisfaction of Engineer in charge. If required, final finish/ touch-up shall be executed at site as per direction of Engineer in charge.
12) Structural stability of solid stone work shall be responsibility of contractor.
13) Contractor shall make necessary provision for any services cut-out/ other required provision, co-ordinate with all services work and making good etc complete.
14) All visible surfaces of stone shall be same finished.

Item No. 28
Sub grade preparation and consolidation
Preparation, consolidation and compacting of sub grade with power road roller of 8 to 12 tonne capacity after excavating earth to an required depth, dressing to camber, consolidating and compacting with road roller or by any other means as directed by the engineer incharge including making good the undulations etc. and re-rolling the sub grade and disposal of surplus earth with all lead and lift.

Rolling and Watering
For spreading materials in layers and bringing the appropriate moisture content the sub grade materials shall be spread uniformly over the entire width of the embankment in layers not exceeding 250 mm in loose thickness successive layers of embankment shall not be placed until under construction has been thoroughly compacted to the requirements set down here under

a. Moisture content of the materials shall be checked at the source of supply and if found less than that specified for compaction the same shall be made good either at the sources or after spreading the soil in loses thickness for compaction. In the latter case water shall be sprinkled directly from a houseline or form a truck mounted water tank and flooding shall not be permitted under any circumstances

b. If the materials delivered to the road bed is too wet dried by evaporation and exposure to the sun till the moisture content is brought down to acceptable standard for compaction. Should circumstances arise where owing to wet weather the moisture content can not be reduced to the required level by the above procedure work of compaction shall be suspended.

c. Moisture content of each layer of soil shall be checked in accordance with IST 2720 (Part-II) and unless otherwise mentioned shall be so adjusted making due allowance for evaporation losses that at the time of the compaction it is in the range if 1 percent to 2 percent below the optimum moisture content determined in accordance with ISI (Part-VII) highly expansive clays shall however be compacted at 2 to 4 percent above the optimum moisture content.

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

e. Clods or hard lump of earth shall be broken to have maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size 60mmwhen placed in the top 0.5 meter portion of the embankment below the sub grade.

f. Hauling equipment shall be desperate uniformly over entire surface of the previously constructed layer to minimize cutting of uneven compaction

g. Where the embankment is to be constructed on low area ground that will not support the weight of trucks of other hauling equipment the lower part of the fill should be conducted by dumping successive loads in a uniformly disturbed layers of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

COMPACTION

Only compacting equipment approved by the engineer in charge shall be employed to compact the materials. The contractor shall demonstrate the efficiency of the plants he intents to use for carrying out compaction trails.

Each layer of the materials shall be thoroughly compacted to the densities specified in

Table 1.2 is compaction requirements for embankment.

Sr No	Type of Work/ Materials	Field dry density as percentage of maximum laboratory dry density as per IS: 2720 (Part-VII)
1	Top 0.5-meter portion of embankment below sub grade level and shoulders	Not Less than 100
2	Other portion of Embankment	Not Less than 95
3	Highly Expensive Class	85 to 90

Subsequent layers shall be placed only after the finished layer has been tested according to M.O.S.T specification clause 902 and accepted by the Engineer In charge.

When density measurement reveals any soft areas in the embankment further compaction shall be carried out as directed by the Engineer in charge. If inside of that the specified compaction is not achieved, the materials and compacted to the density requirement to the satisfaction of the Engineer – in – charge.

The rate shall be for a unit of one **Sqm**.

Item No. 29

Providing and laying of Dry Lean Cement Concrete (DLC) of M15 grade below concrete pavement, cycle track, footpath, hard scape or any similar element/ for sublayers as per design requirement and compacting the same with 8 to 10 Tone vibratory roller as per the specifications and as per drawing and as directed by the Engineer. Rate shall include cost of formwork if any.

1.1 Scope

1.1.1 The work shall consist of construction of (zero slump) dry lean concrete sub-base for cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations, in connection with the work, as approved by the Engineer.

1.1.2 The design parameters of dry lean concrete sub-base, viz., width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the drawings.

1.2 Materials

1.2.1 Sources of Materials

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

1.2.2 Cement

Any of the following types of cement may be used with prior approval of the Engineer:

S. No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade	IS-.8112
ii)	Portland Slag Cement	IS:455
iii)	Portland Pozzolana Cement	IS:1489-Part I

If the subgrade soil contains soluble sulphates in a concentration more than 0.5 percent, sulphate resistant cement conforming to IS:6909 shall be used.

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 1014 and shall be subjected to acceptance test prior to its immediate use.

1.2.3 Fly-ash

Fly-ash up to 20 percent by weight of cementitious material (cement+flyash) may be used along with 43/53 grade cement may be used to replace OPC cement grade 43 up to 30 percent by weight of cement. Fly-ash shall conform to IS:3812 (Part 1) and its use shall be permitted only after ensuring that facilities exist for uniform blending through a proper mechanical facility with automated process control like batch mix plant conforming to IS:4925 and IS:4926.

1.2.4 Aggregates

1.2.4.1 Aggregates for lean concrete shall be natural material complying with IS:383.
The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements set forth in Table 600-2. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, or as directed by the Engineer.

1.2.4.2 Coarse Aggregates

Coarse aggregates shall comply with Clause 602.2.6.2, except that the maximum size of the coarse aggregate shall be 26.5 mm, and aggregate gradation shall comply with Table 600-1.

1.2.4.3 Fine Aggregates

The fine aggregate shall comply with Clause 602.2.6.3.

1.2.4.4 The material after blending shall conform to the grading as indicated in Table 600-1.

Table 600-1: Aggregate Gradation for Dry Lean Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
26.50 mm	100
19.0 mm	75-95
9.50 mm	50-70
4.75 mm	30-55
2.36 mm	17-42
600 micron	8-22
300 micron	7-17
150 micron	2-12
75 micron	0-10

1.2.5 Water

Water used for mixing and curing of concrete shall comply with Clause 602.2.7.
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1.2.6 Storage of Materials

All materials shall be stored in accordance with the provisions of Clauses 602.2.12 of these Specifications and other relevant IS Specifications.

1.3 Proportioning of Materials for the Mix

The mix shall be proportioned with a maximum aggregate cementitious material ratio of 15:1. The water content shall be adjusted to the optimum as per Clause 601.3.2 for facilitating compaction by rolling. The strength and density requirements of concrete shall be determined in accordance with Clauses 601.7 and 601.8 by making trial mixes. Care should be taken to prevent one size of aggregate falling into the other size of the hopper of the feeding bin while loading the individual size of aggregates into the bins.

1.3.2 Moisture Content

The optimum water content shall be determined and demonstrated by rolling during trial length construction and the optimum moisture content and degree of compaction shall be got approved from Engineer. While lying in the main work, the lean concrete shall have a moisture content between the optimum and optimum +2 percent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

1.3.3 Cement Content

The cement content in the dry lean concrete shall be such that the strength specified in
Clause 1.3.4 is achieved. The minimum cement content shall be 150 kg/cu.m of concrete. In case fly ash is blended at site as part replacement of cement, the quantity of fly ash shall not be more than 20 percent by weight of cementitious material and the content of OPC shall not be less than 120 kg/cu.m.

If this minimum is not sufficient to produce dry lean concrete of the specified strength, it shall be increased as necessary by the Contractor at his own cost.

1.3.4 Concrete Strength

The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1 shall not be less than 10 Mpa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 Mpa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

1.4 Sub-grade

The sub-grade shall conform to the grades and cross-sections shown on the drawings and shall be laid and compacted in accordance with Clause 305. The subgrade strength shall correspond to the design strength specified in the Contract. As far as possible, the construction traffic shall be avoided on the prepared sub-grade.

1.5 Drainage Layer

A drainage layer conforming to Clause 401 shall be laid above the subgrade before laying the Dry Lean Concrete sub-base, as specified in the drawings and the Contract.

1.6 Construction

1.6.1 General

The Dry Lean Concrete shall be laid on the prepared granular drainage layer. The pace and programme of the Dry Lean Concrete sub-base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The Dry Lean Concrete sub-base shall be overlaid with concrete pavement only after 7 days of sub-base construction.

1.6.2 Batching and Mixing

The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clauses 602.9.2, 602.9.3.1 and 602.9.3.2.

The design features of Batching Plant should be such that the plant can be shifted quickly.

1.6.3 Transporting

Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tipping trucks with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving site shall be such that the travel time available from mixing to paving as specified in Clause 601.6.5.2 will be adhered to. Tipping truck shall not have old concrete sticking to it. Each tipping truck shall be washed with water jet before next loading as and when required after inspection.

1.6.4 Placing

Lean concrete shall be placed by a paver with electronic sensor on the drainage layer or as specified in the Contract. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base. One day before placing of the dry lean cement concrete subcase, the surface of the granular sub-base/drainage layer shall be given a fine spray of water and rolled with a smooth wheeled roller.

Preferably the lean concrete shall be placed and compacted across the full width of the two lane carriageway, by constructing it in one go. In roads with carriageway more than2 lanes a longitudinal joint shall be provided. Transverse butt type joint shall be provided at the end of the construction in a day. Transverse joints in the concrete pavement shall not be coterminous with the transverse construction joint of the Dry Lean Concrete.

The Dry Lean Concrete shall be laid in such a way that it is at least 750 mm wider on each side than the proposed width including paved shoulders of the concrete pavement. The actual widening shall be decided based on the specifications of the paver, such that the crawler moves on the Dry Lean Concrete, and the cost of extra width shall be borne by the Contractor.

1.6.5 Compaction

1.6.5.1 The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is well closed. The minimum dry density obtained shall not be less than 98 percent of that achieved during the trial length construction in accordance with Clause 601.7. The densities achieved at the edges i.e. 0.5 m from the edge shall not be less than 96 percent of that achieved during the trial construction.

1.6.5.2 The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of

concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the temperature of concrete is between 25°C and 30°C, and 120 minutes if less than 25°C. This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 120 minutes. Work shall not proceed when the temperature of the concrete exceeds 30°C. If necessary, chilled water or addition of ice may be resorted to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35°C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of the curing period except during commencement of next day's work near the location where work was terminated the previous day.

1.6.5.3 Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 kN static weight are suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance. The number of passes required to obtain maximum compaction depends on the thickness of the dry lean concrete, the compatibility of the mix and the weight and type of the roller and the same as well as the total requirement of rollers for the jobs shall be determined during trial run by measuring in-situ density and the scale of the work to be undertaken.

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

1.6.5.4 A preliminary pass without vibration to bed the Dry Lean Concrete down shall be given followed by the required number of passes to achieve the desired density and, a final pass without vibration to remove roller with vibration marks and to smoothen the surface.

Special care and attention shall be exercised during compaction near joints, kerbs, channels, side forms and around gullies and manholes. In case adequate compaction is not achieved by the roller at these locations, use of plate vibrators shall be made, if so directed by the Engineer.

1.6.5.5 The final lean concrete surface on completion of compaction shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material, laid and compacted. For repairing honeycombed/hungry surface, concrete with aggregates of size 10 mm and below shall be spread and compacted as per Specifications. It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency shall be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Surface regularity also shall be checked with 3 m straight edge. Strength tests shall be carried out, and if deficiency in strength is noticed, at least three (evenly spread) cores of minimum 100 mm dia. per km shall be cut to check deficiency in strength. The holes resulting from cores shall be restored by filling with concrete of the specified strength and compacted by adequate rodding.

1.6.5.6 Segregation of concrete in the tipping trucks shall be controlled by moving the dumper back and forth while discharging the mix into the same or by any appropriate means. Paving operation shall be such that the mix does not segregate.

1.6.6 Joints

Construction and longitudinal joints shall be provided as per the drawings.
Transverse butt type joint shall be provided at the end of the construction in a day. Longitudinal construction joint shall be provided only when full width paving is not possible. Transverse joints in Dry Lean concrete shall be staggered from the construction butt type joint in Concrete pavement by 800-1000 mm.

Longitudinal joint in Dry Lean Concrete shall be staggered by 300-400 mm from the longitudinal joint of concrete pavement.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical plane where the correct thickness of the properly compacted material has been obtained.

1.6.7 Curing

As soon as the lean concrete surface is compacted, curing shall commence. One of the following methods shall be adopted:

a) Curing may be done by covering the surface by gunny bags/hessian, which shall be kept wet continuously for 7 days by sprinkling water.

b) The curing shall be done by spraying with approved resin based aluminized reflective curing compound conforming to ASTM-C 309-81 in accordance with Clause 602.9.12. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days. The rate of application shall be as recommended by the supplier.

c) Wax-based white pigmented curing compound with water retention index of not less than 90 percent shall be used to cure the dry lean concrete.
The curing compound shall conform to BS:7542. The compound shall be applied uniformly with a mechanical sprayer and with a hood to protect the spray from the wind. The curing compound shall be applied over the entire exposed surface of the Dry Lean Concrete, including sides and edges, at the rate of 0.2 litres/sq.m, or as recommended by the supplier.

The first application, referred to as curing application shall be applied immediately after the final rolling of Dry Lean Concrete is completed.
As soon as the curing compound loses tackiness, the surface shall be covered with wet hessian for three days. The second application of curing compound also referred to as the debonding application, shall be applied 24 to 48 hours prior to the placement of the concrete pavement.
Any damaged Dry Lean Concrete shall be corrected prior to the second application. Normally, the manufacturer's instructions shall be followed for its application.

1.7 Trial Mixes

The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 percent using specified cement content, specified aggregate grading and aggregate-cement ratio specified in Clause 601.3.1. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done in three layers with vibratory hammer fitted with a square or rectangular foot as described in Clause 3.5.1.1. After establishing the optimum moisture, a set of six cubes shall be cast at optimum moisture for the determination of compressive strength on the third and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory by increasing cement content. After the mix design is approved, the Contractor shall construct a trial section in accordance with Clause 1.8.

If during the construction of the trial length, the optimum moisture content determined as above is found to be unsatisfactory, the Contractor may make suitable changes in the moisture content to achieve the satisfactory mix. The cube specimens prepared with the changed mix content should satisfy the strength requirement. Before production of the mix, natural moisture content of the aggregate should be determined on a day-to-day basis so that the moisture content could be adjusted. The mix finally designed should neither stick to the rollers nor become too dry resulting in ravelling of surface.

1.8 Trial Length

1.8.1 The trial length shall be constructed at least 14 days in advance of the proposed date of commencement of work. At least 30 days prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a "Method Statement" giving detailed description of the proposed materials, plant, equipment, mix proportions, and procedure for batching, mixing, laying, compaction and other construction procedures. The Engineer shall also approve the location and length of trial construction which shall be a minimum of 100 m length laid in two days and for full width of the pavement. The trial length shall be outside the main works. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid

Dry Lean Concrete sub-base. The construction of trial length shall be repeated till the Contractor proves his ability to satisfactorily construct the Dry Lean Concrete sub-base.

1.8.2 After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length and average of these densities shall be determined. The density holes shall not be made in the strip 500 mm from the edges. The average density obtained from the three samples collected shall be the reference density and is considered as 100 percent. The field density of regular work will be compared with this reference density in accordance with Clauses 601.6.5.1 and 903.5.1.2.

1.8.3 The hardened concrete shall be cut over 3 m width and reversed to inspect the bottom surface for any segregation taking place. The trial length shall be constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. The lower surface shall not have honey-combing and the aggregates shall not be held loosely at the edges.

1.8.4 The main work shall not start until the trial length has been approved by the Engineer. After approval has been given, the materials, mix proportions, moisture content, mixing, laying, compaction plant and construction procedures shall not be changed without the approval of the Engineer.

1.9 Tolerances for Surface Regularity, Level, Thickness, Density and Strength Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

1.10 Traffic

No heavy commercial vehicles like trucks and buses shall be permitted on the dry lean concrete sub-base. Construction vehicles at slow speed may be permitted after 7 days of its construction with the prior approval of the Engineer.

1.11 Measurement for Payment

The unit of measurement for dry lean concrete pavement shall be in **cubic metre** of concrete placed, based on the net plan area for the accepted thickness shown on the drawings or as directed by the Engineer.

1.12 Rate

The Contract unit rate payable for dry lean concrete sub-base shall be for carrying out the required operations including full compensation for all labour, materials and equipment, mixing, transport, placing, compacting, finishing, curing, rectification of defective surface testing and incidentals such as trial length to complete the work as per Specifications, all royalties, fees, storage and rents where necessary and all leads and lifts.

The rate shall be for unit of Cum.

Item No. 30
GSB
Construction of granular sub-base (GSB) by providing close graded Crusher run Material conforming to required grade with required size of aggregate (respective as per grade) having CBR Value of 30% or more with grade I aggregate, mixing in a mechanical mix/mix in place method plant at OMC, carriage of mixed material by tipper to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per MoRTH clause 401 and as directed by Engineer in charge.

Scope:-

This work shall consist of laying and compacting well graded material on prepared sub grade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base as directed by the Engineer.

Materials:-

The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag or combination thereof depending upon the grade required. The material shall be free from organic or other deleterious constituents and shall confirm to the grading given in table 16-1. The grading to be adopted for a project shall be as specified in the Contract. If the thickness of GSB layer is more than 150 mm then the sub-base is required to laid in two layers as upper sub-base and lower sub-base.

Table 16-1 : Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by Weight Passing the IS Sieve				
	Grading I	Grading II	Grading III	Grading IV	Grading V
75.0 mm	100	-	-	100	-
53.0 mm	80-100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	55-90	75-100
9.50 mm	35-65	50-80	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	25-50	30-55
2.36 mm	20-40	30-50	-	10-20	10-25
0.85 mm	-	-	-	2-10	-
0.425 mm	10-15	10- 15	-	0-5	0-8
0.075 mm	<5	<5	<5	-	0-3

Table 16-2 : Physical Requirements for Materials for Granular Sub-base

Aggregate Impact Value (AIV)	IS:2386(Part4) or IS:5640	Maximum 40
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30

Construction Operations:-

Preparation of Sub-grade

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

Spreading and Compacting

The sub-base material of the 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.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 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, rotavators until the layer is uniformly wet.

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

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

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

Surface Finish and Quality Control of Work :-

CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

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.

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.

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 below Table.

Table16-3: Tolerances in Surface Levels

1)	Subgrade	±20 mm
2)	Sub-base a) Flexible pavement b) Concrete pavement	 ±10 mm ±6 mm

3)	Base-course for flexible pavement a) Bituminous Base/Binder course b) Granular i) Machine laid ii) Manually laid	±6 mm ±10 mm ±15 mm
4)	Wearing course for flexible pavement a) Machine laid b) Manually laid	 ±6 mm ±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.

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 given Table

Table16-4 : Maximum Permitted Number of Surface Irregularities

	Surfaces of Carriageways and Paved Shoulders				Surfaces of Laybys, Service Areas and all Bituminous Base Courses			
Irregularity	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

Rectification

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

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 tender document.

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 tender document.
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.
Water Bound MacadamA/Vet 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
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.
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.

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.

Control on the quality of materials and works shall be exercised by the Engineer as per Table 16-5.

Table 16-5 : Test and Frequency for Materials for Granular Sub-base

Type of Construction	Test	Frequency (As per Circular No. 66 & 66/1 and all latest Circular of AMC)	IS Code
Granular Sub-Base	Gradation	One test per 400 Cu.m.	IS:2386, Part-I-1963
	Atterberg Limits (Liquid Limit, Plasticity Index)	One test per 400 Cu.m.	IS:2720, Part-V
	Moisture content prior to	One test per 400 Cu.m.	IS:2720, Part-II

	compaction		
	Density of compacted layer	One test per 1000 sq.m	IS:2720, Part-VIII
	CBR	As required	IS:2720, Part-XVI

Arrangements for Traffic
During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

Measurements for Payment

The rate shall be for a unit of one cubic meter.

Item No. 31
WMM
Providing, laying, spreading and compacting required graded stone aggregate to wet mix macadam (WMM) as per specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density, complete as per specifications and directions of Engineer-in-charge. Aggregate shall be in compliance of MORTH.

1.0 Scope
This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as direction by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200 mm upon approval of the Engineer.

2.0 Materials

2.01 Aggregates
2.01.1 Physical requirements: Coarse aggregates shall be crushed stone. The aggregates shall conform to the physical requirements set forth in Table 400-10 below.

TABLE 400-10. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB- BASE/BASE COURSES

	Test	Test Method	Requirements
1	*Los Angeles abrasion value Or *Aggregate Imapct value	IS : 2386 (Part-4) IS : 2396 (Part-4) Or IS : 5640	40% (Max.) 30% (Max)
2	Combined Flakiness and Elongation indices (Total)	IS : 2396 (Part-1)	30% (Max)

* Aggregate may satisfy requirements of either of the two tests.
** To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Fl akiness index is weight of flaky stone metal divided by weight of stone sample. Only

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

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

2.01.2 Grading requirements: The aggregates shall conform to the grading given in Table 400-11.

TABLE 400-11. GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

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

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.
The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

2.02.3 Construction Operations

Preparation of base: Clause 404.3.1. shall apply.

Provision of lateral confinement of aggregates: While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.4.1.

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.
Optimum moisture for mixing shall be determined in accordance with IS : 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.
The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:
(i) Loading hoppers and suitable distribution mechanism

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

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

Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

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

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

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.
Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

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

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

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

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

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

Surface Finish and Quality Control of Work

Surface evenness: The surface finish of construction shall conform to the requirements of Clause 902.

Quality control: Control on the quality of materials and works shall exercised by the Engineer in accordance with Section 900.

Rectification of Surface Irregularity
Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

Arrangement for Traffic
During the period of construction, arrangement of traffic shall be done as per Morth Clause 112.

Measurements for Payment
Wet mix macadam shall be measured as finished work in position in cubic metres.

Rates
The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Morth Clause 401.7

The rate shall be for unit of Cum.

Item No. 32
Primer Coat
Providing and applying primer coat with cationic bitumen emulsion SS1 grade conforming to ASTM GRADE on prepared surface of wet mix macadam including clearing of GSB/Wet mix macadam surface with air compressor to remove all loose material other foreign material. The primer shall be sprayed uniformly at the rate of 0.70-1.0 kg/sqm. It shall be applied by a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. No dilution or heating at site of SS1 bitumen emulsion shall be permitted.

2.1 Scope
This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix. The work shall be carried out on a previously prepared granular/ stabilized surface to Clause 1.8.

2.2 Materials
The primer shall be cationic bitumen emulsion SS1 grade conforming to IS: 8887 or medium curing cutback bitumen conforming to IS: 217 or as specified in the Contract.

2.2.2 Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as given in Table 11-3.

Table 11-3: Quantity of Bitumen Emulsion for Various Types of Granular Surfaces

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

Cutback for primer shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surface shall be as given in Table 11-4.

Table 11-4: Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/Sqm)
WMM/WBM	MC30	0.6-0.9
Stabilized soil bases/Crusher Run Macadam	MC70	0.9-1.2

2.2.4 The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10 mm.

2.3 Weather and Seasonal Limitations

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10OC. Cutback bitumen as primer shall not be applied to a wet surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

2.4 Construction

2.4.1 Equipment

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

2.4.2 Preparation of Road Surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/ moorum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

2.4.3 Application of Bituminous Primer

After preparation of the road surface as per Clause 2.4.2, the primer shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively though the jets of the spray and to cover the surface uniformly.

2.4.4 Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

2.5 Quality Control of Work

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

2.6 Arrangements for Traffic

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

2.7 Measurement for Payment

Prime coat shall be measured in terms of surface area of application in square metres.

2.8 Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 1.7 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of quantity at 0.6 kg per square metre or at the rate specified in the Contract, with adjustment, plus or minus, for the variation between this quantify and the actual quantity approved by the Engineer after the preliminary trials referred to in Clause 2.4.3.

The rate shall be for unit of Sqm.

Item No. 33
DBM
Dense Graded Bituminous Macadam Providing, Carting and laying of dense bituminous macadam with batch type HMP producing an output of 80 to 120 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder VG-40 grade @ min 4.5% by weight of total mix, transporting the hot mix to work site, laying with a self-propelled paving machine equipped with an electronic sensing device to the required grade, level and alignment, rolling with 8-10 tonne static weight or vibratory roller or with a pneumatic tyre roller of 12 to 15 tonne weight to achieve the desired compaction as per approved design mix for As per Morth 5th Revision specification clause No. 505 complete in all respects.

1.1 Scope

The specification describes the design and construction procedure for Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

1.2 Materials

1.2.1 Bitumen

The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, modified bitumen complying with Clause 501.2.1 or as otherwise specified in the Contract. The type and grade of bitumen to be used shall be specified in the Contract.

1.2.2 Coarse Aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates has poor affinity for bitumen, the Contractor shall produce test results that with the use of anti-stripping agents, the stripping value is improved to satisfy the specification requirements. The Engineer may approve such a source and as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, at the cost of the Contractor. The aggregates shall satisfy the requirements specified in Table 500-8.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

1.2.3 Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a

combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve.
These shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand up to 50 percent of the fine aggregate may be allowed in base courses. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37). The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4, when tested in accordance with IS:2720 (Part 5).

1.2.4 Filler

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the limits indicated in Table 500-9.

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

1.3 Aggregate Grading and Binder Content

When tested in accordance with IS.2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 500-10 for grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent sieve.

Table 500-8 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS:2386 Part IV
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386PartV
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min. 80%	AASHTO 283

* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

** If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

The rate shall be for unit of **Cum.**

Item No. 34
Tack Coat
Providing & applying Tack coat with VG-40 Grade bitumen using bitumen pressure distributor at the rate of 0.20-0.30 kg/sqm on the existing bituminous surface cleaned with Air Compressor etc complete.

1.1 Scope

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

1.2 Materials

The binder used for tack coat shall be low viscosity paving bitumen of VG 40 grade conforming to as per latest Morth specification.

1.3 Weather and Seasonal Limitations

Bituminous material shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

1.4 Construction

1.4.1 Equipment

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

1.4.2 Preparation of Base

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

1.4.3 Application of Tack Coat

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

Table 500-5: Rate of Application of Tack Coat

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

1.4.4 Curing of Tack Coat

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

1.5 Quality Control of Work

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

1.6 Arrangements for Traffic

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

1.7 Measurement for Payment

Tack coat shall be measured in terms of surface area of application in square metres.

1.8 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in Clause 1.8 (i) to (v) and as applicable to the work specified in these Specifications. The rate shall cover the provision of tack coat, at 0.2 kg per square metre or at the rate specified in the Contract, with the provision that the variation between this quantity and actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

The rate shall be for unit of **Sqm**.

Item No. 35
Bituminous Concrete
Providing, Carting and laying of bituminous concrete with batch type hot mix plant producing an output of 80 to 120 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder VG-40 @ min. 5.4 % of mix, transporting the hot mix to work site, laying with a self-propelled paving machine equipped with an electronic sensing device to the required grade, level and alignment, rolling with 8-10 tonne static weight or vibratory roller or with a pneumatic tyre roller of 12 to 15 tonne weight to achieve the desired compaction as per approved design mix. for As per Morth 5th Revision specification clause No. 507 complete in all respects.

1.1 Scope

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 30 mm/40 mm/50 mm thick.

1.2 Materials

1.2.1 Bitumen

The bitumen shall conform to Clause 504.2.1.

1.2.2 Coarse Aggregates

The coarse aggregates shall be generally as specified in Clause 4.2.2, except that the aggregates shall satisfy the physical requirements of Table 14-16 and where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 14-16: Physical Requirements for Coarse Aggregate for Bituminous Concrete

Grading	1	2
Nominal aggregate size*	19.0 mm	13.2 mm
Layer Thickness	50 mm	30 - 40 mm
IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing	
26.5	100	
19	90-100	100
13.2	59-79	90 - 100
9	52-72	70 - 88
4.75	35-55	53 - 71
2.36	28-44	42 - 58
1.18	20-34	34 - 48
0.6	15-27	26 - 38
0.3	10-20	18 - 28
0.15	5-13	12 - 20
0.075	2-8	4 - 10
Bitumen content % by mass of total mix	Min 5.2**	Min 5.4**

* If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

1.2.3 Fine Aggregates

The fine aggregates shall be all as specified in Clause 5.2.3.

1.2.4 Filler

Filler shall be as specified in Clause 5.2.4.

1.2.5 Aggregate Grading and Binder Content

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and filler shall fall within the limits shown in Table 14-17. The grading shall be as specified in the Contract.

Table 14-17: Composition of Bituminous Concrete Pavement Layers

Grading	**1**	**2**
Nominal aggregate size*	19 mm	26.5 mm
Layer thickness	50 mm	50 - 75 mm

IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content ** percent by mass of total mix	Min5.2*	Min 5.4**

Notes:
* The nominal maximum particle size is the largest specified sieve size up on which any of the aggregate is retained.

** Corresponds to specific gravity of aggregate being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent

1.3 Mix Design

1.3.1 Requirements for the Mix

Clause 505.3.1 shall apply.

1.3.2 Binder Content
Clause 505.3.2 shall apply.

1.3.3 Job Mix Formula
Clause 5.3.3 shall apply.

1.3.4 Plant Trials - Permissible Variation in Job Mix Formula
The requirements for plant trials shall be as specified in Clause 505.3.4, and permissible limits for variation as given in Table 500-18.

Table 14-18: Permissible Variations in Plant Mix from the Job Mix Formula

Description	Permissible Variation
Aggregate passing 19 mm sieve or larger	±7%
Aggregate passing 13.2 mm, 9.5 mm	±6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±4%
Aggregate passing 0.3 mm, 0.15 mm	±3%
Aggregate passing 0.075 mm	±1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

1.3.5 Laying Trials

The requirements for laying trials shall be as specified in Clause 505.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D2041.

1.4 Construction Operations

1.4.1 Weather and Seasonal Limitations

The provisions of Clause 1.5.1 shall apply.

1.4.2 Preparation of Base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

1.4.3 Geo synthetics

Where Geo synthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

1.4.4 Stress Absorbing Layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

1.4.5 Tack Coat

The provisions specified in Clause 504.4.6 shall apply.

1.4.6 Mixing and Transportation of the Mix

The provisions specified in Clauses 501.3, 501.4 and 504.4.7 shall apply.

1.4.7 Spreading

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

1.4.8 Rolling

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

1.5 Opening to Traffic

Provisions in Clause 504.5 shall apply.

1.6 Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

1.7 Arrangements for Traffic

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

1.8 Measurement for Payment

The measurement shall be as specified in **Clause 505.8.**

1.9 Rate

The contract unit rate shall be all as specified in Clause 14.9, except that the rate shall include the provision of bitumen at 5.2 percent & 5.4 percent for grading 1 and grading 2 by weight of total mix

respectively. The variation in actual percentage of bitumen used will be assessed and the payment adjusted plus and minus accordingly.

The rate shall be for unit of **Cum**.

Item No. 36
Providing and Laying Micro surfacing as per MoRTH Specification (Section-514) & SP 81:200, Type-III grading of Specification, Polymer modified cationic bitumen emulsion, Ordinary Portland Cement, Chemical Additives and Water.

For detailed specification refer 5th revision of MORTH shall apply & also amendment shall be applicable to the latest versions.

22 MICRO SURFACING

22.1 Scope

The work shall consist of design, testing and construction of micro-surfacing composed of modified bitumen emulsion, mineral aggregate, water and necessary additives (if needed), proportioned, mixed and uniformly spread over a properly prepared surface for surface treatment of pavements in accordance with these Specifications.

22.2 Type of Mirco-Surfacing

Micro-surfacing is applied on an existing pavement surface which is structurally sound but the surface shows signs of premature ageing, aggregate loss, cracking, high degree of polishing etc, It may be used as surface sealing treatment to improve skid resistance, surface durability, to seal fine and medium cracks and for preventive maintenance and periodic renewal treatment on low and medium traffic roads. Types of micro-surfacing and rates of application are given in Table 500-31.

Table 22-31 : Types of Micro-Surfacing and Rate of Application

Items	Type II (4 to 6 mm)**	Type III (6 to 8 mm)**
Application	Preventive and Renewal Treatment for Roads Carrying <1500 CVPD	Preventive and Renewal Treatment for Roads Carrying 1500 to 4500 CVPD
Quantity of mix* (kg/m^2)	8.4 to 10.8	11.1 to 16.3
Residual binder (percentage by weight of dry aggregate)	6.5 to 10.5	5.5 to 10.5

* By weight of dry aggregate. ** Indicative only.

22.3 Materials

22.3.1 Binder

The bitumen emulsion shall be a modified bitumen emulsion conforming to requirements specified in Table 500-32. The modifier shall be polymer/rubber, preferably synthetic or natural rubber latex.

Table 500-32 : Requirement of Modified Bitumen Emulsion for Micro-Surfacing

Requirements	Specifications	Method of test
Residue on 600 micron IS sieve (percent by mass) maximum	0.05	IS:8887
Viscosity by Say bolt Furol Viscometre, at 25°C, in second	20-100	IS:8887
Coagulation of emulsion at low temperature	Nil	IS:8887
Storage stability after 24 h (168 h), % maximum	2(4)	IS:8887
Particle charge, + ve/-ve	+ ve	IS:8887
Tests on residue:		
a) Residue by evaporation, % minimum	60	IS :8887
b) Penetration at 25°C/100 g/5 s	40-100	IS :1203
c) Ductility at 27°C, cm, minimum	50	IS :1208
d) Softening point, in °C, minimum	57	IS :1205
e) Elastic recovery*, %, minimum	50	IS: 15462
f) Solubility in tri-chloroethylene, % minimum	97	IS :1216

In case, elastic recovery is tested for Torsional Elasticity. Recovery as per Appendix-8 of IRC:81, the minimum value shall be 20 percent.

22.3.2 Aggregates

As per Clause 512.3.2 (Type II and Type III Grading, Table 500-27).

22.3.3 Filler

As per Clause 512.3.3.

22.3.4 Water

As per Clause 512.3.4.

22.3.5 Additives

As per Clause 512.3.5.

22.4 Design and Proportioning of Micro-Surfacing Mix

22.4.1 The design criteria for micro-surfacing mixture is specified in Table 500-33. The mix design report shall clearly show the proportions of aggregate, filler, water and residual bitumen content based on the dry weight of aggregates and additives used (if any). The set time shall be determined by the method given in Appendix-2 of IRC:SP:81.

Table 500-33 : Mix Design Criteria for Micro-Surfacing Mix

Requirements	Specifications	Method of Test as given in IRC:SP:81
Mix time, minimum	120 s	Appendix-1
Consistency, maximum	3 cm	Appendix-3
Wet Cohesion, within 30 min, minimum	12 kg cm	Appendix-4
Wet Cohesion, within 60 min, minimum	20 kg cm	Appendix-4
Wet stripping, pass %, minimum	90	Appendix-5
Wet track abrasion loss (one hour soak), maximum	538 g/m^2	Appendix-6

22.4.2 Aggregate, modified bitumen emulsion, water and additive (if used), shall be proportioned by weight of aggregate utilizing the mix design approved by the Engineer. If more than one type of aggregates is used, the correct amount of each type of aggregate used to produce the required grading shall be

proportioned separately prior to adding other materials of the mixture, in a manner that will result in a uniform and homogenous blend. Final completed mixture, after addition of water and any additive, if used shall be such that the micro-surfacing mixture has proper workability and permit traffic within a short period depending upon the weather conditions without occurrence of ravelling and bleeding. Trial mixes shall be prepared and laid for the designed mix and observed for breaking time and setting time. The wet track abrasion test is used to determine the minimum residual bitumen content. Indicative limits of various ingredients for job mix of micro-surfacing shall be as given in Table 500-34.

Table 500-34 : Indicative ingredients in mix

Ingredients	Limits (Percent Weight of Aggregate)
Residual bitumen	6.5 to 10.5 for type II and 5.5 to 10.5 for Type III
Mineral filler	0.5 to 3.0
Additive	As needed
Water	As needed

22.5 Construction

As per Clause 512.5.

22.5.1 Weather and Seasonal Limitations

As per Clause 512.5.1.

22.5.2 Surface Preparation

As per Clause 512.5.2.

22.5.3 Application of Tack Coat

As per Clause 512.5.3.

22.5.4 Machine

As per Clause 512.5.4.

22.5.5 Calibration of Machine

As per Clause 512.5.5.

22.5.6 Application of Micro-Surfacing

A calibrated micro-surfacing machine as per requirements of job mix shall be used to spread the material. The surface shall be pre-wetted (if required under extreme hot weather conditions) by spraying water ahead of the spreader box. The rate of application of spray shall be adjusted during the day to suit temperature, surface texture and humidity. The application of micro-surfacing shall be as per Clause 512.5.6.

22.5.7 Rate of Application

The micro-surfacing mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition. The quantities of micro-surfacing mix (by weight of dry aggregate) to be used shall be as given in Table 500-31.

22.5.8 Rolling

As per Clause 512.5.8.

22.5.9 Quality Control and Surface Finish

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

22.6 Control of Traffic

Micro-surfacing mix requires about 2 hours to set. Traffic may be opened only after 2 hours restricting the speed to 20 km/h till 12 hours thereafter.

22.7 Arrangements for Traffic

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

22.8 Measurement for Payment

Micro-surfacing shall be measured as finished work as specified, in square metres.

22.9 Rate

The contract unit rate for micro-surfacing shall be payment in full for carrying out the required operations including full compensation for the specified rate of application of the mix and the quantity of residual binder. The variation in rates of actual application shall be suitably adjusted plus or minus as provided in the Contract. The contract unit rate shall include full compensation for all operations listed in Clause 501.8.8.2.

The rate shall be for unit of **Sqm**.

Item No. 37
CC Pavement - M 25
Providing and laying cement concrete pavement of mix M-25 with ready mixed concrete from batching plant. The ready mixed concrete shall be laid and finished with vacuum dewatering process and Power floater treatment in roads, pavements, platform, floors etc well compacted, mechanically vibrated with screed vibrator, finished to required levels, floated with neat cement and power trowelled to get desired smooth finish/ broom finish as per design, over a levelling course, including casted in panel, MS channel or box shuttering, curing etc as directed by Engineer. The size of panel should be as per drawing as directed by Engineer. The Contraction joints to be formed at every less than 3m distance by grooving with mechanical saw within 48 hrs. Groove/ sawed joints/ longitudinal joints shall be made of 6mm width and 40 mm depth min (1/3 rd depth of the pavement) as shown in the drawing. LDPE sheet (min 125 gsm) shall be laid below pavement. The rate shall be inclusive of labour, making the grooves, filing groves with approved sealant and backer rod, provision of expansion joint, LDPE sheet and machinery cost etc complete and as directed by Engineer in charge. Reinforcement if required shall be paid in relevant tender item. Mock up for concrete pavement work (for brooming pattern and joints as per drawing) shall be prepared by contractor and got approved from architects in all respect prior to mass execution works. Architect reserves right to reject part or all work of sub standard or not in confirmation to sample approved as per mock up.

AND

Item No. 38
CC Pavement - M 40
Providing and laying cement concrete pavement/Pavement Quality Concrete (PQC) of mix M-40 with ready mixed concrete from batching plant. The ready mixed concrete shall be laid and finished with vacuum dewatering process and Power floater treatment in roads, pavements, platform, floors etc well compacted, mechanically vibrated with screed vibrator, finished to required levels, floated with neat cement and power trowelled to get desired smooth finish/ broom finish as per design, over a levelling course, including casted in panel, MS channel or box shuttering, curing, as per Specifications and in conformity with the lines, grades and cross sections shown on the drawings etc as directed by Engineer. The size of panel should be as per drawing as directed by Engineer. The Contraction joints to be formed at location as per drawing by grooving with mechanical saw within 48 hrs. Groove/ sawed joints/ longitudinal joints shall be made of approximate 6mm width and approximate 40 mm depth min (1/3 rd depth of the pavement) or joint/groove shall be as per shown in the drawing. LDPE sheet (min 125 gsm) shall be laid below pavement if required as per design intent. The rate shall be inclusive of labour, making the grooves, filing groves with approved sealant and backer rod, provision of expansion joint, construction joint, longitudinal joints, LDPE sheet and machinery cost etc complete and as directed by Engineer in charge. Dowel bar, Tie bar & other Reinforcement bars if required as per drawing, shall be paid in relevant tender item.

Mock up for concrete pavement work (for brooming pattern and joints as per drawing) shall be prepared by contractor and got approved from architects in all respect prior to mass execution works. Architect reserves right to reject part or all work of sub standard or not in confirmation to sample approved as per mock up.

Scope

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

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

Materials

Source of Materials

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

Cement

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

S. No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade	IS-.8112
Ii)	Ordinary Portland Cement 53 Grade	IS:12269
iii)	Portland Slag Cement	IS:455
iii)	Portland Pozzolana Cement	IS:1489-Partl

If the soil around concrete pavement has soluble salts like sulphates in excess of 0.5 percent, the cement used shall be sulphate resistant and shall conform to IS: 12330. Cement to be used may preferably be obtained in bulk form. If cement in paper bags is proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and dispose them off suitably. No paper pieces shall enter the concrete mix. Bulk
cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test.

Aggregates

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

Table
Permissible Limits of Deleterious Substances in Fine and Coarse Aggregates

Sr. No.	Deleterious Substance	Method of Test	Fine Aggregate Percentage by Weight, (Max)		Coarse Aggregate Percentage by Weight (Max)	
			Uncrushed	Crushed *	Uncrushed	Crushed *
1)	2)	3)	4)	5)	6)	7)
i)	Coal and lignite	IS:2386 (Part II)-1963	1.0	1.0	1.0	1.0
ii)	Clay lumps	Do	1.0	1.0	1.0	1.0

iii)	Mateirals finer than 75 u IS Sieve	IS:2386 (Part I)-1963	3.0		3.0	3.0
iv)	Soft fragments	IS.-2386 (Part II)-1963	-	-	3.0	-
v)	Shale	IS:2386 (Part II)-1963	1.0	-	-	-
vi)	Total of percentages of all deleterious materials (except mica) including Sr No. (i) to (v) for col 4, 6 and 7 and Sr No. (i) and (ii) for col 5 only		5.0	-	5.0	5.0

* Crushed aggregate at least one face fractured

Note: The presence of mica in the fine aggregate has been found to reduce considerably the durability and compressive strength of concrete and further investigations are underway to determine the extent of the deleterious effect of mica. It is advisable, therefore, to investigate the mica content of fine aggregate and make suitable allowances for the possible reduction in the strength of concrete or mortar; in cases where the stretch of the project road passes through micacious belt.

The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalies in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 percent by weight and the total sulphate content expressed as sulphuric anhydride (S03) shall not exceed 0.25 percent by weight. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

Coarse Aggregates

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

Fine Aggregates

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

Combined Gradation of Fine and Course Aggregates

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

Table: Aggregate Gradation for Pavement Quality Concrete

Sieve Designation	Percentage by Weight Passing the Sieve
31.5 mm	100
26.5 mm	85-95
19.0 mm	68-88
9.5 mm	45-65
4.75 mm	30-55

600 micron	8-30
150 micron	5-15
75 micron	0-5

Water

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

Steel for Dowels and Tie Bars

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

Joint Filler Board

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

Joint Sealing Compound

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

If sealant is of hot poured type, it shall conform to

Hot applied sealant: IS: 1834 or ASTM : 3406-95, as applicable

Cold poured sealants shall be one of the following:

i) polysulphide IS.H433 (Part I), BS:5212 (Part II)
ii) polyurethane BS:5212
iii) silicone ASTM 5893-04

Preformed Seals

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

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

Table: Requirement of Preformed Seals as per ASTM D 2628

No.	Description	Requirements	ASTM Test Methods
1)	Tensile strength, min	13.8 MPa	D412
2)	Elongation at break Min.	250%	D412
3)	Hardness, Type A durometer	55 +/-5 points	D2240
4)	Oven aging, 70 h at 100°C Tensile strength loss	20% max	D573
5)	Elongation loss	20%	max
6)	Hardness Change Type A durometer	0 to +10 points	D471
7)	Oil Swell, ASTM Oil 3, 70 h at 100°C Weight Change	45% max	D 1149
8)	Ozone resistance 20 percent strain, 300	No cracks	D2240

	pphm in air, 70 h at 40°C		
9)	Low temperature stiffening, 7 days at -10°C Hardness Change type A durometer	0 to +15	points
10)	Low temperature recovery, 22h at -10°C, 50% deflection	88% min	D2628
11)	Low temperature recovery, 22h at -29°C, 50% deflection	83% min	D2628
12)	Low temperature recovery, 70h at -100°C, 50% deflection	85% min	D2628
13)	Compression, deflection, at 80%of normal width (min)	613 N/m	D2628

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

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

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

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

The ratio between the 7- and 28-day strength shall be established for the mix to be used in the slab in advance, by testing pairs of beams and cubes at each stage on at least six batches of trial mix. The average strength of the 7 day cured specimens shall be divided by the average strength of the 28-day

specimens for each batch, and the ratio "R' shall be determined. The ratio 'R' shall be expressed to three decimal places.

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

Workability
The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer. The control of workability in the field shall be exercised by the slump test as per IS.1199.

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

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

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

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

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

Separation Membrane
A separation membrane shall be used between the concrete slab and the sub-base. Separation membrane shall be impermeable PVC sheet 125 micron thick transparent or white in colour laid flat with minimum creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheathing shall be replaced at the Contractor's

cost. The separation membrane may be nailed to the lower layer with concrete nails. The separation membrane shall be omitted when two layers of wax-based curing compound is used.

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

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

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

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

Transverse Joints
Transverse joints shall be contraction, construction and expansion joints constructed at the spacing described in the drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints.
i) Deviations of the performed filler board (IS: 1838) in the case of expansion joints from the intended line of the joint shall not be greater than ±10 mm.

ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.
iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.

iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 602.10.

Contraction Joints
The contraction joints shall be placed transversely at pre-specified locations as per drawings/ design using dowel bars. These joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab.

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

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

Expansion Joints
The expansion joint shall consist of a joint filler board complying with Clause 602.2.9 and dowel bars complying with Clause 602.6.5 and as detailed in the drawings. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given

in Clause 602.6.2.1. The adjacent slabs shall be completely separated from each other by the joint filler board.

Transverse Construction Joint

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

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

Longitudinal Joint

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

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

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

Dowel Bars

Dowel bars shall be mild steel rounds in accordance with Clause 602.2.8 with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale.

They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. Any protrusions shall be removed by grinding the ends of the dowel bars.

The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.
Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of ±20 mm, and centered equally about intended lines of the joint within a tolerance of ±25 mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given here-in-under, the compliance of which shall be checked as per Clause 602.11.7.

i) For bars supported on cradles prior to the laying of the slab:
a) All bars in a joint shall be within ±2 mm per 300 mm length of bar
b) 2/3rd of the number of bars shall be within ±3 mm per 500 mm length of bar
c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane

d) Cradles supporting dowel bar shall not extend across the line of joint i.e. no steel bar of the cradle assembly shall be continuous across the joint.

ii) For all bars inserted after laying of the slab except those inserted by a Dowel Bar Inserter the tolerance for alignment may be twice as indicated in (i) above. The transverse joints at curves shall be radial in the direction of the radius.

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

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

i) For expansion joints, the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 kN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300 mm from either end of any length of filler board, if a continuous fixing is used. The residual deflection after load shall be not more than 3 mm.

ii) The fixings for joint assembly shall not fail under 1.3 kN load and shall fail before the load reaches 2.6 kN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.

iii) Fixings shall be deemed to fail when there is displacement of the assemblies by more than 3 mm with any form of fixing, under the test load. The displacement shall be measured at the nearest part of the assembly to the centre of the bar or timber packing.

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

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

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

Tie Bars

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

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

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

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

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

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

Weather and Seasonal Limitations

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

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

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

Fixed Form Paving

Side Forms and Rails
These shall be provided in case of fixed form paving. All side forms shall be of mild steel of depth equal to the thickness of pavement or slightly less to accommodate the surface irregularity of the sub-base. The forms can be placed in series of steel packing plates or shims to take care of irregularity of sub-base. They shall be sufficiently robust and rigid to support the weight and pressure caused by a paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms. The forms and rails shall be firmly secured in position by not less than 3 stakes/pins for every 3 m length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3 m and when in place shall not settle in excess of 1.5 mm in 3 m while paving is being done. Forms shall be cleaned and oiled immediately before each use. The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within

tolerances ±10 mm and ±3 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected by the Engineer for his approval 12 hours before construction of the slab and shall not be removed until at least 12 hours afterwards. No concreting shall commence till formwork has been approved by the Engineer.

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

Slip Form Paving

Use of Guide wires

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

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

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

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

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

Construction

General

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

Batching and Mixing

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

Equipment for Proportioning of Materials and Paving

Proportioning of materials shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates. Water shall be measured by volume. Specified percentage of plasticizer in volume will be added by weight of cement. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design, the grading of aggregates shall be controlled by appropriate blending techniques. The capacity of batching and mixing plant shall be at least 25 percent higher than the proposed capacity of the laying/paving equipment.

Batching Plant and Equipment:

1) **General**: The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregates and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. There shall be a separate bin for fly ash, if this additive is specified. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned. A continuous type of mixing plant can also be used provided the ingredients are weighed through electronic sensors before feeding.

2) **Automatic weighing devices**: Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells. The weighing devices shall have an accuracy within ±1% in respect of quantity of cement, admixtures and water and ±2% in respect of aggregates and the accuracy shall be checked at least once a month.

3) **Mixer**: Mixers shall be pan type, reversible type or any other mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mix, without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed in 90 seconds or as per the manufacturer's recommendation the mixer shall be equipped with a suitable non-resettable batch counter which shall correctly indicate the number of batches mixed.

The mixer shall be cleaned at suitable intervals. The pick-up and throwover blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 20 mm wear from new conditions. Drilled holes of 5 mm diameter near each end and at midpoint of each blade are recommended. Batching Plant shall be calibrated in the beginning and thereafter at suitable interval not exceeding 1 month.

4) **Control cabin**: An air-conditioned centralized computer control cabin shall be provided for automatic operation of the equipment.

5) The design features of the batching plant should be such that it can be shifted quickly.

Paving Equipment

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

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

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

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

Placing of Concrete
The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C and 30°C. When the time between mixing and laying exceed these values, the concrete shall be rejected and removed from the site. Tipping trucks delivering concrete shall normally not run on plastic sheathing nor shall they run on completed slabs until after 28 days of placing the concrete.

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

Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 602.8. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per the relevant Clauses of these Specifications. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the concrete in the pavement.
In areas inaccessible to paving equipment, the pavement shall be constructed using side forms, as per Clause 602.9.7.
In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.
The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer when it shall be applied as a mist by means of approved equipment.
If considered necessary by the Engineer, the paving machines shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.
While the concrete is still plastic, its surface shall be textured by brush or tines as per the instructions of the engineer in compliance with Clause 602.9.11. The surface and edges of the slab shall be cured by the application of a sprayed liquid curing membrane in compliance with Clause 602.9.12. After the surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chainage at every 100 m interval by embossing.
As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of 1:1:2, cement : sand : coarse agg (10 mm down) with water cement ratio not more than 0.4 under the supervision of the Engineer.

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

Construction by Slip Form Paver

The slip form paving train shall consist of a power machine which spreads, compacts and finishes the concrete in a continuous operation. The slip form paving machine shall compact the concrete by internal vibration and shape it between the sides forms with either a conforming plate or by vibrating and oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or cross fall.

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

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

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

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

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

Tube Floating

Upon the instructions of the Engineer, Contractor shall scrape the concrete surface when in plastic state with a 3 m long tube float fixed with a long and stable handle before texturing. Tube float shall be of an alloy steel tube of 50 to 60 mm diameter with a long and stable handle. The length of tube float shall preferably be longer than half the length of slab i.e., half the distance between two transverse contractions joints. This operation shall be done to minimize surface irregularity caused due to varied causes like frequent stoppages of work, surface deformation due to plastic flow etc. The

tube float shall be placed at the centre of the slab parallel to longitudinal joint and pulled slowly and uniformly towards the edges. After the use of float tube, it shall be frequently cleaned before further use. The slurry removed shall be discarded. This activity shall be advanced laterally by providing an overlap of half the length of tube float. The removal of the cement slurry from the surface shall be sufficient enough such that the texture is formed on a firm surface and is more durable. This operation, however, shall be carried out after removing bleeding water.

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

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

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

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

Anchor Beam and Terminal Slab Beam Adjoining Bridge Structures
RCC anchor beams shall be provided in the terminal slab adjoining bridge structures as per drawings and IRC:15.

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

Surface Texture

Tining
After final floating and finishing of the slab and before application of the liquid curing membrane, the surface of concrete slabs shall be textured either in the transverse direction (i.e., at right angles to the longitudinal axis of the road) or in longitudinal direction (i.e., parallel to the centerline of the roadway). The texturing shall be done by tining the finished concrete surface by using rectangular steel tines. A beam or a bridge mounted with steel tines shall be equipped and operated with automatic sensing and control devices from main paver or auxiliary unit. The tining unit shall have facility for adjustment of the download pressure on the tines as necessary to produce the desired finish. The tining rakes shall be cleaned often to remove snots of slurry. The tines shall be inspected daily and all the

damaged and bent tines shall be replaced before commencing texturing. Tined grooves shall be 3 mm wide and 3 to 4 mm deep. Before commencing texturing, the bleeding water, if any, shall be removed and texturing shall be done on a firm surface. The measurement of texture depth shall be done as per Clause 602.12.

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

Random spacing in mm

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

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

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

Brush Texturing
Alternatively on the instructions of the Engineer, the brush texturing shall be applied. The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but wider brushes normally of 3 m length are preferred. The brush shall be made of 32 gauge tape wires grouped together in tufts placed at 10 mm centres. The tufts shall contain an average of 14 wires and initially be 100 mm long. The brush shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down to 90 mm long.

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

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

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

Table: Texture Depth

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

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

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

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

The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks of application.

Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying. The curing compound shall be sprayed in two applications to ensure uniform spread.

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

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

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

Preparation and Sealing of Joint Grooves

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

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

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

All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. The Engineer shall instruct cleaning by pressurized water jets. Depending upon the

requirement of the sealant manufacturer, the sides of the grooves shall be sand blasted to increase the bondage between sealant and concrete.

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

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

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

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

If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturer's recommendations and reheated material shall not be used. The Movement Accommodation Factor of the sealant shall be more than 10 percent.
Cold applied sealants with chemical formulation like polysulphide/ polyurethane/ silicone as per IRC:57 shall be used These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor shall be more than 25 percent.

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

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

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

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

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

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

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

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

Surface Levels and Regularity

a) In checking for compliance with Clause 902.3 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.

b) The maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 902.4. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length.

Joints

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

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

Density

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

Strength

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

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

Concrete in the member represented by a core test shall be considered acceptable, if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength (characteristic strength) of the grade of the concrete specified for the corresponding age of 28 days and no individual core has a strength less than 75 percent.

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

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

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

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

When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall be exposed sufficiently in the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of days' work by extending slab length by 2 m. After sawing the transverse joint groove, the extended 2m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances. This joint shall be treated as construction joint. The position of dowel bars in any type of transverse joint ie, contraction, construction or expansion can alternatively be tested by suitable device like MIT SCAN with the permission of the Engineer.

If the position and alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only one joint of the three is defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved.

After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with

epoxy mortar. Plastic sheath as per Clause 602.6.5.5 shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 602.10.

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

Measurement of Texture Depth - Sand Patch Method
The following Apparatus shall be used:

i) A cylindrical container of 25 ml internal capacity;

ii) A flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, next to one face, the reverse face being provided with a handle;

iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

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

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

Measurement of Texture Depth – Tining

The following apparatus shall be used:
i) Tire Tread Depth Gauge
A stainless steel tire tread depth gauge with graduations with least count of 1.0 mm. The gauge end may be modified to measure depth of tine texture.
ii) A stainless steel calliper to measure spacing of tines. If necessary the calliper may be modified to measure the spacing and width of tine texture. The guage shall be used after making necessary calibration.
iii) Wire brush
iv) Corborundum stone
v) Steel straight edge to remove snots etc. sticking to the surface. The straight edge may be of 6 x 25 x 300 mm size.

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

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

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

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

Opening to Traffic

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

Acceptance Criteria in Quality and Distress

i) **Tolerances for Surface Regularity, Level, Thickness and Strength:**
The tolerances for surface regularity, level, thickness and strength shall conform to the requirements given in Clause 903.5. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

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

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

Measurements for Payment

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

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

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

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

Rate

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

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

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

Table 600-6: Payment Adjustment for Deficiency in Thickness

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

No additional payment shall be made for the extra thickness of the slab than shown on the drawings. concreting is in progress.
Architect reserves right to reject part or all work of substandard or not in confirmation to sample approved as per mock up. Any deviations from approved samples/mock-ups must be rectified promptly at the contractor's expense.

The rate shall be unit of Cum.

Item No. 39
Kota Stone - For Flooring - fixing with cement mortar
Providing and laying machine-cut 40 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone of specified thickness, specified finish, any shade (uniform), any size, and any shape for flooring in required design and patterns as per the drawings, laid over upto bedding 20 mm thick cement mortar 1:6 (1 cement: 6 coarse sand) with cement mortar of 1:2 (1 cement: 2 sand) applied to the sides of the stones, with the groove or without groove and jointed with grey/white cement slurry mixed and filling of grooves with cement mortar with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, as specified and as directed by the Engineer-in-Charge.
The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar bedding, cement slurry, matching pigment, all labour, etc complete but excluding filling with epoxy grout and additional cement mortar bedding/ concrete screed bedding (if required as per drawing) which shall be payable under the relevant item. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.
The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

Relevant specification shall be followed as per CPWD specification Vol – I clause No – 11.21 and item no -39 (as below) except thickness of machine-cut 40 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone of specified thickness, specified finish, any shade (uniform), any size, and any shape for flooring in required design and patterns as per the drawings, laid over upto bedding 20 mm thick cement mortar 1:6 (1 cement: 6 coarse sand) with cement mortar of 1:2 (1 cement: 2 sand) applied to the sides of the stones, with the groove or without groove and jointed with grey/white cement slurry mixed and filling of grooves with cement mortar with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, as specified and as directed by the Engineer-in-Charge instead of 25mm thick kota stone. Finishing and texture shall be as per approved by architect before mass execution.

The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar bedding, cement slurry, matching pigment, all labour, etc complete but excluding filling with epoxy grout and additional cement mortar bedding/ concrete screed bedding (if required as per drawing) which shall be payable under the relevant item. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.

The rate shall be inclusive of finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing.

The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

The rate shall be for a unit of one **Sqm.**

Item No. 40
Kota Stone - For treads/copping/seating - fixing with Cement Mortar
Providing and laying machine-cut Kota stone 40 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in treads of steps, coping and seating, etc as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness and laid over upto 20 mm thick base of cement mortar 1: 6 (1 cement: 6 coarse sand)/ suitable adhesive as per manufacturer specification, and jointed (paper joint) with grey/ white cement slurry mixed with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing.
The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar bedding/ adhesive, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.
The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

1.0 Material
1.1 Kota Stone
1.1.1 Kota Stone shall conform to M-44. machine-cut Kota stone 40 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in treads of steps, coping and seating, etc as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness.

1.2 Cement Mortar
1.2.1 Cement mortar shall conform to M-11.

2.0 Workmanship
2.1 For dressing CPWD specifications clause no. 11.21.2 shall be followed.
2.1 For laying and preparation of surface CPWD specifications clause no. 11.21.3 shall be followed except upto thickness of CM shall be 20 mm, cement mortar shall be 1:6 (1 cement : 6 sand) / suitable adhesive as per manufacturer specification used.

2.2 While laying any chiseling which may be required for making the skirting or dado flush with the plaster and/or other finishes shall be done. Necessary grooves of required size in cm. between plaster and/or other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges, gutters, sills, platforms, channels, curbing, etc. if any, if required, shall be provided as per the drawing and design.

2.3 In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothened at edge to give straight and true joints.

2.4 All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Architect and Engineer-in-charge.

2.5 The floor shall be kept wet for a minimum period of 7 days, so that bedding and joints set properly.

2.6 **Polishing** shall be normally commenced after 14 days of laying the slab. For special polish polishing to be done with 2 coats of 60, 120 grades of emery, balckchapadi and gutka. For semi mirror polish polishing to be done with 220, 320, 400, 600 grades of emery. Water shall be properly used during polishing. The flooring shall then be washed clean with oxalic acid. Daily moping for 15 days shall be done after polishing or up to the satisfaction of client and engineer-in-charge. All works shall be carried out as directed by the Architect and as specified in the item, no waxing will be permitted.

2.7 If any tile is disturbed or damaged it shall be refitted or replaced, properly jointed and polished.

2.8 The holes required for Nahni traps, pipes any other fittings shall be made without any extra cost.

3.0 Mode of Measurement and Payment

3.1 Kota slab flooring shall be measured in $m^{2.}$ for visible area of work done. Length and breadth shall be measured correct to a cm before laying skirting, dado or plaster.

3.2 No deductions shall be made or extra paid for any opening in the floor area upto 0.1 m^2. Nothing extra shall be paid for use of cut tiles or for laying the floors at different levels in the same room or courtyard. Kota slabs laid in floor boarders and bands etc. shall be measured in the same item and nothing extra shall be payable on account of these or similar bands formed of half or multiples of half size standard tiles/or other uncut tiles.

3.3 The treads of stairs and steps paved with tiles without nosing shall also be measured under this item.

3.4 The rate shall include the cost of all materials (inclusive of all taxes, levies, and delivery at site), labour & sundry involved in all the operations, at all floors, at any height and level, as described above. It shall also include for breakage and wastage. Floating materials and margin of profit shall also be included. All material samples shall be approved by the Architect/ Engineer-in-charge before placing orders.

3.5 No extra shall be paid for any small quantities like narrow widths, mitred & returned ends, rounds & cutting, fixing and making good upto & around pipes, fittings and fixtures etc.

3.6 The rate shall include for fixing the flooring in composite pattern as per the drawings, using different materials and sizes. The measurements of the different materials shall be taken category-wise separately and paid accordingly.

3.7 The basic rate, if at all provided or agreed upon includes cost of material, all taxes, levies & cost of delivery at site.

3.8 The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar / adhesive bedding, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.

The rate shall be inclusive of finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing.

The actual laid area of the Kota stone shall be measured for payment without considering any wastage..

The rate shall be for a unit of one **Sqm.**

Item No. 41
Kota Stone - For risers of steps, dado etc. or similar - fixing with cement mortar
Providing and laying machine-cut Kota stone 25 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in the risers of steps, dado or similar etc. as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness and laid in any pattern fixed on any type of leveled surface with approximate 12 mm thick (average) cement mortar 1:3 (1 cement : 3 coarse sand)/suitable adhesive as per manufacturer specification, and jointed (paper joint) with grey/ white cement slurry mixed with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing. The rate shall be inclusive of Kota stone (as per the approved sample), cement mortar for fixing/ adhesive, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.
The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

Relevant specification shall be followed as per item no -42 (as above) machine-cut Kota stone 25 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in the risers of steps, dado or similar etc. as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness and laid in any pattern fixed on any type of leveled surface with approximate 12 mm thick (average) cement mortar 1:3 (1 cement : 3 coarse sand)/ /suitable adhesive as per manufacturer specification, and jointed (paper joint) with grey/ white cement slurry mixed with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing instead of 40mm thick kota stone. Finishing and texture shall be as per approved by architect before mass execution.

The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar / adhesive, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.

The rate shall be inclusive of finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing.

The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

The rate shall be for a unit of one **Sqm.**

Item No. 42
Kota Stone - For risers of steps, dado etc. or similar - fixing with cement mortar
Providing and laying machine-cut Kota stone 55 to 65 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in the risers of steps, dado, planter sides, or similar etc. as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness and laid in any pattern fixed on any type of leveled surface with approximate 12 mm thick (average) cement mortar 1:3 (1 cement : 3 coarse sand)/suitable adhesive as per manufacturer specification, and jointed (paper joint) with grey/ white cement slurry mixed with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding,

wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing. The rate shall be inclusive of Kota stone (as per the approved sample), cement mortar for fixing/adhesive, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution. The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

Relevant specification shall be followed as per item no -42 (as above) machine-cut Kota stone 55 to 65 mm thick any type of Polished/ Textured (i.e. river wash finish, leather finish, linen finish, canvas finish etc) finish Kota stone in a single piece of any shade (uniform), any size, and any shape in the risers of steps, dado or similar etc. as per the drawings. Kota stone slab having pencil corner and same polished at the exposed edge in even and uniform thickness and laid in any pattern fixed on any type of leveled surface with approximate 12 mm thick (average) cement mortar 1:3 (1 cement : 3 coarse sand)/ /suitable adhesive as per manufacturer specification, and jointed (paper joint) with grey/ white cement slurry mixed with pigment to match the shade of the slabs, including finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing instead of 40mm thick kota stone. Finishing and texture shall be as per approved by architect before mass execution.

The rate shall be inclusive of Kota stone (as per the approved sample), fixed with cement mortar / adhesive, cement slurry, matching pigment, all labour, etc complete. The contractor shall arrange loose Samples for approval from the Engineer-in-Charge before mass execution.

The rate shall be inclusive of finishing, rubbing, curing, polishing, cleaning, protection, scaffolding, wastage, etc. all complete for all levels, all floor, all height, and as directed by the Engineer-in-Charge. The joint between the tread and riser shall be finished as per the drawing.

The actual laid area of the Kota stone shall be measured for payment without considering any wastage.

The rate shall be for a unit of one **Sqm.**

Item No. 43
Additional Floor bedding with Cement mortar :
Providing and laying cement mortar 1:6 (1 cement : 6 coarse sand) for additional thickness below flooring item required for gradient and as per drawing and as directed by engineer in charge including spreading as per gradient, levelling, finishing, curing etc complete as directed by Engineer in charge. Actual laid volume for floor bedding shall be measured for payment without considering any wastage.

Relevant specification shall be as per CPWD specification clause no – 11.19.3 except cement mortar 1:6 (1 cement: 6 coarse sand) below additional thickness below flooring item required for gradient and as per drawing and as directed by engineer in charge including spreading as per gradient, levelling, finishing, curing etc complete as directed by Engineer in charge.

Actual laid volume for floor bedding shall be measured for payment without considering any wastage.

The rate shall be for a unit of one Cum.

Item No. 44
Precast Cement Concrete Paver Block - 60mm thick, M-35 Grade
Providing and laying factory-made chamfered edge shot blasted/sand blasted finished, non-interlocking type, square/ rectangle shape paver blocks of approved make, any sizes, any shade, any pattern, any colour having 60 mm thickness and minimum M-35 grade, machine made, factory finished for footpath, parking areas, service lanes and other similar areas as

mentioned in the drawing Including providing and laying 50 to 80 mm thick average bedding layer of coarse sand below paver block as per required grading and specification. The laid paver block shall be mechanically compacted. The work of the paving blocks shall be executed in line and level. The paver block shall be cut by mechanical means only, if required. Paver blocks shall be compacted and shall be re-laid if necessary. The actual laid area shall be measured for payment without any wastage. The Sample and mock-up shall be approved before execution. damaged block shall not be used in laying. Sample and mock shall not be payable if rejected.

AND

Item No. 45
Precast Cement Concrete Paver Block - 80mm thick, M-40 Grade
Providing and laying factory-made chamfered edge shot blasted/sand blasted finished, non-interlocking type, square/ rectangle shape paver blocks of approved make, any sizes, any shade, any pattern, any colour having 80 mm thickness and minimum M-40 grade, machine made, factory finished for footpath, parking areas, service lanes and other similar areas as mentioned in the drawing Including providing and laying 50 to 80 mm thick average bedding layer of coarse sand below paver block as per required grading and specification. The laid paver block shall be mechanically compacted. The work of the paving blocks shall be executed in line and level. The paver block shall be cut by mechanical means only, if required. Paver blocks shall be compacted and shall be re-laid if necessary. The actual laid area shall be measured for payment without any wastage. The Sample and mock-up shall be approved before execution. damaged block shall not be used in laying. Sample and mock shall not be payable if rejected.

1.0 Material:
Paver block factory-made chamfered edge shot blasted/sand blasted finished, non-interlocking type, square/ rectangle shape paver blocks of approved make, sizes, shade, pattern, colour as per drawing.

2.0 Workmanship:
Paver block shall be laid over 50 to 80 mm thick compacted bed of sand in required grading, including compacting, through vibratory compaction by using plate vibrator, filling the joints with sand, and cutting of paver blocks by machine in required size and pattern, finishing, and sweeping extra sand etc. complete.

3.0 Mode of Measurement & Payment:
The rate shall be inclusive of paver, sand, laying, compaction, finishing, transporting from store to site, loading, unloading, cleaning etc complete and as directed by Engineer in charge.

The actual area of paver shall be measured for payment.

The rate shall be for units of **Sqm**.

Item No. 46
Providing and fixing Modular Concrete Cobble block in different sizes with 60mm thickness, Shot blasted finish, grey/ coloured, of Vyara (Beganit) make or equivalent as per design. Top coat / wear coat (not less than 5mm) shall have using UV resistant colour pigments from Lanxess, compressive strength 400kg/ cm2. Including providing and laying 50 to 80 mm thick average bedding layer of coarse sand below cobble block as per required grading and specification. Laid cobble block shall be mechanically compacted. Cutting of paver block by machine cut only and laying to be done by skilled flooring mason. cobbles shall be compacted and shall be re-laid if necessary.

Sample to be approved by the Architect & Engineer-in-charge.

1.0 Material

All clauses given under CPWD specifications clause 8.8 and 11.31 shall apply except concrete cobble square 60mm thick stone blasted finish will be used instead of granite stone. All cobble work shall average 50 mm coarse sand bedding over compacted sub-base (in required slope and of specified thickness). Sample to be approved by the Architect & Engineer-in-charge. Rate shall be exclusive of sub-base.

2.0 Workmanship:

50 mm thick coarse sand shall be laid as a cushioning layer for arranging the blocks. Joints of the blocks shall be filled with the sand. The blocks shall be laid properly on the prepared sub-base as per manufacturer's specification and as per Architect and Engineer-in-charge's instruction.

Cobbles shall be in modular sizes, top layer/ wear layer (not less than 5mm) made of using UV resistant colour pigments from Lanxess & Premier Shield integral and topcoat treatment for satin finish, water and oil repellence, reduction of algae, moss and efflorescence.

3.0 Mode of Measurement & Payment:

The rate shall be for a unit of one **Sqm.**

Item No. 47

Pre-cast concrete kerb

Providing & fixing minimum M25 grade of customized concrete factory-made precast exposed concrete finish kerb of approved make and as per sample approved of specified sizes, specified shape etc. complete. (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.) Kerb shall have chamfered type/ pencil corner edges. Kerbs shall be fixed on the base PCC with cement mortar 1:2 including flush pointing in CM (1:2) or suitable approved make adhesive for all joints of the kerbstones, curing, etc. complete. The rate shall also include erecting and fixing in position all varieties/ shapes of kerbs (i.e. radius kerbs, corner kerb, quadrant kerbs, drain out kerb, flat kerb, parking edge kerb, ramp kerb or other any type of kerb with any shape as per drawing/design intent etc) as per drawing. Precast kerb shall be protected with good quality plastic sheet for protection against bituminous/ concrete work. The rate shall include the joining, curing, finishing, protection etc complete as directed by the engineer in charge. Actual installed kerb volume shall be measured in payment.

The rate shall include the cost of base excavation, base PCC M15 grade, joining, curing, protection etc complete as directed by engineer in charge. Rate shall be unit of One Cum. For the payment kerb volume shall be considered. (Sample must be approved). Sample and Mock-up shall be carried out as suggested by the Architect and as directed by the Engineer in charge. Sample and mock shall not be payable if rejected.

1.0 Material

M25 minimum grade of customized concrete factory-made precast exposed concrete finish Precast kerb shall be of approved make and as per approved sample. Shape and size of kerb shall be as per design.(finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.)

2.0 Workmanship

All Precast members shall be customized concrete factory made. Sufficient curing shall be done before placement of the same.

The method of transporting and placing the precast members shall be as approved by the Architect and Engineer-in-charge. Members shall be so transported that no breakage or undue stresses are induced in them.

The pits of required size shall first be excavated, true to line and level. The specifications for excavation shall be followed as per relevant item.

The pits shall be filled with a layer of 0.15 M thick concrete M15. The kerbs shall be laid on existing PCC base in true line and plumb. The specifications for PCC work shall be followed as per relevant item.

The rate shall also include for erecting and fixing the pieces in position, transporting from store to site, loading, unloading, cleaning and jointing for complete Kerb systems with Chamfered type of kerbs including necessary accessories of kerb like all varieties/ shapes of kerbs (i.e. radius kerbs, corner kerb, quadrant kerbs, drain out kerb, flat kerb, parking edge kerb, ramp kerb or other any type of kerb with any shape as per drawing/design intent etc) as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerb stones.

3.0 Mode of Measurement

The rate shall include the cost of all labour and activities involved in the operations described precast kerb, laying, jointing and finishing the same.

The rate shall be for a unit of one Cum.

Item No. 48
Pre-cast concrete kerb
Providing & fixing minimum M25 grade of customized concrete factory-made precast exposed concrete finish kerb of approved make and as per sample approved of specified sizes, specified shape etc. complete. (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.) Kerb shall have chamfered type/ pencil corner edges. Kerbs shall be fixed on the base PCC with cement mortar 1:2 including flush pointing in CM (1:2) or suitable approved make adhesive for all joints of the kerbstones, curing, etc. complete. The rate shall also include erecting and fixing in position of kerbs as per drawing. Precast kerb shall be protected with good quality plastic sheet for protection against bituminous/ concrete work. The rate shall include the joining, curing, finishing, protection etc complete as directed by the engineer in charge. Actual installed kerb length shall be measured in payment.
The rate shall include the cost of base excavation, base PCC M15 grade, joining, curing, protection etc complete as directed by engineer in charge. Rate shall be unit of One Rmt. For the payment kerb length shall be considered. (Sample must be approved). Sample and Mock-up shall be carried out as suggested by the Architect and as directed by the Engineer in charge. Sample and mock shall not be payable if rejected.
a) Type A Kerb of size 600mm L x 150mm B x 300mm H
b) Type B Kerb of size 600mm L x 150mm B x 375mm HT x 150mm TH
c) Type C Kerb of size 600mm L x 300mm B x 150mm H

1.0 Material

M25 minimum grade of customized concrete factory-made precast exposed concrete finish Precast kerb shall be of approved make and as per approved sample. Shape and size of kerb shall be as per design. (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.)

2.0 Workmanship

All Precast members shall be customized concrete factory made. Sufficient curing shall be done before placement of the same.
The method of transporting and placing the precast members shall be as approved by the Architect and Engineer-in-charge. Members shall be so transported that no breakage or undue stresses are induced in them.

The pits of required size shall first be excavated, true to line and level. The specifications for excavation shall be followed as per relevant item.

The pits shall be filled with a layer of 0.15 M thick concrete M15. The kerbs shall be laid on existing PCC base in true line and plumb. The specifications for PCC work shall be followed as per relevant item.

The rate shall also include for erecting and fixing the pieces in position, transporting from store to site, loading, unloading, cleaning and jointing for complete Kerb systems with Chamfered type of kerbs including necessary accessories of kerb like all varieties/ shapes of kerbs (i.e. radius kerbs, corner kerb, quadrant kerbs, drain out kerb, flat kerb, parking edge kerb, ramp kerb or other any type of kerb with any shape as per drawing/design intent etc) as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerb stones.

3.0 Mode of Measurement

The rate shall include the cost of all labour and activities involved in the operations described precast kerb, laying, jointing and finishing the same.

The rate shall be for a unit of one Rmt.

Item No. 49
MS Cylindrical Bollard/ delineators
Providing and placing in position MS Bollard / delineators of any size, any shape, in required thickness as per drawing (factory made). Bollard/delineators shall be made of MS section with base plate and bolts. Bollard/delineators shall be finished with two or more coats of PU paint (min 60 DFT) of approved make and shade over two coat of anti-corrosive epoxy base primer, as per manufacturer's specification. Retro reflective strips of approved make shall be fixed on bollard/delineators after painting work as per drawing.
Bollard /delineators shall be fixed on concrete base with required anchor fastener, bolts, other accessories etc with required civil work.
Rate shall be inclusive of all material (MS work, PU paint, reflective tape, fastener, accessories etc) but excluding the cost of required civil work (i.e. excavation, filling, concrete base etc) as suggested by Engineer in charge.

1.0 Material & Workmanship

1.1 Prior to fabrication, all tubular/ rolled sections/ plates shall be cold straightened and freed from twists, wraps etc. Hot working shall be done only after prior permission of the Engineer-in-charge. The surface of the members to be welded shall even so that temporary fastening alignment shall not allow passage of a 0.2 mm thick filler gauge more than 20mm. deep from the member's edge. All members shall be cut mechanically by saw or shear or by oxyacetylene flame.

1.2 Welding shall generally be done by electric process. Gas welding shall be restored to using oxyacetylene flame with specific approval. Gas welding shall not be permitted for structural steel work.

1.3 The work shall be done as shown in the shop drawings which shall clearly indicate various details of the joints to be welded; shop and site welded as well as type of electrodes to be used. Symbol for welding on plans and shop drawing shall be according to I.S. 813-1961. As far as possible every effort shall be made to limit the welding that must be done after improper welding that is likely to be done due to heights and difficult position on scaffolding etc.
The welding work shall conform to I.S. 816-1969.

1.4 **Preparation of surface**
Surfaces, which are to be welded together, shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

1.5 **Assembly for welding**
Before welding is commenced, the plates shall be first be brought together and firmly clamped or spot welded at specified distance. The temporary connection in form of tack welding has to be strong enough to hold the plates accurately in place without displacement and shall be done keeping in view the finished dimensions of the structure.

1.6 **Precautions**
The operations connected with welding and cutting equipment shall conform to safety requirement given in I.S. 818-1968.

The following points shall be borne in mind during the process of welding:
(a) Welds shall be made in flat position wherever practicable.
(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.
(c) The segments of welding shall be such that where possible, the members which offer the greatest resistance to compression are welded first.
(d) Proper care shall be taken while welding, for shrinkage and distortions, as the drawing dimensions are the finished dimensions of the structure.

1.7 The defective welds which shall be considered harmful to the strength shall cut out and rewelded.

1.8 Finished welds and adjacent part shall be protected with clean boiled linseed oil and after all stag has been removed welds and adjacent parts shall be painted after the same are approved.

1.9 All the members shall be thoroughly cleaned of rust, cakes, dust etc. and given a priming coat with epoxy primer before fixing them in position. All fabricated members shall be suitably packed to be protected from any damage while transportation, if any.

1.10 Grinding to the finished level is to be done, if directed by the Architects and Engineer in charge. All exposed welds shall be ground smooth. Welds which have not been ground shall be scrubbed with a 10% solution of Hydrochloric acid which shall be washed off with water before painting unless alkali resistant paint is used.

1.11 Erection in general, of the entire/part structure shall be carried out as per the requirement and approval of the Engineer-in-charge. Positioning and leveling of the structure, alignment and plumbing and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Engineer-in-charge. The following checking and inspection shall be carried out before, during and after erection:
- Damages during transportation
- Accuracy of alignment of structures
- Erection according to drawings and relevant specifications
- Progress and workmanship

1.12 After total erection, two or more coats of PU paint (min 60 DFT) of approved make and shade over two coat of anti-corrosive epoxy base primer, as per manufacturer's specification.
Retro reflective strips of approved make shall be fixed on bollard/delineators after painting work as per drawing.

2.0 Mode of Measurement

2.1 (a) All work shall be measured on the basis of finished dimensions, as fixed on site and measured net unless specified otherwise.
(b) The weight of steel sections, steel strips in finished works shall be calculated from standard weight on the same basis on which steel is supplied to the Contractor by the Client or those given in relevant IS Codes, if steel is arranged by the contractor.
(c) The weight of steel plates and strips shall be taken from relevant IS Codes, based on 7.85 kg/m² for every mm. sheet thickness, if steel is supplied by the Contractor, otherwise, the weight shall be calculated on the basis on which steel is supplied to the Contractor by the Client.
(d) Unless otherwise specified weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance

pieces, separators, diaphragm gusset (taking over all square dimension) fish plates etc. shall be added to the weight of respective items.

(e) In riveted work, allowance shall be made for weight of rivet heads. No deductions shall be made for rivet or bolt holes excluding holes for anchor or holding down bolts.

(f) For forged steel and steel castings, weight shall be calculated on the basis of 7850 kg/m3.

(g) Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structure.

(h) Dimensions other than cross sections and thickness of plates shall be measured to nearest 0.001 m.

(i) Mill tolerance shall be ignored when weight is determined by calculation.

2.2 The rate includes cost of all material, labour, erection, hoisting, painting, scaffolding, safety measures and sundry required for proper completion of the item of work, at all heights. This shall also include conveyance and delivery, handling, loading, unloading, and storing etc. required for completion the item described above including necessary wastage involved. Bollard shall be fixed on concrete base with required anchor fastener, bolts, other accessories etc but excluding the cost of required civil work (i.e. excavation, filling, concrete base etc) as suggested by Engineer in charge.

2.3 Only standard sectional weight will be considered, and welding will not be considered in weight.

The rate shall be for a unit of one **Kg**.

Item No. 50
Flexible/ Spring Post
Providing and fixing in position flexible/ spring post of approximately size of 80 mm dia., base 200 mm dia. and height 900 mm with 75 mm wide retro reflective strips of 3 nos. and any colour, any shape etc. complete as per design intent. The post shall be made of high-impact resistant polyurethane with strong and resistant against crashes and shocks as per manufacturer's specification for approved make and as directed by Engineer in charge and architect. The flexible spring post fixed on bituminous/ concrete base with required anchor fastener, bolts, other accessories etc. complete fixed can be bolted/fastener/ anchor to the floor using the base. The post of high-quality UV-stabilized polyurethane, designed to provide durable, high-visibility lane segregation and to withstand repeated vehicle impacts while returning to its original upright position.
The rate shall be inclusive of flexible post (as per the approved sample), fixed with anchor bolts and epoxy adhesive, all labour, arranging in position, loading, transportation, unloading, etc complete as directed by Engineer in charge. The contractor shall arrange loose samples for approval from the Engineer-in-Charge before mass execution.

1.0 Material & Workmanship

Flexible/ spring post of approximately size of 80 mm dia., base 200 mm dia. and height 900 mm with 75 mm wide retro reflective strips of 3 nos. and any colour, any shape etc. complete as per design intent. Relevant specifications shall be followed as per item description and as directed by engineer in charge.

2.0 Mode of Measurement

The rate shall be inclusive of flexible post (as per the approved sample), fixed with anchor bolts and epoxy adhesive, all labour, arranging in position, loading, transportation, unloading, etc complete as directed by Engineer in charge. The contractor shall arrange loose samples for approval from the Engineer-in-Charge before mass execution.

Sample shall be approved by Architect and Engineer in charge before mass production. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

The rate shall be for a unit of one No.

Item No. 51
Pre cast Cylindrical Bollard
Providing, hoisting, and arranging in position exposed concrete finish, factory made pre-cast bollard of approximately size 800mm high and 280mm Dia as per design intent, of approved make, made of minimum M-30 grade reinforced cement concrete. (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.)
The rate shall also include for erecting and fixing the bollard in position as per drawing, curing, finishing, cost of excavation, base PCC M15 grade and finish good, rendering (if required), transportation, loading and unloading charges, etc complete as directed by Engineer in charge. Precast bollard shall be with provision with MS Hook & fixing safety chain between two bollard. Weight of hook and chain shall be paid in relevant tender items.
Contractor shall submit methodology for erection of bollard and get approved from Engineer in charge. Location and type of each lifting hook shall be as per design intent and approved from engineer in charge.
Sample shall be approved by Architect and Engineer in charge before mass production. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

Relevant specifications shall be followed as per reinforced concrete work for precast bollard of minimum M30 grade concrete as per drawing.

The rate shall also include for erecting and fixing the bollard in position as per drawing, curing, finishing, cost of excavation, base PCC M15 grade and finish good, rendering (if required), transportation, loading and unloading charges, etc complete as directed by Engineer in charge. Precast bollard shall be with provision with MS Hook & fixing safety chain between two bollard. Weight of hook and chain shall be paid in relevant tender items.

The rate includes transportation for all lead and lift, hoisting by any means, placing in position.

Contractor shall submit methodology for erection of bollard and get approved from Engineer in charge. Location and type of each lifting hook shall be as per design intent and approved from engineer in charge.
Sample shall be approved by Architect and Engineer in charge before mass production. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

The rate shall be for a unit of one No.

Item No. 52
Precast Bench
Providing, hoisting, stacking and arranging in position Precast Bench of size 1500mm x 450mm x 380mm as per drawing, Contractor shall submit methodology for erection of precast bench and get approved from Engineer in charge. Installed precast bench shall not have any damages. (exposed concrete finish of precast element shall be up to the satisfaction of the engineer in charge & Architect.)
Sample shall be approved by Architect and Engineer in charge before mass production. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

1.0 Material & Workmanship

Relevant specifications as per reinforced concrete work shall be followed except the item will be executed for precast element.

The method of transporting and placing the precast members shall be as approved by the Engineer-in-charge. Members shall be so transported that no breakage or undue stresses are induced in them.

All members shall have a key provided on both the faces i.e. top and bottom surfaces, of adequate size so as to fill the same with concrete while laying. The function of this key is to avoid the leakage through the joint between the precast member and the member on which it is laid.

While fixing the precast member, the key provided in the member shall be filled with ordinary cement concrete made of same proportion as that of the member except that grit shall be used instead of stone aggregate. Except for the key, cement mortar of proportion 1:1 (1 cement: 1 sand) shall be spread over the surface on which the member is to be laid. The mortar shall be of dry consistency as is possible to use. The member and the surface shall be thoroughly cleaned before placement, and both shall be kept moist for a sufficient period after placement.

Rendering exposed surface for the exposed RCC precast elements shall be carried out and the rate for the same shall be included in this item.

Sample shall be approved by Architect and Engineer in charge before mass production. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

2.0 Mode of Measurement

Rate shall be inclusive of RCC, shuttering, reinforcement, rendering for exposed surface and all labour required for complete execution as per item description.

The rate shall be for a unit of one No.

Item No. 53
Terrazzo
Providing, applying and polishing of self levelling type factory premixed Terrazzo for Horizontal, Vertical, incliend, or any shape with all exposed rounding edge or similar location, 10 to 12 mm thick in approved base colour and with selected and approved coloured natural stone aggregates including densification and sealing as per following :
1) Surface preparation - surface shall be without any pot holes, cracks or any other defects, if any found, proper repair work shall be carried out i.e. grouting etc. Surface shall be in proper level.
2) provision of Aluminium divider Strips for joints as required
3) Primer application as per manufacturer's specification. If required, cement mortar 1:4 (1 cement : 4 coarse sand) to be applied before application of terrazo.
4) Application of terrazzo ready-mix in required thickness in proper level and with provision of groove
5) Proper curing as per manufacturer's specification
6) Use of suitable Terrazzo Grout of matching colour as the terrazzo and densifier as per manufacturer's specification
7) Carrying out the polishing on the terrazzo, to provide mirror polish finish, as per the sample approved and as per manufacturer's specification.
8) application of water resistant non film forming sealer of same manufacturer as terrazzo pre mix, as a sealer for the polished surface.
9) Manufacturers application method is required at each stage to get desired finish.
10) Cleaning off and protection after each stage of works as required.
The contractor shall submit construction methodology for the confirmation of engineer in charge. Terrazzo applied area shall be measured for payment.
Loose sample for material and required number of mock-up for terrazzo work to be prepared by contractor and got approved from architects prior to mass execution works. Architect

reserves right to reject part or all work of sub standard or not in confirmation to sample approved as per mock up.

1.0 Material

1.1 Natural Stone Chips

1.1.1 Natural Stone Chips shall conform to the relevant material specifications.

1.2 Cement Concrete

1.2.1 CPWD specifications clause no. 11.2.1 shall be followed.

2.0 Workmanship

2.1 CPWD Specification clause no. 11.6.1, 11.6.2, 11.6.3, 11.6.4 shall be followed.

3.0 Mode of Measurement and Payment

3.1 CPWD Specification clause no. 11.6.5.1 shall be followed. The rate also includes the cost of borders, margins and similar bends up to 30 cm width and on staircase treads & risers, skirting, seating bench, coping, coving, flooring in narrow bands etc. complete.

3.2 The rate shall include the cost of base concrete (under layer) and cost of providing and fixing strips of 5 mm thick glass used for making panels.

3.3 The rate shall be for unit of Sqm.

Item No. 54

Precast elements for misc. items

Providing, hoisting and fixing exposed concrete finish Precast Concrete of minimum M 25 grade in light pole cover, base of dustbin, duct covers, manhole covers, saucer drain, coping etc. (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.) including cost of required centring and shuttering and arranging precast members in position with required joining arrangement, MS stud or anchor/bolting with grouting etc complete all material, loading, transportation, unloading, tools, tackles, scaffolding, machinery, equipment, for all level, for all height/ depth, and as per direction of Engineer-in-Charge. Contractor shall provide loosed sample of each elements at location suggested by engineer incharge for review and approval from Engineer in charge before mass production/ execution. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Contractor shall prepare coordinated shop drawing for all elements with all members including all services/other allied civil works provision and get approval from Architect and engineer in charge.

If required, excavation and base preparation work shall be paid in relavent tender items.

Actual volume of installed precast elements shall be measured for payment. Sample and mock shall not be payable if rejected or casted in other location (not in scope of work area).

Material and Workmanship:-

Providing, hoisting, and fixing precast concrete elements of minimum M 25 grade for various items including light pole cover, base of dustbin, saucer drain, coping etc.

The precast elements should have a exposed concrete finish and meet the specified grade (M 25). (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.)
The contractor must provide loose samples of each element for review and approval by the Engineer-in-Charge before mass production.

Contractor shall provide loosed sample of each elements at location suggested by engineer in charge for review and approval from Engineer in charge before mass production / execution. Architect reserves right to reject part or all work of sub standard or not in confirmation to approved sample as per mock up. Contractor shall prepare coordinated shop drawing for all elements with all members

including all services/other allied civil works provision and get approval from Architect and engineer in charge. Shop drawings to be approved by both the Architect and Engineer-in-Charge.

Measurement and Payment
Actual volume of installed precast elements shall be measured for payment.

Samples and mock-ups shall not be payable if rejected or casted in other locations not within the scope of work area.

Rate shall be including all materials, loading, transportation, unloading, tools, tackles, scaffolding, machinery, equipment, etc., required for the installation of precast elements at all levels and heights/depths as directed by the Engineer-in-Charge.

The rate shall be for a unit of one Cum.

Item No. 55
FRP Recessed Manhole cover
Providing and Fixing heavy duty double seal FRP recessed Manhole cover with frame of 12.5MT capacity, in matching shade of surrounding pavement and design according to EN - 124:1994 of approved make and shade having clear opening size of 600mm x 600mm and recesse depth upto 80mm with client's logo etc. complete for all lead and lift. Cover shall be with 4 number lifting key with proper lifting arrangement. Frame shall be embedded in concrete of required grade and top level of frame shall be flush with road/surrounding level as per drawing and as directed by Engineer in charge. Rate shall be inclusive of cover frame and concrete work for fixing the frame. Sample and mock-up shall be approved by architect before execution.

1.0 Material & Workmanship
Heavy duty FRP frame and cover shall be of approved make. Relevant specifications shall be followed as per item description and as directed by engineer in charge. Sample shall be approved by Architect before execution of work.

2.0 Mode of Measurement
The rate shall be for a unit of one No.

Item No. 56
Recessed manhole cover
Providing and fixing recessed manhole cover having capacity of 40T made with corrosion resistant metal (GI) with clear opening 600mm x 600mm. Recessed manhole cover shall be with frame and double seal system. Recessed manhole cover shall be with four side lifting arrangement with minimal dimensions and two lifting keys. The cover shall be with proper drainage arrangement, if cover to be used for softscape/ lawn area. Recess depth shall be as per adjoining development material and as per approved shop drawing. The contractor shall submit a shop drawing of cover with test certificate. Cover shall be installed in proper level as per adjoining surfaces.

1.0 Material & Workmanship
The GI recessed manhole shall be of approved make, specified size, depth, finish, material, capacity, opening system, etc.

Recessed manhole cover shall be with frame and double seal system. Recessed manhole cover shall be with four side lifting arrangement with minimal dimensions and two lifting keys. The cover shall be with proper drainage arrangement if cover to be used for softscape/ lawn area. Recess depth shall be as per adjoining development material and as per approved shop drawing. The contractor shall submit a shop drawing of cover with test certificate.

Frame of manhole cover shall be fixed with cement concrete/ cement mortar on manhole slab/ concrete wall of manhole as per manufacturer's recommendation. Cover shall be installed in proper level as per adjoining surfaces.

Sample shall be approved by Architect before execution of work.

2.0 Mode of Measurement

The rate shall be for a unit of one No.

Item No. 57

Precast Perforated Drain Cover

Providing and placing in position factory made exposed concrete finish Precast RCC frame & perforated cover on drains of size 600mm x 600mm x 100mm of approved make of footpath of various sizes, of M-25 grade cement concrete for RCC work, including cost of moulding, reinforcement, rendering, etc i.e. cost of transportation for all leads & lift, handling at site etc. all complete (finish of precast element shall be upto the satisfaction of the engineer in charge & Architect.) as per direction of Engineer-in-Charge. Sample and mockup shall be approved by Architect before execution.

1.0 Material & Workmanship

Relevant specification shall be followed as per item description and as per reinforce cement concrete work.
Solid Precast RCC frame & perforated cover on drains shall be of approved make and per approved sample.

2.0 Mode of Measurement

The rate shall be for a unit of one No.

Item No. 58 & 59

Providing and fixing FRC Heavy Duty (HD35) Man hole cover with frame 600mm x 600mm or 600mm dia clear opening with 100 x 2mm MS flat all-round, 16mm ø plain round bar for lifting the cover & shall be fitted with plastic cups. On the upper periphery of frame 25 x 3 mm wide MS flat with hot dip galvanizing shall be well embed in concrete to protect the edges of frame. Frame shall be fixed with cement mortar or cement concrete as per site condition, as per drawing and as directed by Engineer in charge. Sample shall be approved before execution.

AND

Providing and fixing FRC Heavy Duty (HD35) Man hole cover with frame 900mm x 900mm or 900mm dia clear opening with 100 x 2mm MS flat all-round, 16mm ø plain round bar for lifting the cover & shall be fitted with plastic cups. On the upper periphery of frame 25 x 3 mm wide MS flat with hot dip galvanizing shall be well embed in concrete to protect the edges of frame. Frame shall be fixed with cement mortar or cement concrete as per site condition, as per drawing and as directed by Engineer in charge. Sample shall be approved before execution.

Heavy duty Frame and Cover suitable for Clear opening of MH

Precast RCC Manhole Frame & cover shall be as per IS: 12592 (part – I & II). The M.H. Frame & Cover shall be of Heavy duty of Grade designation HD- 35 – Rectangular/ circular in shape with clear opening of Manhole.

Materials such as cement, aggregate, water, reinforcement shall be of standard as prescribed in the material part. Other materials to be used for Frame & Cover shall be as under:

Concrete

The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing, etc. (IS: 456 – 1978). The minimum cement content in the concrete shall be 360 Kg/m3 with a maximum water content ratio of 0.45. Concrete weaker than grade M 20 shall not be used. Compaction of concrete shall be done by table machine vibration.

Steel Fibers

The diameter/equivalent diameter of steel fibers shall not be greater than 0.75 mm. The aspect ratio of the fibers shall be in the range of 50 to 80. The minimum volume of fibers, where used, shall be 0.5 percent of the volume of the concrete.

Additives or Admixtures

Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used for covers may be:

a) Accelerating, water-reducing and air-entertaining admixtures confirming to IS: 9103-1979.
b) Colouring pigments
c) Fly ash confirming to IS: 3812-1981
d) Water proofing agents conforming to IS: 2645-1975.

Dimensions and Tolerances

Length, breadth and diameter of precast concrete manhole covers shall be such that the maximum clearance at top between the cover & frame of corresponding grade and shape shall be 5 mm. The minimum thickness of heavy duty precast manhole cover shall be 70 mm. The top surface of frame & cover is in level within a tolerance of ± 5 mm. Placing of reinforcement, compaction of concrete & curing shall be attended as per IS: 12592. Edge Protection & Finishing shall be provided as per relevant IS.

Physical requirements

All the frame & covers shall be sound and shall be free from cracks & other defects, which interferes with the proper placing of the units or impair the strength or performance of the units. Minor chippings resulting from the customary methods of handling and transportation shall not be deemed ground for rejection.

Marking

Each Cover shall have following marking:
Date of manufacture
Grade Designation
ISI mark
GWSSB - Identification mark

Sample shall be approved before execution.

Frame & covers will be tested at factory by owner / consultant & accepted goods shall be procured on site of work.
Sample shall be approved before execution.

The rate shall be paid on number basis for set of Frame & Cover.

Item No. 60
Hume pipe for Tree Pit
Providing and fixing RCC NP3 class hume pipe of 750mm internal dia. and required length in single piece or two circular half for tree pit shall be placed in excavated pit as per drawing and as directed by engineer in charge. Rate shall be inclusive of material, labour for cutting, excavation, placing in position etc complete. After Execution of Tree pit, If it is filled with debries or C&D waste due to any reason, It shall be removed without any extra cost before filling garden soil in tree pit. Tree pit shall be filled with garden soil only however garden soil filling shall be paid in relevant tender item.

1.0 Material :

1.1 The material shall be of standard specifications and shall be approved make.

2.0 Workmanship:

2.1 Hume pipe shall be of required length and cut in two halves as per drawing.
2.2 The pit prepared shall be cleared of all the debris, roots and other deleterious materials attaining the natural earth level sufficient for the growth of the trees.
2.3 The Bottom 600 mm depth of the pit shall be filled up with natural good quality garden earth as approved by Engineer- In –Charge.
2.4 The filling shall be properly compacted.
2.5 In the remaining 750 mm proper NP3 class Hume pipe shall be erected.
2.6 The pipe shall be factory made of 750 mm dia such that both the faces are finished.
2.7 No piece pipes broken from full length pipes shall be used for this purpose.
2.8 The Hume pipe shall be secured into position by filling the sides with good quality earth and proper ramming.
2.9 The inside of Hume pipe shall be filled with garden earth along with Farmyard manure and required fertilizers etc. as directed by Engineer-In-Charge.
2.10 The rate shall be for per Rmt. of Tree pit prepared.

Item No. 61
Supplying and fixing Cat Eye (Stimsonite) made out from Acrilo beautile sterine injuction high compressed molding with reflector made of MMC (prismatic type of size 12cm x 6cm x 2.5cm) with each unit for foxing. (High intensity grade).

1.0 Material & Workmanship

Relevant specifications given for sign boards as described in MORTH 5th revision Section 804 shall be applicable to this item.

2.0 Mode of Measurement

The rate shall be for a unit of one No.

Item No. 62
Providing and applying 2.5 mm thick road marking strips (retro reflective) or graphic/ letter/ arrows etc of specified shade/ colour using hot thermoplastic material by fully/ semi automatic thermoplastic paint applicator machine fitted with profile shoe, glass beads dispenser, propane tank heater and profile shoe heater, driven by experienced operator on concrete/ tar road surface including cost of material, labour, T&P, cleaning the road surface of all dirt, seals, oil, grease and foreign material etc. complete as per direction of Engineer-in-charge and accordance with applicable specifications.

1.0 Material & Workmanship

Hot applied Thermoplastic compound shall have approved make and any approved shade. The

colour width and layout of road makings shall be in accordance with the Code of Practice for Road Markings with thermoplastic paints and as specified in the drawings or as directed by the Engineer-in-Charge.

The relevant specifications given in Section – 803 of MORTH fifth revision specification shall apply to this item.

2.0 Mode of Measurement

The painted markings shall be **measured in sq. meters** of actual area marked (excluding the gaps, if any) correct up to the two places of decimal.

The rate includes of reflectorizing glass beads at 250 gm/sqm area. Thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC 35. The finished surface shall be level uniform free from streaks and holes and as per direction of engineer in charge.

Item No. 63

ACP sheet signage on Existing Pole/ New Pole for Vehicular Direction Signages:

Providing, making and fixing 4 mm thick ACP sign of any shape and size and of approved make to be cut on CNC router cutting and smoothen all corners and edges. Matter shall be cut in 3M High intensity prismatic Reflective vinyl ASTM Type 4 and paste on it as per design and detail and as per manufacturer's specifications. UV stabilized lamination (exterior grade) shall be done on it. The ACP sheet shall be fixed with clamp and angle on new or any type of Pole as per drawing. Content of sign shall be letters (in any language), number, graphics/ maps, signs, arrows, etc. in any colour as per design, drawing and approved by Architect and Engineer. All side of box shall be covered with ACP sheet, but only one side elevation area shall be measured and paid in sqm. Cost of MS Pole, MS framing and civil works shall be paid as per relevant tender items. The rate shall also include cost of scaffolding, drilling, fabrication, finishing, adhesive material, back and sides plain cap sheet, fixing charges, etc at all height and all lead. The contractor shall submit the drawings with as per concept design and do the sampling and get it approved before execution.

1.0 Materials:

Material shall be as per item description and material specifications of approved make. Contractor shall get ACP sheet and reflective vinyl approved before procurement. The sign board and matter of sign board should be as per drawing.

ACP sheet – 4mm thick, approved shade, bubble free, cutting with CNC cutter in any shape and size as per drawing.

Reflective vinyl – of 3M for matter, letter, graphic pasting as per design.

The sign board and matter of sign board should be as per drawing.

2.0 Workmanship:

Module of signage shall be fixed on new or existing pole or column as per drawing. Workmanship shall be of best quality as described and approved by Engineer and Architect. Relevant manufacturer's specifications shall be followed.

3.0 Mode of Measurements and Payment:

The item shall be measured and paid for a unit of Sqm. of only one side elevation area of the sheet. Rate shall be inclusive of all labour, material, and scaffolding, fixing, drilling, fabrication, screws, studs, fasteners/ adhesive materials and finishing for all height but exclusive of the cost of structural steel work.

The rate shall be for unit of Sqm.

Item No. 64
Vinyl Stickers:
Providing, Cutting & pasting of vinyl stickers of approved make and shade with digitally printed graphic/ letter as per design and as directed by engineer in charge. Pasting of vinyl must be accurate as per the design on the approved size ACP without any kind of bubbles. The rate shall also include cost of scaffolding, drilling, fabrication, finishing, adhesive material etc at all height and all lead. Only out to out area elevation of vinyl stickers shall be measured and paid in sqmt. The contractor should submit the drawings based on concept design and do the sampling and get it approval before execution.

1.0 Materials :
Material shall be as per item description and material specifications of approved make. Contractor shall approve reflective vinyl before procurement.
The sign board and matter of sign board should be as per drawing.
Reflective vinyl – of 3M for matter, letter, graphic pasting as per design of approved shade, bubble free, of any shape and size as per drawing.
The sign board and matter of sign board should be as per drawing.

2.0 Workmanship:
Reflective vinyl shall be paste on any existing surface as per drawing. It shall be bubble free.
Workmanship shall be of best quality as described and directed by EIC.

3.0 Mode of Measurements and Payment:
The item shall be measured and paid for a unit of Sqm.
Only out to out area elevation of vinyl stickers shall be measured and paid in sqmt..
Rate shall be inclusive of all labour, material, and scaffolding, fixing and finishing for all height all level.

Item No. 65
SS Plate Signs:
Providing Making and fixing SS plate signs on 2mm thick ISI Brushed S.S. Grade 304 plate with acid etching and duco painting. All plates will be made in CNC Water Jet Cutting, with all edges smoothen and all corner to be cute round. Acid etching should be done 0.3mm deep and Use ICI duco paint for colour infill of approved colour. The letters of made of Vinyl stickers. The font colour shall be of as per drawing and specified by Architect. The plate will be fixed on wall with the stud/ fastener/ adhesive tape of 3M, jointing sealant as per design as per specification and approved by Architect or Engineer in charge. The rate shall be inclusive of scaffolding, drilling, fasteners/ adhesive material etc. at all heights as directed by engineer in charge. Only elevation area shall be measured and paid. The rate shall also include cost of scaffolding, drilling, fabrication, finishing, adhesive material etc at all height and all lead. The contractor should submit the drawings based on concept design and do the sampling and get it approval before execution.

1.0 Materials:
Material shall be as per item description and material specifications of approved make. Contractor shall get SS sheet and duco paint/ acid etching approved before procurement. The sign board and matter of sign board should be as per drawing.

SS Plate shall be of SS 304 grade – 2mm thick, approved shade, cutting with CNC cutter in any shape and size as per drawing.
Acid etching should be done 0.3mm deep and ICI duco paint shall be used for colour infill of approved colour.
The sign board and matter of sign board should be as per drawing.

2.0 Workmanship:

Module of signage shall be fixed on walls, doors, etc. as per drawing. Workmanship shall be of best quality as described and approved by Engineer and Architect.
The contractor should submit the drawings based on concept design and do the sampling and get it approval before execution

3.0 Mode of Measurements and Payment:

The rate shall be inclusive of scaffolding, drilling, fasteners/ adhesive material etc. at all heights as directed by engineer in charge.
Only elevation area shall be measured and paid. The rate shall also include cost of scaffolding, drilling, fabrication, finishing, adhesive material etc at all height and all lead.

Item No. 66
Map Sign:
Providing, making and fixing Modular system signage of approved make system for Direction Signs as per concept drawings. Modular sign using Aluminium extrusions (Alloy 6060) with Anodizing (Thickness 15-20 microns) according to ISO:9001-2008 product with Premium grade Anodizing as per Qualanod and Qualicoat International standards and warranty as per manufacturer's specifications. Sections can be used to create totems upto 6m with variable depths as per requirement. Providing, Making and fixing 4 mm thick ACP sign of any shape and size of Flexi bond or as per approved make to be cut on CNC router cutting and make all corners and edges smooth with matter and graphic as per the concept design and manufacturer's specifications. Protective coating shall be applied over the surface of ACP. The Rate shall include all civil work related to foundation, fixing and ACP with printed matter (both side), protective coating (both side), co-sign profile, finishing good etc. for all height all level. Only one side elevation area shall be measured and paid in sqmt. The contractor should submit the drawings based on concept design and do the sampling and get it approved before mass production. The contractor shall submit the drawings based on concept design and do the sampling and get it approval before execution.

1.0 Materials :

Relevant specification shall be followed as per manufacturer’s specification and as per approved sample and as directed by engineer in charge.

2.0 Mode of Measurements and Payment:

The item shall be measured and paid for a unit of Sqm. of only one side elevation area of ACP sheet.
The Rate shall include all civil work related to foundation, fixing and ACP with printed matter (both side), protective coating (both side), Modular signage profile, finishing good etc. for all height all level.

Item No. 67
Providing, laying and joining ISI Marked (Conforming to IS 458) RCC NP3 Hume pipe of various diameter with socket spigot joint with "O" ring. Rate shall also include freight, taxes, insurance, laying, jointing, testing , as per site condition etc.complete and as instructed by Engineer in charge.
a) 150 mm dia.
b) 300 mm dia.
c) 450 mm dia.
d) 600 mm dia.
e) 750 mm dia.
f) 900 mm dia.
g) 1000 mm dia.
h) 1200 mm dia.

1.1 SCOPE

This specification covers the requirements for manufacturing, testing, supplying, jointing and testing at work sites of Reinforced Cement Concrete (RCC) pipes, of non pressure varieties, sewers and storm water drains. R.C.C. NP3 class pipes are to be used for Storm Water collecting system.

1.2 Applicable Codes

The manufacturing, testing, supplying, jointing and testing at work sites of RCC pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

Materials

IS: 458	Specification for concrete pipes (with and without reinforcement.– latest edition, 2003) (where mentioned it should be latest revised code.)
IS: 3597	Method of tests for concrete pipes.
IS: 5382	Specification for rubber sealing rings for gas mains, water mains & sewers.
IS: 516	Method of test for strength of concrete.

Codes of Practice

IS: 456 - Code of practice for plain and reinforced concrete.

IS: 783 - Code of practice for laying of concrete pipes.

1.3 Design

Design of RCC pipes shall be in accordance with the relevant clauses of IS 458.
The details of reinforcement shall be as per clause 5.2 of IS: 458-2003.
The ends of pipes shall be in accordance with relevant clauses of IS: 458.

1.4 Manufacturing

General

Pipe can be manufactured by spinning process or by vibrated casting process.
The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

The RCC pipes and rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.

Owner representative / Engineer In-Charge shall at all reasonable times have free access to the places where the pipes and collars / rubber rings are manufactured for the purpose of examining and testing the pipes and collars / rubber rings and of witnessing the test and manufacturing.

All tests specified either in this specification or in the relevant Indian Standards shall be performed by Supplier / Contractor at his own cost and in presence of Owner representative / Engineer In-Charge if desired. For this, sufficient notice before testing of the pipes shall be given to Owner representative / Engineer In-Charge.

If the test is found unsatisfactory, Owner representative / Engineer In-Charge may reject any or all pipes of that lot. The decision of Owner representative/ Engineer In-Charge in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

MATERIALS

Cement

Cement used for the manufacture of RCC pipes should be Sulphate Resisting Cement (SRC) only and shall confirm to relevant IS codes.

Aggregates

Aggregates used for the manufacture of RCC pipes shall conform to IS: 383. The maximum size of aggregate should not exceed one-third the thickness of the pipe or 20 mm, whichever is smaller.

Mixing and Curing Water

Water shall be clean, colorless and free from objectionable quantities of organic matter, alkali, acid, salts or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar.

Reinforcement

Reinforcement used for the manufacture of the RCC pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-I) or hard-drawn steel wire conforming to IS: 421 (Part-2). A reinforcement cage for pipes shall be as per relevant requirements of IS: 458.

Concrete

Concrete used for the manufacture of RCC pipes shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458 (Latest Edition). Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

Rubber Ring

Rubber ring chords used in pipe joints shall be EPDM rubber ring as per IS 5382: 1985.

Curing

Pipes manufactured in compliance with IS: 458 (Latest Edition) shall be either water cured or steam cured for minimum stipulated curing period in accordance with relevant requirements of the latest revised IS:458 (Latest Edition).

Dimensions

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes.

Table – 1 PHYSICAL TEST AND DIMENSIONAL REQUIREMENTS FOR STANDARD STRENGTH BELL AND SPIGOT, PERFORATED NONREINFORCED CONCRETE UNDERDRAINAGE PIPE (clauses 4.1, 4.2, 4.3.1, 4.3.2 and fig 1 {IS: 7319 - 1974}**)**

Internal Diameter, D mm	Minimum Thickness of Barrel, T mm	Minimum Laying Length, L m	Inside Diameter at Mouth of socket, D S mm	Depth of Socket, L S mm	Minimum Taper of Socket, H:L S	Minimum Thickness of Socket, TS	Rows of Perforation	Perforation per Row	Length of Slots mm	Spacing of Slots mm	Minimum Strength, kg/m, Three Edge Bearing Method	Maximum Absorption, %
1	2	3	4	5	6	7	8	9	10	11	12	13
80	25	1	130	40	1 : 20		4	9	25	50	-	8
100	25	1	150	40	1 : 20		4	9	25	75	1560	8
150	25	1	210	50	1 : 20		4	9	37.5	75	1560	8
200	25	1	275	57	1 : 20		4	9	50	100	1560	8
225	25	1	305	65	1 : 20	¾ T	6	10	50	100	1670	8
250	25	1	330	65	1 : 20		6	10	50	100	1670	8

300	30	1	390	65	1 : 20	all sizes	6	10	75	150	1790	8
350	32	1	475	65	1 : 20		6	10	75	150	1880	8
400	32	1	525	65	1 : 20		8	10	75	150	2020	8
450	35	1	565	70	1 : 20		8	10	75	150	2230	8

Note:
Shorter lengths may be used for closures and specials.
When pipes are furnished having an increase in thickness over that given in col. 2, then the diameter at the inside of the socket shall be increased by an amount equal to twice the increase of the barrel.

This measurement TS shall be taken 6 mm from the outer end of the socket. For laying lengths greater than 1 m, the perforations per row shall be in increased to provide a spacing of approximately 75 mm.

Table – 2 Design and Strength Test Requirements of Concrete Pipes of Class NP3 Reinforced Concrete, Medium Duty, Non-Pressure Pipes

Internal Diameter of Pipes in mm	**Barrel Wall Thickness**	**Reinforcements**			**Strength Test Requirements for Three Edge Bearing Test**	
		Longitudinal, Mild Steel or Hard Drawn Steel		**Spirals, Hard Draws Steel**	**Load to Produce 0.25 mm Crack KN/ linear**	**Ultimate Load**
		Minimum number	**Kg/linear meter**	**Kg/linear meter**		**KN/linear meter**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
300	40	8	0.78	1.80	15.50	23.25
400	75	8	0.78	3.30	19.16	28.74
600	85	8 or 6+6	1.18	7.01	28.74	43.11
800	95	8 or 6+6	2.66	13.04	38.32	57.48
900	100	6 + 6	2.66	18.30	43.11	64.67
1000	115	6 + 6	2.66	21.52	47.90	71.85
1200	120	8 + 8	3.55	33.57	57.48	86.22
1400	135	8 + 8	3.55	46.21	67.06	100.60
1600	140	8 + 8	3.55	65.40	76.64	114.96
1800	150	12 + 12	9.36	87.10	86.22	129.33
2000	170	12 + 12	9.36	97.90	95.80	143.70
2200	185	12 + 12	9.36	133.30	105.38	158.07

Note:
If mild steel is used for spiral reinforcement, the weight specified under col.5 shall be increased to 140/125.

The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m. effective length for internal diameter of pipe up to 250 mm and up to 3 m. effective length for higher diameter pipes.

Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col.4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Concrete for pipes shall have a minimum compressive strength of 35 N/mm^2 at 28 days.

Table – 3 Design and Strength Test Requirements of Concrete Pipes of Class NP3 Reinforced Concrete, Medium Duty, Non-Pressure Pipes Made by Vibrated Casting Process

Internal Diameter of Pipes in mm	Minimum Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Draws Steel	Load to Produce 0.25m m Crack KN/linear meter	Ultimate Load KN/linear meter
		Minimum number	Kg/linear meter	Kg/linear meter		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	50	8	0.78	1.53	15.5	23.25
400	60	8	0.78	1.6	19.16	28.74
600	75	8 or 6 +6	1.18	2.2	28.74	43.11
800	95	8 or 6 +6	2.66	6.87	38.32	57.48
900	100	6 + 6	2.66	11.55	43.11	64.67
1000	115	6 + 6	2.66	15.7	47.9	71.85
1200	125	8 + 8	3.55	21.25	57.48	86.22
1400	140	8 + 8	3.55	30	67.06	100.6
1600	165	8 + 8	3.55	50.63	76.64	114.96
1800	180	12 + 12	9.36	64.19	86.22	129.33
2000	190	12 + 12	9.36	83.12	95.8	143.7
2200	210	12 + 12	9.36	105.53	105.4	158.07

Note :
Concrete for pipes shall have a minimum compressive strength of 35 N/mm2 at 28 days

The tolerances regarding overall length, internal diameter of pipes or socket and barrel wall thickness shall be as per relevant clauses of IS: 458.

Workmanship and Finish
Pipes shall be straight and free from cracks except that craze cracks may be permitted.

The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between Owner representative / Engineer In-Charge and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or molding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipes throughout its effective length, tested by means of a rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameter 3 mm for every meter run.

Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.(Latest Edition)

During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by Owner representative /Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Owner representative/Engineer and such cylinders or cubes shall withstand the tests prescribed by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458(Latest Edition) and tests in accordance with the methods described in IS: 3597.

1. Hydrostatic test
2. Three edge bearing test
3. Absorption test.

Note:
Three edge bearing strength to produce 0.25 mm crack in case of special design of pipes shall be as per IS:458:2003.

For Inspection at manufacturing site 24 hrs. access shall be provided to Client's Engineers as well as engineer appointed by PMC/TPI agency. Apart from this Client will establish its own pipe testing facility where pipes will be randomly tested. The cost of transporting the pipe to the testing facility & testing charges shall be borne by the contractor

Sampling and Inspection

In any consignment, all the pipes of it class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this specification shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with column 1 and 2 of Table 22 of IS: 458-2003. (Latest Edition)
Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every 'n' th pipe be selected till the requisite number is obtained 'n' being the integral part of N/n where N is the lot size and 'n' is the sample size.

All the pipes selected, as per clause IS: 458 shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested for tests under clause IS: 458 shall be in accordance with column 4 of Table 15 of IS: 458 (Latest Edition). These pipes shall be selected from pipes that have satisfied the requirements mentioned in clause above.

A lot shall be considered as conforming to the requirements of IS 458 (Latest Edition) of the following conditions are satisfied.

The number of defective pipes (those not satisfying one or more of the requirements for dimensions, finish and deviation from straight) shall not be more than the permissible number given in column 3 of Table 15 of IS: 458 (Latest Edition).

All the pipes tested for various tests as per IS: 458 (Latest Edition) shall satisfy corresponding requirements of the tests. The Contractor shall inform the Engineer-in-Charge about the lot of pipes to be brought at site. The pipe brought as specified in IS code 458 (Latest Edition). From the lot brought on site any one pipe at random will be selected and will be broken and quality of concrete and quantity of steel (reinforcement) will be checked. If any deviation i.e. poor quality of concrete or less steel is found, the whole lot of pipes will be rejected and the Contractor shall remove the same from the site. No payment shall be made for pipe, which is broken for checking and clearing, rejected lot of pipes from the site.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further sample of same size shall be selected and tested for the test or tests in which failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.
Arrangement for inspection, testing & acceptance of pipes, collars/rubber ring at factory will be made by owner. Pipes & collars confirming to I.S. specification and accepted by owner / consultant only shall be transported to site of work.

Marking

The following information shall be clearly marked on each pipe:

1. Internal diameter of pipe.
2. Class of pipe.
3. Date of manufacture, and
4. Name of manufacturer or his registered trademark or both.
5. Name of scheme: Kathlal U/G Drainage Scheme.
6. All pipes and fittings shall be manufactured as per ISI Code.

LAYING & JOINTING

Laying
Before lowering the pipe the trench section shall be got approved from the Engineer in charge.
The contractor shall have to provide and maintain sight rails and bonding rods whenever required till the compilation of work. The pipe shall be laid in reasonably dry condition and under no circumstances they shall rest on slushy bedding.

The pips shall be lowered by means of chain pulley block and tripod stand or with the help of ropes and suitable size of wooden bullies slowly into the trench. They shall be brought to the required level by giving packing with wooden sleeper pieces and ultimately with well consolidated hard murrum must be got approved by the Engineer –in-charge. Under no circumstances pipe shall be allowed to be thrown in to the trenches.

The rubber gasket shall be inserted into the socket in the groove. The spigot end shall be lubricated with good quality of grease. Then the spigot and with gasket shall be supplied in to the socket by means of jack on the other end. The lubricating grease shall be got approved by Engineer in charge by the contractor. The socket ends of all pipes shall face up hill irrespective of the direction of water flow

Reasonable care shall be exercised in loading, transporting and unloading concrete pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined planks or by chain pulley block is recommended.

Jointing of RCC pipes shall be done with SRC cement only and as per the requirements of following specifications and as per the relevant IS. The type of joints shall be as per 'Data Sheet - A'. After jointing extraneous material if any, shall be removed from the inside of the pipe and newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS 5382.

Spigot and Socket Joint (Flexible)

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings as specified in IS-458-2003, shall be used, and the manufacturer's instructions shall be deemed to form a part of these specifications. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

Socket & Spigot NP3 pipe with rubber ring roll on joint for diameter up to 900 mm should be provided as per table 14 of IS 458: 2003. (Latest Edition)

Socket & spigot NP3 pipe with rubber ring confined joint for diameter 1000 mm to 2200 mm should be provided as per Table -17 of IS 458:2003.(Latest Edition)

Cleaning Of Pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by Owner / Engineer In-Charge, contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by Owner / Engineer In-Charge to prevent entry of mud or slit etc.

If as a result of the removal of any obstruction Owner / Engineer In-Charge considers that damages may have been caused to the pipelines, he shall be entitled to order the stretch to be tested immediately. If during such test prove unsatisfactory contractor shall amend the work and carry out such further tests as area required by Owner / Engineer In-Charge.

It shall also be ascertained by Contractor that each stretch from manhole to manhole or the stretch as directed by Engineer In-Charge is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

Testing At Work Site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following specifications and as directed by Owner / Engineer In-Charge. All equipment for testing at work site shall be supplied and erected by contractor and shall be rectified by him to the full satisfaction of Owner / Engineer In-Charge.

The water required for the flow test shall have to be arranged by the contractor at his own cost. The entire section of the pipe line laid by the contractor shall be tested by flow test from manhole to manhole or as directed by Engineer in charge. Any earth, mud, rubbish, dummy walls etc., in the pipeline or manhole be removed and whole pipeline shall be cleaned before testing is given. In side vata etc., be rectified and completed with all respect before given hydraulic test. The water shall be poured in first manhole and it should run smoothly from manhole to manhole upto last manhole without any pounding. There shall not be accumulation of water inside the pipeline. If it accumulates in certain stretch, the laid pipeline shall have to be removed and shall be laid again in gradient as specified. If this being not attended the payment for the same stretch of pipeline shall not be paid and shall be recovered in the final bill. Necessary certificate for cleaning of pipeline in all respects shall be given in writing before hydraulic flow test is given on site by the contractor. Water used for test shall be removed from pipes and should not be released to the excavated trench.

After the joints have thoroughly set and have been checked by Owner/ Engineer and before backfilling the trenches, the entire section of the sewer drain shall be tested for water tightness. The test procedure to be adopted as per Clause 15.5.3 of IS 783 (Code of practice for laying of concrete pipes). As per the codal provision, 6.5% water loss in 24 hours is recommended. The test procedure shall be as follows:

1. Seal one end of the pipe which is to be tested.
2. Fill the water through manhole from one end keeping constant water head of 0.6 m.
3. Keep the pipe line and manhole filled with water for 6 hours.
4. Water head of 0.6 m. should be maintained in manhole prior to start of testing.
5. Keeping constant water head of 0.6 m. by adding water in manhole, water loss should be measured after one hour.
6. If water loss will be more than specified for one hour, the test should be continued for further 6 hours and if it satisfy the required loss / hour, the test is found in order.
7. Even after 6 hour the test is more than required, the test should be continued in multiple of six hours interval till 24 hours.
8. If loss rate after 24 hours satisfy the required loss rate the test is accepted and if it does not fulfil the required loss rate the pipe laying is not accepted. The defective part of the work should be removed and made good without extra cost.

Measurement

All RCC pipes shall be measured accordingly to the work actually done and no allowance will be made for any waste in cutting to the exact length required. The measurement for pipes shall be in running meters nearest to a cm. of length along the centre line of pipe as actually laid at work sites.
The rate for providing, laying and jointing of RCC pipes shall be deemed to include the cost of rubber rings, jointing material, testing and the extra excavation required for ordinary bedding of pipes and also for collars and pipe sockets if any.
Notes:

1. If any damage is caused to the pipeline during the execution of work or while cleaning /testing the pipeline as specified, contractor shall be held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost to the full satisfaction of Owner / Engineer In-Charge.
2. After for testing of pipeline shall be arranged by contractor at his own cost.
3. Pipes shall be brought on site proportionate to the required progress for thirty (30) days only.

DATA SHEET – A

Sr. No.	Item	Specification
1.	Monsoon period.	16th June to 15th September
2.	Width of the trench from invert level of pipe upto the top (Bt) and cross-section of trench.	As per Drawing
3.	Three edge bearing strength to produce 0.25mm crack for, NP3.	As per latest IS Code
4.	Type of joints	Socket Spigot with Rubber ring joint
5.	Proportion of cement mortar for use in jointing of pipes. Cement should be OPC only.	1cement:1 sand
6.	Hydraulic test pressure at factory.	0.7 kg/cm2
7.	Site test pressure	0.15 kg/cm2

Payment: -

The measurement of pipe line is in running meter. Payment will be made on lowering and laying of pipes as per payment schedule after satisfactory hydraulic/ flow test.

Item No. 68
Providing, laying and joining ISI Marked (Conforming to IS 458) RCC NP4 Hume pipe of various diameter with socket spigot joint with "O" ring. Rate shall also include freight, taxes, insurance, laying, jointing, testing , as per site condition etc. complete and as instructed by Engineer in charge.
a) 300 mm dia.
b) 450 mm dia.
c) 600 mm dia.
d) 900 mm dia.
e) 1000 mm dia.
f) 1200 mm dia.

Relative specification will be followed as per item no 66.0 except NP4 pipe will be used instead of NP3 and above-mentioned size will be followed.

Item No. 69
Providing and fixing FRP steps of size 500 mm x 150 mm x 25 mm including fixing in manholes with cement concrete block or grouting, curing etc complete as per design and as directed by Engineer in charge.

FRP steps shall be as per approved sample of size 500mm x 150mm x 25mm.

FRP steps shall be fixed in manhole with cement concrete or grouting in concrete wall as per site condition and as directed by Engineer in charge.

The rate shall be for unit of Number.

Item No. 70
Tree pit cover
Providing and fixing tree pit cover around the tree pit, made of FRP Tree pit cover block shall be in two/four halve of size - 1.0 to 1.2 Mt dia including casting the cover in pattern and cut outs as per drawing and as per architect in charge, transporting, fixing etc. complete as directed by Engineer in charge. The rate shall also include for erecting and fixing the pieces in position as shown in the drawing with necessary equipments without any damage.
(Sample shall be prepared by contractor for approval of architect before mass execution)

Tree pit cover shall be as per drawing and as per approved sample.

The rate shall be for unit of No.

DISMANTLING WORKS

Note: -
1) The method of demolition work shall be approved by the Engineer-in-charge before execution of work.
2) Demolition work shall be carried out by any means and as per approved method without damaging adjoining elements/ building and any building/ campus property.
3) The rate includes all necessary machinery, labour, tools, and tackles for the dismantling of specified elements in any condition, by any means, etc. complete as directed by the Engineer-in-charge including disposing of serviceable material within the campus and unserviceable material outside the campus for all lead and lift at the non-objectional place as directed by Engineer-in-charge.

1.0. Workmanship

1.1. The demolition shall consist of demolition of one or more parts of the building as specified or shown in the drawings. Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawings.

1.2. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property, which is to be left intact, before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining property.

1.3. Dismantling shall be commenced in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roof, masonry etc. shall be carefully dismantled first. The dismantled articles shall be properly stacked as directed.

1.4. All materials obtained from demolition shall be the property of Client unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.

1.5. Any serviceable materials, obtained during dismantling or demolition shall be separated out and stacked properly as directed with all lead and lift. All unserviceable materials, rubbish etc., shall be stacked as directed by the Engineer-in-charge.

1.6. On completion of work, the site shall be cleared of all debris rubbish and cleaned as directed.

2.0. Mode of measurements and payment

2.1. Measurements of all work except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed. Specification for deduction for voids, openings etc. shall be on same basis as that employed for construction of work.

2.2. All work shall be measured in decimal system as fixed in its place subject to the following limits; unless otherwise stated hereinafter: (a) Dimensions shall be measured to the nearest 0.01 mt. (b) Area shall be worked out to the nearest 0.01 sqm. (c) Cubical contents shall be worked out to the nearest 0.01 cum.

2.3. The rate shall include cost of all labour involved and tools used in demolishing and dismantling including scaffolding.

2.4. The rate shall also include the charges for disposing the unserviceable materials with all lead and lift.

2.5. The rate also includes for temporary shoring for the safety of the portion not required to be pulled down or of adjoining property arid providing temporary enclosures or portions where considered necessary.

2.6 Unit for measurement shall be as per respective items description.

MISCELLANEOUS WORK

Item No. 79
Core cutting:
Providing and wet drilling accurate and clean holes of specified diameter in RCC walls, slabs, beam or any other RCC member without vibration by core cutting (diamond drilling) machine of approved make for laying service lines including scaffolding, safety majors, disposing the debris, cleaning, making good, providing epoxy mortar/ micro concrete/ patch repair mortar for concrete for grouting the gaps around the pipes for all levels/ all height, after approval and as per instruction of engineer in charge etc compete. Measurement shall be taken for the depth of holes in running meter for specified diameter. Holes shall made by authorized approved agency. Scanning of reinforcement shall be carried out before core cutting if required and as instructed by Engineer in charge.
79.1 holes upto & from 52 to 77 mm dia.
79.2 holes from 77 to 102 mm dia.
79.3 holes from 102 to 125 mm dia.
79.4 holes from 125 to 152 mm dia.
79.5 holes from 152 to 202 mm dia.
79.6 holes from 202 to 250 mm dia.
79.7 holes from 250 to 350 mm dia.

1.0 Materials and Workmanship

1.1 Marking of holes is to be approved by Architect or engineer-in-charge. Holes in RCC walls, slabs, beams or any other RCC member by Core cutting machine of HILTI or equivalent is to be done. RCC surface is cleaned after drilling including disposing of debris as specified in the disposal item. Necessary platform for the machine location and electrical wire management shall be adhering to safety standards.

2.0 Mode of Measurement and Payment

2.1 The rate shall be for a unit of running meter length.

2.2 Rate shall be inclusive of scaffolding, cleaning, disposing of debris etc. complete for all height as directed by engineer-in-charge.

Item No. 80
Chemical Anchor:
Supplying, Drilling/ Cleaning hole and injecting grouting chemical with the help of dispenser, into a hole of dia & depth as per manufacturer/ structural consultant's specification and fixing rebar of the required diameter subsequently. Fixing methodology shall be followed as per manufacturer's guidelines. Steel will be paid under relevant item. Manufacturer to submit Rebar Depth Calculation based on design loads & other parameters as provided by consultant and in accordance with EOTA-TR-023/029 "guidelines for post installed rebar connections" for approval. Rate shall be inclusive of all material, labour, necessary scaffolding etc complete for all height as directed by engineer in charge.
80.1 10mm x 150mm
80.2 12mm x 180mm
80.3 16mm x 240mm
80.4 20mm x 300mm
80.5 25mm x 375mm

1.0 Materials and Workmanship

Chemical anchor shall be of approved make. The item shall be executed as per manufacturer's specification. Item shall be executed as directed by engineer in charge, not executed for installation tender item i.e. stair railing, doors windows, etc.

2.0 Mode of Measurement and Payment

Rate shall be for unit of one No.

Item No. 81
Rebaring:
Providing material and labour for Drilling/ Cleaning hole and injecting grouting chemical with the help of dispenser, into a hole as per manufacturer/ structural consultant's specification and fixing rebar of the required diameter subsequently. Fixing methodology shall be followed as per manufacturer's guidelines. Steel will be paid under relevant item. Manufacture to submit Rebar Depth Calculation based on design loads & other parameters as provided by consultant and in accordance with EOTA-TR-023/029 "guidelines for post installed rebar connections" for approval. Rate shall be inclusive of all material, labour, necessary scaffolding etc complete for all floors, all height as directed by engineer in charge.

81.1 Dia 8mm and depth 120mm
81.2 Dia 10mm and depth 150mm
81.3 Dia 12mm and depth 180mm
81.4 Dia 16mm and depth 240mm

1.0 Material:
Medium duty injection adhesive for rebar fixing shall be of approved make of required dia as suggested by engineer in charge.

2.0 Workmanship:
The item shall be executed as per manufacturer's specification. Item shall be executed as directed by engineer in charge, not executed for installation tender item i.e. stair railing, doors windows, etc.

3.0 Mode of measurement:
Rate shall be inclusive of all material, labour, necessary scaffolding etc. Rate shall be for unit of one No.

SECTION IV

TECHNICAL SPECIFICATIONS

SUB SECTION 4.2

TECHNICAL SPECIFICATION

FOR

ELECTRICAL WORKS

TECHNICAL

MATERIAL SPECIFICATION

GENERAL & SPECIAL CONDITIONS OF CONTRACT FOR ELECTRICAL & ELV WORKS

GENERAL INSTRUCTIONS

1.0 Scope of work:

1.1 The contractor's scope of work covers supply, installation, commissioning and testing of the complete Electrical installation as specified in material specification, item specification, drawings and schedule of quantities.

2.0 Location:

2.1 The works are to be carried out at Along Embankment, ahmedabad**.** All electrical equipment and gear shall be designed for an average ambient of 50°C with a peak of 55°C and relative humidity 100%.

3.0 Drawings, Specifications & Deviations:

3.1 The drawings and specifications lay down minimum standards of equipment and workmanship. Should the tenderer wish to depart from the provisions of the specifications and drawings either on account of manufacturing practice or for any other reasons, he should clearly draw attention in his tender to the proposed points of departures and submit such complete information, drawings and specifications as will enable the relative merits of the deviations to be fully appreciated. In the absence of any deviations, it will be deemed that the tenderer is fully satisfied with the intents of the specifications and drawings and their compliance with the statutory provisions and local codes.

3.2 In case of discrepancy between the drawings and specifications, the tenderer shall assume the more stringent of the two and furnish his rates accordingly.

3.3 The Contractor shall prepare fabrication and working drawings and all work shall be as per the approved working drawings. Approval of drawings does not relieve the Contractor of his responsibility to meet with the intents of the specifications. All such drawings for approval shall be in duplicate.

3.4 Equipment data shall be submitted along with the filled tender. The contractor shall be responsible for any unfilled data of the data sheets and the same shall be executed according to the requirements of the Engineer in charge / Consultant without any extra cost.

3.5 All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

4.0 Tools and Spare Parts:

4.1 All the tools, tackle, scaffolding and staging require for erection and assembly of the equipment and installation covered by the contract shall be obtained and maintained by the contractor himself. All other materials such as foundation bolts, nuts, anchor fasteners etc. required for the installation of the plant shall also be supplied and included in the contract.

4.2 Tenderer should submit the spares recommended by him for two years operation of each type of equipment covered by these specifications on completion of work.

5.0 Testing & Handing over:

5.1 The contractor shall carry out tests on different equipment as specified in various sections in the presence of representatives of clients, Architects and Consulting Engineers in order to enable them to determine whether the plant, equipment and installation in general comply with the specifications.

5.2 All equipment shall be tested after carrying out necessary adjustments and balancing to establish equipment ratings and all other design conditions. At least six sets of readings shall be taken for each item tested and submitted.

5.3 The project shall be handed over after satisfactory testing along with six sets of documentation along with two sets of soft copy each consisting of :

i) Detailed equipment data as approved by the Consulting Engineers/Employer.

ii) Manufacturer's maintenance and operating instructions.

iii) Set of drawings, showing plant layouts, piping, ducting, cabling etc

iv) Approved Test reading & certificate of local authorities.

v) List of recommended spares.

5.4 Submission of the above documentation shall form a precondition for the final acceptance of the plant and installation and final payment.

6.0 Performance guarantee:

6.1 **All electrical equipment/items shall be suitable for Seismic Zone V.** All equipment and the entire installation shall be guaranteed to yield the specified ratings and design conditions plus/minus 3% tolerance. Any equipment found short of the specified ratings by more than the allowable tolerance as determined by the test readings shall be rejected.

7.0 Defects Liability:

7.1 All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12 months reckoned after the plant is commissioned and handed over to the clients along with the 6 sets of completion documents. During the defects liability period, the contractor shall rectify, repair or replace defective parts and components free of cost.

8.0 Statutory Inspections:

8.1 The contractor shall be fully responsible for meeting all the statutory obligations pertaining to the works carried out by them. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved. All statutory fees will be paid by the clients directly against demand in writing from the appropriate authority and all other expenses for submission and approval of the various and relevant statutory/bodies shall be embodied in the tender prices. To get the power connection and all other approval from Supply Company is also in the scope of contractor and the same is included in the tender prices. Hence contractor will not get any extra amount for the same.

9.0 Payment to civil contractor.

The electrical contractor will have to pay to the civil contractor for any work done on behalf of the electrical contractor like laying of pipes, filling of zarries etc.

10.0 Temporary wiring

Whenever any temporary wiring is done, it has to be done so that all precaution for safety is taken and temporary wiring shall be also done so that, it is not hazardous to any body. Any accidents happen because of temporary or permanent installation, it will be entire responsibility of contractor for all compensation to concern parties.

Employer, engineer in charge, consultants shall not be responsible for such accidents, mistake etc.

11.0 Completion Drawing:

The contractor shall to submit 4 sets of as built drawings showing all power and control circuit diagrams and soft copy of the same.

12.0 GA Drawings

Successful tenderer shall submit General Arrangement drawings for approval of employer/consultant before manufacturing of any part of equipments.

13.0 Works to be done by the Contractor

13.1 The contractor shall also furnish 4 copies of detailed installation, operation and maintenance manuals of manufacturers for all items of equipment together with all relevant data sheet, spare parts catalogues, repairs, assembly and adjustment procedure etc.

13.2 The contractor shall furnish such facilities as will be necessary for inspection of the equipment before dispatch at the manufacturer's works and also for witnessing such tests, at the works, if so required by employer/consultant.

13.3 Copies of all documents for routine, acceptance and type test certificates of the equipment carried out at the manufacturers premise shall be furnished to the employer along with supply of equipment.

13.4 The contractor shall coordinate his work and cooperate with other agencies by exchange of all technical information like details of foundation, weight, overall dimensions, clearances and other technical data required for successful and proper completion of his portion of the work in relation to the work of others without any reservation. No remuneration shall be claimed for such cooperation.

13.5 Care shall be taken, while handling/installing the equipment to avoid damage to the building as well as equipment. On completion of installation, the contractor shall arrange to repair all damages to the building and equipment caused during installation so as to bring to the original condition without any extra cost.

13.6 Sealing of all floor openings provided for electrical pipes and cables, from fire safety point of view, after laying the same without any extra cost.

13.7 Testing and commissioning of completed installation.

13.8 All tools and tackles required for handling of equipments and material at site of work as well as for their assembly and erection and also necessary test instruments shall be the responsibility of the contractor.

13.9 The contractor shall co-ordinate with all other agencies involved in the building work so that the building work is not hampered due to delay in his work. Recessed conduit and other works, which directly affect the progress of building work, should be given priority.

13.10 No structural member in the building shall be damaged / altered, without prior approval. All openings provided by others for electrical services shall be grouted / filled by the contractor after installing the cables/conduits etc. as the case may be, by any suitable means as approved by the engineer in charge without any extra cost. All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost as per instruction of architect to the original architectural finish of the building.

13.11 All the electrical works shall be carried out in accordance with the provisions of Indian electricity act, 1910 and Indian electricity rules, 1956 amended up to date(date of call of tender).All components shall confirm to relevant Indian standard specifications, wherever existing, amended up to date.

13.12 For all kind of fabricated equipments, the contractor will first submit dimensional detailed drawings for approval before fabrication is taken up in the factory. Suitable stage inspection at factory also will be made to ensure proper use of materials, workmanship and quality control.

13.13 All testes prescribed in specification, to be done before, during and after installation, shall be carried out, and the test results shall be submitted to the engineer in charge in prescribed Performa, forming part of the completion certificate.

13.14 Completion plan (AS BUILT) drawn to the scale to be submitted for each building with location of main switch board, distribution boards, panels, circuit diagram, conduit layouts, points, outlets, light fixtures etc complete in all respect as per instruction of engineer in charge.

14.0 Guarantee

The contractor shall guarantee the entire installation as per specifications. All equipments shall be guaranteed for one year from the date of acceptance against unsatisfactory performance or break down due to defective design, manufacture and installation. The installation shall be covered by the conditions that whole installation or any part there of found defective within one year from the date of taking over shall be replaced or repaired by the contractor free of charge.

15.0 After sales services

The contractor shall ensure adequate and prompt after sales services in the form of maintenance personnel and spares as and when required with a view to minimizing the break down period. Particular attention shall be given to ensure that all spares are easily available during the normal life of installation.

SPECIAL CONDITIONS OF CONTRACT

1. Equipment & Machinery on Work Site

The contractor shall provide and maintain in working order power driven machines like welding, drilling machine, zarri cutters, meggar, multimeter, continuity tester etc. till the completion of work.

2. The quantity for measurement will be actual quantity used in electrification:

I) The contractor shall bear all incidental charges for the storage and safe custody of the materials at site at his own responsibility.
II) The contractor shall make arrangement at the site of works for safe custody of materials to protect from damage by rain, dampness, fire, theft etc.
III) In case any materials get damaged the contractor shall replace the same at his own cost.
IV) The contractor shall furnish to Engineer-in-Charge sufficiently in advance a statement showing his requirements of quantities of materials to be supplied by Owner if any and the time when he will require the same.
V) A day to day account of the material supplied by Owner/Contractor shall be maintained by the contractor in the agreed Performa.

4. Engineer Incharge/Employer will provide operative instructions on regular basis related to project during contract execution period, which are not covered in this tender document. Contractor and his staff at site shall comply all these instructions.

5. Client's approval will be final in all concerned matters.

6. All correspondences between contractor and architect will be through client/PMC.

7. The Electrical contractor must be licensed Electrical contractor.

8. The Electrical contractor must have available all kind of necessary equipments at site.

9. The Electrical contractor should get approval prior to appoint any sub agencies for specialized jobs. Client /Consultant/Architect have right to reject any contractor at any stage of project.

10. It is required that all insurance formalities & workman's compensation policy should be followed by the contractor.

11. All HT cable jointer should possess necessary license for HT cable jointing/termination and should be well experienced with similar work.

12. The contractor will have to provide senior Electrical site engineer during the execution of work

13. All wiring person must be in possession of wireman license.

14. Minimum Criteria for selecting Electrical Sub contractor.

1. The contractor must be government approved as "Class A" licensed Electrical contractor.

2. The Electrical contractor must have completed following kind of jobs under one project head in last 3 years.

- SITC MV/LV Cabling and termination work.

- SITC of all M.V. Switch gear and power panels made by CPRI approved panel vendor.
- Internal wiring with PPI (Per Phase Isolation) type Distribution Boards.
- SITC of external lighting like poles, cables, Timers, cable trenches etc.

3. The Electrical contractor shall get approval prior to appoint any sub agencies for specialized jobs. Employer /Consultant/Engineer in charge has right to reject any contractor at any stage of project.

4. The contractor will have to provide:
   - Minimum one senior Electrical site engineer B.E. with more than 3 years experience.
   - All wiring person must be a supervisor level grade.

5. Emphasis shall be given to the sub contractor who has already completed similar kind & Magnitude of projects and has worked with renowned Employer / Consultant.

TECHNICAL

MATERIAL SPECIFICATION

MATERIAL SPECIFICATION

SUMMARY PAGE

ELECTRICAL MATERIAL SPECIFICATION

E – 1 Panels_Section Feeder Pillar

1.1 Scope:

The scope covers supply, installation, testing and commissioning of power panels, incorporating circuit breakers, fuse units, busbars, interconnections, earthing etc., meeting the requirements shown in equipment schedule and the drawings.

1.2 Standards:

AS PER SCHEDULE OF INDIAN STANDARD ATTACHED WITH THE DOCUMENT

The PCCs & MCCs shall comply with the latest edition of relevant Indian standards and Indian Electricity rules and regulations. The following Indian Standards shall be complied with:

IS: 4237 : General requirements for switch gear and control gear for voltage not exceeding 1000 v.

IS: 375 : Switchgear bus-bars, main connection and auxiliary wiring, marking and arrangement.

IS: 2147 : Degree of protection provided by enclosures for low voltage switch gear and control gear.

IS: 8197 : Terminal marking for electrical measuring instrument and their accessories.

IS: 2557 : Danger notice plates.

IS: 2516 : Specification for AC circuit breaker.

IS: 1818 : Specification for AC isolator and earthing switch.

IS: 3072 : Code of practice for installation and maintenance of switchgear.

IS: 8623 : Specification for factory built as symbolize of switch gear and control gear for voltage up to and including 1000v. A.C.& 1200 v. D.C.

IS: 8828 : Miniature Circuit Breaker.

IS: 2516 : Air circuit breaker.

IS: 4064 : Fuse switch and switch fuse unit.

IS: 9224 : HRC fuse unit.

IS: 2705 : Current transformer.

IS: 3155 : Voltage transformer.

IS: 3231 : Electrical relay for protection.

IS: 1248 : indicating instrument.

IS: 722 : Integrating instrument.

IS: 6875 : Control switches & push buttons.

IS: 2959 : Auxiliary contactor.

IS: 1822 : AC motor starters of voltage not exceeding 1000V.

1.3 TYPE OF M.V. SWITCH GEAR:

1.3.1 All the PCC's / PDB's / MCC's shall be metal clad, totally enclosed, rigid, floor / wall mounted, air - insulation, cubical type suitable for operation on three phase / single phase, 415 / 230 volts, 50 Hz. neutral effectively / Non effectively grounded at transformer and short circuit level not less than 30 MVA at 415 volts.

1.3.2 The PCC's / MCC's shall be designed to withstand and heaviest condition at site, with minimum expected ambient temperature of 45 degree celsius, 80 percent humidity and dusty weather.

1.3.3 Should confirm to Indian Electricity Act and rules. (As amended up to ate) & approval of FIA. Of India.

1.4 STRUCTURE:

1.4.1 The PCCs, MCCs & PDBs shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation having dead front operated and floor mounting type.

1.4.2 All CRCA sheet steel used in the construction of PCCs / MCCs / PDBs shall be 2 mm thick and shall be folded and braced as necessary to be provided a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

1.4.3 The PCCs / MCCs / PDBs shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-55 to IS 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasket with foam rubber and / or rubber strips and shall be lockable.

1.4.4 All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes taped into an adequate thickness of metal or provided with bolts and nuts. Self threading screws shall not be used in the construction of PCCs / MCCs / PDBs.

1.4.5 A base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom.

1.4.6 PCCs / MCCs /PDBs shall arranged in multi-tier formation. The PCCs / MCCs / PDBs shall be of adequate size with a provision of 20 percent spare space to accommodate possible future additional switch gear. The size of the PCCs / MCCs / PDBs shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component does not attain temperature more than 40 degree celsius. If necessary openings shall provided for natural ventilation, but the said openings shall be screened with fine weld mesh.

1.4.7 Knockout holes of appropriate size and number shall be provided in the PCCs / MCCs/ PDBs in conformity with number, and size of incoming and outgoing conduits / cables.

1.4.8 Alternatively the PCCs / MCCs / PDBs shall provided with removable sheet plates at top and bottom to drill holes for cable / conduit entry at site.

1.4.9 The PCCs / MCCs / PDBs shall be designed to facilitate easy inspection, maintenance and repair.

1.4.10 The PCCs / MCCs / PDBs shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition, they shall be suitable braced for short circuit duty.

1.5 PROTECTION CLASS:

All the indoor PCCs / MCCs / PDBs shall have protection class as IS.

1.6 PAINTING:

All sheet steel work shall undergo a process of decreasing pickling in acid, cold rinsing, phosphating, pesivating and then sprayed with a high corrosion resistant primer. The primer shall be backed in an oven. The finishing treatment shall be by application. Three coats of synthetic enamel paint of approved colour shall be applied by spray and stoves in dust free atmosphere or the panel shall be powder coated.

1.7 CIRCUIT COMPARTMENT:

1.7.1 Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed an all sides. Sheet steel hinged lockable door shall be duly inter locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be from being drawn out when the breaker is in ON position.

1.7.2 The door shall not form as integral part of the drawout position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tires in a vertical section.

1.8 INSTRUMENT COMPARTMENT

Separate and adequate compartment shall provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, busbars and connections.

1.9 BUSBARS

1.9.1 The busbar shall be air insulated and made high quality, high conductivity, high strength copper and as per relevant IS code. The busbar shall of three phases and neutral system with separate neutral and earth bar. The busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn, electrolytic copper. the busbar shall be of rectangular cross section designed to withstand full load current for phase busbar and full rated current for neutral busbar and shall be extensible type on either side. The busbar shall be rated for the frame size of the main incoming breaker. The busbar shall have uniform cross section throughout the length.

1.9.2 The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and be colour coded in red, Yellow, Blue and Black to identify the three phases and neutral of the system. The busbar shall be supported on unbreakable, non hygroscopic DMC insulated supports at sufficientevely close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 50 KA RMS symmetrical for one second and a peak short circuit withstand of 105 KA minimum.

1.9.3 The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick bakalite sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearance between the busbar are maintained as per below.

Between phases	:	27 mm min.
Between phases and neutral	:	25 mm min.
Between phases and earth	:	25 mm min.
Between neutral and earth	:	23 mm min.

1.9.4 All busbar connection shall be done by drilling holes in busbars and connecting by chromium plated brass bolt and nuts. Additional cross section of busbar shall be provided in all PCCs / MCCs / PDBs to cover-up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

1.9.5 All connection between busbar and circuit breaker / switches and between circuit breaker/ switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating strips.

1.10 ELECTRICAL POWER & CONTROL WIRING CONNECTION

a) Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminum/copper conductor PVC insulated and sheathed, armoured cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the PCCs, MCCs, PDBs.

b) Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.

c) Both control and power terminals shall properly be shrouded.

d) 10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.

e) Terminal strip for power and control shall preferably be separated from each other by suitable barriers of enclosures.

f) Wiring inside the module for power, control protection and instrument etc. shall be done with use of 660/1100 confirming to IS 694 and IS 8130. Power wiring inside the starter module shall be rated for full current rating of contactor, but not less than 4 sq mm cross section area. For current transformer circuits, 2.5 sq mm copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq mm copper conductor wires. Wires for connections to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

g) Control power for the motor starter module shall be taken from the respective module switchgear outgoing from R phase and Neutral. Control wiring shall have control fuse (HRC type).

h) Particular care shall be taken to ensure that the layout of wiring neat and orderly. Identification ferrules shall be filled to all the wire termination for ease of identification and to facilate and testing.

i) "CUPAL" washers shall be used for all copper and aluminum connections.

j) Final wiring diagram of the PCC, MCC, PDB power and control circuit with ferrules number shall be submitted along with the PCC/MCC/PDB as one of the documents.

1.11 TERMINALS

The outgoing terminals and neural link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted, only one conductor may be connected in one terminal.

1.12 WIREWAYS

A horizontal PVC wire way with screwed covers shall provided at the top to take interconnecting control wiring between different vertical sections.

1.13 CABLE COMPARTMENT

Cable compartment of adequate size shall be provided in the PCCs, MCCs, PDBS for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate support shall be provided in the cable compartment shall be brought out to terminal blocks in the cable compartment.

1.14 EARTHING

a) Copper earth busbar of 25 mm x 3 mm shall be provided in the PCCs, MCCs, PDBS for the entire length of panel. The frame work of the PCCs, MCCs, PDBs shall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the PCCs, MCCs, PDBs.

b) The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp and the clamp shall be ultimately bounded with the earth bar.

1.15 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

1.16 NAME PLATE

a) A name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder giving feeder details shall be provided for each feeder module door.

b) Inside the feeder compartment, the electrical component, equipments, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by providing stickers.

c) Engraved name plates shall preferably be of 3 ply, (red-white-red or black-white-black) lamicold sheet. However black engraved perplex sheet name plates shall also be applicable. Engraving shall be done with square groove cutters.

d) Name plate shall be fastened by counter sunk screws and not by adhesives.

1.17 DANGER NOTICE PLATE

a) The danger plate shall be affixed in a permanent manner on operating side of the panel.

b) The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones.

c) The danger notice plate in general shall meet to requirements of local inspecting authorities.

d) Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

e) The letter, the figure, the conventional skull and bones shall etc. shall be positioned on the plate as per recommendations of IS: 2551-1982.

f) The said letter, the figure and the sign of skull and bones be painted in single red colour as per IS: 5-1978.

g) The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit design of the panel.

h) The danger notice plate, if possible, be of ISI certification mark.

1.18 INTERNAL COMPONENTS

a) The PCC / MCC / PDB shall be equipped complete with all type of required number of air circuit breakers, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the PCC / MCC / PDB but not indicated on the drawings shall be supplied and installed on the PCC / MCC / PDB. **Panel Should be compartmentalized with inner cover Plate of 16 Gauge.**

b) All part of the PCC / MCC/ PDB carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the PCC / MCC / PDB.

c) All units of the same rating and specifications shall be fully interchangeable.

1.19 INSPECTIONS

Each equipment should inspect and witness by client & consultant.

a) The PCC / MCC / PDB shall be inspected and checked as per inspection manual of the PCC / MCC / PDB manufacturer.

b) Various electrical components and accessories of the PCC / MCC / PDB shall be checked as per drawing for the respective PCC / MCC / PDB.

c) The PCC / MCC / PDB shall be checked for rigid mounting, earthing connections, proper rating and size of components, internal wiring, etc.

d) All mechanical fasteners and electrical connections shall be checked and tightened before installation.

e) Type test certificates for all ACB for similar rating shall be submitted.

f) Test:

g) Prior to dispatch of the PCC / MCC / PDB following tests shall be carried out.

h) Mechanical endurance test shall carried out by closing and opening of all the ACB's, MCB's switches etc.

i) Over voltage and Insulation resistance test shall be carried out between phases and between phase to earth bus, keeping the isolating switch in ON position. Similar test shall be carried out keeping the isolating switch in closed position.

j) All the interlocks, controls and tripping mechanism of the switch gears shall be tested for their proper functioning.

1.20 COMPONENTS:

A) GENERAL

a) The type, size, and rating of the components shall be as indicated on the relevant drawings.

b) While selection of the capacity of the components resulting from the prevailing conditions like room temperature shall be allowed for the Thermal and magnetic trip rating shall be compensated for the ambient temperature.

c) The rating indicated on the drawings are rating anticipated at prevailing site condition.

B) FUSE SWITCH UNITS:

The fuse switches unit shall be 3 pole double break type suitable for load break duty (AC 23), quick make and break action. Separate neutral link shall be provided with hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in "ON" position and also prevent closing of the switch when the door is not properly secured. All contacts shall be silver plated and all live parts shall be shrouded. The incoming and outgoing terminals of switches shall be adequately sized to receive proper size of the cables. High Rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS : 2208-1962 and having rupturing capacity of not less than 35 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to show that they have operated. The switch fuse unit shall be manufactured in accordance with IS: 4047 - 1967 as amended to date.

C) MINIATURE CIRCUIT BREAKER

Miniature circuit breakers shall be quick make and break and break type conform with British standard BS: 3871 (Part-I) 1965 and IS: 8825 (1996). The housing of MCBs shall be heat resistant and having the high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faculty current.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay 3 as for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

D) FUSE

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS: 2000-1962 and having rupturing capacity of not less than 35 MVA at 415 Volts. Backup fuse rating for each motor / equipment. HRC fuses shall be of English Electric make or approved equal.

E) MOULDED CASE CIRCUIT BREAKER

The MCCB shall be air break type and having quick make quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

Operating handle of the MCCB shall be in front and clearly indicate ON / OFF / TRIP positions.

The electrical contact of the circuit breaker shall be of high conducting non deteriorating silver alloy contacts.

The MCCB shall be provided with thermal / magnetic type bi-metal over load release and electro-magnetic short circuit protection device. All the releases shall operate on common trip busbar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB whenever called for in the appendix drawings shall provide an earth fault relay.

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

The electrical parameters of the MCCB shall be as per the descriptions given in the appended drawings.

F) CONTACTORS:

The contactor shall meet with the requirements of IS: 2959 and BS: 775.

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC 3 and shall be suitable for minimum class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

G) LOAD MANAGER / Multi-function meter:

The load manager should meet the following requirement unless and otherwise specified in the bill of material or drawings.

KWH METER: Digital KWH meter 96 x 96 x 80 mm size Acc Class 1.0 suitable for true RMS reading having reverse LED. Optically isolated pulse output having pulse with 500 ms and pulse amplitude 12 volts.

Load Manager (For Main Incoming): The load manager should be 192 x 144 mm size having facility to read voltage current harmonics power parameters. It should contain real time clock. The meter should be field programmable and to generate high / low profile for all power parameters with date & time, also able to store previous period integrated data. The meter

should have RS 485 port for networking purpose. All the programming should be pass word protected.

Load Manager (For Outgoing): Load manager facility to measure A, V, Hz, PF, kW, KWH with RS 485 port for networking. The meter should be totally field programmable and having a password protection. Size should be 96 x 96 mm.

H) CURRENT TRANSFORMER

Where ammeters are called for, CT's shall provided for current measuring. Each phase shall be provided with separate CT of class I accuracy and suitable VA burden for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1964 as amended up to date.

I) PUSH BUTTON:

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.

J) INDICATING LAMP:

Indicating Lamp shall be transformer operated low voltage rated and shall supplied complete with translucent covers to diffuse the lamp light.

Colour shade for the indicating lamps shall be as below:

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow, and Blue.

K) CENTRALIZED CONTROL & MONITORING SYSTEMS (CCMS):

Sl No.	Features	Description
1	Energy measurement and communication features	• The CCMS unit Should be able to capture (record) and provide following parameters at variable time-intervals (Individual switching point wise and/or networked switching points) : ØVoltages ØCurrent ØPower Factor ØActive Power (kW) ØApparent Power (kVA) ØMetering kWh cumulative ØMetering kVAh cumulative • Number of hours each group of LED luminaries was glowing (Based on load current %) • Number of hours the power supply was unavailable • Special emergency on/off facility with wireless control. • Benchmarking capacity so as to generate alert SMS for: o Phase-wise currents on crossing threshold values o Phase-wise voltages on crossing threshold values o Theft alerts o Group failure of lights o No output supply • Alert SMS shall be forwarded to five (5) phone numbers, in each of the respective Client / municipality. • Class 1.0 accuracy Energy Meter with ISI marking/IS-13779 is to be used for power measurement. Type testing report from NABL Accredited Lab to be provided.
	Web based - Application	• Central Control and Monitoring System functionalities • CCMS shall have a web-server to receive and record all data with time stamping from the streetlight controllers. • It should be able to communicate with any individual switching points or collectively amongst networked switching points for control and monitoring. • It should able to record LED luminaires glowing and non-glowing hours of a particular switching point. • It should be able to display the power failure details of a particular switching point and the relevant luminaires. • It should register all fault conditions like excess voltage/current drawn, lamps failure, no-power supply,

		etc through the instantaneous alert messages sent by the CCMS unit. • Reports such as energy saving report, lamp failure report, actual hours of operation, uptime (%), etc. should be generated on a daily basis from the data/readings received from the CCMS units. • It should be able to track the failure of lamps in a particular switching point based on % load • Different user authorization levels should be settable and the central server should be capable of scalability to more than 5000 CCMS units • GIS Mapping should be done covering all switching points and the details of each switch point shall be viewable in the web application software through a Google-map interface or web based digital map. • All the CCMS units should be remotely configured from the Central Control Unit: o Setting new ON/OFF timings o Setting the Response Time Count (RTC) time of Automation unit o Knowing the current status of any particular switching point. < Reset the unit. o Alarm limit settings • The minimum interval for the update of data should be 15 minute but programmable up to 5 minute. • Auto synchronization of controller with server timing to be further synchronized with standard GSM clock timing. • The system monitors all the following from the CCMS unit o Voltages each phase o Current each phase o PF each phase o Metering kWh cumulative o Metering kVAh • Further system is able to indicate various faults o Number of estimated operational lights

		○ Number of estimated non-operational lights ○ Failure of contactor ○ Status of the incoming supply (power failure) ○ High /low voltage ○ Overload on the phases • CCMS shall have server preferably dedicated server set-up or cloud based arrangement to ensure 100% guarantee of the data transmission and real-time data storage for last 1 year. • Data authenticity and validation has to be ensured. Reports to be submitted in a common CSV/PDF format. • CCMS system should have a self-healing mechanism and in case of failure, Successful Contractor to ensure resumption of service within 24 hours. Till resumption of full services, the default settings of the CCMS should ensure timely ON/ OFF operation of the street lights.

Note:- Sim cards for CCMS shall be provided by success full contractor with five-year necessary Data Plan require to run the system without interrupting from the completion date of Defect liability period.

Technical Specifications:

- Supply: 1 Phase 230 V AC +/- 10 %
- Unit Power Consumption: 3 W (Stand by), 10 W (on full load)
- Controller : 32 Bit micro controller or better
- Switching output: 03 nos - separate for each phase contactor
- Programming function :
    - Switching on Longitude & Latitude base
    - Schedule based - Separate schedule for each phase should be possible
    - Manual operation from web based interface
- Real Time Clock : With battery backed for more than 10 years
- Local Storage : With special device which hold the data for more data than 10 years with automatic history sync function
- By pass : Provision to bypass by way of Auto / manual switch

- Operating Temperature : 2 to 55°C and humidity 90 % non-condensing
- Installation: Outdoor type. Floor Mounted. Material of construction: 14-gauge M S with industrial exterior powder coated.
- Panel intruder alarm: Door open sensor to be provided

CCMS features compliance:

SN	Item
A	**CCMS features**
1	Scheduling of Streetlight operations as per Astronomical timings
2	Local operation through maintenance switch with key lock
2	Remote operation of streetlight cluster from central control room
3	Energy consumption monitoring and local storage for more than 30 days
4	Data transmission to central server and two-way communication through cellular GPRS based connectivity
5	Local communication to CCMS controller through communication device – Laptop / Smart phone
6	Device settings update locally using communication device or remotely through central server
7	Over voltage, Under voltage protection with auto reset facility
8	IoT based MQTT protocol for handling communication from thousands of devices concurrently from central server
9	DI / DO for status inputs and commands
10	Energy meter interface – RS 485Modbus rtu
11	Local storage - SD card expandable upto 32 GB
12	GPRS connectivity – Quad band
13	Built-in RTC with battery backup
15	Power interruption and Run hours monitoring
16	Open communication to connect with existing CCMS system installed certain zones of AMC
17	CCMS Software covers:
18	Web based monitoring through secure username and password
19	Tree type GUI with Zone – Ward – Switching point hierarchy for summary as well as individual Switch point monitoring
20	Google mashups with GIS mapping
21	Multi-level user authorizations and security
22	Fault detection and reporting for overload, under-load, lights failure (group derived from consumption profile), theft, unscheduled consumption etc.

Eligibility for CCMS system:

1) **Successful Contractor shall have installed more than 1000 CCMS units in last 2 years and shall be able to successfully demonstrate the same on its web based platform.**

2) **Vendor Approval: Successful Contractor shall be OEM of CCMS and shall be directly approved by EESL or its sub-contractor working for EESL SLNP projects**

E – 2 LT CABLING AND TERMINATION

1.1 Scope:

The scope consists of Supply, laying, testing and commissioning of L.T. XLPE Cable and its termination.

1.2 Standards:

AS PER SCHEDULE OF INDIAN STANDARDS; ATTACHED IN THE DOCUMENT

1.3 Cables:

A) LV POWER CABLES will be 1100 Volts grade single / multicore standard aluminum conductor extruded XPLE insulated with extruded PVC inner sheath outer sheath made of FRLS PVC compound conforming to IS-7098 part-1. Single core will be used for DC application. Cables in buried insulation shall be armoured type. Armoured cable should be provided with galvanized steel wire or strip armouring.

B) Control cables will be 1100 Volts grade multicore minimum 2.5 sqmm cross section standard copper conductor minimum 7 strands PVC insulated inner extruded sheathed and other sheath made of extruded FRLS PVC compound conforming to IS-1554 part-1.

Cables in buried insulation shall be armoured type.

C) All cables shall be new without any kind or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600 mm centres.

1.4 Cable joints and termination:

A) Connectors:

Cable terminations shall be made with copper/Aluminium Heavy duty long neck copper crimping lugs only crimped type solder-less lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solder-less lugs shall be used.

Crimping shall be done with the help of hydraulically operated crimping tool. All cable lugs should be long neck type only.

B) Cable Glands:

Cable glands shall be of heavy duty brass compression / whether proof type as specified. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations. Glands for classified hazardous areas shall be CMRI approved.

C) Ferrules:

Ferrules shall be of self sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

D) Cable joints:

Kit type joint shall be done and filled with insulating compound. The joint should be of 1.1 KV grade insulation.

E – 3 EARTHING

1.1 Scope of Work:

The scope of work shall cover supply, laying, installation, connecting, testing and commissioning of:

1.1.1 chemical or Electrode type Earthing station.

1.1.2 copper strips from earthing station to equi-potential bar.

1.1.3 copper strips/ wires from equi-potential bar to lay feeder mains and circuit to connect power panels, DBs, switchboards etc.

1.1.4 Bonding of Non-current carrying parts, and metallic parts of the electrical installation.

1.1.5 Provide inter connection between all earth pits of same type.

1.2 STANDARDS

1.2.1 The following standards and rules shall be applicable:

1) IS: 3043 - 1966 Code of practice for Earthing.

2) Indian Electricity Act and Rules

1.2.2 All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice or the British Standard Codes of Practice in absence of Indian standard.

1.3 GENERAL

All the non-current carrying metal parts of the electrical installation and mechanical equipments shall be earthed properly. The metal conduits, trucking, cables armoured and sheath, electric panels boards, lighting fixtures, ceiling and exhaust fan and all other parts made of metal shall be bonded together and connected by means of specified earthing system.

An earth continuity conductor shall be installed with all the feeders and circuits and shall be connected from the earth bar of the panel boards, to the conduit system, earth stud of the switch box, lighting fixture, earth pin of the socket outlets and to any metallic wall plates used. All the enclosures of motors shall be also connected to the earthing system.

1.4 TYPE OF EARTHING STATION

1.4.1 ELECTRODE / CHEMICAL TYPE EARTHING STATIONS:

1.4.1.1 The substation earthing and equipment earthing shall be with T-39 OR & T-19 as per earthing scheduled in BOQ & Drawing.

1.4.1.2 The earthing station shall be as shown on the drawing.

1.4.1.3 The earth resistance shall be maintained with suitable soil treatment as shown in the drawing.

1.4.1.4 The resistance of each earth station should not exceed the limit specified in IS: 3043.

1.4.1.5 The earthing grid and the earthing conductors shall be of copper strip of size as mentioned on the drawing.

1.4.1.6 The block masonry chamber with Cast Iron hinged cover shall be provided for housing the termination block as shown in the drawing.

1.4.1.7 The hardware and other consumable for earthing installation shall be of copper/brass, as per details shown in the drawing.

1.5 INSTALLATION AND CONNECTION:

1.5.1 The plate \ pipe electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level.

1.5.2 The plate \pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall \ column.

1.5.3 The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

1.5.4 G.I. pipe for watering shall run from top edge of the plate \ pipe electrode to the mid level of block masonry chamber.

1.5.5 Top of the pipe shall be provided with G.I. funnel and screen for watering the earth \ ground through the pipe.

1.5.6 The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

1.5.7 The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

1.5.8 Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS : 3043, Code of Practice for Earthing Installation.

1.5.9 The earth conductors (Strips / Wires copper/ Hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws \ bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

1.5.10 The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

1.5.11 Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

1.5.12 The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

1.6 EARTH LEADS AND CONNECTIONS:

1.6.1 Earth lead shall be bare copper or galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. Galvanized steel buried in the ground shall be protected with bitumen and Hessian wrap or polytene faced Hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

1.6.2 The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

E-4 External Lighting

1.0 Scope:

1.1 The scope of work covers the supply, installation and testing of lighting poles with required foundation as per Boq / drawing complete in all respect, weather proof LED light fixtures, wiring up to the fixtures, cable laying & termination, earthing as specified and shown on drawings complete in all respect.

2.0 Standards:

As per Applicable standard.

3.0 Light Fixtures: - All the light fixtures shall be with LED source only unless specified otherwise.

3.1 The LED light fixture construction shall be of **IP 66. Die** cast aluminum with a separate compartment for integral ballast equipment, with driver. The reflector shall be anodized polished aluminum. The glass refractor shall be heat resistant.

3.2 Lamp holder shall be of porcelain and shall comprise of a terminal block of non-- hygroscopic material. The luminaries shall have integral Driver housed in water tight and dust tight metal cases. Driver shall be pre-wired to the Lamp socket and terminal block, requiring only power supply leads to the ballast primary terminals.

3.3 Lighting fixtures shall be designed for minimum glare and for continuous operation under specified atmospheric condition.

3.4 The Lamp & Luminary shall generally follow the specification under section `LIGHT FIXTURES'.

3.5 **The LED lights system will have to meet the following Specifications**:

Tilting angle	- 0 -10 degree
Maintenance Factor	- 0.8
Protection level	- **IP 66 & IK-08**
Power factor	- > 0.95
Operation Mode	- On/Off/Dim (Light should be able to dim as per the command given from Command Center)
Construction	- Die cast Aluminum body with finish to be of colour and with the confirming to the safety of IS 10322 (part - 2) - 1982.
Heat Sink	- Integrated with in luminaries & The dimensions of luminaries shall be adequate to permit sufficient heat dissipation through the body itself, so as to prevent abnormal temperature rise inside the lantern & consequential damage to cover & gasket materials, LEDs, lenses & Electronic Driver.
Application	- Outdoor Use
System efficacy-Lm/W25c amb	- > = 130 Lm/W (For Street Light as asked (K))

System efficacy-Lm/W25c amb	- > = 75 Lm/W (For Post Top lantern asked (K))
Warranty	- 5 years on the LEDs, Fixture & Driver
Protection	- Overheat, Overload, Short Circuit, HV Surge up to 10 KV internal and 20 KV external
Certification	- LM 79, LM80 , RoHS, EMC, EMI, CE
Marking	- Company LOGO Engraving/Embossing on Body, AMC marking
LED life-time (L70)	- > 50000 hrs
Colour Temperature (K)	- **2700 to 6500 K (as decided by Architect)**
Driver Life Rating	- > 50000 hrs
Beam angle	- 135/80 degree
LED	- CREE, Osram, Philips, Nichia
LED junct temp in ℃@	- < 75
Lens material	- Polycarbonate / PMMA
Working humidity	- 10% - 90% RH
Working temp in ℃	- 05 to 50 deg C
LED driver type	- Constant Current
Drive Current	- ≤ 750mA
Driver Efficiency	- >80%
T H D Amp	- < 15%
T H D Volt	- < 5%
Input Voltage range (Vac)	- 150-270 +/- 5%
Input Voltage frequency (Fac)	- 50 Hz +/-3%
CRI Color Rendering Index	- > 70
Lumen Maintenance Factor	- 70% up to 35000 burning hrs
Uniformity ratio U0	- > = 0.6 (Min /Avg.)
Uniformity ratio UT	- > = 0.33 (min / max)

Required Avg. Lux level on road - > = 40 (CIE method / 9 point method)

Successful contractor need to submit dialux design report for selected light fixtures by Architect for sampling, stating avg. lux level, Uo, UT, based on drawing and then as per site

measurements during sampling on site (Minimum three samples of each selected fixtures required for sampling on site).

3.6 Particulars and Details to be submitted by the Successful Contractor:

In order to properly assess and due diligence on submissions, the Successful Contractor should provide following information on the quality and photometric of proposed luminaries.

3.6.1 General description

Following details of the proposed luminaries shall be submitted as per Annexure I by Successful Contractor for selected light fixtures for execution after onsite sampling & selection process.

ANNEXURE I

Sr. No.	Description
1	Luminaries manufacturer
2	Luminaries model name
3	Wattage
4	Stated lumen output
5	IP rating
6	Lumen output (as per LM79 report, mentioning current in mA)
6	Luminous efficacy (as per LM79 report)
7.	Lumen deprecation (L70 mentioning temperature in 0C and current in mA)
8	Correlated colour temperature (CCT)
9	Colour rendering index (CRI)
10	LM 80 report to prove the authentications of LED module
11	Third party NABL accredited LAB report as per relevant IS and for LM79

3.6.2 Electrical specifications

Electrical ratings of the proposed luminaries product for the following criteria shall be submitted in Annexure II by Successful Contractor for selected light fixtures for execution after onsite sampling & selection process.

ANNEXURE II

Sr No.	Description
1	Voltage range or rating single phase AC
2	Amperage range or rating

3	Frequency range
4	Power factor
5	Total harmonic distortion
6	Working humidity
7	Working temperature
8	Ingress protection
9	Electrical connector
10	Ability to operate under conditions of unpredictable voltage variations

Submit the information whether and how the proposed luminaries product might accommodate adaptive controls that allow remote dimming or switching on/off, and indicate what types of controls may be integrated into the proposed luminaries product;

3.6.3 LED chip and driver information - details to be filled up by Successful Contractor for selected light fixtures for execution after onsite sampling & selection process.

LED chip and driver information of the proposed luminaries product for the following criteria in Annexure III.

ANNEXURE III

Sr No.	Description
1	Name of the LED chip manufacturer
2	LED chip model name and number
3	LM 80 report from the LED chip manufacturer on the lumen depreciation characteristics of the specific LED chip employed in the proposed luminaries product
4	Junction temperature (0C)
5	Information on drivers employed in the Proposed luminaries
6	LED DRIVER - Name of the manufacturer
7	LED Driver - Model name and number
8	Expected lifetime of the LED driver used in the proposed luminaries
9	Estimated cost of driver replacement by your company, including component and

installation cost

10 Name of the LED chip manufacturer

3.7 Successful Contractor shall have to offer the following minimum warranty:

a. Provide a five year on-site replacement warranty covering material fixture finish and workmanship, to include transportation, removal, and installation of new products.

b. Provide five year replacement warranty for defective or non-starting LED source assemblies and all drivers.

c. Provide a five year warranty for luminaries exhibiting inadequate lumen maintenance at the end of the warranty period.

d. A luminaries dirt depreciation (LDD) factor may be included in the above calculation, such a value be determined by mutual agreement between Client and the manufacturer, consistent with local ambient environmental conditions and practice.

e. A monitoring programme to implement will be determined by mutual agreement between Client and the Successful Contractor. The costs of the monitoring programme over the five year warranty period will be borne by the Successful Contractor, unless agreed otherwise by Client and the Successful Contractor.

f. The warranty shall cover all LED light sources (packages or modules/arrays) including but not limited to the LED die, enclosure, and phosphor. If the expected life of the luminaire system is not maintained net of LDD, then the Successful Contractor shall replace the light source(s) and/or luminaries as needed.

3.8 Photometric information

The Successful Contractor needs to submit the following photometric information:

1) Photometric modeling results, preferably within a LM79 report, from an Third Party NABL accredited laboratory showing generic candlepower traces and iso footcandle plots for the proposed luminaries product.

2) Photometric information, data and diagrams that model the luminance flux distribution of the proposed luminaries referencing the site characteristics. The Successful Contractor should consider the following during the modeling exercise.

3) Such modeling should verify that the Successful Contractor's proposed luminaries will meet Indian Roadway Lighting standard IS 1944, which specifies average luminance (E avg.) and uniformity (Emin / Eavg) for roads at the above sites.

4) Use industry accepted, standardized software like Dialux for the above modeling While modeling, a maintenance factor of 0.8 should be used.

Note: The Successful Contractor needs to submit a soft copy of the IES file of the proposed luminaries along with the bid.

3.9 Lumen maintenance statement

1) The Successful Contractor must submit a lumen maintenance statement that estimates how many operating hours can be expected from the proposed luminaire product until its light output declines to 70% of its initial output (L70), given the specific climactic character, including extremes of temperature and high humidity, associated with the local condition.

2) The lumen maintenance statement should also clearly explain that how or what method was used to determine the rated lifetime.

3) Describe in details the thermal management: how the physical and thermal design of the luminaire will prevent the LED chips from overheating on extremely hot days.

4) Other trials or pilot projects: submit information and contacts for other relevant trials in which the Successful Contractor's proposed luminaire product, or similar products sold by the agency, have been tested in the field.

5) Such information should include: LM 80 report for the LED chip package employed in the proposed luminaire product Illuminance or luminance measurements, if available, taken over a minimum of two years of operation from pilot projects that have tested the proposed luminaire product, or a similar luminaire product, in the field.

3.10 Luminaire specifications -

The Successful Contractor shall provide information and certifications

1) Luminaries: General Requirements, Tests, and Certifications specified in IS 10322

2) Electrical safety certifications such as ISI and CII

3) Ingress Protection - Certification IP66

3.11 DRAWINGS AND DATA OF LIGHTING FIXTURES:

As per proposal, the Successful Contractor shall furnish relevant descriptive and illustrative literature of the lighting fixtures and accessories along with drawings/ data for the respective lighting fixtures :-

i) Dimensional Drawings.

ii) Mounting details cable entry facilities and weights.

iii) Lamp output V/S temp. curves.

4.0 Lighting Poles: Lighting Poles for Post top lights shall be cylinder type GI pole construction

Detail specifications of "GI POLE made out of B CLASS ERW G.I. PIPE"

The lighting poles shall be fabricated from heavy duty cold rolled steel tubes to IS: 1239-1958 and hot dip galvanized or painted as specified by Architect. The pole shall have a base plate, adequate size stiffener plate, a large access hinged door with chain welded between access door and pole, and with necessary fixture mounting single arm / Double arm GI bracket as per drawing at top. The access panel / integral junction shall have a multi-way connector, MCB, cable clamp etc. mounted

on hylem sheet, GI Patti clamp, as per drawing, The integral junction box access shall covered with weather gasket to prevent ingress of moisture and vandal proof. Poles shall have large diameter entries for incoming and outgoing cable and two earth studs. The pole fabrication shall conform to the drawings and where such drawing is not available; the contractor shall make such drawing and have it approved before fabrication. It will be fixed with the foundation, j bolt etc. as shown in the drawing. Pole shall supplied with 2 Nos. 40 mm diameter pipe for each cable entry / exit.

The pole shall supply with a multi-way integral type terminal block, MCB etc. and all required accessories as shown on the drawings. Pole shall have a concrete foundation complete in all respect with foundation bolt, required hardware, reinforcement etc.

-

B. SPECIAL CONDITION FOR TESTING

(CONTRACTOR TO READ THIS CAREFULLY)

1.0 SCOPE :

If required contractor should have to take all necessary testing/ random testing of equipments and component prior to supply as per the guidelines / rules / sampling method etc. of IS at manufacturing works or other standard lab in presence of Client's representative & consultant as witness testing. Any deviation in parameters which is not as per IS, is not accepted and client reserve the rights to reject the same at any stage of the project.

C. APPLICABLE STANDARDS

Sr. No.	IS No.		Description
1)	IS: 2026-1977 &1981 -1994	:	Power transformers fittings.
2)	IS 3639-1966	:	Fittings and acc. For P.T.
3)	IS10028-Part III 1981	:	Installation of Transformer.
4)	IS: 13118-1991	:	Specification for High voltage AC circuit breakers.
5)	IS: 335-1993	:	Insulating oil for Transformers & switch gear.
6)	IS: 2705-1992	:	CT for measuring and protection.
7)	IS: 3156-1992	:	Voltage (Potential) Transformers.
8)	IS: 3156-1992	:	Voltage Transformer.
9)	IS: 8623-Part II	:	Bus-bar arrangement and marking
10)	IS: 2099-1986	:	Bushing
11)	IS: 5621-1980	:	Large Hollow Porcelains Insulator
12)	IS: 2544-1973	:	Insulators greater than 1000V
13)	IS: 2629-1985 IS: 2633-1986	:	Hot Dip Galvanizing
14)	IS: 3842-1967	:	Relays for AC system
15)	IS: 1248-2003	:	Meters (measuring).
16)	IS: 10118-1982	:	Installation of Switch gears.
17)	IS: 692-1994	:	HV Cable Paper Insulated Lead Sheathed Cables for Rated Voltage up to and Including 33 kV Specification.
18)	IS: 1255 -1983	:	Installation of HV cables and jointing.
19)	IS: 3043-198	:	Code of practice for earthing.
20)	IS: 13947-Part II I -1993	:	HD Air breaker, Switch gears and fuses for Voltage not exceeding 1000 Volts.
21)	IS: 13703-Part IV	:	Selection, installation and maintenance -1993 of of fuses up to 650 Volts.

22)	IS: 13947-Part I -1993	:	General requirements for switch gear and control gear for voltage not exceeding 1000 Volts.
23)	IS: 13947-Part III - 1993	:	Air-break isolators for Voltage not exceeding 1000 Volts.
24)	IS:8623-1993	:	Factory built assemblies of switch gears and control gears for voltage up to and including 1000 Volts A.C. and 1200 Volts D.C.
25)	IS: 11353-1985	:	Marking and arrangement of switch gear bus bars main connectors and auxiliary wiring.
26)	IS: 13947 PART-1	:	Cubical Boards
27)	IS: 8084-1976	:	Insulated Bus bar rating.
28)	IS: 2675-1983	:	Enclosed distribution fuse boards and cut-outs for Voltage not exceeding 1000 Volts.
29)	IS: 8828-1995	:	Miniature Circuit Breaker.
30)	IS: 9926-1981	:	Fuse wire used in rewirable type electric fuses up to 650 Volts.
31)	IS: 1554-Part I - 1988	:	PVC insulated electric cables Heavy duty.
32)	IS: 3961-Part II & IV -1967	:	Recommended current rating for cables
33)	IS: 8130-1984	:	Copper conductor in insulated cables and cores.
34)	IS: 8130-1984	:	Conductor for insulated electric cables and flexible cords.
35)	IS: 3975-1999	:	Low Carbon Galvanized Steel Wires, Formed Wires and Tapes for Armouring of Cables - Specification
36)	IS: 5831-1984	:	PVC insulation and sheath of electric cables.
37)	IS: 8130-1984	:	Aluminum conductor for insulated cables.
38)	IS: 11955-1987	:	Recommended current rating for Cable.
39)	IS: 732-1989	:	Code of practice for electrical wiring installation system Voltage not exceeding 650 Volts.
40)	IS: 1646-1997	:	Code of practice for fire safety of Buildings (general) electrical installation.
41)	IS: 9537-1981	:	Rigid steel conduits for electrical wiring.
42)	IS: 2667-1988	:	Fittings for rigid steel conduits for electrical wiring.

43)	IS: 3480-1966	:	Flexible steel conduit for electrical wiring.
44)	IS: 3837-1976	:	Accessories for rigid steel conduits for electrical wiring.
45)	IS: 694-1990	:	PVC insulated cables (wires).
46)	IS: 9537-Part III -1983	:	Installation of Rigid non-metallic conduits for electrical wiring.
47)	IS: 6946-1973	:	Flexible (playable) non-metallic conduits for electrical installation.
48)	IS: 1293-2005	:	Plugs and sockets up to 250V.
49)	IS: 8130-1984	:	Conductors for insulated electrical cables and flexible codes.
50)	IS: 9537-1980	:	Specification for conduit for electrical installation.
51)	IS: 3419-1988	:	Accessories for non-metallic conduits for electrical wiring.
52)	IS: 3854-1997	:	Switches.
53)	IS: 6538-1971	:	Plugs.
54)	IS: 13585-Part I -1998	:	Shunt Capacitors for power systems up to 650V.
55)	IS: 1370	:	Low voltage fuse and links up to 1000 volts.
56)	IS: 1913-1978	:	General and safety requirement for lighting fittings.
57)	IS: 1944-1981	:	Code of practice for lighting public thorough fares.
58)	IS: 3528-1966	:	Waterproof electric lighting fittings.
59)	IS: 3553-1966	:	Water tight electric lighting fitting.
60)	IS: 1239-Part I -2004	:	Mild Steel tubular and other wrought steel pipe fitting.
61)	IS: 10322-Part V -1987	:	Luminaries for street light.
62)	IS: 13703-Part III -1993	:	HRC fuses having rupturing capacity voltage up to 1000V.
63)	IS: 2312-1967	:	Exhaust Fan.
64)	IS: 374-1979	:	Class I Ceiling Fan.
65)	IS: 7098 (Part I, II, III) -1988	:	XLPE armoured Cables up to 1000V.

NOTE: All codes and standards means the latest where not specified otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

PLEASE FOLLOW:

a. Indian Electricity Act of 1910 and rules issued there under revised up to date.

b. Regulations for electrical equipment in building issued by The Bombay Regional Council of insurance Association of India.

D. LIST OF APPROVED MAKE / MANUFACTURER

1)	Rigid PVC Conduit	:	ISI & FIA approved & manufactured from virgin material. Precision, Nihir, Polycab, BBC, BEC
2)	Accessories for conduit	:	Same make as of pipe
3)	Flexible Copper Wires	:	FRLS type: KEI, Havells, Polycab
4)	Switch fuse Units 60 Amps - AC 23 duty	:	Schneider, Siemens, Lauritz Knudsen (L&T), Hager.
5)	DB/MCCB/MCB/RCCB/Iso & Acc:		Legrand (Lexic), Schneider MG, Lauritz Knudsen (L&T), Hager.
6)	PVC tape	:	Steel grip, Anchor
7)	HRC Fuses	:	Schneider MG, Siemens, Lauritz Knudsen (L&T), Hager.
8)	LT Cables	:	KEI, Havells, Polycab, Finolex, RR Kabel
9)	Glands	:	Compression type, Heavy duty and deep threading with rubber ring and double washers. (Sample to be approved) HMI, Comet
10)	Cable Lugs	:	Jainson/ Hmi/ Raychem/ Baliga/ Skytone / 3-D
11)	Industrial Plug-socket	:	Legrand, Indoasian, Lauritz Knudsen (L&T), Schnieder, Hager
12)	Connectors	:	Wago / Elmex / Connectwell / Phoenix
13)	M.S. Conduit ISI	:	BEC, Steel Craft, AKG
14)	Meter (DIGITAL ENERGY METERS) :		Secure, L&T, ElMeasure, HPL
15)	Panel Fabricators (Metallic)	:	CPRI approved vendors only
16)	Anchor Fasters	:	Hilti, Fischer, Wurth
17)	Meters (V, A, PF etc)	:	Conzerv, AE, RISHABH, El Measure, HPL
18)	LT CT	:	KAPPA/ AE / Pragati
19)	DWC Pipes	:	Rex, Dutron, Astral,Ciphon, Tirupati, Gemini
20)	Electrode type Earthing	:	OBO, JEF, Axis, Cape
21)	Control Cables	:	Finolex, Primecab, Poly Cab, RR Kable
22)	Led Chip	:	Philips Lumiled / Osram / Nichia / Cree
23)	"B" CLASS ERW G.I. PIPES	:	Tata , Surya , Zindal , Zenith , Asian

24) Water Tight Junction Box	:	Hensel, Schneider, Spelsberg, Neptune.
25) Light fixtures	:	(Keselec, Philips, Lighting Technologies, Neri)
26) Electrical Pole	:	(Keselec, RR Ispat, Reytech, Trans Rail, Bajaj,)
27) Timer	:	Schneider, Siemens, Lauritz Knudsen (L&T), Legrand, Gelco
28) Stabilizer	:	Servo con, Protek, Beltronics, Fugi
29) SPD/VSP	:	Legrand, Schneider, Hager, Lauritz Knudsen (L&T)
30) Controller	:	Cimcon, Philips, Keselec
31) HDPE Pipe	:	Dutron/ Supreme/ Reliance/ Astral

Special Notes:

- The successful tenderer will have to supply the makes from above in consultation with the Client / Architect / Consultant without any extra cost.
- The tenderer should have to submit considered makes from the above list along with the tender with covering letter of separate letter enclosure. However, the final decision for accepting make specified by tenderer would be of client / Architect / Consultants.
- As far as possible, the successful tenderer will have to place order directly to the manufacturer OR it's authorized dealer.
- The Client/Architect/Consultants have right to check the challans of supplier.
- The MCB and MCB DBs must be of same make.
- Make of components required to be used by contractor to complete the installation, if not mentioned anywhere, shall be required to GOT IT APPROVED by Client/Architect/Consultant before installation in writing manner.
- The contractor shall submit the sample of each item / component of above mentioned approved make for the approval of the Client/Architect/Consultant.
- Pole manufacturers should have at least two years of manufacturing experience in similar field and require to provide necessary documents to client for necessary verification.

ITEM SPECIFICATION

SUMMARY PAGE

I. Electrical Works Page No

A. Item Specification

ELECTRICAL ITEM SPECIFICATION

1.0 Panels Section Feeder Pillar

1.1 Supplying, unloading at site, shifting to site, assembling, leveling, grouting, erecting, Testing, & Commissioning double compartmentalized Double door type section feeder piller with IP 55 protection & should be powder coated fabricated from 14 Guage CRCA sheet & folded channel totally enclosed cubical type with pad lock arrangement. The successful tenderer will have to prepare general arrangement with dimensions (referring the typical elevation drawing provided) & get it approve through Architect/ Consultant. All civil work including RCC platform for section pillar should be in scope of Electrical contractor complete in all respect as per detail drawing and directed by engineer in charge.

1) Material:

MV switch gear & power panel shall confirm E-1.

2) Workmanship:

1. Main bus bar should be electrolytic tinned copper type.
2. All internal wiring and all connections shall be with copper wires and strips as required. Use copper flexible wire for below 100 Amps and copper strips for 100 Amps and above ratings.
3. All components, frame etc shall be earthed. A common internal earth bar with two separate earthing leads to be provided.
4. Painting or powder coating to be done on all sheet metal works as required.
5. Panel should have MS base frame for floor mounting unless otherwise specified.
6. The board should be front operated and extensible type.
7. Compression type brass glands and crimping lugs for incomer and outgoing ends.
8. All ammeters to be provided with C.T.s and selector switch and voltmeter with selector switch and control fuses.
9. Panel components shall be as specified.
10. The design and location of all panels to be approved by the architect / consultant before fabrication and Instalment.
11. All panels should be dust and vermin proof.
12. All panels should be fabricated out of 14 gauge sheet, the door should be made from 14 gauges (2 mm) and the other parts should be made from 14 gauge sheet metal (**Applicable for Metallic Panels**).
13. All meters should be digital type with communication port only unless and otherwise specified.
14. The metering on main panels shall be LOAD MANAGER with communication port unless and otherwise specified.

15. All the Switches used should be capable of withstanding the AC23 duty for motor operation. The Switches should have quick make quick break. The contacts should be silver plated double break type.

16. The board should withstand the system prospective fault current.

17. Engraved plastic labels shall be provided indicating the feeder details, capacity, cable size and load in KW and danger signs.

18. The entire panel board should be with adequate height width & depth as per relevant prevailing I.S. code and Installation include foundation bolts of suitable size as per requirement.

19. All compartment doors should be concealed hinged type & handles of feeders to be interlocked mechanically with the doors such that door cannot be opened when the switch is in 'ON' position & switch cannot be 'ON' when the door is in open position.

3) Mode of measurement:

The rate shall be for one unit of panel complete in all manners.

1.2 to 1.4 SITC of Plug point, JB, etc.

1) Material

As per BOQ.

2) Workmanship

As above

3) Mode of measurement:

The rate shall be for one unit of JB or Plug point etc. complete in all manners.

2.0 CABLE TRENCH

2.1 Excavation and back filling of 90 cms deep cable trenches required for laying the cables directly buried in the ground. This includes supplying and providing cable markers at an interval of 10 meters.

1 **Material:**

All the tools and tackels required for the excavation shall be provided by the contractor. Cable markers shall be provided.

2 **Workmanship:**

Excavation shall be done as per the route specified in the plan of the consultant. Also the depth as specified in the item shall be strictly maintained. Cable markers shall be installed at length specified in the item.

3 **Mode of measurement:**

The item shall be paid in Running Mtr. And the measurement shall be certified by the engineer in charge from the Clients side. Depth of the excavation shall be measured from average ground level given in drawing

2.2 Covering of cable with second class bricks or cement tiles laid cover the cable crosswise & also on both sides with covering of 7. 5 Cms. layer of sand above & below cable (16 bricks per meter)

1 **Material:**

All the tools and tackels required for the spreading fine sand and back filling shall be provided by the contractor. Bricks of 2nd class or higher quality shall be used.

2 **Workmanship**

Bricks shall be laid on all the three sides of the cable as per the drawing of the consultant. Proper thickness for the fine sand as specified in the item shall be strictly maintained. After back filling proper levelling shall be done and lumps of soil should not be visible. The trench should give a levelled look.

3 **Mode of measurement:**

The item shall be paid in running Mtr. and the measurement shall be certified by the engineer in charge from the Clients side.

3.0 LT CABLING

Supply, testing and Laying XLPE steel wire/flat armoured cable of 1100 V grade of Aluminum / Copper Conductor of following sizes in ready-made trench or mounted on wall with necessary clamping arrangement or in pre-laid RCC hume / DWC pipe with necessary cable identification mark to be provided at distance of 10 mt. The vertical cable on wall shall be drawn in prelaid conduit for vertical mechanical support.

1) Material

Shall be confirm to E- 2,

2) Workmanship

Installation

A) Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

B) Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be laid in GI/PVC pipe and not to fix on wall slab directly or drawn through GI / PVC pipes fixed on wall or ceiling and supported at not more than 500 mm. Where number of cables is run, necessary perforated cable trays shall be provided wherever shown. Perforated trays shall be mild steel or Aluminum as specified in the schedule of work and supported on mild steel frame work as shown on drawings or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic / Aluminum identification tags shall be provided at every 30 m. All cables laid shall be properly dressed and at least 50 mm space shall be kept between the cables.

C) Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

D) In the case of cables buried directly in ground, Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

E) The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

F) In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rain water may enter the building after the cables are

tested. The pipes shall be sealed with M. seal & then tarpaulin shall be wrapped around the cable for making the entry of water light.

G) Cables shall be provided with stainless steel/Aluminum cable identification tags at a maximum distance of 10m.

H) All cables to be laid should be properly dress and at least 50 mm space should be kept between the cables.

Testing:

A) MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:

1) Continuity on all phases.

2) Insulation Resistance.

(a) Between conductors.

(b) All conductors and ground.

All test readings shall be recorded and shall form part of the completion documentation.

3) Mode of measurement

The cable shall be measured in per running mtr. Basis and the rates shall include,

1) Cables and clamps
2) Installation, Commissioning and testing.

Cable length shall be certified by engineer in charge from Client's / PMC side.

4.0 CABLE TERMINATION

4.1 Supplying & fixing single/double compression type Brass glands & making joint with necessary bi metalic crimping socket of long nack type connecting the same to various equipment/panel/DB etc. for the following sizes:

1) Material

Should conform to E – 2.

2) Workmanship

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool.

3) Mode of measurement

Rate shall be considered for 1 nos of joint complete.

4.2 Supplying & making joint with necessary bi metallic crimping socket of long neck type connecting the same to various SFP's/ PP/ Poles etc. for the following sizes for all cores at end as specified.

1) Material

Should conform to E –2.

2) Workmanship

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool.

3) Mode of measurement

Rate shall be considered for 1 nos of joint for all cores complete but without Gland.

5.0 EARTHING

5.1 Providing earthing stations for equipment earthing as shown and specified in drawing for equipment complete with :

Supplying & erecting earth pit of minimum bore dia.150mm size approved make Earthing Electrode consisting Pipe-in-Pipe Technology as per IS 3043-1987 made of corrosion free G.I.Pipes having Outer pipe dia of 50mm having 80-200 Micron galvanising, Inner pipe dia of 25 mm having 200-250 Micron galvanising, connection terminal dia of 12mm with constant ohmic value surrounded by highly conductive compound with high charge dissipation suitable for following type of applications.

(c) For Electrical Installation covering Transformer Neutrals, Lightning arrester Earthing, A.C.Plant & Sensitive Computer System(like Automation, SCADA) i.e independent Earthing in normal soil.

Length of Pipe : 3.00 mtrs

Back filling Compound :2 nos Bags of 25 Kg.

1) Material

Shall be as per E - 6

2) Workmanship

A) The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

B) Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS : 3043, Code of Practice for Earthing Installation.

C) The earth conductors (Strips / Wires copper/ Hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws \ bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

D) The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

E) Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

F) The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

G) The connection between strip and plate shall be through stainless steel bolts and washers.

Following tests shall be carried out:

A) The following earth resistance values shall be measured with an approved earth meager and recorded.

1) Each earthing station

2) Earthing system as a whole

3) Earth continuity conductor

B) Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 3 Ohm in each case.

C) Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

D) All tests shall be carried out in presence of the Site Engineer & the test results shall be submitted in duplicate to the consultants & client with the signatures of the authorities present at the time of testing.

3) Mode of measurement

Rate shall be considered for one unit of pit complete.

5.2 Earth wire/strips:

Supply and laying cu. earthing required size strips for interconnecting the earthing stations, panels, DB's etc. in built up trenches, on walls/ceiling, buried in ground generally as specified and shown on drawings complete with:

1) Material

sizes specified in the BOQ.

2) Workmanship

Cu. Strip shall be laid along with the cables and mains as instructed by the consultant and along the path of the cable. The strips/ Wire shall be terminated at both the ends properly via brazing SS nut and bolts with double washer screws and nuts as instructed by the consultant. Strips shall not be bend to and extent that they go brittle.

3) Mode of measurement

The rate shall be considered on meter basis and the quantity shall be certified by the engineer in charge from Clients side.

6.0 MISCELLANEOUS

6.1 Supplying and laying following sizes PVC pipe of approved make in open / concealed in wall manner including excavation and back filling (if required) as per layout and drawing and re-filling the trenches etc. complete as directed.

1) Material:

Rigid and Flexible conduits:

A) All conduits shall be rigid PVC having minimum wall thickness of medium gauge 1.6 to 1.8 approved by F.I.A. & I.S.I. All rigid pipe and its accessories shall be of suitable material complying with IS: 3419-1989 and IS: 9537 (Part 5) 2000 for flexible conduits.

The conduits shall be circular in cross-section and designated by their nominal outside diameter. Minimum thickness of walls shall be as follows:

a) Up to 38 mm. diameter - minimum 1.8 mm. wall thickness.

b) Above 40 mm. diameter - minimum 2.2 mm. wall thickness.

The maximum number of PVC insulated copper conductor cables of 650/1100V grade confirming to IS: 694-1990 that can be drawn in one conduit of various sizes shall be as specified.

B) Flexible conduits shall be formed from a continuous length of spirally wound interlocked steel strip with a fused zinc coating on both sides. The conduit shall be terminated in brass adapters.

Accessories:

A) PVC conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs etc. shall be specifically designed and manufactured for their particular application. All conduit fittings shall conform to IS: 2667-1964 and IS: 3857-1966. All fitting associated with galvanized conduit shall also be galvanized.

2) Workmanship

As directed by engineer in charge

3) Mode of measurement

4) The rate shall be for 1 mtr of PVC pipe complete with all required accessories.

6.2 Providing and laying non pressure DWC of approved make.

1 Material

The pipe should be of NP2 class, DWC Pipe

2 Workmanship

Including excavation of trenches, laying the pipe as per layout and drawing, filling the joints with stiff mixture of cement mortar (1:1) and jute, curing, testing the pipe and re-filling the trenches etc. complete as directed

3 Mode of measurement

The rate shall be for 1 mtr of DWC Pipe

6.3 Follow Up with supply co. for getting supply to various Section Pillar. The scope also covers lying of L.T. cable from Section Pillar to company's cut-out. This also covers to obtain any permission required for road crossing from any authority (if required), Filling the necessary application to supply co., following up and getting the supply filling the necessary test report to the supply co. All official fees shall be paid by client on presentation of documentary proof and all other out of pocket expenses shall be of contractor.

1) Material

Not Applicable

2) Workmanship

As directed by engineer in-charge /Consultant.

3) Mode of measurement:

Shall be measured on lump sum basis.

7.0 EXTERNAL LIGHTING

General Note: The sampling should be required for each type of light fixtures as per requirement. **No extra cost** shall be paid for the process to the contractor; it is the responsibility of contractor to co-ordinate with all the required concerns & vendors for sampling & takes the approval of the same from the authorities of client & architects.

7.1 Poles

7.1.1 Supply, erecting, testing, commissioning of 4 Mtr. / 7.5 Mtr. GI pole (As per BOQ).

1) Material

Shall conform E - 7.

2) Workmanship

The pole shall be installed as shown in the drawing and shall be checked for proper earthing. Wiring sequence shall as per the design given by the consultant.

3) Mode of measurement

The rate shall be for one pole complete in all manners.

7.2 Supplying, erecting, connecting, testing and commissioning of Following type LED Decorative Light Fixture with all necessary Hardware, Internal Wiring with Driver, lamp etc. all required accessories Complete in all respect for at site.

1) Material

As per item no 7.1

2) Workmanship

As per item no 7.1

3) Mode of measurement

The rate shall be for one no of light fixture with Lamp / LED & control gear / Driver complete.

SECTION IV

TECHNICAL SPECIFICATIONS

SUB SECTION 4.3
TECHNICAL SPECIFICATION
FOR
IRRIGATION AND HORTICULTURE WORKS

IRRIGATION WORKS

SCOPE OF WORKS

- This contract is for Supply, Installation, Commissioning & maintenance of **SRFD Project** Irrigation System
- The contract shall include for the complete installation, testing and commissioning of the irrigation system summarized below and as per the specification and drawings:
- The irrigation Contractor is to visit site and ensure that he can fulfill the requirements as stated in this document; submission of tender deems this to be the case. No allowance will be made for claims due to failure to examine the enclosed specification and the site.
- The scope of Irrigation will start Irrigation Water Tank.
- Providing, fixing & commissioning of Pump station & self-cleaning filter on the delivery main of the pump.
- Laying the Main and Sub-main lines for Landscape Irrigation scheme.
- Providing Product data sheet prior to supply & installation, as built drawings and O&M manuals for client's approval and records.
- Packing and transportation from the manufacturer's works to the site including insurance, customs clearance & port clearance, port charges, if any.
- Receipt, storage and preservation of equipment at the site.
- Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment / material including successful Commissioning.
- It is not the intent to specify all aspects of design and construction of equipment mentioned herein. Systems, sub-systems and equipment shall conform in all respect to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in most economic option and is acceptable to the client's representative, who will interpret the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable to Indian standards mentioned elsewhere in tender specification document.

EXCLUSIONS

- Intake Pipe, Intake Isolation Valve Chamber, Wet Well, & Pump Room.
- Road crossing – Road cutting, Auguring.

TECHNICAL SPECIFICATIONS

Irrigation

Piping Materials

General:

- All sizes are in metric unit, whereas equivalent imperial unit shall be used in case of imported material.

UPVC Pipes and Fittings:

- The pipes shall be round and shall be supplied in straight lengths with socket ends. The internal and external surfaces of pipes shall be smooth, clean, and free from grooving & other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS: 4985: 1988/2000 & ASTM 1785. The pipes shall be of equitant pressure Class as described in BOQ.

Fittings:

- Fittings shall be injection molded and shall be 10 kg/cm2 pressure rating and to conform to Indian Standard, however all bends should be fabricated from 10kg/cm2 Pipes & Sch 40 & 80 Fittings for PVC Pipes as per ASTM 1785.

HDPE Pipe & Fitting

- The HDPE pipes is to be manufactured, supplied and delivered under the scope of this contract so as to meet the requirement of pressure rating not less then PN10 from material grade PE 80 in accordance and conforming to IS 4984 Part-I : 1994 and it's latest revision.

Valves

Mainline Isolation Valves:

- Mainline isolation points will be achieved by installing butter fly valves at designated locations. These valves will be housed in valve boxes.

- PVC Butterfly Valve for Main Line Isolation Shaft – Zinc Plated Steel, Shaft Gasket & O-ring EPDM, Body PVC, Torque is 25 n/M. Leak and corrosion resistant stem for easy operation.

Quick Coupling Valves:

- The quick coupling valve shall be a one-piece type. The valve body shall be constructed of red brass. The cover shall be a durable, protective self-closing rubber cover. The valve shall be opened and closed by a brass key of the same manufacturer having a 3/4” (MNPT) and 3/4" (FNPT) outlet. The valve throat shall have a key-way with detent positions for regulating water flow.
  Pressure – 0.35 Bar to 8.6 Bar

Valve Boxes:

- 12" Rectangle Valve Box
  Size:
  Length: 520mm
  Width: 400mm
  Height: 330mm

- Round Valve Box 6” For Hydrants.
  Top Dia: 152mm
  Bottom Dia: 243mm
  Height Dia: 261mm

Hose Pipe

- Construction water hose is ideal for conveying water especially for engineering, construction and industrial development work. It is more rough and tough with longer life. Working Pressure 2.5 to 4.0 kg/cm2.

Laying of pipe work

- Pipes will be laid in the routes and sizes as indicated on the drawings and stated in the relevant sections of this specification. In the case where multiple pipes or electrical conduits are laid in the same trench, they must be located side by side, not crossing each other or stacked one upon the other.

- All pipe laying and jointing will be performed in site in the trench on the prepared bedding; not assembled above ground and placed in the trench at a later stage.

- At the end of each day’s work, all open ends of pipe work and conduit will be plugged and staked to prevent entry of vermin, dirt, water or moisture and movement of the pipe.
- Where pipe is required to pass over or under drainage pipe, the Contractor is to ensure a minimum clearance of 100 mm between the irrigation pipe and the drainage pipe.
- Main Line Trench Should be 600 mm + Mainline Size and Sub main should be 450 + Sub main size.
- Refilling trench with good soil and free from any rock/ stones.
- Mainline Pipe should be Tested as per IS Specification.

Crossings at Road pipe:

Road crossing

RCC Hume pipe

- Where the pipe work goes under a road, the contractor will install:
- RCC Hume pipe sleeve of sufficient diameter to allow easy installation.

Trench Work:

Mainline Excavation:

- Trenching for mainlines will be performed by hand digging only
- The depth of trench for mainline shall be minimum 600 mm + Pipe diameter from the finish ground level.
- The material removed whilst digging will be placed no closer than 300 mm to the top edge of the completed trench and there will be a minimum of loose soil left in the bottom of the trench prior to pipe laying.

Sub-main/Lateral line Excavation:

- Trenching for lateral lines will be performed by hand digging or by backhoe with a maximum bucket width of 300 mm, to minimize disturbance to the surrounding area.
- The depth of trench for sub mainline shall be minimum 450 mm + Pipe diameter from the finish ground level.
- These trenches will be straight with the bed level and graded.

Back Filling:

- Where trench work encounters unsuitable bedding material such as hardened clay, rock, shale, loose stones, excessive tree roots, etc. a 100mm bed of sand or loam will be placed below the pipe in the trench prior to pipe laying.

- This policy will apply to the back filling of all trenches, where the pipe will be covered with 100 mm of sand or loam to prevent similar debris coming in contact with the pipe or control cables. Under no circumstances will construction debris of any kind be included in any back-fill material.

- Allowances should be made for back filling during the heat of the day to minimize the effects of thermal expansion and contraction on pipe already laid.

- Trenches will be back filled on the same day as they are excavated. i.e., trenched will not be excavated until required. This is to prevent flooding of trenches and floatation of pipes.

Compaction:

- Compaction should take place only after suitable bedding and back filling has been completed to the satisfaction of ENGINEER I/C.
- Compaction can be achieved by either:
  - Plate compaction in layers not exceeding 300 mm.
  - Wheel rolling with a suitable vehicle after 450 mm of cover is provided.
- Regardless of which method is used, it will remain the Contractor's responsibility to ensure reinstatement of trench subsidence during both the contract and the defects liability period.

Staking:

- The staking of the mainline, sprinklers, valve and controller will be done by the contractor subject to approval by the Engineer I/C Representative.

Irrigation Work – Make List

Sr. No.	Item Description	Make
1	UPVC pipe with fittings	Astral / Finolex / Supreme
2	Valve Chamber for Valve & Hydrant	Ecorain / Rainspa / Cepex
3	Quick coupling valve, Key & Swivel Elbow	Harit Automat / HUNTER
4	Hose Pipe	Riblon/ Dutron
5	Isolation Valve	AUDCO / Zoloto / L & T
6	HDPE Pipes & Fittings	Reliance/ Jain

HORTICULTURE & LANDSCAPING

General Notes for Horticulture work:
1.All plants shall be of the size specified in the Plant Schedule & Planting Palette at the time of delivery to the site and shall be obtained from an approved source.
2.All plants shall be supplied as specified in tender documents and the Contractor is expected to import stock if it is not available locally.
3.Consultant shall inspect and approve all imported and locally sourced plant material at place of origin.
4.All plants shall be container grown, except for field grown palm species. Container grown nursery stock shall be vigorous, healthy, and have a well established root system spread throughout the growing medium container to maintain a firm ball when the container is removed.
5.The Tender must be based, without exception, upon plants that are specified. If plants are subsequently found to be unobtainable, alternatives may be submitted, stating how they differ from the Specification. Such substitutions may not be acceptable and submission of further alternatives may be required. Approval in writing shall be obtained for any substitution.

1. GENERAL REQUIREMENTS

1.1. Scope

1.1.1. The scope of this section includes the preparation of planted areas and the supply, planting, protection and maintenance of trees, shrubs, vines, ground cover plants and grass of the species and size shown on the drawings. The section covers the provision of qualified labour, equipment, and material necessary to carry out all operations required for landscaping herein specified and shall be read in conjunction with all other relevant sections of the Specification.

1.2. Submittals

1.2.1. The Contractor shall submit to the Engineer-in-charge information and certificates for materials to be used for this Contract for approval.

1.2.2. Such submittals shall include, but not be limited to the following:

a. Shop Drawings:
The contractor shall submit shop drawings of the planting plans and details to the Architect and Engineer-in-charge for review and action.
The Contractor shall submit a method statement for the soft landscape installation including all milestones according to best practices.

b. Product Data:
Provide manufacturers certified data analysis of all standard products, including fertilizers, soil amendments, herbicides, pesticides, fungicides, showing description of ingredients, and recommendations for usage and application rates for each material to be used.

c. Samples:
1. Samples of all materials to be used in this contract shall be submitted for approval. The approved samples shall be the quality standard for the material and its placement.
The Architect shall inspect all plant material at the site-growing nursery.
The Architect shall reserve the right to reject any plant material deemed unacceptable which shall then be replaced with approved specimens

d. Certifications & Quality Control: Submit the following for approval:
A certified analysis by an approved laboratory for non-standard products (soil, compost).
Certificates confirming the origin, size, and age of all plant material.

Phytosanitary certificates for all imported plant material.
Turf: Provide certification from the grower for the type and trueness to the grass variety or strain.

e. Programs and Schedules: Provide the following for approval:
Schedules showing program of implementation for each type of landscape work, indicating anticipated dates and locations for each type of planting.
The contractor shall submit a Plant Procurement Schedule, identifying the source of every plant species, including the imported plants.
If necessary revised planting schedules with documentation of reasons for the revision.

f. As-Built Drawings:
1. The As-Built drawings shall be submitted to the Architect and Engineer-in-charge for approval prior to the issue of the Completion Certificate.

2. The drawings shall include accurate documentation of the final planting installation, including but not limited to:
- Plant material substitutions with size, genus, and species.
- Material substitution.
- Revisions to the scope of work.

3. On approval of the As-Built drawings, the Contractor shall forward the following:
-Three complete sets of As-Built drawings properly folded and provided in the plastic folders as part of the Operations and Maintenance manual.
-Annual maintenance schedule
-One set of computer discs properly labeled and marked.

1.3. Project/ Site conditions

1.3.1. Weather conditions:

a) All work shall be carried out during the appropriate season and in weather conditions suitable for the operation.
b) When special conditions affect the planting times and conditions, a planting schedule shall be submitted to the Engineer-in-charge for review and approval.

1.3.2. Existing Services

a) The Contractor shall determine the location of all existing underground services prior to commencing excavation works. Damage to underground utilities shall be repaired at the Contractor's expense.
b) When conditions on site are considered detrimental to the plants, such as rubble, ongoing works or obstructions, the Contractor shall notify the Engineer-in-charge prior to performing the planting works.
c) Any excavation in confined spaces, around existing trees or in the vicinity of major utility services shall be executed by hand.

1.3.3. Rubbish:

All rubbish and litter as it accumulates within the landscape boundary shall be cleared and removed daily.
The areas shall be kept in a clean and tidy condition with all driveways, paths, edges, gutters and gullies swept and kept clear of debris at all times. All rubbish and debris shall be removed from site.

1.3.4. Oil and Petrol Storage

All oil and petrol containers are to be kept in suitable sheds provided by the Contractor, who is to observe all regulations regarding the storage of inflammable liquids. If any areas of soil are affected by oil or petrol spillage, the contaminated soil is to be dug up until uncontaminated ground is reached and removed from site and such areas made good as directed by the Engineer-in-charge.

1.4. Nursery

1.4.1. The Contractor shall establish and maintain a suitable holding/acclimatization nursery on or adjacent to the site. It shall be protected from construction works, shaded from sun and wind, and shall be provided with an adequate supply of irrigation water. The size, location, and timing of establishing the site nursery shall be approved by the Engineer-in-charge.

1.5. Horticultural Supervisor

1.5.1. A written approval of the Engineer-in-charge shall be obtained for the Contractor's proposed Horticultural Specialist.

1.5.2. The written approval of the Engineer-in-charge shall be obtained for any temporary or permanent replacements.

1.5.3. The Engineer-in-charge shall inspect all plants for approval and shall supervise the planting of all accents and ornamental palms.

1.6. Approved Chemicals

1.6.1. Only chemicals approved and listed by the IIHR India shall be used. All chemicals shall be non-toxic to human beings, birds, and animals and subject to the approval of a qualified specialist. The Contractor shall be liable for ensuring that all chemicals are stored separately, handled, and supplied strictly in accordance with the manufacturer's printed instructions. Neem cake shall be used as biological pesticide where specified.

2. PRODUCTS AND MATERIALS

2.1. Soil

2.1.1. Sweet soil shall be free draining, non-toxic and capable of sustaining healthy plant growth. The soil shall not contain calcium carbonate, subsoil, refuse, roots, heavy clay, noxious weeds, phytotoxic materials, coarse sand, rocks, brush, litter, or any other deleterious materials.

The soil shall have the following characteristics:

1.	PH	6.0 to 7.5 of saturated soil
2.	EC	less than 2500 mmhos in saturated extract
3.	Chlorides	<220 ppm in saturated extract
4.	Sulphates	<15 ppm in saturated extract
5.	SAR	<5%
6.	Nitrates	75 ppm in saturated extract.

2.1.2. Loam made up by particle size as follows:

sand (2mm to 0.05mm)	70% to 80%
silt (0.05mm to 0.002mm)	25% to 30%
clay (<0.002mm)	5% max.

2.1.3. 'Black' sand shall not be approved.

2.1.4. The representative samples of sweet soil shall be analysed for all the above characteristics and results Submitted to the Engineer-in-charge for approval.

2.1.5. The soil report shall include recommendations on soil amendment, and fertilizer application, depending on the soil analysis results.

2.2. Compost

2.2.1. Compost shall be approved well-rotted cow manure (poultry manure shall not be accepted), free from any deleterious matter. The rotted manure is to be guaranteed to be free from nematodes and harmful bacteria. Special care is to be taken to ensure manure is weed free (especially cypress rotundus)

2.2.2. Vermi compost shall be recycling of garden waste/ kitchen waste or other preferable kind of waste. It can be done by natural composting/ vermin composting and mechanical composting (In vessel Composting (OWC)) technique coverts the waste into manure to increase soil fertility and used as manure. It shall be added in soil mixture as suggested by Engineer-in-charge

2.3. Fertilizers

2.3.1. General fertilizer shall be sulphur coated compound N.P.K.16-18-5+ trace elements for shrubs, trees, and grass areas, and shall be Osmocote or equal and approved by the Engineer-in-charge.

2.3.2. Slow-release fertilizer tablets shall be equivalent to N.P.K.18-18-5+TSE or N.P.K 17-17-4+TSE and shall be used for trees and shrubs.

2.3.3. Fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked.

2.3.4. When a mixed fertilizer is specified, the first number shall represent the minimum percentage of soluble nitrogen, the second number shall represent the minimum percentage of available phosphoric acid and the third number shall represent the minimum percentage of water-soluble potash.

2.4. Planting Medium

2.4.1. Planting medium shall consist of a homogeneous mixture of soil, compost and fertilizers as specified.

2.4.2. One bag of compost shall contain 25kg of compost and shall be applied at the following rates:

palm pit	One and a half bags per pit (applied 6months after planting)
tree pit	One bag per pit
shrub pit	Half bag per pit
grass/ground cover bed	Half bag per m2
vine pit	Half bag per pit
shrub bed	One bag per m2
bedding plants	1 bag per m2

2.4.3. General fertilizer shall be applied at the following rates:

palm pit	175 gms per pit (applied 6months after planting)
tree pit	100 gms per pit
shrub pit	50 gms per pit
shrub beds	100 gms per m2
grass/ground cover bed	100 gms per m2
bedding plants	100 gms per m2

2.4.4. Slow-release fertilizer tablets shall be applied at the following rates:

trees	21gms for every 10mm of trunk diameter
shrubs	21gms for every 300mm of height

2.4.5. The rates mentioned in this clause are for the first application prior to planting only. Further applications before and during the maintenance period shall be done in accordance with the Engineer-in-charge's instructions and Client's approval.

2.5. Planting medium for palms

Planting medium shall consist of a homogeneous mixture of soil, compost and fertilizers as specified.

2.5.1. Soil mix in all areas where palms are to be planted will consist of 30% Coco Peat, 30% Composted organic pine bark, 30% sweet sand and 10% Perlite mix.

2.5.2. Coco peat shall be coarse brown coco peat, not containing woody materials, free from sulphur and iron. Its pH value shall be in the range of 4 and 5. Organic matter content shall be 95-99% dry weight, and the water holding capacity shall be from 45-55%.

The peat shall have the following physical characteristics:

- Fibrous quality
- Brown in colour when dry
- High resistance to decay (lasting one year minimum)
- High cation exchange capacity.

2.5.3. Composted organic tree bark shall be aged over a period of 5-10 years to prevent nitrogen drawdown. The composted bark shall typically have a size range of 5-8mm and a pH value of 6.5

2.5.4. The sweet soil shall be free-draining, non-toxic and capable of sustaining healthy plant growth. The soil shall not contain calcium carbonate, subsoil, and refuse, roots, heavy clay, noxious weeds, phyto-toxic materials, coarse sand, rocks, brush, litter or any other deleterious materials.

2.5.5. The sweet soil shall have following characteristics:

a)	PH	6.0 and 7.5 of saturated soil
b)	EC	less than 2500 mmhos in saturated extract
c)	Chlorides	<220 ppm in saturated extract
d)	Sulphate	<15 ppm in saturated extract
e)	SAR	<5%
f)	Nitrates	75 ppm in saturated extract

Physical loam made up by particle size as follows:

Sand (2mm to 0.05mm)	70% to 80%
Silt (0.05mm to 0.002mm)	25% to 30%
Clay (<0.002mm)	5% max.

2.5.6. The representative samples of sweet soil shall be analyzed for all the above characteristics and results submitted to the Engineer for approval.

Perlite shall be used in the growing medium for its light weight, physical stability and ability to provide non capillary pore space, which improves the soil texture.
Horticulture grade perlite shall have a 25% size grading between 1.18mm and 0.0075mm.

Bulk density shall be approximately 0.1g/m3 and moisture less than 0.5%.

2.6. Plants

2.6.1. General

a. All plants shall be of the size specified in the Plant Schedule & Planting Palette at the time of delivery to the site and shall be obtained from an approved source. The Contractor shall allow for all imported and locally sourced plants to be 'grown on' in the holding nursery in order to meet the required specification at time of planting.

b. All plants shall be supplied as specified in tender documents and the Contractor is expected to import stock if it is not available locally. All imported plant material must be sourced from a reputable Nursery

to be approved by the Architect and Engineer-in-charge prior to purchase. Plants shall be true to and supplied under Latin names. Synonyms must be checked with the Architect and Engineer-in-charge.

c. Engineer-in-charge shall inspect and approve all imported and locally sourced plant material at place of origin. Samples from all plant material shall be made available for approval by the Architect and Engineer-in-charge.

d. When inspected, plants shall show no sign of pest infestation, disease, infection, nutrient deficiencies or sunscalds.

e. All plants shall be container grown, except for field-grown palm species. Container grown nursery stock shall be vigorous, healthy, and have a well-established root system spread throughout the growing medium container to maintain a firm ball when the container is removed.

f. All trees and particularly palms forming avenues or formal planting lines shall be selected to be uniform size and appearance all to the approval of the Architect and Engineer-in-charge. Clear stem height, overall height, and trunk girth shall be consistent and standardized among the selected trees/palms stock.

g. The Tender must be based, without exception, upon plants that are specified. If plants are subsequently found to be unobtainable, alternatives may be submitted, stating how they differ from the Specification. Such substitutions may not be acceptable, and submission of further alternatives may be required. Approval in writing shall be obtained for any substitution.

h. Plants shall be true to and supplied under Latin names. Synonyms must be checked with the Architect and Engineer-in-charge. Nomenclature of trees and plants shall confirm to the scientific names given in:

(i) Royal Horticultural Society, "Directory of Gardening"
Oxford University Press, reprinted 1974 and Supplement 1969
(ii) Hortus 3.
(iii) Exotica

All plants must agree with the botanical description in these books. Hortus 3 and Exotica are the only authorities for plants that are not listed in the RHS Directory.

2.6.2. Trees

a. Tree stock shall be container grown, or bur lapped with geo fabric and grown in sandy beds.

b. Trees shall have a girth of 10cm to 25cm unless otherwise specified in the planting schedule (girth/ trunk circumference shall be measured at 1.0m above the soil level, excluding container height).

c. The tree trunk shall be free of any damage caused by insect, fungal or viral infestation and free from any physical damage or scarring.

d. The tree trunk shall be straight and vertical. There should not be any abrupt changes in girth of the trunk.

e. The form or shape of the crown shall be typical for the specimen of the species. The crown shall not be significantly deformed by wind, pruning practices, pests or other factors.

f. Trees shall be single stemmed unless otherwise specified.

g. Main branches shall be well spaced with a minimum of four branches at planting.

h. The size, colour and appearance of leaves shall be typical for the time of year and stage of growth of the tree species. Leaves shall not be damaged or discoloured.

i. The root system shall be free of injury from biotic (insects, pathogens) infestation and shall be uniform throughout the soil mix or growth media. Container grown nursery stock shall have a well-established root system reaching the sides of the container to maintain a firm ball when the container is removed.

2.6.3. Shrubs/ Ground Covers/ Cactus and Succulents/ Other Plantation

a. Shrubs and ground covers shall be twin or multi stemmed, full and bushy. The form or shape of the plants shall be typical to its species. Should be nursery grown in 12" grow bags.

b. The size, colour and appearance of leaves shall be typical for the time of year and stage of growth of the plant species. Leaves shall not be damaged or discoloured.

2.6.4. Hedges

a. Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters, respectively.

2.7. Tree Stakes

2.7.1. All stakes shall be double stakes of timber, straight, free of projections and pointed at one end. The stakes shall be pressure impregnated with non-injurious wood preservative to be applied at least two weeks before use.

2.7.2. Stakes shall be stained green. A sample shall be submitted and approved by the Architect and Engineer-in-charge.

2.7.3. The tripod type tree guard/ tree stakes be made out of 3 no 50mm dia and approximate 2.5 mt long (2.0 mt above ground and 0.50 mt below ground) Eucalyptus/ Cedar stakes.

2.7.4. The tree guard stack shall be painted with bituminous paint at below ground portion plus 150mm above ground portion. The tree guard shall be installed vertically outside the root ball properly, so tree grown in upright position. The tree guard shall be maintained up to the tree become well set and as directed by architect and Engineer-in-charge.

2.7.5. For Climber, contractor shall provide vertical support (i.e., metal wire/ frame, jute thread, or similar kind of support suitable to type of species) as per site condition during plantation and as approved by Engineer-in-charge.

2.8. Tree Ties

2.8.1. Tree stakes shall be tied to steam of planted tree with rubber tie/ patta of size 30mm x 10mm in twisted pattern as per drawing. Trees shall be supported by two stakes each and shall be fixed to the tree by a suitable rubber tie.

2.9 Temporary Planting Screens

2.9.1 Whenever planting in an exposed position liable to extreme prevailing wind conditions and windbreaks shall be provided until such time as the planting is firmly established. Screens shall be 1750mm high shade cloth of 75% density supported on a firm wooden frame of adequate size and diameter so as not to disturb the growth of the plant.

2.10 Anti-desiccant

2.10.1 Anti-desiccant shall be an emulsion type, film-forming agent designed to permit transpiration but retard excessive loss of water from plants. This is to be done during transplanting.

2.11 Mulch

2.11.1 Mulch shall be tree bark mulch or smooth river pebbles of the following random distribution size:
Length: 10mm - 60mm
Width: 10mm - 50mm
Thickness: 4mm - 10mm

2.11.2 Certified product data and sample shall be submitted and approved by the Architect and Engineer-in-charge.

2.11.3 Mulch shall cover all shrub beds, in a 75mm layer, unless otherwise specified by the Architect and Engineer-in-charge.

2.12 Pruning Paint

2.12.1 Pruning paint shall be waterproof, antiseptic, adhesive, elastic and free of kerosene, coal, tar, creosote and other substances harmful to plants.

2.13 Drainage layer system

2.13.1 The Contractor shall install a gravel drainage layer, as per the Detail Drawings, to all in situ planters with slab bases. The gravel drainage shall be 150mm washed river pebbles with a layer of geo textile placed on top and wrapped up the sides of the planters.

2.14 Soil Separator Membrane/Geo textile Fabric

2.14.1 Non-woven, synthetic, continuous fiber isotropic felt 70% polypropylene 30% polyethylene, weight 125gms/sq.m, thickness 1.0mm, with good permeability to water, resistant to all naturally occurring soil acidities and resistant to tearing and stress. To be laid with 300mm overlaps at junctions.

3.0 EARTHWORKS

3.1 Setting out

3.1.1 The Contractor's calculations for setting out from established points shall be available for inspection by the Engineer-in-charge.

3.1.2 The Contractor shall take all necessary precautions during the progress of the works to ensure that coordinated points are not damaged.

3.2 Site Levels

3.2.1 The Contractor shall check that the existing ground levels as indicated on the drawings are correct. Should there appear to be any discrepancies the Contractor shall agree the correct level with the Engineer-in-charge.

3.2.2 Prior to the commencement of any excavation or earthworks the Contractor shall furnish the Engineer-in-charge for his approval, drawings and / or schedules indicating the existing site levels on a suitable grid.

3.3 Records

3.3.1 If the Engineer-in-charge requires foundation depths to be varied from those shown on the drawings it shall be the responsibility of the Contractor to ensure that proper records of the actual excavated levels are kept.

3.3.2 The Contractor shall ensure that the revised levels area measured in the presence of the Engineer and are clearly identified, recorded, dated and signed as agreed by both parties.

3.3.3 Where excavation meets the water table, detailed records of ground water levels, including any tidal variations shall be maintained.

3.4 Site Investigation

3.4.1 Site Conditions

i). The Contractor shall be deemed to have satisfied himself as to the character of the site and all the various materials, strata, ground water levels etc., and of all items and things liable to affect or be encountered in the excavation and earthworks.

ii). Any site investigation reports included in the Contract Documents are provided solely for the guidance of the Contractor and no guarantee is given regarding their accuracy, nor it is guaranteed that similar condition apply elsewhere on site.

iii). The Contractor is entirely responsible for informing himself to the conditions of the site and for carrying out such additional investigations at his own cost as he may consider necessary prior to submitting his tender or during the course of construction of the works.

3.5 Special Requirements of Statutory Authorities

Prior to commencing excavation work the Contractor shall ascertain from the responsible departments whether any mains or services are to be diverted or cut off.

4.0 MATERAILS

4.1 Definitions

4.1.0 Suitable Material

Suitable material shall comprise all material that is acceptable in accordance with the contract for use in the works. Suitable material for earthworks shall be approved non-plastic soil obtained from excavations within the works, or from borrow pits approved by the Engineer-in-charge. It shall not contain an excess of fines or organic material where the material is to be placed below road or building construction it shall comply with 4.1.2 below

4.1.1 Unsuitable Material

Unsuitable material shall comprise

a) Organic material, stumps and other perishable material
b) Material susceptible to spontaneous combustion
c) Cohesive materials of liquid limit exceeding 25% and plasticity index exceeding 6.
d) Material with an excessive moisture content
e) Any other material which the Engineer may deem unsuitable for earthworks
f) Dredged material unless approved in writing by the Engineer
g) Stones larger than 10 mm dia.

4.1.2 Embankment Fill

i Embankment fill shall imported form an area approved by the Engineer-in-charge.

ii It shall be the responsibility of the Contractor to locate suitable material and carry out such tests as the Engineer-in-charge may require to demonstrate the suitability of the fill to be supplied.

iii The fill shall have a maximum stone size of 75 mm liquid limit not exceeding 25% and plasticity index not exceeding 6. Total water-soluble salts shall not exceed 3%.

iv Material shall have a CBR not less than 30% at 95% maximum dry density.

4.1.3 Rock

Rock shall mean those geological strata or deposits so designated on the drawings and any hard, natural or artificial material requiring the use of approved pneumatic tools or blasting or its removal but excluding individual masses of less than 0.20 cubic meters.

5.0 PLANT FOR EARTHWORKS

5.1 General

All plant and equipment used for earthworks shall be maintained in good working condition for the duration of the works. The Contractor shall supply adequate quantities and types of plant and equipment for the proper execution of the works in an expeditious manner.

5.2 Plant and Equipment

5.2.1 General

The main items of plant and equipment shall comply with the requirements detailed bellow. All plant shall be operated only by trained operators and banksmen shall be provided where necessary

5.2.2 Bulldozers

Bulldozers shall be tracked /pneumatic tyred vehicles equipped with a blade for earth moving / leveling and ripper teeth where necessary. The blade level shall be hydraulically controlled.

5.2.3 Tractor Shovel

Tractor shovel shall be tracked or pneumatic tyred vehicles equipped with a shovel for earthmoving. The shovel shall be hydraulically controlled.

5.2.4 Rotary Cultivators

Rotary Cultivators shall be purpose designed to ensure proper pulverization and mixing of soil. Cultivators shall be equipped with metal teeth or plates.

5.2.5 Motor Graders

Motor graders shall be pneumatic tyred vehicles, equipped with hydraulically controlled blades, capable of both level and angular adjustment.

5.2.6 Water Sprinklers

Water sprinklers shall be mounted on pneumatic tyred trucks equipped with suitable pumping and water distribution equipment. The distributors shall be designed to add water to the soil uniformly and in controlled quantities.

5.2.7 Pneumatic Tyred Rollers

Pneumatic tyred rollers shall be equipped with tyres of equal size and diameter, uniformly inflated. The wheels shall be spaced such that one pass will achieve complete coverage equal to the rolling width of the machine. Pneumatic tyred rollers may be towed or self-propelled.

5.2.8 Steel Wheeled Rollers

Steel Wheeled rollers shall be one of the following types:

i Three wheeled rollers – shall be self-propelled and equipped with a reversing clutch, differential drive and have adjustable scrapers to keep the wheel surface clean. The wheels shall be spaced such that one pass will achieve complete coverage equal to the width of the machine.

ii Tandem rollers – shall be self-propelled and equipped with reversing clutches, a sprinkling system to spray front and rear rolls and adjustable spring scrapes fitted to each roll.

iii Vibratory tender rollers – shall have a static weight of at least 5000 kg and a vibratory frequency between 1500 and 2000 cycles per minute.

iv Single drum vibratory rollers – shall be double axle, self-propelled rollers with rear axle equipped with pneumatic flotation tyres. The steel roll shall have a vibrating frequency between 1500 and 2000 cycles per minute

6.0 EXCAVATION

6.1 General

6.1.1 Line and Levels

Excavation shall be carried out to such lengths, widths, depths and profiles as are specified, or shown on the drawings plus any necessary allowance for working space for temporary works.

6.1.2 Oversized Excavations

Where excavations are taken out to greater depths, widths or lengths than required, the Contractor shall make good with concrete or other approved compacted material.

6.1.3 Support of Excavations

The sides of excavations shall be adequately supported to prevent slips or subsidence and shall be close sheeted where necessary to prevent the entry of running sand, mud etc.

6.1.4 Formation Levels

Where the excavated level forms the formation level for subsequent construction, the surface shall be suitably compacted to the satisfaction of the engineer prior to the commencement of any subsequent construction works. Compaction shall be to 95% maximum dry density.

6.2 Removal of Water

6.2.1 Removal of water

The excavation shall at all times be kept free from standing water from whatever source arising by pumping or other means.

6.2.2 Adjacent Structures

The Engineer shall be informed should continuous or near continuous pumping be required. If necessary, arrangements shall be made for the prevention of withdrawal of support from adjacent structures.

6.3 Soft Spots

6.3.1 General

i The bottom of all excavations shall be proved, and any poor bearing area shall be reported to the Engineer, who will direct remedial work.

ii Soft spots shall be cut out and filled with either approved compacted fill or concrete as directed by the Engineer.

6.4 Inspections:

6.4.1 Engineer-in-charge's Approval

No excavation for foundations shall be filled in or covered with concrete until the Contractor has notified the Engineer that is ready for inspection and has received his sanction to proceed with the works. The Contractor shall give a minimum of 24 hours notice of any inspection.

7.0 FILLING

7.1 General

7.1.1 Engineers Approval

Excavations shall only be backfilled after the permanent works therein are approved by the Engineer and after the removal of any building debris or deleterious material from the excavations. All final level formations shall be within a tolerance of (+) or (-) 25 mm.

7.1.2 Selected Material

Selected excavated material shall normally be used for backfilling. Selected material shall comply with the requirements of 4.1.0 and 4.1.2 above. Where the excavated material is not considered suitable by the Engineer, selected material from an approved source shall be used.

7.1.3 Backfill Grades

The backfill shall be brought to a suitable level above grade to provide for anticipated settlement and unless indicated otherwise, shall be sloped away from structures.

7.2 Compaction

7.2.1 Compaction Plant

Compaction shall be approved compaction plant as scheduled in Section 5.0 or plate type vibrators, pedestrian operated vibrator rollers, small tandem rollers or other approved plant.

7.2.2 Placing and Compaction

Unless otherwise stated below, the procedure shall be as follows

i The material shall be placed in loose layers within the effective range of compaction plant; however, the maximum compacted layer thickness shall be limited to 150 mm irrespective of plant type.

ii The material shall be watered and mixed as necessary to ensure that prior to compaction the moisture content of the whole layer is within +2% of the optimum moisture content. Compaction of each layer shall continue until a density of at least 95% of the maximum dry density has been achieved, unless otherwise specified on the drawings.

7.2.3 Fill below Ground Slabs

i The installation of cable ducts for service entries and service pipe work shall be completed before preparation of the fill to receive ground slabs.

ii The compacted material shall be shaped and trimmed to the required levels and dimensions and blinded with sand other approved find material which shall also be watered and compacted to provide a smooth surface.

7.2.4 Sweet soil to Planted Areas

I Where fill material is placed to areas designated for planting, the material shall be sweet soil as described above.

ii Sweet soil shall be compacted by the application of water only. No compaction plant shall be used.

iii The material shall be placed in layers not exceeding 200 mm well-watered and mixed to ensure full saturation.

iv Material shall be placed to achieve the contours shown on the drawings. On completion of filling final profiling shall be carried out to avoid flat grades and abrupt changes of level or direction and to create a smooth, curved cross sectional profile.

7.3 Workmanship

7.3.0 Soil Grading and Preparation

7.3.1 Subsoil shall be excavated to achieve tolerances of (+) or (-) 25 mm specified for finished level of soil, and when reasonably dry and workable, graded to smooth, flowing contours with all minor hollows and ridges removed.

7.3.2 Non-cohesive, light subsoil shall be loosened with a three-time ripper, 300 mm deep at one-meter centers. Stiff clay and other cohesive subsoil shall be loosened with a single tine ripper to a depth of 450mm at one-meter centers.

All perennial weeds and undesirable plant and scrub growth shall be manually removed or treated with herbicides, and the period of time recommended by the manufacturer shall be allowed to elapse before grading. The contractor shall obtain approval from engineers before any plants are removed.

7.3.3 All weeds, rocks and other debris shall be removed and disposed of. Finished ground level adjoining buildings shall be kept 150 mm below the level of the damp-proof course.

7.4 Handling and Transportation of Plants

7.4.1 Plant material shall be lifted or moved in such a manner that the roots are not disturbed. Plant material shall be lifted or moved by holding the container and not the stem or foliage.

7.4.2 Root systems of all plants shall not be allowed to dry out at any time and shall not be exposed to excessive or artificial heat or to freezing temperatures.

7.4.3 During transportation all plants shall be packed correctly to ensure protection from climatic or physical injuries. Tarpaulins or other covers shall be placed over plants when they are transported by trucks or in open freight cars.

7.4.4 Immediately prior to lifting, palm trees shall have their fronds reduced in length by 30%, sprayed with anti-desiccant and tied up with 3 layers of hessian to enclose the growing tip. The roots shall be pruned, and the root ball protected with three layers of hessian secured with wire and kept constantly moist with wet straw or other suitable material.

7.5 On-site Acclimatization and Storage

7.5.1 Plants shall be kept at the site nursery, in shaded areas until planted. Plant material shall be protected from wind exposure, and direct sunlight, and shall be watered correctly.

7.5.2 All imported plant materials shall be delivered to site nursery for acclimatization within the first six months of the contract period, unless approved otherwise by the Architect and Engineer-in-charge and protected against drying at all times.

7.5.3 Palm trees shall be planted directly on arrival on site. If palms have to be held for longer than twenty-four hours before planting they should be 'heeled-in' in trenches which are kept moist at all times.

7.5.4 Soil, compost, fertilizes and other products shall be delivered to the site nursery, and stored in appropriate locations to avoid contamination, and wetting until the soil mixing operations.

7.6 Planting Timing

7.6.1 Planting shall take place before 1000 hours and after 1630 hours but can be carried out at other times if the Architect and Engineer-in-charge gives approval.

7.6.2 Prior to planting all grading and ripping, paving, laying of services and other builder's work shall be completed. The irrigation system shall, wherever possible, shall be operational and soil brought to field capacity.

7.7 Medium Preparation

7.7.1 Specified soil additives shall be mixed with sweet soil at the rates specified.

7.7.2 Application rates for ameliorants and soil mix components shall be checked and approved by the Architect and Engineer-in-charge and Client prior to mixing each batch.

7.7.3 The soil shall be mixed mechanically by an approved method to create a homogeneous mixture. Mixing of planting medium shall be accomplished at one centrally located section on a raised concrete slab to prevent contamination of field soil from diseases, weed seeds, and nematodes transported by run-off water.

7.8 Planting

7.8.1 The sequence of planting shall be as follows:

a) Grade soil as specified.

b) Stake out the outline of planting areas and individual tree and shrub locations for approval by the Architect and Engineer-in-charge.

c) Excavate planting areas and individual pits to the sizes specified for palms, trees, shrubs, groundcovers, flowers and grass. Excavated sub-soil shall be removed from site and shall not be mixed with the planting medium or used to form berms around the plants.

d) Fill planting pit with irrigation water and ensure the water can drain away. In case of poor drainage, a percolation test shall be carried out and drainage holes augured if required.

e) Backfill pit/beds, after having been tested for drainage with approved planting medium in layers not exceeding 300mm and water compact. Allow for compaction/subsidence by overfilling by 100mm. Once placed the growing medium shall be covered with plastic sheeting and clearly marked to prevent disturbance until planting commences.
During backfilling place slow-release fertilizer tablets 25-30cm deep. For trees the tablets should be located approximately 1.0m from the trunk or adjacent to drip emitters as per site conditions.

f) Prior to planting tree stakes shall be driven into tree pits.

g) At the time of planting a hole of size slightly bigger than the root ball shall be made into the pit/bed large enough to take the plants root ball. The planting hole shall be thoroughly watered prior to planting.

h) Plants shall be carefully removed from containers. Plastic pots shall be split with a knife and plants removed with all the soil intact around the roots. Care shall be taken not to damage the roots or foliage of the plants. The plant shall be placed upright in the hole. Care shall be taken to ensure that the collar line (line of contact between soil and stem) is at the same level as the surrounding ground.

i) Fill around the plant with planting medium in layers of 150mm, each layer separately firmed to eliminate all air pockets until final soil level is reached.

j) Trees shall be tied to the tree stakes with tree ties as specified. At least two pairs of ties per tree shall be used but other ties shall be provided if necessary to keep the stem straight. If a leader stake is required, this shall be 20mm round softwood stake slotted inside the tree tie loops.

k) A circular watering basin slightly larger than the planting hole shall be formed. During and after planting the plants shall be thoroughly watered.

l) After planting the area surrounding the plant shall be restored to finished grade and excess soils and rubbish disposed of properly.

m) Immediately after planting all plants are to be pruned in accordance with accepted horticultural practices or as directed by the Architect and Engineer-in-charge. Pruning shall consist of carefully cutting back any damaged, dead or diseased branches and the removal of any weak or malformed growth, with the aim of forming each type of stock to the standard shape for its species. All pruning cuts greater than 20mm shall be treated with a pruning paint as specified.

n) An aluminum label clearly marked with the Latin name shall be attached to or adjacent to every tenth tree, every twelfth shrub and every fifteenth ground cover.

o) Monitor all plants after planting for signs of windshake and loosening due to soil subsidence; firm and make good as necessary.

p) The Contractor shall not add compost and fertilizer to palm pits at the time of planting and until so instructed by the Architect and Engineer-in-charge/Client.

7.8.2 Percolation test procedure:

a) One day prior to the test the pit/bed shall be filled with water.

b) A marker bar is placed in the pit/bed before the test is performed

c) The pit/bed is half filled with water and the level is indicated with tape on the marker bar.

d) The test is monitored over a period of one hour. If the water level drops by 20mm or more within that time the pit/bed passes.

e) If a pit/bed fails the percolation test, boreholes shall be augured (2 no/tree pit or 10m spacing in planting beds).

f) Tests should be repeated until a satisfactory result is achieved.

g) After auguring the boreholes shall be capped with wire gauze.

h) Percolation tests shall be carried out at a rate of 1 test per 50 plants. The Architect and Engineer-in-charge / Client may instruct additional tests on an exploratory basis in the event of unsatisfactory percolation being evident.

7.8.3 Planting pits:

a) Size of planting pit shall be as follows:

1.	Large Tree/palm pit	1.3m x 1.3m x 1.3m
2.	tree pit	1.0m x 1.0m x 1.0m
3.	shrubs/grasses/succulents	0.6m x 0.6m x 0.6m
4.	lawn areas	0.3m minimum depth

7.8.4 Grass Stolons and seeding

The procedure for planting grass stolons shall be as follows:

a) Prior to beginning planting operations, the irrigation system must be completely operational ensuring 100% coverage.

b) Bring the water content of the area to be planted to field capacity and allow water to percolate until standing water disappears.

c) Apply complete fertilizer as specified prior to planting stolons.

d) Cultivate to a depth of 200mm.

e) Keep dry dormant stolons refrigerated 0-3°C, until the area to be planted is prepared. Do not exceed two weeks of refrigeration. Soak stolons in water after removing from cold storage and prior to planting.

f) Do not exceed two days of storage on job site. Stolons are to be kept moist, shaded and ventilated during such storage.

g) Plant during the time of year when daytime temperatures do not exceed 38°C and night time temperatures are not below 15°C. Mean temperature should exceed 26°C. Water within 15 minutes of planting at 38°C, 30 minutes at 28°C, 60 minutes at 21°C, and 120 minutes at 16°C.

h) Sow at 200litres per 100 square meters.

i) Plant utilizing a disc to cut in stolons and followed by a culti packer roller, or other technique approved by the Architect and Engineer-in-charge.

j) Water as necessary to keep the stolon bed moist until germination. Once grass is up begin lengthening intervals between irrigation.

7.9 Mowing Strips

7.9.1 The Contractor shall install mowing strips as per Detail drawings.

8.0 COMPLETION AND MAINTENANCE

8.1 Substantial Completion

8.1.1 At the date of Substantial Completion all plants shall be in their specified position and condition.

8.2 Plant Establishment Period

8.2.1 The Plant Establishment Period shall be for three months from the date of Substantial Completion and may run consecutively with the One Year Maintenance Period. Any plant material not showing acceptable levels of growth shall be replaced by the Contractor who shall bear all the associated costs.

8.3 Failure of Plants

8.3.1 Any plants that are found to be missing, defective or not in good condition at any time during the contract period and maintenance period shall be immediately replaced by the Contractor, who shall bear all the associated costs.

8.4 Maintenance Period

8.4.1 The Maintenance Period shall run for a period of one calendar year from the date of Substantial Completion of the whole of the Works.

8.4.2 The Contractor shall maintain insurances of relevant items as required by the Contract throughout the Maintenance Period.

8.4.3 The contractor shall carry out maintenance of the planting strictly in accordance with the Operations and Maintenance manual as approved by the Client. The Contractor is to provide all required labour, plant and materials to comply with the approved procedures.

8.4.4 During the Maintenance period the Contractor shall make adequate provision for irrigation and/or operate the irrigation system as required and maintain same for handover to the Client on completion of the Plant Establishment Period, comprehensively overhauled and in perfect working order.

8.4.5 The contractor shall keep necessary number of personnel (gardeners, laborers, irrigation supervisor) in proper uniform, full time at site, and shall be required to send additional manpower as and when required to carry out special maintenance works like removing dry palm fronds, aeration, planting seasonal, replacing trees and all the treatments required for plant protection.

8.4.6 A qualified and experienced agricultural engineer, approved by the Client, shall be required to inspect the site regularly for correct diagnosis of pests or diseases and to take timely remedial measures.

8.4.7 An experienced plumber will be deputed to the site on regular intervals to check the irrigation system and adjust/replace the equipment that is not working properly. Seasonal adjustments to the irrigation operation schedule and programming of controllers shall be done by a qualified irrigation engineer, prevailing according to the weather conditions and Client's requirements.

8.4.8 The contractor shall maintain, at all times, sufficient stock of regularly utilized fertilizers, chemicals, tools, spare parts and other consumables at site.

8.4.9 Trimmings, cut branches, dry leaves and other waste shall be removed daily from the site and disposed of in the Municipality dump.

8.4.10 The site shall be kept neat, tidy and in good condition at all times.

8.4.11 In the case of any horticultural staff designated by the Client, the Contactor shall fully train such staff for the duration of the Maintenance Period at no additional cost.

8.5 Operations and Maintenance Manual

8.5.1 The Contractor shall compile a comprehensive Operations and Maintenance Manual which will include the following:

a) Pesticide/fungicide/herbicide applications - including safety application rates and procedure, schedules of pesticides/fungicides/herbicides.

b) Water application rates and maintenance procedures, including a detailed description of Irrigation and Storm water drainage methods.

c) Fertilization - including fertilizer descriptions, application rates and programs.

d) Salinity Control - including leaching methods and leaching program monitoring.

e) Turf Grass Management - including mowing procedure, replacement of turf grass by stolon and sods and routine management procedures; aeration, top dressing, vertical mowing, thatch removal, cleaning, rolling and over seeding.

f) Propagation and replacement of seasonal flowers every 3 months maximum or when deemed necessary.

g) General Maintenance Monthly Operations Schedule - including pruning, stakes and ties, berm work, replacement and clean-up, protective fencing etc.

h) Equipment Inventory, maintenance procedures and full manufacturers maintenance manual.

i) Personnel

8.5.2 The Operation and Maintenance Manual for Soft Landscape shall be submitted to the Architect and Engineer-in-charge/Client by the Contractor for approval at least three months prior to the date for Substantial Completion of any part of the Works and must be approved prior to the commencement of the Plant Establishment Period. Three bound copies of the manual in A4 format shall be presented to the Client.

9.0 REFERENCES

9.1 Standards

9.1.1 The following Standards are referred to in this specification:

i Pest Management in Horticultural crops, IIHR Bangalore
ii Proceeding of the National consultation Seminar on Horticultural Research & Development, IIHR Bangalore
iii Neem Cake- An organic formulation for Insect Pest Management in Horticulture, IIHR Bangalore

10.0 SCOPE OF HORTICULTURE MAINTENANCE WORK

10.1 Complete maintenance of the entire horticulture features of the all four street area i.e. lawn, trees, shrubs, hedge, potted plants, flowers beds, creepers etc. and other garden feature including watering hoeing, making of plants basic manuring, trimming and cleaning of hedges / plants, Beds, spraying of insecticides, fungicides, weeding, mowing, and top dressing of lawn with good earth and manure and hedge clipping and removal of the garden waste, composting of green waste from plants, trees, lawn mowing, etc as per direction and satisfaction of the officer-in-charge to maintain the plants, hedge and lawns in good and healthy conditions at all the time during the maintenance period.

10.2 The following activities are covered under this contract.

Item of work	Nos./Qty./Frequency Required
Pruning & trimming of trees/shrubs creepers etc.	Yearly/need base with the permission of forest department
Hedges Cutting	Monthly
Any other item (Horticulture, Civil, Elect, U/F water supply) required for proper maintenance	On need basis
Irrigation	Daily
(i) Manuring (ii) Fertilization	As per requirement
Lawn Moving	Monthly
PlantProtection	Need Based
Cultivation & Weeding	As and when required
Seasonal Flowers	Wherever feasible
Top dressing with soil &/or manure	Yearly
Repair & replacement of plants, leveling etc.	As and when required

10.3 The following conditions shall be followed:

a. In case of any causality of shrubs, trees or any other plants has been found during maintenance the Agency should replace the trees/ shrubs/ other plants of the same height and specification by another at his risk and cost and nothing extra shall be paid for the same. The decision of the Engineer in Charge shall be final and binding in this regard.

b. In case, if it is observed that the maintenance is not healthy and to the required standard, no payment shall be made of the specific area for the period over which the maintenance has been found to be neglected. The decision of the Engineer in Charge shall be final and binding in this regard.

c. The required quantity of insecticides/ Pesticides will be arranged by the agency for proper maintenance (only during the maintenance period) if needed.

d. The rejected & substandard material should be removed from the site of work immediately; the Department shall not be responsible for any damage/ loss of rejected material. If the same will not be removed within five days after issuing notice in writing by Engineer in Charge.

1.4 In no case the irrigation / watering of plants and greenery should be deprived

11.0 GENERAL SPECS FOR HYDRO-SEEDING WILDFLOWER SEED MIXTURES

11.1 Amending soils

This section specifies the hydraulically applied Biotic Soil Media, Slow-Release Bio-stimulant, Fast-Acting Lime, Gypsum to correct soil pH issues, accelerate development of poor or depleted soils/substrates and establish vegetation.

11.2 Submittals

a. Product Data: Submit manufacturer’s product data and installation instructions. Include required substrate preparation, list of materials and application rate.

b. Certifications: Manufacturer shall submit a letter of certification that the product meets or exceeds all technical and packaging requirements and is made in India.

11.3 Delivery, storage and handling

a. Deliver materials and products in UV and weather-resistant factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage, weather, excessive temperatures and construction operations.

11.4 Products

Biotic Soil Media

The Biotic Soil Media shall conform to the following typical property values when uniformly applied at a rate of 4000 kg/hectare.

a. Fresh Cow Dung mixed with cow urine to create a hydraulically pumpable slurry.

b. The Sustained-Release Bio-stimulant such as "NCOF Decomposer" or "ICAR Natural Farming Starter" consisting of Nutrient solubilizing microbes such as Azotobacter, Nitrobacter, Trichoderma etc.

c. All components of the Sustained-Release Bio-stimulant shall be a micronized powder or Nano-particle solution, pre-packaged by the manufacturer to assure both material performance, optimal mixing and compliance with the following values. No chemical additives, except for hydraulic mulch, fertilizer, soil neutralizers, biotic soil media, and additional bio-stimulant materials should be added.

d. Fast-Acting Lime: pH Range: 8.9 ± 0.3, Relative Neutralizing Value: 95.0% minimum

All components of the Fast-Acting Lime shall be a micronized powder, pre-packaged by the manufacturer to assure both material performance, optimal mixing and compliance with the following values. No chemical additives, except for hydraulic mulch, fertilizer, biotic soil media and additional bio-stimulant materials should be added to this product. Materials: Micronized limestone, Calcium Carbonate: 97.8% minimum
Solids: 100% Application Rate, The Fast-Acting Lime shall be applied at a rate of 45 kg/ha.

Gypsum

This section specifies Gypsum, which is designed to incorporate calcium into soils that are either calcium deficient or contain excess sodium. Calcium Sulfate Dihydrate: ≥ 80%

a. Application Rate: The Gypsum shall be uniformly applied at a rate of 1000 Kilograms per Hectare.
b. Application Method: The Gypsum shall be uniformly applied at the specified rate and disked into the substrate to a depth of 300 mm, prior to any hydraulic applications.

Fertilizer

a. The Fertilizer shall have an NPK Rating of 19-19-19.
b. Application Rate: The Fertilizer shall be applied at a rate of 450 kg/ha.

11.5 Execution

Soil Testing

a. Soil Samples shall be taken and sent to a third-party, independent lab for analysis and in compliance with Chemical Sampling and Analysis of Soils, if applicable.
b. The tests shall include analysis and interpretation of results.
c. The soil testing methods used shall be compliant with recognized agronomic testing standards, for revegetation of disturbed sites.
d. Soil Analysis shall include results for:
Soil pH, Soluble Salts, Excess Carbonate, Organic Matter, Nutrient readings for: Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Manganese, Sulfur, Zinc, Copper, Iron, Boron, Cation Exchange Capacity and Percent Base Saturation Sodium
e. Bio stimulants, soil neutralizers or other amendments shall be specified applied in accordance with Biotic soil media with the hydroseeding slurry at recommended rates based on soil test results.

11.6 Vegetation species selection

Once soils have been analyzed for agronomic potential and amendment recommendations, selection of suitable plant species for achieving sustainable growth and effective erosion control shall be determined by an approved seed supplier, consulting professional and/or regulatory agency.

a. Site and project specific information considered for species selection shall include:
Project Location and Planning, Climate, Elevation, Aspect, Slope/Gradient, Permanent or Temporary Planting, Installation Date(s)

b. Soil Conditions:
Soil Texture, Soil pH, Toxicities/Deficiencies noted in the previous section.

c. Site Maintenance Requirements
Mowing, Irrigation, Animal grazing preference, Preferred Vegetation, Drought Tolerant, Native Vegetation.
Shrub Species (attached separately)
Shrub species should not constitute more than 10% of the seed mix
Application rate for the wildflower seed mix will be 25kgs seeds / hectare

11.7 Installation Biotic Soil Media

a. Strictly comply with equipment manufacturer's installation instructions and recommendations. Use approved hydroseeding machines. To achieve optimum soil surface coverage, apply BSM from opposing directions to soil surface. Erosion control products, slope interruption devices or water diversion techniques should be used in conjunction with this product. No chemical additives except for fertilizer, soil neutralizers and bio-stimulant materials should be added to this product.

b. For Revegetation: To ensure proper application rates, measure and stake area.

c. Mixing: A mechanically agitated hydroseeding machine is strongly recommended:
Fill mechanically agitated hydro-seeder with water to at least 1/3 of displacement. Turn pump on and thoroughly purge pump and pre-wet lines. Turn pump off.
Turn agitator on and load low density materials first (i.e. seed).
Continue slowly filling tank with water while loading BSM (Slow-Release bio stimulant and Fast-Acting Lime).

d. Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 45.4 kg of BSM per 379 liters in machines equipped with gear or positive displacement pumps and 34.0 kg of BSM per 379 liters in machines with centrifugal pumps. Contact Equipment manufacturer to confirm optimum mixing rates.

e. All BSM should be completely loaded before the water level reaches 75% of the top of tank.

f. Add fertilizer and (hydraulically applied granular amendments) and continue mixing.

g. Top off with water and mix until all material is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to allow the BSM to fully hydrate. Shut off recirculation valve to reduce potential for air entrainment within the slurry. Slow down agitator to very low speed and start applying with optimum nozzle.

h. Spray in opposing directions for maximum soil coverage. Return to water source as quickly as possible to purge pump and lines, then repeat mixing and application process.

i. Slow-Release bio stimulant
Strictly comply with engineer’s/consultant representative installation instructions and recommendations. Use approved hydroseeding machines to apply Sustained-Release bio stimulant. No chemical additives except for hydraulic mulch, fertilizer, soil neutralizers, biotic soil media, and additional bio stimulant materials should be added to this product.

j. Fast-Acting Lime
Strictly comply with manufacturer's installation instructions and recommendations. Use approved hydroseeding machines to apply Fast-Acting Soil Neutralizer.

11.8 Cleaning and Protection

a. After application, thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills. Once dry, the material will be more difficult to remove.

b. Clean spills promptly. Advise owners of methods for protection of treated areas. Do not allow treated areas to be trafficked or subjected to grazing.

11.9 Inspection and Maintenance

a. All inspections and maintenance recommendations shall be conducted by qualified professionals consistent with the owner, engineer/specifier and regulatory entity expectations.
b. Initial inspections shall ensure installations are in accordance with the project plans and specifications with material quantities and activities fully documented. Refer to Section 32 92 00 – Turf and Grasses for any additional details.
c. Subsequent inspections shall be conducted at pre-determined time intervals and corrective maintenance activities directed after each significant precipitation or other potentially damaging weather or site event.

12.0 GENERAL SPECS FOR ESTABLISHMENT OF NATIVE GRASS/GROUND COVER LAWNS

12.1 Amending Soils

This section specifies the hydraulically applied Biotic Soil Media, Slow-Release Bio-stimulant, Fast-Acting Lime, Gypsum to correct soil pH issues, accelerate development of poor or depleted soils/substrates and establish vegetation.

12.2 Submittals

a. Product Data: Submit manufacturer's product data and installation instructions. Include required substrate preparation, list of materials and application rate.
b. Certifications: Manufacturer shall submit a letter of certification that the product meets or exceeds all technical and packaging requirements and is made in India.

12.3 Delivery, Storage and Handling

a. Deliver materials and products in UV and weather-resistant factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage, weather, excessive temperatures and construction operations.

12.4 Products Biotic Soil Media

The Biotic Soil Media shall conform to the following typical property values when uniformly applied at a rate of 4000 kg/hectare.

a. Fresh Cow Dung mixed with cow urine to create a hydraulically pumpable slurry.

b. The Sustained-Release Bio-stimulant such as "NCOF Decomposer" or "ICAR Natural Farming Starter" consisting of Nutrient solubilizing microbes such as Azotobacter, Nitrobacter, Trichoderma etc.

c. All components of the Sustained-Release Bio-stimulant shall be a micronized powder or Nano-particle solution, pre-packaged by the manufacturer to assure both material performance, optimal mixing and compliance with the following values. No chemical additives, except for hydraulic mulch, fertilizer, soil neutralizers, biotic soil media, and additional bio-stimulant materials should be added.

d. Fast-Acting Lime: pH Range: 8.9 ± 0.3, Relative Neutralizing Value: 95.0% minimum

All components of the Fast-Acting Lime shall be a micronized powder, pre-packaged by the manufacturer to assure both material performance, optimal mixing and compliance with the following values. No chemical additives, except for hydraulic mulch, fertilizer, biotic soil media and additional bio-stimulant materials should be added to this product. Materials: Micronized limestone, Calcium Carbonate: 97.8% minimum
Solids: 100% Application Rate, The Fast-Acting Lime shall be applied at a rate of 45 kg/ha.

Gypsum

This section specifies Gypsum, which is designed to incorporate calcium into soils that are either calcium deficient or contain excess sodium. Calcium Sulfate Dihydrate: ≥ 80%

a. Application Rate: The Gypsum shall be uniformly applied at a rate of 1000 Kilograms per Hectare.
b. Application Method: The Gypsum shall be uniformly applied at the specified rate and disked into the substrate to a depth of 300 mm, prior to any hydraulic applications.

Fertilizer

a. The Fertilizer shall have an NPK Rating of 19-19-19.
b. Application Rate: The Fertilizer shall be applied at a rate of 450 kg/ha.

12.5 Execution Soil Testing

a. Soil Samples shall be taken and sent to a third-party, independent lab for analysis and in compliance with Chemical Sampling and Analysis of Soils, if applicable.
b. The tests shall include analysis and interpretation of results.
c. The soil testing methods used shall be compliant with recognized agronomic testing standards, for revegetation of disturbed sites.
d. Soil Analysis shall include results for:
Soil pH, Soluble Salts, Excess Carbonate, Organic Matter, Nutrient readings for: Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Manganese, Sulfur, Zinc, Copper, Iron, Boron, Cation Exchange Capacity and Percent Base Saturation Sodium
e. Bio stimulants, soil neutralizers or other amendments shall be specified applied in accordance with Section 2.4.1 with the hydroseeding slurry at recommended rates based on soil test results.

Grass Species Selection
Turf Grasses (List as attached)
Seeding Material

a. Stolon pieces containing at least 2-3 rooting nodes
b. Verti cut grass lawns with grass stolon cuttings
c. Native grass seeds

12.6 Installation Biotic Soil Media

a. Strictly comply with equipment manufacturer's installation instructions and recommendations. Use approved hydroseeding machines. To achieve optimum soil surface coverage, apply BSM from opposing directions to soil surface. Erosion control products, slope interruption devices or water diversion techniques should be used in conjunction with this product. No chemical additives except for fertilizer, soil neutralizers and bio-stimulant materials should be added to this product.
b. For Revegetation: To ensure proper application rates, measure and stake area.
c. Mixing: A mechanically agitated hydroseeding machine is strongly recommended: Fill mechanically agitated hydro-seeder with water to at least 1/3 of displacement. Turn pump on and thoroughly purge pump and pre-wet lines. Turn pump off. Turn agitator on and load low density materials first (i.e. seed).
Continue slowly filling tank with water while loading BSM (Slow-Release Bio stimulant and Fast-Acting Lime).
d. Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 45.4 kg of BSM per 379 liters in machines equipped with gear or positive displacement pumps and 34.0 kg of BSM per 379 liters in machines with centrifugal pumps. Contact Equipment manufacturer to confirm optimum mixing rates.
e. All BSM should be completely loaded before the water level reaches 75% of the top of tank.
f. Add fertilizer and (hydraulically applied granular amendments) and continue mixing.
g. Top off with water and mix until all material is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to allow the BSM to fully hydrate. Shut off recirculation valve to reduce potential for air entrainment within the slurry. Slow down agitator to very low speed and start applying with optimum nozzle.
h. Spray in opposing directions for maximum soil coverage. Return to water source as quickly as possible to purge pump and lines, then repeat mixing and application process
i. Slow-Release Bio stimulant

Strictly comply with engineer's/consultant representative installation instructions and recommendations. Use approved hydroseeding machines to apply Sustained-Release bio stimulant No chemical additives except for hydraulic mulch, fertilizer, soil neutralizers, biotic soil media, and additional bio stimulant materials should be added to this product.

j. Fast-Acting Lime

Strictly comply with manufacturer's installation instructions and recommendations. Use approved hydroseeding machines to apply Fast-Acting Soil Neutralizer.

12.7 Cleaning and Protection

a. After application, thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills. Once dry, the material will be more difficult to remove.

b. Clean spills promptly. Advise owners of methods for protection of treated areas. Do not allow treated areas to be trafficked or subjected to grazing. Regular use of brush cutter to maintain the native grasses at 50mm height required as part of maintenance period.

12.8 Inspection and Maintenance

a. All inspections and maintenance recommendations shall be conducted by qualified professionals consistent with the owner, engineer/specifier and regulatory entity expectations.

b. Initial inspections shall ensure installations are in accordance with the project plans and specifications with material quantities and activities fully documented. Refer to Section 32 92 00 – Turf and Grasses for any additional details.

c. Subsequent inspections shall be conducted at pre-determined time intervals and corrective maintenance activities directed after each significant precipitation or other potentially damaging weather or site event.