



REQUEST FOR PROPOSAL

For

Improvement of Selected Roads to Smart Roads and 24 X 7 Water Supply System Under “Smart City Mission- at Raipur (C.G.)” Consisting of Footpath, Utility Conduits, Storm Water Drains and Rain Water Harvesting, Underground Electric Cabling, Street Light, Street Furniture, Traffic Signage, Street Landscaping Works, Junction Improvement, Refurbishment of Existing Water Supply Network Including All Works for Mechanical, Electrical, SCADA, House Hold Connections, Consumer Water Meter Fittings Work and other Miscellaneous Works on Preparation and Approval of Working Drawings, Procurement and Construction Basis Including Defect Liability Period and Operation & Maintenance of All Works for Five (05) Years.

Volume III: Employer’s Requirement and Technical Specifications

Volume-III
Employer's Requirement and Technical Specifications

1.0 SCOPE OF WORKS

- 1.1. The works under Contract consists of Improvement of Selected Roads to Smart Roads and 24 X 7 Water Supply System Under “Smart City Mission- at Raipur (C.G.)” Consisting of Footpath, Utility Conduits, Storm Water Drains and Rain Water Harvesting, Underground Electric Cabling, Street Light, Street Furniture, Traffic Signage, Street Landscaping Works, Junction Improvement, Refurbishment of Existing Water Supply Network Including All Works for Mechanical, Electrical, SCADA, House Hold Connections, Consumer Water Meter Fittings Work and other Miscellaneous Works on Preparation and Approval of Working Drawings, Procurement and Construction Basis Including Defect Liability Period and Operation & Maintenance of All Works for Five (05) Years.
- 1.2. Details and drawings given in Tender document are for information purpose only and successful bidder shall undertake confirmatory survey for accuracy and completeness of data. It is in scope of successful Bidder to undertake all Site surveys, Geotechnical investigations, Underground Utility Survey and Scanning of the roads for utility shifting, obtaining all required approvals from the relevant authorities, Carry out Design and Drawings for all the components of the work as per Employers requirement and submit the same to client for review and approval, Prepare Good for Construction Drawings, submit maintenance manual to client for approval before start of Maintenance period.
- 1.3. The successful bidder shall have to prepare and submit ‘As Built Drawings’ depicting the exact construction carried out on site, in soft and hard copy format.
- 1.4. Statutory and other charges for getting various required approvals shall be in scope of Successful bidder.
- 1.5. **The scope of work also includes :**
 - 1.5.1. **Construction and completion of the following:**
 - 1.5.1.1. Site clearance, demolition works, earthworks, temporary works, traffic diversion, barricading the construction site, utility shifting and all ancillary works deemed necessary for the carrying out of temporary & permanent construction works.
 - 1.5.1.2. Widening/ re-cambering/ raising/ milling down & overlaying of existing carriageways, flexible/ rigid pavement at grade road intersections & accesses to adjoining developments. Work also includes removal of street furniture, exiting foot path, existing median, exiting signage, trees if any way of revised ROW, existing structures that obstruct the revised ROW as per instruction of RSCL.
 - 1.5.1.3. Tree cutting (if any) as indicated in the drawings.
 - 1.5.1.4. Construction of Utility ducts, cross drains as per approved drawing.
 - 1.5.1.5. Retrofitting the existing roads as per the proposed road sections w.r.t carriageways, provision of footpath, cycle track, services lanes.

- 1.5.1.6. Installing RPM, making road markings along the road edge, road center line & as per IRC guidelines, bus stop marking, cycle track marking, construction of medians & speed breakers, & junction improvements as per the drawings & in accordance with the Employer's requirements and to the satisfaction of the Engineer in charge.
- 1.5.1.7. Construction of footpaths, kerbs, railings, vehicular impact guardrails and other road related facilities as per the guidelines of IRC in accordance with the Employer's requirements and to the satisfaction of the Engineer in charge.
- 1.5.1.8. Supply and installation of new traffic signage, directional signage, street name signs & re-sitting of such existing signs & other road signs to be retained, inclusive of support & foundation as per Employers Requirement.
- 1.5.1.9. Supply & installation of street furniture seating bench, planter box, bollards, cycle hoops, advertisement/ branding/ way finding boards & poles in accordance with the Employer's requirements and to the satisfaction of the Engineer in charge.
- 1.5.1.10. Planting of trees, shrubs and installation of lawns as a part of Landscape work & installation of services for the same, as per the drawing in accordance with the Employer's requirements and to the satisfaction of the Engineer in charge.
- 1.5.1.11. All other works and services ancillary or related to the full completion of the Works in accordance with the Employer's requirements.
- 1.5.2.** The Contractor shall ascertain, determine and verify the locations of all utility services by scanning the roads in the vicinity of the Works, and co-ordinate with utility agencies for the diversion of affected services and the laying of new services. The Contractor shall support and protect services that need not be diverted or pending diversion and remove all abandoned services. Contractor shall be responsible for relocation, reconstruction, reconfiguration of driveways, site accesses, temporary and permanent drains, pipe conduits and necessary connections for public lighting and traffic lighting, earth works, turfing, environmental assessments, necessary safety measures and protection works, sewer lines etc
- 1.5.3.** The Contractor's responsibility for the design and build works includes the submissions to relevant government authorities / technical departments for obtaining all necessary clearances/approvals.
- 1.5.4.** The Contractor shall co-ordinate and interfaces his works with that of all other contractors, subcontractors, utility services, statutory authorities, etc. and achieve the completion of the Works to the satisfaction of the Engineer
- 1.5.5.** The Contractor shall verify the proposed road reserve, cadastral boundary and contract boundary and all dimensions on Site prior to submission of Tender. The Contractor is responsible for clarifying any discrepancy between the Drawings and actual condition on Site.

- 1.5.6.** The Contractor shall make good all works including road surfaces, drains, concrete slabs, gratings, kerbs, pavements, turfing, railing, fence, boundary wall, etc. affected or damaged during the course of construction, to the satisfaction of the Engineer. The costs of making good all these defects shall be borne solely by the Contractor and deemed included in his Contract Sum
- 1.5.7.** All works specified shall include the provision of all labour, tools, equipment, material, traffic control, transport and everything else necessary for the satisfactory completion of the Work by the Contractor to the satisfaction of the Engineer.
- 1.5.8.** Description of the Works involved in this Contract is given in the Specifications for the guidance of the Contractor. The Contractor shall be solely and fully responsible for investigating and ensuring the actual extent and nature of the Works comprised in this Contract prior to submission of his Tender.
- 1.5.9.** Construction, management and quality of the Works shall comply with the Drawings, Specifications and Employers requirement.

2.0 CONTRACTOR'S OBLIGATION

2.1. Site Responsibility Chart

- 2.1.1.** The Contractor shall submit, within 15 days after the Date of Commencement of the Contract, a site responsibility chart to show the functions and responsibilities of various personnel from the Project Manager to the workmen responsible for executing the Works, as well as the functions and responsibilities of the sub-contractors involved.

2.2. Setting Out And Existing Levels

- 2.2.1.** The Contractor shall take levels and set out for the whole of the Works. The information on existing levels as shown on the Drawings is provided in good faith for the general guidance of the Contractor. The Contractor is to note that accuracy of information shown on the Drawings is not guaranteed. The Contractor shall visit the site and carry out field surveys if he considers it necessary to ascertain the full extent of the Works. Within one week after the commencement of the Works, the Contractor shall submit to the Engineer for his verification and endorsement, records of levels of the existing site condition. Similarly, the Contractor shall submit the as-constructed levels of the site to the
- 2.2.2.** Engineer upon completion of the Works. Such records shall be certified and endorsed by a Registered Surveyor engaged by the Contractor at his own cost.

2.3. Design Of Works:

- 2.3.1.** The Contractor shall carry out, and be responsible for the design of the Works, including any site surveys, subsoil investigations, materials testing, and all other things necessary for proper planning and design.
- 2.3.2.** Within 10 days from approval of final survey drawing, the Contractor shall start submitting drawings, construction documents, etc., for review and approval by the Employer's Representative. The Contractor will be fully responsible for ensuring that its designs, drawings, and construction documents satisfy all requirements for constructing Works that are complete and fully functional in all respects.
- 2.3.3.** The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the work as executed. These records shall be kept on the Site and two sets of such records shall be submitted to Employer.
- 2.3.4.** In addition, the Contractor shall supply to the Employer's Representative as-built drawings of the Works, showing all Works as executed.

2.4. Programming & Planning

2.4.1. Baseline Programme:

- 2.4.1.1.** Within 15 days after the award of the Contract, the Contractor shall submit six (6) hardcopies and one (1) softcopy of a Baseline Programme to the Engineer for his acceptance. The Contractor's project manager shall make a presentation of his proposed programme to the Engineer to demonstrate his understanding of the contract

requirements, planning, control, monitoring of works programme and resources of the Works. Upon acceptance of the Baseline Programme by the Engineer, the Contractor shall adhere to it strictly. The Contractor shall ensure that preparation, updating and revision of programme of works are carried out by experienced and qualified personnel. The Baseline Programme shall be developed by the computerized Critical Path Method (CPM) using the Precedence Diagramming Method (PDM). The programming software shall be Primavera Project Planner or Microsoft Project or Open Plan, subject to the Engineer's approval.

2.4.2. Programme Details

- 2.4.2.1. The level of programme development, information and detail shall be sufficient to accurately define the Contractor's intentions and sequence of works. The programme shall show every significant activity required for the completion of the Contract that include but not limited to the following:
- 2.4.2.2. Key dates, milestones, interface and handover dates, phased completion and completion of Whole of the Works;
- 2.4.2.3. Contractor's design including dates for submission to and acceptance by the Engineer;
- 2.4.2.4. Submission and acceptance of road diversion plan, utilities diversion plan, Temporary Works and other works requiring approvals from authorities;
- 2.4.2.5. Procurement of major equipment and material, in particular long lead items and the delivery to site;
- 2.4.2.6. All on-site works, including preliminary and Temporary Works by the Contractor, his sub-contractors and suppliers;
- 2.4.2.7. Any off-site work such as the production and/or fabrication of any components or materials;
- 2.4.2.8. The different stages of traffic diversion and specific requirements with regard to traffic aspects as given in this Specification;
- 2.4.2.9. Interface with Utility Agencies and work done by Utility Agencies or the Contractor for diversion;
- 2.4.2.10. Interface with other contracts/contractors; and,
- 2.4.2.11. Any outside influence which will or may affect the progress of Works

2.5. SITE MEETINGS

- 2.5.1.1. The Contractor shall provide all facilities at the site for the purpose of conducting joint site meetings between the Contractor and the Engineer. The Contractor's key representatives (Project Manager, Construction Managers, Safety and Health Officer, Environmental Control Officer and site engineers, etc.) are required to attend daily pre-

work meeting punctually prior to commencement of site activities and submit daily and weekly works programme to the Engineer (or his representatives).

2.6. NOISE CONTROL

- 2.6.1.1. The Contractor shall maintain noise levels for construction premises as stipulated under the Environmental Pollution Control (Control of Noise at Construction Site Regulations) (Amended) Regulations latest and subsidiary legislation and any amendments and/or reenactment thereto. All vehicles and mechanical construction plants used for the purpose of the Works shall be fitted with effective exhaust silencers and shall be maintained in good and efficient working order. All compressors shall be sound reduced models fitted with properly lined and sealed acoustic covers which shall be kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools shall be fitted with mufflers or silencers of the type recommended by the manufacturer. All construction plants shall, where appropriate, be muffled and the Engineer shall have the authority to instruct the Contractor to shut down any which is not adequately muffled and to remove it from the Site. All machines in intermittent use shall be shut down or throttled down to a minimum in the intervening periods between works. Noise emitting equipment running continuously shall be housed in a suitable acoustic enclosure. Constructional plant shall be maintained in good and workmanlike condition so that extraneous noises from mechanical vibration, creaking and squeaking are reduced to an acceptable minimum. Percussive methods will not be permitted for breaking concrete. Equipment which breaks concrete or used for bending or such other equipment as is approved by the Engineer shall be used. All pile driving, demolition works etc shall be carried out by a recognized noise reducing system. Rotary drills and busters actuated by hydraulic or electrical power shall, where practicable, be used for excavating hard material. Noisy constructional plant shall be sited as far away as possible from occupied buildings. The use of barriers (noise barriers, site huts, acoustic sheds, screens or partitions) to absorb and or deflect noise away from occupied buildings shall be employed wherever possible. Care shall be taken when loading or unloading vehicles, dismantling scaffolding or moving materials to reduce impact noise. Access to the working areas shall be such as to ensure minimum disturbance to persons in occupied buildings. The Contractor shall not execute any of the works or carry out maintenance of construction plants in such a manner as to cause nuisance unless the work is absolutely necessary to save life or property or for the safety of the works in which case the Contractor shall immediately advise the Engineer. The Contractor shall provide all that is necessary, including competent and qualified personnel and suitable equipment for all the measurements and recordings of the noise levels as and when requested by the Engineer during the Contract duration and submit a detailed report including analysis within two days after the day of measurements to the Engineer. The Contractor shall provide and use construction plant and equipment, which have been specifically designed or modified to reduce the noise of normal operation. All night work after 6pm shall be subject to the approval of the Engineer.

2.7. MAPPING OF EXISTING SERVICES

- 2.7.1.** Prior to commencement of any part of the works under the contract, the Contractor shall locate the exact positions of all existing sewer mains, gas mains, water mains, electrical cables, telecommunication cables and other utility services.
- 2.7.2.** Underground Utility Surveying shall be carried out by the Contractor, using the most advanced technology to get accurate & reliable Underground Utility information. Based on the findings of Underground Utility Surveying, the Contractor shall submit the Utility map and his plan for shifting of same to the Employer and respective Utility services Authorities. The Contractor shall commence the work of Shifting / Relocation of Utilities only on reviewing approval for same.
- 2.7.3.** The Contractor shall take all precautionary measures to prevent damage to the services and minimize all inconvenience to residents, during the cutting of trial trenches.
- 2.7.4.** Where utility services which are in the way of the works are not diverted or not to be diverted, they must be supported and protected during the construction of the works. The Contractor shall submit to the engineer and the relevant utility services authorities, calculations and detailed drawings, for the necessary support and protection of these services.
- 2.7.5.** Any requirement that may be imposed by the utility services authorities in this connection shall be met fully and without compromise.
- 2.7.6.** The Contractor shall note that the employer will not be responsible for any damage of the existing services caused by the construction works, etc. The Contractor will be liable for any damage to the existing services and carry out the repair works to the satisfaction of the engineer and the appropriate utility services authorities at his own expense.
- 2.7.7.** All relevant utility services authorities shall be kept informed of any changes affecting their services
- 2.7.8. Diversion and Maintenance of Existing Drains**
- 2.7.8.1.** Upon award of the contract and prior to the commencement of the works, the contractor shall submit to the engineer his proposal for the diversion and maintenance of existing drains for the whole period of construction to the engineer and respective authority for approval.
- 2.7.8.2.** The contractor shall be responsible for the maintenance of the free flow of the drains at all times. At no time shall the contractor obstruct or reduce the free flow area of the existing canal / drain without the prior approval of the engineer and respective authority.
- 2.7.8.3.** If, in the opinion of the engineer, the contractor has not carried out or is unable to carry out such maintenance of temporary drain diversion to his satisfaction, the engineer reserves the right to employ others to carry out such works and deduct the cost of all such works from any money due to or to become due to the contractor.

2.7.8.4. The contractor shall remove all temporary works as soon as these are no longer required and reinstate the site to its original condition to the satisfaction of the engineer and respective authority.

2.7.8.5. The contractor shall take all necessary precautions to prevent any damage to the existing culverts and drains. Existing drains/culverts/sumps etc. Made redundant when the new drains / culverts / sumps are completed, shall be completely removed and filled with suitable materials to the satisfactory of the Engineer

2.8. Interface with Government Authorities / Consultants / Contractors / Contractors

2.8.1. Contractor shall Coordinate with Various Government Authorities / Agencies , Chhattisgarh State Power Distribution Company Ltd. (CSPDCL), State Electricity Board, Raipur Municipal corporation (RMC), Gas Authority, ICT Consultant, ICT Contractor, various other Contractors / Contractors engaged by Employer for this Project for finalizing the Drawings, Implementation Schedule, shifting and Alignment of Utilities, for Proper Execution of works. All the Statutory Charges/ Fees. Etc required for the same shall be borne by the Contractor.

2.8.2. Interface Matrix is given as a Guideline to the Contractor; however it is in the scope of Contractor to coordinate with all Relevant Authorities for Proper Execution and Completion of Works.

Table 1 INTERFACE MATRIX

Sr. No.	Description	Coordination
1	For design & implementation of various Roads as per detail scope as mentioned in Tender document	Owner of the road (RMC / PWD / NHAI), Traffic Police department, Police
2	Smart pole features regarding traffic management and sensors, Traffic Signals	Raipur Municipal Corporation, Traffic dept
3	For all Statutory / planning /Designing / Safety / Environmental norms	With Relevant departments. All charges / fees required shall be borne by the Contractor
4	Assessment of Power Requirement, Location and Space required for Supply of Power Equipments.	Chhattisgarh State Power Distribution company Ltd
5	For storm water collection pits	Owner of the road (RMC / PWD / NHAI), Traffic Police department, Police
6	For utility trench proposal & implementation at proposed location	Owner of the road (RMC / PWD / NHAI), Traffic Police department, Police
7	Shifting of Required Utilities	Concerned department of Utilities and others. Traffic Police department, Police
8	Power supply for street light feeder pillars	Chhattisgarh State Power Distribution company Ltd,
9	Utility trench for laying cables and pipe lines in	Chhattisgarh State Power

Sr. No.	Description	Coordination
	CSPDCL area	Distribution company Ltd, State Road Authority, RMC & associated various dept.
10	24x7 Water Supply works-	Coordination with RMC Water Supply Staff, PHE Department, AMRUT Consultant & other contractors deployed for water supply works.
11	Streetscape Design, Visual Improvement at road & Junctions	Coordination with on ground & Underground services working department for location of elements & landscape (above ground level)

2.9. Design and Drawings to be submitted for review and Approval

- 2.9.1.** On Award of work the Contractor shall submit the design and Drawing for review and approval. Drawings mentioned in the list are indicative and for Information. Contractor shall not limit himself to the same but it is in scope of Contractor to submit all required design and drawings for review and approval as per Instruction from Engineer-In-Charge.

Table 2 List of Documents to be submitted

Sr. No.	Documents
General	
1	Geotechnical investigation report
2	Topography Survey Layout
3	Civil / structural design basis report
4	Consumer Household survey with GIS base map in hard & soft copies. (shape files)
5	Structural design (calculations) report
6	Proposed Layout for Shifting of Utilities
7	Design, Drawings, Sections for all Roads indicating the Proposed Visual Development
8	Operation & Maintenance manual for all components
A	ROAD WORKS
1	Complete Road plan showing all the items as per BOQ (For all roads in ABD Area)
2	Road Levels (For all roads in ABD Area)
3	Typical ROW cross sections (For all roads in ABD Area)
4	Section at pedestrian crossing, raised pedestrian crossing at junctions, entry exits, through flyover
5	Detail sections for Re-carpeting works for roads
6	Typical details for Pavement (For footpath, shared paving (@ junctions, tactile pavement)- Plan, sections, details

Sr. No.	Documents
7	Typical details for medians & kerb conditions (For all roads in ABD Area)
8	Typical details for Road Markings (text, arrows, lines, bus stop marking, cycle lane marking, pedestrian crossing, parking area etc as per IRC guidelines)
9	Typical details for Road Delineators
10	Typical details for painting of kerbs, medians, flyover edge condition etc.
11	Traffic island design including plan , sections, typical details etc. at junctions in co-ordination with respective SMC zone
B	STORM WATER DRAINAGE SYSTEM & RAIN WATER HARVESTING
1	Design basis report for Storm Water Drain
2	Design basis report for culvert structure or any structure needed for storm water drainage network.
3	Detail design of Storm Water drainage Network for ABD area with relevant calculation along with output file including soft and hard copy.
4	Over all planning of Storm water including discharge points
5	Typical RCC box details of proposed drains for every section.
6	Approved Structural detailing of any structure from (RMC/ PWD or Owner of Road) including rate analysis as per latest CG-SOR rates.
7	L-section of proposed drains according to finished road level.
8	Typical details of cleaning and maintenance arrangement of network.
9	Shoring and strutting details of excavation when depth of cutting is more than 1.5 M
10	Form work details of drain of invert depth more than or equal to 1.5M
11	Typical reinforcement details of Precast slab
12	Diversion details and drawing for drain having invert level more than 1.5M
13	Hydro-geological Investigation Reports for RWH scheme with locations
14	Design basis report for Rain Water Harvesting System
15	Typical Details of RWH Structure
C	24X7 WATER SUPPLY
1	Design Basis Report, Network Analysis report, design output in hard & soft copies (.dxf & .wtg files)
2	Detailed Distribution Network layout drawing with locations of all valves, bulk water meters, pressure transmitters, actuators etc.
3	Detailed structural drawings of valve chambers, thrust blocks, road restoration, etc.
4	Detailed architectural & structural drawings of SCADA Center & billing office.
5	Contractor Datasheet /Drawings & QAP for all Field Instruments, SCADA & Data Communication equipment, Cables and all Accessories
6	Detail System Architecture Drawing
7	Operation & Control Philosophy
8	Instrument Hook-up drawings with Erection Hardware BOQ
9	Cable Schedule & Termination Schedule
10	Operation & Maintenance Manual

Sr. No.	Documents
D	ELECTRICAL WORKS
1	Master Plan drawing for electrical services showing Manholes, DTs
2	BOQ Listing Equipments designation, make, model, rating, quantity, etc.
3	Cable Route Marker
4	CSS & RMU
5	DT Box, Service Feeder Pillar
6	Design Calculations for Lighting (Road-wise) & Cable Schedule for HT, LT cable
7	Confirmatory Survey Details with Map
8	Type & Technical Datasheet for Cables, DT Box, Service Feeder Pillar, CSS, RMU, etc.
9	Exit Plan, As-Built Drawings, etc.
10	Refer Volume III D for further detail list of drawing & documents for electrical works
E	VISUAL IMPROVEMENT
1	Base map preparation of existing roads and Junctions with sections .Proposed plan with sections elaborating street elements & details, streetscape elements locations, visual improvements areas, themes and landscape.
2	Notes , Photos, Observations, Sketches, illustrations , Presentations, reports, Summery sheets ,2D and 3D presentation of designed layout.
3	Concept & Methodology till execution of work. Design details and execution details of each streetscape element.
4	Quarterly progress report
5	Drawings and documents (Hard copies and soft copies) shall be in colour with appropriate legends formatted on suitable standard international paper sizes (signed at stamped) as per drawings and documents contents at readable font and scale. Softcopies shall be in PDF format – at least Medium quality pixels.
6	Designed items (e.g. themes, artwork etc.) have to be approved from the client before starting the further process of work.

2.10. Brief Scope of work:

2.10.1. Road layout of all roads under the scope of this tender is as below

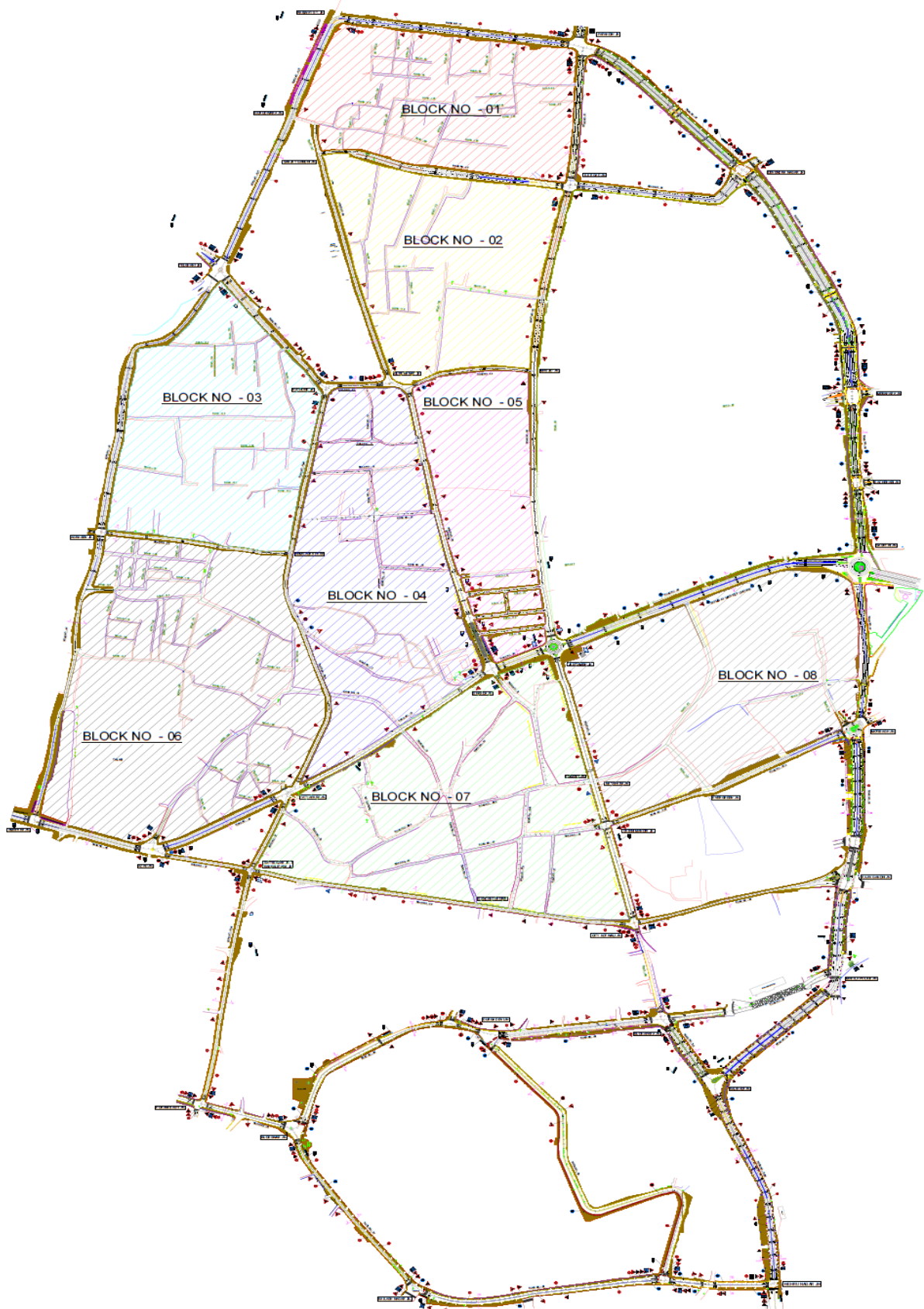


Figure 1 Block Key Details-Internal Roads

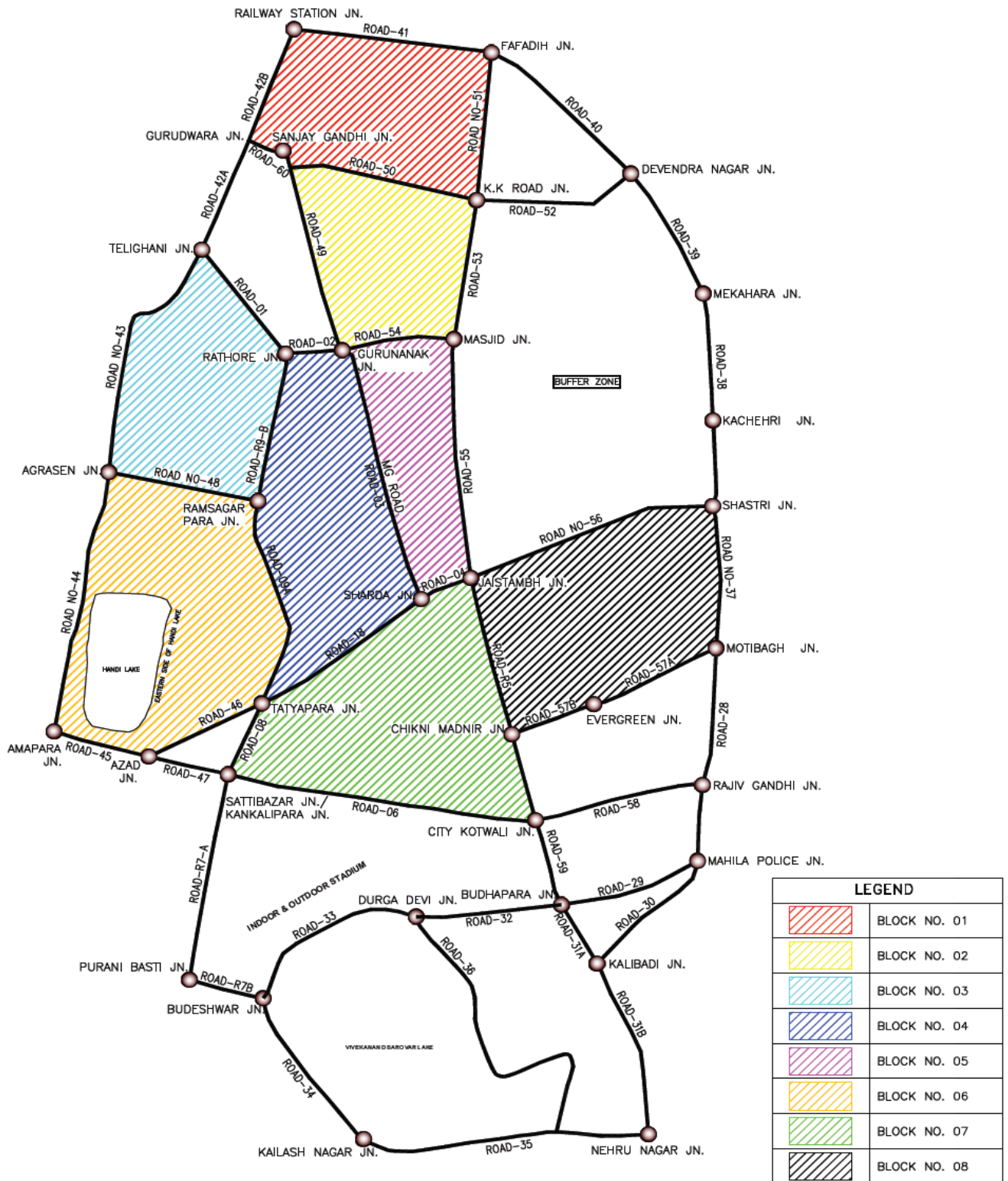


Figure 2 Block Key Details- Smart Roads

2.10.2. For more clarity, legends of Roads names and 41 km Road length breakup are as given below

Table 3 List of Major Roads

Road No.	Major Roads	Length (in Mtr)	ROW	Type of Pavement
Road -1	Rathore Chowk to Telghani Chowk	360	15	Flexible Pavement
Road -2	Gurunanak Chowk to Rathore Chowk	130	12	Flexible Pavement
Road -3	Sharda Chowk to Gurunanak Chowk	724	18	Flexible Pavement
Road -4	Sharda Chowk to Jaistambh Chowk	140	24	Flexible Pavement
Road -5	Jaistambh Chowk to City Kotwali Chowk	677	18	Flexible Pavement
Road -6	City Kotwali Chowk to Sattibazar Chowk	812	12	Flexible Pavement
Road -7A	Satti Bazaar Chowk to Purani Basti Thana Chowk	565	12	Flexible Pavement
Road -7B	Budeswar to Purani Basti Thana Chowk	200	15	Flexible Pavement
Road -8	Satti Bazaar Chowk to Tatyapara Chowk	200	13	Flexible Pavement
Road -9A	Tatyapara Chowk to Ramsagar Para	610	12	Flexible Pavement
Road -9B	Ramsagar Para to Rathore Chowk	400	15	Flexible Pavement
Road -28	Motibagh to Mahila Police Station.	560	34	Flexible Pavement
Road -29	Mahila Police Station to Budhapara	394	15 & 19.5	Flexible Pavement
Road -30	Mahila Police Station To Kalibadi	376	24	Flexible Pavement
Road -31A	Budhapara to Kalibadi Jn.	171	24	Flexible Pavement
Road -31B	Kalibadi to Nehru Nagar Jn.	503	18	Flexible Pavement
Road -32	Budhapara to Durgadevi	380	24	Flexible Pavement
Road -33	Durgadevi to Budheswar	530	24 & 12	Flexible Pavement
Road -34	Budheswar to Kailash Nagar	454	13	Flexible Pavement
Road -35	Kailash Nagar to Nehru Nagar	775	20	Flexible Pavement
Road -36	Nehru Nagar to Durgadevi Junction	890	17.5	Flexible Pavement

Road No.	Major Roads	Length (in Mtr)	ROW	Type of Pavement
Road - 37	Motibagh Junction to Shastri Chowk	388	23	Flexible Pavement
Road - 38	Shastri Chowk to Mekahara Chowk	407	30	Flexible Pavement
Road - 39	Mekahara Chowk to Devendra Nagar Junction	600	35	Flexible Pavement
Road - 40	Devendra Nagar Junction to Fafadih Junction	447	30	Flexible Pavement
Road - 41	Fafadih Junction to Railway Station Junction	518	25	Flexible Pavement
Road - 42A	Telghani Naka Jn to Gurudwara Jn.	400	18	Flexible Pavement
Road - 42B	Gurudwara Jn. To Railway Station Chowk	247	28	Flexible Pavement
Road - 43	Telghani Naka Junction to Agrasen Chowk	717	20	Rigid Pavement + Flexible Pavement
Road - 44	Agrasen Chowk to Amapara Chowk	700	21	Rigid Pavement
Road - 45	Amapara Chowk to Azad Chowk	260	23	Flexible Pavement
Road - 46	Azad Chowk to Tatyapara Chowk	310	24	Flexible Pavement
Road - 47	Azad Chowk to Kankalipara Chowk	210	12	Flexible Pavement
Road - 48	Agrasen Chowk to Ramsagarpara Road	400	11	Flexible Pavement
Road - 49	Sanjay Gandhi to Gurunanak Chowk	680	14	Flexible Pavement
Road - 50	KK Rd to Sanjay Gandhi Junction	530	20	Rigid Pavement
Road - 51	Fafadih Junction to KK Rd Jn.	328	20	Flexible Pavement
Road - 52	Devendra Nagar Jn. To KK Rd Junction	400	23	Rigid Pavement
Road - 53	K K Road To Masjid Junction	446	20	Flexible Pavement
Road - 54	Gurunanak to Masjid (KK Road)	270	12	Flexible Pavement
Road - 55	Masjid Junction To Jaistambh Junction	660	16	Flexible Pavement
Road - 56	Jaistambh Chowk to Shastri Chowk	680	30	Flexible Pavement

Road No.	Major Roads	Length (in Mtr)	ROW	Type of Pavement
Road - 57A	Motibagh to Evergreen Jn.	330	12	Flexible Pavement
Road - 57B	Evergreen Jn. to Chikani Mandir	240	18	Flexible Pavement
Road - 58	City Kotwali Junction To Rajiv Gandhi Junction	460	11	Flexible Pavement
Road -59	City Kotwali Junction To BUDHAOARA	235	18	Flexible Pavement
Road -60	GURUDWARRA JN TO SANJAY GANDHI JN	115	15	Flexible Pavement
Total Length of Main Roads (m)			20829	

Table 4 List of Internal Roads

Road No.	Block	Length (in Mtr)	ROW
Internal roads -61	B 1	85	3
Internal roads -62	B 1	112	3.5
Internal roads -63	B 1	160	3.5
Internal roads -64	B 1	126	4
Internal roads -65	B 1	124	4.5
Internal roads -66	B 1	120	4.5
Internal roads -67	B 1	87	4.5
Internal roads -68	B 1	91	4.8
Internal roads -69	B 1	173	5
Internal roads -70	B 1	130	5.2
Internal roads -71	B 1	74	5.5
Internal roads -72	B 1	82	5.5
Internal roads -73	B 1	162	6
Internal roads -74	B 1	50	6
Internal roads -75	B 1	148	6
Internal roads -76	B 1	192	6
Internal roads -77	B 1	125	6
Internal roads -80	B 1	140	6.5
Internal roads -81	B 1	55	6.8
Internal roads -82	B 1	158	7
Internal roads -83	B 1	60	7.5
Internal roads -84	B 1	52	9
Total Length of Internal Roads in Block 1		2856	
Internal roads -85	B2	226	5

Road No.	Block	Length (in Mtr)	ROW
Internal roads -86	B2	400	5
Internal roads -87	B2	196	5
Internal roads -88	B2	145	5
Internal roads -89	B2	140	5.5
Internal roads -90	B2	102	7
Internal roads -91	B2	67	9
Internal roads -92	B2	267	13
Internal roads -93	B2	198	14
Total Length of Internal Roads in Block 2		1741	
Internal roads -94	B3	225	3.5
Internal roads -95	B3	55	4
Internal roads -96	B3	74	4.5
Internal roads -97	B3	73	4.5
Internal roads -98	B3	106	4.5
Internal roads -99	B3	250	5.7
Internal roads -100	B3	353	6.5
Internal roads -101	B3	145	7
Internal roads -102	B3	305	7.5
Internal roads -103	B3	71	8
Internal roads -104	B3	125	9
Total Length of Internal Roads in Block 3		1782	
Internal Roads - 10	B4	126	4.5
Internal Roads - 11	B4	210	5.5
Internal Roads - 12	B4	233	5.5
Internal Roads - 13	B4	230	7
Internal Roads - 14	B4	272	7.5
Internal Roads - 15	B4	140	8
Internal Roads - 16	B4	48	8
Internal Roads - 17	B4	338	10.2
Total Length of Internal Roads in Block 4		1597	
Internal roads -105	B5	170	8.2
Internal roads -106	B5	155	11.75
Internal roads -107	B5	56	12
Internal roads -108	B5	194	14.5
Internal roads -109	B5	143	15.5
Total Length of Internal Roads in Block 5		718	
Internal roads -110	B6	44	3.5

Road No.	Block	Length (in Mtr)	ROW
Internal roads -111	B6	41	4
Internal roads -112	B6	222	4
Internal roads -113	B6	81	4
Internal roads -114	B6	77	4
Internal roads -115	B6	76	4
Internal roads -116	B6	69	4
Internal roads -117	B6	120	4
Internal roads -118	B6	123	4.5
Internal roads -119	B6	129	4.5
Internal roads -120	B6	197	5
Internal roads -121	B6	150	5
Internal roads -122	B6	66	5
Internal roads -123	B6	59	5
Internal roads -124	B6	230	5
Internal roads -125	B6	145	5
Internal roads -126	B6	148	6
Internal roads -127	B6	115	6.5
Internal roads -128	B6	80	6.5
Internal roads -129	B6	188	6.5
Internal roads -130	B6	218	7
Internal roads -131	B6	145	7.5
Internal roads -132	B6	77	8
Internal roads -133	B6	150	8.5
Internal roads -134	B6	205	8.5
Internal roads -135	B6	196	9
Internal roads -136	B6	558	9
Internal roads -137	B6	143	10
Internal roads -138	B6	80	10
Internal roads -139	B6	110	10
Internal roads -140	B6	215	10
Internal roads -141	B6	80	11
Internal roads -142	B6	79	12
Internal roads -143	B6	82	16
Internal roads -144	B6	52	20
Total Length of Internal Roads in Block 6		4750	
Internal Roads - 18	B7	519	6
Internal Roads - 19	B7	635	6
Internal Roads - 20	B7	283	6
Internal Roads - 21	B7	129	7.5

Road No.	Block	Length (in Mtr)	ROW
Internal Roads - 22	B7	272	8
Internal Roads - 23	B7	230	8
Internal Roads - 24	B7	770	8
Internal Roads - 25 (A)	B7	247	8
Internal Roads - 25 (B)	B7	298	9
Internal Roads - 26 (A)	B7	169	10
Internal Roads - 26 (B)	B7	101	11
Internal Roads - 27	B7	186	18
Total Length of Internal Roads in Block 7		3839	
Internal roads - 145	B8	540	7
Internal roads - 146	B8	138	7.6
Internal roads - 147	B8	282	16.5
Internal roads - 148	B8	262	17.5
Total Length of Internal Roads in Block 8		1222	
Total Length of Internal Roads		18505	
Total Length of Roads		39334	

2.10.3. Improvement of Roads

- 2.10.3.1. There are about 42 no's main roads of total length 20.829 km and 106 no's secondary roads with total length 18.505 Km in the ABD area are to be resurface.
- 2.10.3.2. The work also includes disposal of debris and broken materials, preparation of earthen sub grade in 1 m wide excavated strip, overlaid with 250 mm thick GSB layer & 250 mm thick WMM layer.
- 2.10.3.3. The undulated surface stretches in carriage way of bituminous road top shall be improved by overlaying one 50 mm thick (average) layer of DBM. Strengthening of existing pavement by overlaying bituminous surface. Surface coat shall be laid on top as 40 mm thick Bituminous concrete (BC).
- 2.10.3.4. The excavated CC roads rigid pavement & Parking shall be made good with earthen sub grade, river sand/murum, 250 mm GSB layer, 100 mm PCC base concrete overlaid with 200 mm thick PQC layer on top.
- 2.10.3.5. Longitudinal joint shall come up at interface of old and new CC road strips and transverse joints in fresh CC strip shall match with the similar joints in existing CC roads.
- 2.10.3.6. Providing, footpath, with paver blocks and concrete tiles. The road side shoulder shall be made flushed with the road carriage way top level in 12 m wide (ROW) roads. A raised shoulder, 200 mm higher than the top level of carriage way, shall be made in case of 15 m wide roads laterally supported at edge with cast in situ CC kerb. Such kerb shall be painted with synthetic enamel paint.
- 2.10.3.7. Top of the flushed shoulders are made up of 60 mm thick M40 grade paver block overlaid on 150 mm thick PCC base concrete. Top surface of raised shoulders shall be made of 22-25 mm thick pre-polished M 30 grade CC tiles over 150 mm thick base concrete.
- 2.10.3.8. Streetscape design which includes making of separate vehicular zones (Carriage way & shoulder) and pedestrian zones (Pathway +Cycle track) along with Street Furniture e.g. Bench, dustbin, bollards, signage etc. Hardscape (engraving) and softscape (Shrubs, trees) along the road and at Median, Mandatory traffic lanes, road markings and signage. Development shall be considering locations of Bus stops, auto stands & Public bicycle sharing stations (PBS) and services of underground and above ground.
- 2.10.3.9. Road furniture which includes, road marking, traffic signage, street landscaping & hardscaping works.
- 2.10.3.10. A detailed topographical survey, of the components involved as shown in the battery limit, within the project area shall be carried out using Total Station equipment (DGPS survey). The spot levels at 30 m interval and the contour interval of 1m shall be carried out, stored and submit in editable digital format.

2.10.3.11. Contractor will survey all underground utilities located within the Project Area up to 1.5 m depth at interval of 50 m in a staggered way and mark on GIS based maps. Utilities can be checked by using non-destructive methods.

2.10.3.12. For Further details Bidder to refer Volume III A – Employers Requirement and Technical Specifications for Improvement of Roads

2.10.4. Storm Water Drains & Rain Water Harvesting

2.10.4.1. A detailed topographical survey using Total Station equipment (DGPS survey) to capture all site features as per site condition within the project area shall be carried out.

2.10.4.2. Contractor will survey all underground utilities using non-destructive methods located within the Project Area.

2.10.4.3. Accurately describe existing permanent boundary markers.

2.10.4.4. Design and analysis of Storm water drain collection & conveyance system for Project Area.

2.10.4.5. Scope of work includes the conditional assessment & capacity analysis of existing drains within the project area.

2.10.4.6. Construction of RCC Box section Storm Water drains shall be as per the approved design.

2.10.4.7. Shifting of existing utilities shall be identified by Contractor prior to start of execution activity.

2.10.4.8. Contractor should take the prior approval from the concerned authorities before shifting of utilities.

2.10.4.9. Contractor has to re-lay those utilities which are shifted due to construction work in consultation with client.

2.10.4.10. Contractor shall connect all household water outlets to Storm Water Drains.

2.10.4.11. Providing suitable arrangement for O&M of system.

2.10.4.12. The Contractor shall provide temporary drainage or bypass arrangements for under construction drains to avoid damage or nuisance due to scour, sedimentation, seepage, or other adverse effects to the works or surrounding areas and structures as a result of construction activities.

2.10.4.13. Design output, construction drawing should be submitted as per work schedule, before commencing the proposed construction work.

- 2.10.4.14. Contractor shall submit as-built drawings immediately after completion of approved work.
- 2.10.4.15. Storm Runoff from project area shall be effectively harvested before disposing into road side drains.
- 2.10.4.16. To achieve effective harvesting of rain water, suitable Rain Water Harvesting scheme shall be proposed.
- 2.10.4.17. Periodic cleaning / replacement of filter media in RWH system have to be done for proper efficient functioning of system.
- 2.10.4.18. The system / utilities shall be covered to avoid any unforeseen accidents, and can be aesthetically improved under visual improvement.
- 2.10.4.19. For Further details Bidder to refer Volume III B – Employers Requirement and Technical Specifications for Storm Water Drains & Rain Water Harvesting.

2.10.5. 24 x 7 Water Supply:

- 2.10.5.1. Scope of work includes Refurbishment of existing network in ABD and Outer Area including all work of Mechanical, Electrical, SCADA, Household Connections, Consumer Water Meter Fittings work with three months trial run and post completion Management of 24 x 7 Water Supply in Smart City for a period of 5 years Including 5 years defect liability period on DBO basis.
- 2.10.5.2. For Further details Bidder to refer Volume III C – Employers Requirement and Technical Specifications for 24 x 7 Water Supply

2.10.6. Electrical Works

- 2.10.6.1. Scope of work includes survey & improvement of Electrical power network by conversion of overhead line into underground cable, optimization of distribution transformers into compact substation, replacement of service pole by service feeder pillar (FP), provision of Cable manholes along the proposed smart road, replacement of conventional street lighting system including pole, fixtures by decorative octagonal pole , smart LED fixtures with smart electronic driver for control and integration of smart lighting system with ICCC at Multilevel car parking of ABD area, dismantling of lighting pole , fixtures, electric poles & transport to employer store.
- 2.10.6.2. Scope of work includes submitting of design & construction drawings, all calculation sheets, for Vender drawing review and approvals.
- 2.10.6.3. For Further details Bidder to refer Volume III D – Employers Requirement and Technical Specifications for Electrical Works.

2.10.7. Visual Improvement for Roads & Junctions

- 2.10.7.1. Plan must meet the minimum requirements for the streetscape and roadway outlined in the Codes, and any applicable City of Raipur.
- 2.10.7.2. Roads & junctions should be with specific themes.
- 2.10.7.3. Suitable listed streetscape elements should be for each road and Junction according to the width of the road.
- 2.10.7.4. Streetscape elements installations above ground level shall be done after work of all underground the services network.
- 2.10.7.5. After starting the work of streetscape above the ground, Green cover areas i.e. landscape shall be done in priority with respect to street furniture locations and final markings of other elements and installations shall be done accordingly.
- 2.10.7.6. The streetscape must create a unique sense of place. With the help of various colored materials, paving, signage, lighting, landscaping, crosswalk markings, and art of sculptural pieces.
- 2.10.7.7. Any streetscape element placed on the non-motorized zone should not create a hindrance for pedestrians and for cyclist.
- 2.10.7.8. A Separation between vehicles and pedestrian is important. This could be done with trees, low vegetation, planters, bollards, or other elements as per proposal.
- 2.10.7.9. The movement between vehicles and sidewalks should ensure for smooth flow. Ease of accessibility should be ensured from a vehicle to a desired location on the sidewalk.
- 2.10.7.10. Most low landscaping should be a maximum of 18-24" tall. Any trees or upper level landscape should be maintained at 6' or above. The middle area of the landscape should be kept clear. This accomplishes two things it, keeps a line of site into things along the street such as retail areas and it helps with safety by not providing potential places for people to hide.
- 2.10.7.11. For Further details Bidder to refer Volume III E – Employers Requirement and Technical Specifications for Junction Improvement & Visual Improvement.

3.0 SPECIFICATIONS FOR CIVIL WORKS

3.1. PREAMBLE

- 3.1.1.** This section contains the specifications for proposed work and shall be read in conjunction with the various other sections forming the Contract namely, Instructions to Tenderers, General Conditions, Special Conditions, Bill of Quantities, Drawings and other related documents mentioned in this Tender Document together with any Addendum issued thereto.
- 3.1.2.** The General Technical Specifications comprise the “Specification for Road and Bridge Works” (Fifth Revision) issued by the Ministry of Road Transport and Highways (MORTH)-Government of India and published by the Indian Road Congress, New Delhi, Latest Specifications of Chhattisgarh Public Health Engineering Department (CG-PHE)-USOR-2013 & all latest amendments, Chhattisgarh Public Works Department (CG-PWD)-SOR-2015 for Roads, Buildings & Electrical works, Latest Specifications of CPWD, Specifications as per Tender Documents and as Approved by Engineer-In-Charge.
- 3.1.3.** The Contractor must clear all obstacles which may cause obstruction to the Works. In the case of a parked vehicle, he shall, at the direction of the Engineer's representatives, serve notice to inform the driver to move it from site.
- 3.1.4.** All construction plant and equipment shall not be parked on main roads and shall be moved from site as soon as work completes. In cases where the construction plant and equipment are left on site for the purpose of works on the next day, then, subject to the Engineer 's approval, the Contractor shall take necessary precautions for safety and security of the equipment/material and will be responsible for any loss or damage to the material.

3.2. Storage of Material:

- 3.2.1.** Materials required for the works shall be stored by the Contractor only at places, in standard profiles and in the manner as approved by the Engineer-in-Charge. Storage and safe custody of all materials shall be the sole responsibility of the Contractor. Special care should be taken as per relevant specification for storage of bitumen etc.
- 3.2.2.** The Contractors shall construct suitable go-down at the site of work for storing the material safe against damage due to sun, rain, dampness, fire, theft etc. He shall also employ necessary security measures for the purpose and no extra claim whatsoever shall be entertained on this account.
- 3.2.3.** From commencement till completion, all materials and works shall be under the safe custody of Contractor. The Contractor is solely responsible for and to make good all injuries, damages and repairs accrued to or rendered necessary to the same by fire, storm, rain, traffic or other causes and to hold the Engineer-in-Charge indemnified from any claim for injuries to person or for structural damage to property occurring from only neglect, default, want of proper care or misconduct on the part of the Contractor.

- 3.2.4.** The Contractor shall produce samples of all materials to be procured by him sufficiently in advance to obtain approval of the Engineer-in-Charge. Subsequently the materials to be used in the actual execution of the work shall strictly conform to the quality of samples approved. In case of variation in quality such materials shall be liable for rejection. The rejected materials shall be removed from the site within 48 hours of their rejection, also the Engineer-in-Charge shall be authorised to remove the same at the risk and cost of the Contractor.

3.3. Temporary Works

The contractor shall submit comprehensive method statements for all temporary works before the start of any works to the engineer's approval. Submission of this method statement shall be sufficiently (minimum 3 weeks) in advance of the construction of the works to allow adequate time for review, resubmission as necessary and future review. The statement shall clearly identify in details, the contractor's proposed methods (including machinery/equipment material and other resource needed), sequence of working with necessary plans, drawings and calculations.

Designs and drawings for Temporary Works shall be submitted for the acceptance of the Engineer and relevant authorities.

All Temporary Works shall be removed after use and approval must be sought from the Engineer with justification if otherwise.

Bentonite slurry waste shall not be discharged into the public sewerage and drainage systems

3.4. TRAFFIC CONTROL AND ROAD SAFETY AT WORK ZONE

TRAFFIC CONTROL AND ROAD SAFETY

- 3.4.1.** The Contractor shall comply strictly with the specifications given in the code of practice for traffic control at work zone which sets out the requirements, standards and procedures and provides guidance to implement traffic control plan necessary for carrying out work activities on the road so as to protect the public, equipment and workmen.
- 3.4.2.** The Contractor shall submit detailed construction sequence and detailed traffic diversion schemes including scaled cross-sectional drawings and layout plans to the Employer. All construction sequences proposed by the Contractor shall have primary considerations for the safety of road users.
- 3.4.3.** The Contractor shall note the traffic conditions at the Site and his proposed traffic diversion schemes shall be based on his investigation and appreciation of the Site for the completion of the whole of the Works.
- 3.4.4.** The Contractor shall note that the construction methods and schedule of his Works proposed shall not cause any disruption to traffic flow. All accesses to premises affected shall be maintained at all times. Unless authorised in writing by the Engineer, the Contractor shall not be allowed to close off any traffic lane along any existing roads. He

shall not be allowed to place, or cause obstruction near or on the carriageway in a manner which would cause a reduction in the traffic capacity of the road.

- 3.4.5.** Closure of any traffic lane or any carriageway required shall be implemented in accordance with the approved traffic diversion scheme for all affected traffic movements.
- 3.4.6.** All temporary traffic diversion schemes proposed for the Works shall be provided with a one-to-one replacement of all affected traffic lanes, footpath, pedestrian crossing, bus-stop and other road related facilities. Alternative pedestrian crossing facilities shall be provided prior to the dismantling of existing facilities.
- 3.4.7.** The Contractor shall adhere to the minimum provisions of work zone safety as per IRC SP55. The Contractor's qualified engineer shall submit all detailed temporary traffic diversion schemes for the Works to the Engineer and relevant authorities including the Traffic Police, and etc. for approval. These proposed traffic diversion schemes shall be submitted in properly scaled engineering drawings and shall be supported with traffic analysis report. Such drawings shall include traffic layout plans showing all traffic signs, lane-markings, advance warning and directional signs etc., longitudinal section drawings and all other drawings necessary for the implementation of the schemes. The Contractor shall comply with the requirements of all relevant authorities in his implementation of the temporary traffic diversion scheme.
- 3.4.8.** The temporary diversion road pavement shall be Asphalted or equivalent.
- 3.4.9.** The Contractor shall also liaise, co-ordinate with and assist the Employer in scheming and designing the provision of adequate street lighting along the diversion route. Foundations for lamp-posts and all ancillary works shall be provided by the Contractor.
- 3.4.10.** For traffic diversion schemes which are to be implemented for a period of more than 3 months, all lane-markings shall be done in thermoplastic material. Lane-markings for each stage of the traffic diversion shall be maintained and, if necessary, replaced and repainted in good condition at all times to the satisfaction of the Engineer. All existing lane markings affected by the temporary diversion of traffic are to be properly grinded off. Diverted lane/arrow markings must be properly painted and must not be confused with the existing markings.
- 3.4.11.** The Contractor shall note that all vehicular impact guardrails or kerbs removed during the construction stage shall be replaced with water filled safety barriers complete with safety reflective discs.

3.5. TECHNICAL SPECIFICATIONS FOR CIVIL WORK

3.5.1. EARTHWORK

3.5.1.1. SCOPE OF WORK

- 3.5.1.1.1.** The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with earthworks of all underground supplies and services and for all

structural units, stock piling, of specifications and applicable drawings, and subject to terms and conditions of the contract. The scope of this section of specifications is also covered with detailed specifications as laid down herein.

3.5.1.2. **GENERAL**

- 3.5.1.2.1. The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be encountered during excavation of earthworks. The Employer does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the report, drawings or in any other contract documents or to material obtained from boring or trial holes. The contractor shall be deemed to have made local and independent inquiries and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive any extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.
- 3.5.1.2.2. All excavations, cutting, and fills shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the period of maintenance the ground shall be at the required lines, levels and gradients.
- 3.5.1.2.3. During the course of the Contract and during the period of maintenance any damage or defects in cuttings and fills, structures and other works, caused by slips, falls or basins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at this own cost.

3.5.1.3. **SITE PREPARATION**

- 3.5.1.3.1. The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Project Engineer. The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.
- 3.5.1.3.2. The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.
- 3.5.1.3.3. The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.
- 3.5.1.3.4. The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork. Tests for compaction shall be carried out as per IS 2720.

3.5.1.4. **EXCAVATIONS**

- 3.5.1.4.1. Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings and as directed by the Project Engineer.
- 3.5.1.4.2. The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per drawings or as directed by the Project Engineer. The excavation which cannot be done by mechanical means including leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and back fill shall be stock piled within the free haulage limit of the 200m of the works.
- 3.5.1.4.3. The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Project Engineer full details of his proposals. The Project Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.
- 3.5.1.4.4. For major excavations, the Contractor shall submit for the prior approval of the Project Engineer full details and drawings showing the proposed method of supporting and strutting etc. The design, provisions construction, maintenance, and removal of such works shall be the responsibility of the Contractor and all cost in these respects shall be included in the unit rates for the permanent work.
- 3.5.1.4.5. The Contractor's attention is drawn particularly to his obligations under the general conditions in respect of those works which are in close proximity to existing buildings.
- 3.5.1.4.6. The Contractor shall preserve the complete excavation from damage from slips and earth movements, ingress of water from any source what so ever and deterioration by exposure to the sun and the effects of the weather.
- 3.5.1.4.7. All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the permanent works caused by excavation on other parts of the works.
- 3.5.1.4.8. Excavation shall extend to sufficient distance from walls and footing to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces.
- 3.5.1.4.9. All excavations in foundations shall be taken to 150mm and shall be trimmed carefully to a smooth and level surface, immediately after trimming to the final elevation a layer of building concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation

which is left overnight or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the Project Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.

- 3.5.1.4.10. No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Project Engineer and his permission to proceed given. If excavations for sub-structures are carried below the required level, as shown in the drawings or as directed by the Project Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.
- 3.5.1.4.11. All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient equipment for this purpose. Adequate precautions shall be taken to prevent any corrosion due to undercutting from underneath the previously constructed adjoining foundations.
- 3.5.1.4.12. Existing utility lines to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be required to be repaired by the Contractor at his expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Project Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Project Engineer in ample time for necessary measures to be taken to prevent interruption of the service.
- 3.5.1.4.13. Excavated material suitable for use as filling material shall be stock piled within the free haulage limit 200m of works as directed by the Project Engineer. This stock piled material shall be transported back to places requiring fill or backfill. Surplus or material unsuitable for use as filling shall be disposed of by the Contractor at locations approved by the Project Engineer within specified free haulage limit.
- 3.5.1.4.14. The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer is not bound in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, drawings and documents.
- 3.5.1.4.15. Excavation for Recharge pits, Recharge trenches shall be taken out to the levels and dimensions as the Project Engineer may direct.
- 3.5.1.4.16. Before starting the excavations, the Contractor shall ensure the correct alignment of the recharge trenches and location of recharge pits on the ground, the depth and width of excavation of the trench and pits, all in accordance with the drawings and instructions of the Project Engineer.

3.5.1.4.17. The Contractor at his cost shall provide to the satisfaction of the Project Engineer all timbering, approved supports and shores and bracings to the sides of the excavated trench and foundations in such a manner to secure the sides of the trench and excavations from falling or adverse movement. All responsibility connected with such shoring shall rest with the Contractor. Adequate clearance / working space on both sides of the structure/pipe line shall be provided for which no payment shall be made.

3.5.1.4.18. Without the written permission of the Project Engineer no more than 50.0m the trench shall be opened in advance of the completed pipe line. The bottom of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottom of the pits and trenches shall be removed and the cavities so formed filled with lean concrete at the Contractor's expense.

3.5.1.4.19. The Project Engineer may require the Contractor to excavate below the elevations shown on the drawings or he may order him to step above the elevations shown depending upon the suitable foundation material encountered.

3.5.1.4.20. If for any reasons, the levels grades or profiles of the excavations are changed adversely, the Contractor shall at his own cost be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Project Engineer.

3.5.1.5. **EXCAVATION TOLERANCES**

3.5.1.5.1. Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Project Engineer as accepted for the design and type of work involved.

3.5.1.6. **BACK FILLING**

3.5.1.6.1. After completion of foundation footing, foundation, walls, and other construction below the elevation of the final grades and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris.

3.5.1.6.2. The backfilling shall include filling around the foundations, trenches.

3.5.1.6.3. Filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable for compaction by ordinary means.

3.5.1.6.4. The excavated material if found suitable shall be stock piled within the free haulage limit of the site of the works. This material shall be used for backfilling if approved by the project engineer and shall be transported by the contractor any where required for the purpose of backfilling work in this contract.

- 3.5.1.6.5. The contractor shall provide the approved quality fill and backfilling material as required to complete the fill/backfilling work. Filling in trenches and foundation shall be placed in 200 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the project engineer.
- 3.5.1.6.6. Fill in around trenches and pits shall be carefully placed with fine material to cover the completely before the normal infilling is done.
- 3.5.1.6.7. Material for backfilling shall be as approved by the project engineer and shall be placed in layers of 150 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum density at optimum moisture content, achieved in test no.15 of IS 1377:1975 or similar clause of relevant is code.
- 3.5.1.6.8. All filled areas shall be left neat, smooth and well compacted with the top surface consisting of the normal site surface soil unless otherwise directed.
- 3.5.1.6.9. Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.
- 3.5.1.6.10. Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.
- 3.5.1.6.11. Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.
- 3.5.1.6.12. Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.
- 3.5.1.6.13. In case the contractor is instructed to arrange for the fill material the quality of the fill material will be subject to the approval of the project engineer. The project engineer shall require the contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the contractor. Once a material from a specific source has been approved, the material for the same quality and from that source only shall be used. Any fill material from borrow pits which has not been approved or the quality of which differs from the approved material shall be rejected outright. The project engineer reserves the right to order removal of any such materials brought to the site of works at his discretion at contractor's expense. In order to ensure satisfactory compaction, it will be necessary to carry out, depending upon the type of material, particle size distribution tests, determination of organic content tests, maximum and minimum density tests and determination of optimum moisture content for the filling material.

- 3.5.1.6.14. The method of compaction, namely type of compactor, type of roller, weight of roller and number of passes proposed by the contractor for any particular fill material shall be subject to the approval of the project engineer after completion of satisfactory field tests, subsequent to the laboratory analyses, using the materials and equipment proposed to be used for the earth work in conditions similar to those likely to be encountered during construction.
- 3.5.1.6.15. The final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at contractor's expense.
- 3.5.1.6.16. Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the project engineer. Adequate control of the fill and compacting operations shall be ensured by in-situ density tests and in order to obtain significant results, not less than two measurements shall be carried out per one hundred square meters of area compacted. The frequency of tests shall be determined on site and may be varied at the discretion of the project engineer. Compaction shall not be less than 95% in-situ density with respect to the maximum density, at optimum moisture content.
- 3.5.1.6.17. The exact thickness of layers and the method of placing and compacting the fill shall be determined by the field tests, as stated above, but not withstanding the results of these trials, fill shall not be placed in layers exceeding 200mm in thickness. In order to maintain control of the thickness of layers, timber profiles shall be used wherever feasible. The travelers of such profiles for each layer of fill shall be checked by the supervisory staff of the project engineer. The contractor shall provide adequate supply of water and sufficient capacity of mechanical water carriers to ensure uniform and uninterrupted operation of compaction. The project engineer may forbid the contractor to proceed with placing and/or compaction of fill and/or order removal and re-compaction of such fill when he finds that the contractor has insufficient or defective equipment or that the fill has been improperly laid and/or compacted.
- 3.5.1.6.18. If it is found necessary to alter the moisture content of the fill material in any way, then very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests.
- 3.5.1.6.19. The fill material should be well graded non-cohesive and nearly silt-free (silt content between 5 to 10 percent) salt free and free of organic materials (less than 2%). It should also be free of stones larger than 100 mm. Maximum dimensions. It should be of such nature and characteristics that it can be compacted to the specified densities in reasonable length of time. It shall be free of plastic clays, of all materials subject to decay, decomposition or dissolution and or cinder or other material which corrode piping and other metals.

3.5.1.7. TOLERANCES

- 3.5.1.7.1. The stabilization of compacted backfill/fill surfaces shall be smooth and even and shall not vary more than 100mm in 3 meters from true profile and shall not be more than 12.5mm from true elevation.

3.5.1.8. DISPOSAL OF SURPLUS MATERIAL

- 3.5.1.8.1. The rejected unsuitable material and surplus excavated material shall be disposed of within 200 m free haulage limit measured from boundary of the works to places or as directed by the Project Engineer.
- 3.5.1.8.2. The disposal of surplus excavated material shall include loading, unloading, transporting, stacking, spreading as directed by the Project Engineer.

3.5.2. PLAIN AND REINFORCED CEMENT CONCRETE

The work covered by this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials, and in performing all operations in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the Specifications and relevant documents, subject to the Conditions of the Contract.

3.5.2.1. GENERAL

- 3.5.2.1.1. Full co-operation shall be given to other trades to install embedded items and/or any associated services.
- 3.5.2.1.2. Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.
- 3.5.2.1.3. Formwork shop drawings shall be designed and prepared by the Contractor at his own cost. Approval of shop drawings as well as those of mock-ups /actual samples of finished concrete shall be obtained before Work is commenced.
- 3.5.2.1.4. Contractor shall prepare bar bending schedules, and get the same approved by the Project Engineer, prior to commencement of work.

3.5.2.2. RELATED SPECIFICATIONS

The codes and standards generally applicable to the work of this section are listed herein after.

IS 269	:	Ordinary and low heat Portland cement
IS 8041	:	Rapid Hardening Portland cement
IS 455	:	Portland slag cement
IS 1489	:	Portland Pozzolana Cement
IS 8112	:	High Strength Ordinary Portland Cement

IS 383	:	Coarse and fine aggregates from natural sources for concrete
IS 456	:	Code of practice for plain and reinforced concrete
IS 516	:	Method of sampling and analysis of concrete
IS 1199	:	Method of sampling and analysis of concrete
IS 1139	:	Hot rolled deformed bars
IS 23896	:	Methods of testing of aggregates for concrete (Part I to III)
IS 2751	:	Recommended Practice for welding for reinforcement bars
IS 9103	:	Admixtures for concrete
IS 10262	:	Recommended guide lines for concrete mixed design

3.5.3. MATERIALS

3.5.3.1. CEMENT

- a. Cement shall conform to standards listed in section 2 of IS: 456, latest edition.
- b. Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.
- c. There shall be sufficient cement at site to ensure that each section of Work is completed without interruption.
- d. Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- e. Contractor shall provide and erect, at his own cost, in a suitable place, dry, well ventilated, and water proof shed of sufficient capacity to store the cement.
- f. The cement shall be used as soon as possible after delivery, and cement which the Project Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at Contractor's expense.
- g. The mixing together of different types of cement shall not be permitted.

3.5.3.2. AGGREGATES

- a. The sources of supply of all fine and coarse aggregates shall be subject to the approval of Project Engineer.
- b. All fine and coarse aggregates shall be clean and free from clay, loam, silt, and other deleterious matter. If required, Project Engineer reserves the right to have them washed by the Contractor at no additional expenses. Coarse and fine aggregates shall be delivered and stored separately at Site. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.
- c. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of IS: 383 latest editions. Fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a

suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregate shall conform to IS: 383 and test for conformity shall be carried out as per IS: 2386 (Part I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modules of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

- d. Coarse aggregate shall be gravel or broken stone or hard, durable material free from laminated structure and conforming to IS: 383 latest editions. Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali silica reaction shall not be used. All coarse aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386 Parts I to VIII. Nominal size of the coarse aggregate shall be as described in the respective item in the schedule of quantities.
- e. The aggregates shall be graded as follows for use in mass concrete as in foundations:

TOTAL PASSING	PERCENT BY WEIGHT
2" B.S. Sieve (50.00 mm)	100
1-1/2" Sieve (38.10 mm)	95-100
3/4" Sieve (19.00 mm)	35- 70
3/8" Sieve (9.50 mm)	10- 30
No. 4 Sieve (4.75 mm)	0- 5

- f. Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:-

TOTAL PASSING	PERCENT BY WEIGHT
1" Sieve (25.00 mm)	100
3/4" Sieve (19.00 mm)	90-100
3/8" Sieve (9.50 mm)	20- 55
No. 4 Sieve (4.75 mm)	0- 10

3.5.3.3. Water:

- 3.5.3.3.1. Only clean potable water from the city supply, tube well installed at the Site or from other sources approved by Project Engineer shall be used. Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubts exist as to the suitability of the water, it shall be tested in

accordance with IS: 3025. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, Project Engineer may refuse to permit use. As a guide, the following concentrations represent the maximum permissible values:

- a. To neutralize 200 ml sample it should not require more than 2 ml of 0.1 normal NaOH.
- b. To neutralize 200 ml sample it should not require more than 10 ml of 0.1 normal HCL.
- c. Percentage of solids should not exceed the following:

	PERCENT
Organic	0.02
Inorganic	0.30
Sulphates	0.05
Alkali Chlorides	0.10

- 3.5.3.3.2. In case of doubt, Project Engineer may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90 percent of the strength of concrete mixed with distilled water.

3.5.3.4. Reinforcement

- 3.5.3.4.1. Reinforcement for concrete shall conform to the respective IS or other standards as specified in the drawings and Contract Documents or as may be specified by Project Engineer.
- 3.5.3.4.2. Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of IS: 432, and shall have a minimum yield stress of 248 N/sq mm.
- 3.5.3.4.3. Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of IS: 1786 for deformed cold worked steel bars and shall have minimum characteristic stress of 415 N/sq mm.
- 3.5.3.4.4. Reinforcement shall be obtained only from manufacturers approved by Project Engineer. If and when required Contractor shall provide all necessary facilities to Project Engineer for the selection of test pieces and shall cause these to be prepared and submitted where directed for tests at Contractor's cost.
- 3.5.3.4.5. If the reinforcement is to be supplied by Employer, Contractor shall inform Project Engineer of his requirements much before its use in construction.
- 3.5.3.4.6. Reinforcement of all types is to be stored at Site in an approved manner so as to avoid damage.
- 3.5.3.4.7. Contractor shall report immediately on receipt of any consignment, having any deviation in the standard weights of the reinforcing bars beyond those allowed in respective standards mentioned in clause (3.3.3.4.b) and (3.3.4.4.c) herein before.

3.5.4. CONCRETE MIX PROPORTIONS

3.5.4.1. General:

- 3.5.4.1.1. The proportions of ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the Work, but without permitting the materials to segregate or excessive free water to collect on the surface. Specific approval of the Project Engineer is required to waive limitations on mixture proportions.
- 3.5.4.1.2. The proportions of ingredients shall be selected in accordance with Section 5.7 to produce the proper placeability, durability, strength and other required properties.

3.5.4.2. Strength

- 3.5.4.2.1. The Specified compressive strength of the concrete cube, shall be 15 N/sq mm. or 20 N/sq mm. Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

3.5.4.3. Durability

- 3.5.4.3.1. Requirements of Clause 7 of IS: 456-1978 shall be followed.

3.5.4.4. Slump

- 3.5.4.4.1. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 100 mm or less. A tolerance of up to 25 mm above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit.
- 3.5.4.4.2. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.
Note: If S.R. Cement is used, permissible water-cement ratio may be increased by 0.05.
- 3.5.4.4.3. Slump shall be determined by the "Test for slump for Portland Cement Concrete" as per relevant IS code.

3.5.4.5. Maximum Size of Coarse Aggregate:

- 3.5.4.5.1. The nominal maximum size of the aggregate shall be 20mm for all portions of the structure except footings which may be 38 mm. These limitations may be waived if, in the judgment of the Project Engineer, workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids.

3.5.4.6. Admixtures:

- 3.5.4.6.1. If required or permitted, admixtures used shall be in accordance with the manufacturer's instructions except as otherwise specified herein.
- 3.5.4.6.2. Use of chemical admixtures to enhance the properties of concrete may be permitted by the EIC upon tests on trial mixes of concrete to establish that overall chloride content of the concrete mix is within acceptable limit as described in IS 456 and properties of concrete like strength & durability are not compromised. Chemical admixtures to be used in the concrete mix shall conform to IS 9103 – Indian Standard – Concrete Admixtures – Specifications. Instructions of the manufacturers' of the chemical admixtures shall be followed while mixing them in the concrete.

3.5.4.7. Methods of Obtaining Mix Design:

- 3.5.4.7.1. For concrete of normal weight, mix proportions to provide the desired characteristics shall be developed using the methods/procedure covered by the Recommended Practice for Selecting Proportions for Normal Weight Concrete ACI-211.1-77/ IS:456-1978.
- 3.5.4.7.2. Trial mixtures having proportions and consistencies suitable for the Work shall be made based on above codes, using at least three different water-cement ratios which will produce a range of strengths encompassing those required for the Work. Trial mixes shall be designed to produce the specified slump. The temperature of concrete used in trial batches shall be reported.
- 3.5.4.7.3. For each water-cement ratio, compression test of cube shall be made, cured, and tested in accordance with IS: 1199 and IS: 516. From the results of these tests a curve shall be plotted showing the relationship between the water-cement ratio and compressive strength. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce the required design strength. The cement content and mixture proportions to be used shall be such that this water- cement ratio is not exceeded when slump is the maximum permitted. Control in the field shall be based upon maintenance of proper cement content and slump.

3.5.5. Ready mix concrete**GRADES AND STRENGTH REQUIREMENTS OF CONCRETE****3.5.5.1. General**

- 3.5.5.1.1. Ready mix Concrete shall consist of the material described under site batched concrete sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the of mix design . The overall grading shall be such as to produce a concrete of the specified quality which will work readily in to position without segregation. The ready mix concrete shall conform to IS: 4926 and shall be delivered in agitating trucks. The RMC may contain fly ash as per the acceptable norms.

3.5.5.2. Slump

- 3.5.5.2.1. The water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS456-1978 when a suitable amount of water has been determined, the resulting consistency shall be maintained throughout the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency. The max slump at the point of the discharge should not exceed 110mm max.

3.5.5.3. Concrete Grades

- 3.5.5.3.1. Grade of concrete used in the works shall be shown on the drawings or as directed by the Architect/Project Manager. The minimum cement used for M-20 shall be 300 Kg. Per Cum, 350 Kgs for M-25 and 400Kgs for M-30.

3.5.5.4. Admixtures

- 3.5.5.4.1. It shall conform to the requirements of IS: 456 and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete shall conform to IS: 3812 (Part II). However, partial replacement of cement by fly ash shall not be more than 15% of designed requirement. In case if fly ash is to be used more than 15%, the same shall be guided under table of the IS, and in which case specific care shall be taken in terms of curing, protecting, repairing, finishing, de-shuttering etc.

3.5.5.5. TRANSPORTING CONCRETE

- 3.5.5.5.1. Concrete shall be transported in agitating trucks without contamination, loss of ingredients or segregation. In no case shall a period of more than 4 hours have elapse between the wetting of mix and discharge of the concrete at site.

3.5.5.6. CONCRETE PLACEMENT

- 3.5.5.6.1. Concrete, when deposited, shall have a temperature of not less than 5°C (41°F) and not more than 32°C (90°F).
- 3.5.5.6.2. The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Architect/Project Manager.
- 3.5.5.6.3. Contractor shall give adequate notice to the Architect/Project Manager of his intention to concrete any section of the works.
- 3.5.5.6.4. Except where otherwise directed, concrete shall not be placed unless the representative of the Architect/Project Manager is present and has previously

examined and approved the positioning, fixing and condition of the reinforcement or any other items to be embedded and the cleanliness, positioning and suitability of the concreting surface.

3.5.5.6.5. The concrete shall be deposited as nearly as possible in its final position. It shall be placed in such a manner as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in horizontal layers not exceeding 450 mm in compacted thickness unless otherwise authorized or directed by Architect/Project Manager. Concrete shall not be placed simultaneously on each side of large horizontal specified or approved construction joints.

3.5.5.6.6. Shutters for walls or thin sections of considerable height shall be provided with openings or other devices that will facilitate the cleaning of the accumulation of hardened concrete on the shutters or on the metal reinforcement above the level of the concrete and the removal of concrete in the case of segregations.

3.5.5.7. **Quality Control**

3.5.5.7.1. In order to ensure that the quality of materials and the mix proportions are suitable for the particular grade of concrete required are so maintained, sampling and testing shall be carried out regularly during the course or the works.

3.5.5.7.2. Workability testing shall be carried out in accordance with IS: 456. The results shall lie within the range upon which the accepted mix design is based. Testing shall be carried out at such a frequency that the required workability is consistently achieved.

3.5.5.7.3. Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete at a frequency of sampling for each grade of concrete and from each concrete mixing plant at six cubes of 150 mm nominal size per 50 cubic meters of concrete placed in the works or twice per week.

3.5.5.7.4. Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Architect/Project Manager. The test cube procedure shall be in accordance with IS: 516 throughout.

3.5.5.7.5. Compliance with the specified characteristic strength shall be assumed if:

- a. Each of the six cubes in a group has a test strength not less than the characteristic strength or,
- b. Not more than one cube has test strength less than the specified characteristic strength but not less than 85% of the specified characteristic strength and the average strength of the group of four test results is not less than the specified characteristic strength plus the standard deviation of the group.

3.5.5.8. Seven day cube tests

3.5.5.8.1. Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relationship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relationship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the Architect/Project Manager of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

3.5.5.9. Acceptance Criteria

3.5.5.9.1. The general Acceptance Criteria of any and all of the concrete work shall be as per the relevant Clauses of IS. 456. If any of the works tests are not up to the standard, the Architect/Project Manager shall have the power to stop the work until the reason is investigated and steps taken to prevent further low results. The contractor shall not be entitled to any claims on account of such delays. Any concrete carried out from the batch that is afterwards found to be faulty, will be liable for rejection and if so directed, the contractor shall at his own expenses dismantle and replace the defective work and any work built thereon or shall take such other measures as may be deemed necessary by the Architect/Project Manager. At the discretion of the Architect/Project Manager, the contractor may be allowed to prove by means of a load test to be carried out at his own expense, that the concrete is capable of safely withstanding the loads as specified in the test.

3.5.5.10. Quality of Water

3.5.5.10.1. Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

3.5.5.10.2. The pH value of water shall not be less than 6.

3.5.5.10.3. Seawater shall not be used for concrete mixing and curing.

3.5.5.10.4. The proposed admixtures shall comply with requirements of specification part 11- Water sealing materials.

3.5.5.11. Measurement

3.5.5.11.1. Ready mixed concrete (RMC) will be the same as mode of measurement for concrete work already mentioned in section 1.8.

3.5.5.11.2. However, consumption of RMC shall be maintained at site. Wastage, spill over, wastage due to pump blockage etc. shall not be considered for payment.

Note: Clean-up

3.5.5.11.3. Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and area surrounding the site shall be cleaned thoroughly.

3.5.5.11.4. Debris resulting from the work shall be removed from the premises and disposed of as per approved HSSE plan.

3.5.5.11.5. All debris, i.e. empty containers, wooden pieces etc. shall be removed.

3.5.5.11.6. The finished concrete surfaces shall be left in a clean condition satisfactory to PMC.

3.5.6. STEEL REINFORCEMENT

3.5.6.1.1. The work to be done under this section consists of furnishing, cutting, fabricating, bending, placing and tying steel reinforcement in concrete structures or elsewhere as shown on the drawings or directed by the Project Engineer. The scope of this section of this section of specifications as laid down herein.

3.5.6.2. MATERIAL AND SIZE OF BARS

- 3.5.6.2.1. Reinforcement for concrete shall conform to the respective Indian or other standards as specified in the drawings and in the contract documents or as may be specified by the Project Engineer.
- 3.5.6.2.2. Unless otherwise specified, all plain mild steel reinforcing bars shall comply with the requirements of IS: 432 (Part- I) and shall have a minimum yield stress of 250 N/mm.sq.
- 3.5.6.2.3. Unless otherwise specified, all deformed reinforcing bars shall comply with the reinforcements of IS: 1786 for deformed cold twisted steel bars and shall have a minimum characteristic strength of 415 N/mm.
- 3.5.6.2.4. Reinforcement shall be obtained only from manufacturers approved by the Consultant/Project Engineer. Each consignment of reinforcement steel shall be accompanied by a manufacturer's certificate or shall refer to a previous certificate, if the consignment is from the same batch, showing that the reinforcement steel complies with the following requirement.
- 3.5.6.2.5. If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.
- 3.5.6.2.6. Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.
- 3.5.6.2.7. Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond.
- 3.5.6.2.8. Reduced section steel reinforcement shall not be used.
- 3.5.6.2.9. If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.
- 3.5.6.2.10. If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

3.5.6.2.11. Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.

3.5.6.2.12. Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

3.5.6.2.13. Steel wire mesh reinforcement shall conform to requirement of relevant Indian codes or those of ASTM: A 185-64 or BS. 4483, 1969: Standard Specifications for welded steel wire fabric for concrete reinforcement. It shall be used where shown on the drawings.

3.5.6.3. Applicable standards

3.5.6.3.1. Latest editions of Indian Standards as per 4.3 or other International Standards

3.5.6.4. DELIVERY & STORAGE

3.5.6.4.1. Delivery

Steel reinforcement bars shall be delivered in bundles firmly secured and tagged. Each bars or bundle of bars shall be identified by marks stamped on hot or cold or painted on or by any other means. The identifying marks shall contain the following information:

- a. Name of the producer or his trade.
- b. Standard to which the bars have been manufactured.
- c. The clause, type and strength respectively.
- d. The diameter.
- e. The number of the test certificate (if available).

3.5.6.4.2. Storage

The method of storage shall be approved by the Project Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separate.

3.5.6.5. BAR BENDING SCHEDULES

3.5.6.5.1. The Contractor shall prepare bar bending schedule of all the reinforcing steel bars and these bar bending schedules will be supplied to the Consultants/Project Engineer in duplicate on the basis of which the work shall be carried out. However, the Contractor shall be responsible to satisfy himself as to the correctness and accuracy of the bar

bending schedule. Any discrepancy shall immediately be notified to the Consultant / Project Engineer before commencing work.

3.5.7. DWC HDPE PIPE WORK

3.5.7.1. GENERAL

3.5.7.1.1. Design of HDPE pipes including material details and the maximum allowable hydrostatic design stress taking into consideration, the temperature and design life of pipes shall be in accordance with the relevant clauses of IS:14333

3.5.7.2. Material

3.5.7.2.1. The DWC (Double Wall Corrugated) High Density Polyethylene Pipes (HDPE) shall be in the range of 160 mm to 1000 mm nominal diameter of pressure rating of PN6 / PN 8 on material grade of PE 80. Material Grade, Minimum Required Strength and Maximum Allowable Hydrostatic Design Stress shall conform to the relevant clause of IS – 14333. The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any reputed organization as per the satisfaction of the Engineer.

3.5.7.3. Examining

3.5.7.3.1. The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 2530 and tests in accordance with the methods described in relevant clause of IS: 14333. Following tests shall be taken in consideration:

- a. Hydrostatic Test
- b. Reversion Test
- c. Density Test
- d. Melt Flow Test
- e. Carbon Black Content and Dispersion.

3.5.7.3.2. Three samples of the same size and same pressure rating selected at random shall be tested for compliance with the requirements of the type test for Internal Pressure Creep Rupture Test.

3.5.7.3.3. In case, any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to type test again. In case of the sample fails in the repeat tests, the type of pipe shall not be approved.

3.5.7.3.4. Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

3.5.7.3.5. A lot having satisfied dimensional and visual requirements shall be tested for hydraulic characteristics, reversion, density, MFR and Carbon Black content / dispersion requirements. The lot shall be considered to have met the requirements of these tests, if none of the samples tested fails.

3.5.7.4. **WORKMANSHIP AND FINISH**

3.5.7.4.1. Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

3.5.7.5. **Laying**

3.5.7.5.1. For lowering and laying of pipes, the following points shall be considered:

- a. Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer shall be laid.
- b. While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. The bedding for HDPE pipes shall be provided as per relevant drawing and as directed by engineer. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, 15cm thick sand bed as approved by the engineer shall be provided.
- c. As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.
- d. During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day).
- e. For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

- f. The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.
- g. The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.
- h. The Installation of flanged fittings such as connections to sluice / air / gate valves on pumping main requires the use of stub ends (flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.
- i. Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.
- j. PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done.
- k. When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.
- l. However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.
- m. Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density

3.5.7.6. Making Joint

- 3.5.7.6.1. The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as per IS: 7634 (Part II) shall be selected considering site and working condition, pressure and flow of liquids.

3.5.7.7. CLEANING

- 3.5.7.7.1. As soon as a stretch of HDPE pipes has been laid complete from manhole to manhole or for a stretch as directed by Engineer, Contractor shall remove soil, debris etc and clean the entire stretch to the satisfaction of Engineer. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by Engineer to prevent

entry of mud or slit etc. If as a result of the removal of any obstruction, Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory Contractor shall amend the work and carry out such further tests as are required by Engineer. It shall also be ascertained by Contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably enlightened by projected sunlight or otherwise

3.5.7.8. FITTING AND SPECIALS

- 3.5.7.8.1. All HDPE fittings/ specials shall be fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or injection moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer. Fittings will be butt welded on to the pipes or other fittings by use of heat fusion.

3.5.8. RCC PIPE WORK

3.5.8.1. GENERAL

- 3.5.8.1.1. Design of RCC pipes, details of reinforcement and the ends of the pipe shall be in accordance with the relevant clauses of IS: 458. The Class of the pipe shall be of RCC NP3 conforming to IS 458.

3.5.8.2. Material

- 3.5.8.2.1. For all materials, Factory's test result and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the Engineer before carrying to sites.
- 3.5.8.2.2. **Cement Ordinary Portland cement / Sulphate Resisting:** Cement as specified in Data Sheet –A shall be used for the manufacture of RCC pipes and fittings and shall conform to relevant IS codes. The use of Pozzolana as an admixture to Portland cement shall not be permitted.
- 3.5.8.2.3. **Aggregates:** Aggregates used for the manufacture of RCC pipes shall conform to IS: 383. The maximum size of aggregate should be 10mm for pipes of internal diameter 150 to 250mm but should not exceed one third thickness of the pipe or 20mm, whichever is smaller, for pipes of internal diameter above 250mm.
- 3.5.8.2.4. **Mixing and Curing Water:** Water used for mixing of concrete and curing of pipes shall conform to IS: 456. 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. Contractor shall submit water quality report before using it.

3.5.8.2.5. **Reinforcement:** Reinforcement used for the manufacture of the spigot and socket RCC pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (part- 2). A reinforcement cage for pipes shall be as per relevant requirement of IS: 458.

3.5.8.2.6. **Concrete:** Concrete used for the manufacture of spigot and socket 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. Compressive strength tests shall be conducted on 15cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

3.5.8.3. **CURING**

3.5.8.3.1. Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

3.5.8.4. **WORKMANSHIP AND FINISH**

3.5.8.4.1. 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 3mm in pipes upto 600mm diameter (inclusive), and 6mm in pipes larger than 600mm diameter.

3.5.8.4.2. 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 Engineer and the manufacturer or supplier.

3.5.8.4.3. The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

3.5.8.4.4. The pipes shall be free from local dents or bulges greater than 3.00 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

3.5.8.4.5. 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 diameters, 3 mm for every meter run.

3.5.8.5. **Laying**

3.5.8.5.1. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Engineer. Pipes shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes shall be made by Contractor. In no case pipes shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes shall be

used to lift and lower the pipes. The pipes shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside, of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes damaged during lowering or aligning shall be rejected by Engineer. All the pipes are to be laid perfectly true both in alignment and to gradient specified and the socket end of the pipe shall face upstream. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be cantered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

3.5.8.6. Making Joint

3.5.8.6.1. Collar Joint

Jointing of RCC pipes shall be done as per the requirements of following Specifications and as per the relevant IS. The type of joints shall be spigot and socket type. 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. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

3.5.8.6.2. 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 pipes. The manufacturer's instructions 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. The socket of RCC pipes shall face up the gradient.

3.5.8.7. Cleaning of pipes

- 3.5.8.7.1. As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by Engineer, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by Engineer to prevent entry of mud or slit etc. If as a result of the removal of any obstruction, Engineer considers that

damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory Contractor shall amend the work and carry out such further tests as are required by Engineer. It shall also be ascertained by Contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably enlightened by projected sunlight or otherwise.

3.5.8.8. Testing at works site

- 3.5.8.8.1. 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 Engineer. All equipment for testing at work site shall be supplied and erected by the Contractor and shall be rectified by him to the full satisfaction of Engineer. Water used for test shall be removed from pipes and not released to the excavated trenches. After the joints have been thoroughly jointed and have been checked by Engineer and before backfilling the trenches, the entire section of the sewer shall be proved by Contractor to be water tight by filling in pipes with water at a constant head of 2.5m above the top of ground level for the highest pipe in the stretch and heading the water up for the period of one hour. The testing apparatus used for the purpose shall normally be fixed on the upstream end and should be got approved by Engineer. Contractor if required by Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular intervals (not more than 1 minute) and noting the quantity of water required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 liter / hour / 100 linear meters / 10 mm nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good. All of results of test and inspection data must be prepared by contractor at site so that the Engineer shall make decision of "fail or pass" at once. All cost for the inspection shall be borne by the Contractor. Notes a) 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 Engineer. b) Water for testing of pipeline shall be arranged by Contractor at his own cost.

3.5.8.9. Construction Specification

- 3.5.8.9.1. When a truck mixer or agitator is used for mixing or transportation concrete, no water from the truck-water system or from elsewhere shall added after the initial introduction of the mixing water for the batch, when on arrival at the site of the work, the slump of the concrete is less that specified, such additional water to bring the slump within limits shall be injected into the mixer under such pressure and direct flow that the requirements for uniformity specified.
- 3.5.8.9.2. Unless otherwise specified when a truck or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be complete

within 1 ½ hour (when the prevailing atmospheric temperature above 20 degree Centigrade) and within 2 hours (when the prevailing atmosphere temperature is at or below 20 degree centigrade) of adding the mixing water and appropriate admixture if any, to the mix of cement and aggregate or adding the cement to the aggregate whichever is earlier.

- 3.5.8.9.3. Adequate facilities shall be provided by the manufacturer/supplier to inspect the materials used the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities to take samples of the materials used.
- 3.5.8.9.4. The tests for consistency or workable shall be carried out in accordance with requirements of IS 1199 by such other method as may be agreed to between the purchaser and manufacturer.
- 3.5.8.9.5. The sampling and testing of concrete shall be done in accordance with the relevant requirements of IS 456, IS 1199 and IS 516.
- 3.5.8.9.6. The compressive strength and flexural strength tests shall be carried out in accordance with the requirement of IS: 516 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements and other related requirements of IS 456.
- 3.5.8.9.7. The testing shall be carried out in accordance with the requirements and the cost shall be borne by the Contractor.
- 3.5.8.9.8. The manufacturer shall keep batch records of the quantities by mass all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required insisted, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

3.5.9. Masonry

3.5.9.1. Scope

- 3.5.9.1.1. Scope of this specification covers the work of masonry at all locations and levels in terms of materials, workmanship, supervision, etc.

3.5.9.2. General

- 3.5.9.2.1. The work shall be carried out as per the drawings and/ or description of the item in the schedule of quantities and/ or instructions issued to the contractor by the EIC. Contractor shall allow for placement of other services like electrical conduits, switch boxes, pipes, cable trays, RCC lintels in the masonry. Work shall be carried out by skilled masons under competent supervision.
- 3.5.9.2.2. The rates quoted by the contractor shall include the cost of materials, labor, supervision, electricity, water, fuel, logistics, scaffolding, mixing of mortars, laying of bricks in mortar, preparing the areas & contact surfaces, soaking of bricks, setting out,

curing, cleaning the work place daily, providing sufficient lighting at the work place, taking measurements of the work, providing safety measures etc. complete to the satisfaction of the EIC.

- 3.5.9.2.3. Cement mortar shall be mixed in the tray and water cement ratio shall be controlled. Quantity of mortar mixed with water should be consumed within 30 minutes (initial setting time) from the time of mixing water. Not more than 1200mm height of masonry should be constructed per day.
- 3.5.9.2.4. Work area shall be maintained clean. All loose mortar or mortar patches set on the floor shall be cleaned at the end of day's work by the contractor before leaving the site.
- 3.5.9.2.5. Safety measures in terms of induction, safety equipment, instructions, caution signs, notices should be taken by the contractor at his own cost.
- 3.5.9.2.6. Work shall be protected from any damage till it is handed over to the employer. Any damage to work shall be rectified by the contractor at his own cost to the satisfaction of the EIC.
- 3.5.9.2.7. Construction joints shall be planned and provided as directed by the EIC.
- 3.5.9.2.8. Contractor shall do the initial setting out of the work and obtain the approval of the EIC of the first course of masonry work laid at the site before continuing the work further.
- 3.5.9.2.9. Mortar for masonry shall be prepared as per IS 2250 – code of practice for preparation and use of masonry mortars-. Mix proportions and/ or grade of mortar shall be as mentioned in the description of the respective item of work. Mortar shall be machine mixed as far as possible. Mortar shall be kept in the tray at the site and no mortar shall be placed on the floor. Water cement ratio of the mortar shall be controlled and mortar left unused for more than 30 minutes shall be rejected. Mortar shall be tested if instructed by the EIC.

3.5.9.3. **Brick Masonry**

- 3.5.9.3.1. Bricks shall be table molded, of uniform size, shape & color, well burnt, should give a clear ringing sound when struck, clean, free from cracks & flaws; shall have sharp edges, even surface and required strength. Brick shall be as described in the item in the schedule of quantities and/ or as instructed by EIC. Water absorption of the bricks shall not be more than 20% by weight after soaking in water for 24 hours. Bricks shall be from a source approved by the EIC. Bricks shall conform to IS 1077 –“Indian standard, common burnt clay building bricks specification” and brickwork shall conform to IS 2212 – “Brick Works Code - of Practice” Bricks shall have been approved by the EIC prior to start of masonry work. Bricks shall be tested as per IS 3495 -Indian Standard, if instructed by EIC. Size of the brick shall be as specified in the description of the item in the schedule of quantities and/ or as per the instruction of EIC. Bricks shall not be dumped on site; they shall be stored neatly in stacks as directed by the EIC.

- 3.5.9.3.2. Bricks shall be thoroughly soaked in the water for about 12 hours before getting used in the masonry work. The course shall be laid flush in mortar and every course shall be thoroughly grouted. Joints shall be broken in vertical direction and thickness of joint should not exceed 12mm. Laying of bricks, providing of construction joints and finishing of the joints shall be as described in the respective item of work and in accordance with IS 2212: 1991. 230mm thick and 115mm thick walls shall be constructed with fair face on one side.
- 3.5.9.3.3. Toothed provisions shall be kept in the work for future wall connections as per the drawings.
- 3.5.9.3.4. Curing of the work shall be done by maintaining the work in moist condition in the first 10 days and for next 20 days the work shall be watered lightly at least twice daily. Care shall be taken not to damage the work by applying water under pressure.
- 3.5.9.3.5. Work shall be measured as per IS 1200 – part III, "Indian Standard- Method of measurement of building and civil engineering work, part III Brickwork."

3.5.10. Plaster

3.5.10.1. Scope

- 3.5.10.1.1. This specification covers the work of plaster over masonry and/or concrete surfaces at all locations.

3.5.10.2. General

- 3.5.10.2.1. The work shall be carried out as per the drawings, description of the item in the schedule of quantities and instructions issued to the contractor by the EIC. Contractor shall allow for placement of other services like electrical conduits, switch boxes, pipes, cable trays, RCC lintels, in plaster as described in the drawings. Work shall be carried out by skilled masons under competent supervision.
- 3.5.10.2.2. The rates quoted by the contractor shall include the cost of materials, labor, electricity, water, fuel, supervision, logistics, scaffolding, mixing & laying of mortars, admixtures, hacking of the concrete surface, raking of joints in the masonry, preparing the areas & contact surfaces, setting out, curing, cleaning the work place daily, providing sufficient lighting at the work place, taking measurements of the work, safety measures etc. complete to the satisfaction of the EIC.
- 3.5.10.2.3. Scaffolding shall not be supported by puncturing the plaster surface. Scaffolding shall not be used in single plane.
- 3.5.10.2.4. Cement mortar shall be mixed in the tray and water cement ratio shall be controlled. Quantity of mortar mixed with water should be consumed within 30 minutes (initial setting time) from the time of mixing water in the mortar.

- 3.5.10.2.5. Work area shall be maintained clean. All loose mortar or mortar patches set on the floor shall be cleaned at the end of day's work by the contractor before leaving the site.
- 3.5.10.2.6. Safety measures in terms of induction, safety equipment, instructions, caution signs, notices should be taken by the contractor.
- 3.5.10.2.7. Work shall be protected from any damage till it is handed over to the employer. Any damage to work shall be rectified by the contractor at his own cost to the satisfaction of the EIC.
- 3.5.10.2.8. Work shall be measured as per IS 1200.
- 3.5.10.2.9. Curing of the plaster shall start as soon as the plaster is fully set. It shall be done by maintaining the freshly plastered area moist for first 7 days and the plastered surface shall be watered lightly, twice a day for next 21 days as directed by the EIC. Care shall be taken by the contractor to protect the plastered area while curing and till it is handed over.
- 3.5.10.2.10. Mortar for plaster shall be prepared as per IS 2250 – code of practice for preparation and use of masonry mortars. Sand for plaster mortar should be as per IS 1542 and cement & water should conform to specifications mentioned in the RCC work. Mix proportions and/ or grade of mortar shall be as mentioned in the description of the respective item of work. Mortar shall be machine mixed as far as possible. Mortar shall be kept in the tray at the site and no mortar shall be placed on the floor. Water cement ratio of the mortar shall be controlled and mortar left unused for more than 30 minutes shall be rejected. Mortar shall be tested if instructed by the EIC.
- 3.5.10.2.11. All existing surfaces where plaster is going to be laid shall be thoroughly cleaned, roughened and watered prior to start of plaster work. Minor repairs to fill up the cavities, removing of loose material shall have been done prior to start of plaster work. Concrete surfaces receiving the plaster should be hacked and joints in the masonry surfaces receiving plaster should be raked to serve as keys to bond to the plaster.
- 3.5.10.2.12. Grooves, bands and drip molds shall be provided as per the drawings and instructions of the EIC.
- 3.5.10.2.13. Construction chemicals, water proofing chemicals or admixtures shall be added to the mortar as per the description of the item, manufacturer's instructions and as directed by the EIC.
- 3.5.10.2.14. Work shall be measured as per IS 1200 – part XII," Indian Standard- Method of measurement of building and civil engineering work, part XII Plastering and Pointing."

3.5.10.3. Mode of Measurement

- 3.5.10.3.1. Work shall be measured as per IS 1200 – part XII," Indian Standard- Method of measurement of building and civil engineering work, part XII Plastering and Pointing."

3.5.11. Compaction

- 3.5.11.1. Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.
- 3.5.11.2. Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sqcm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.
- 3.5.11.3. Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used. Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic -tyred roller, at least the nominal width of 300mm.
- 3.5.11.4. In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.
- 3.5.11.5. Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

3.5.11.6. Joints

- 3.5.11.6.1. Where longitudinal joints are made in pre-mixed bituminous materials, the materials shall be fully compacted and the joint made flush in one of the following ways; only method (iii) shall be used for transverse joints:
- 3.5.11.6.2. By heating the joints with an approved joint beater when the adjacent width is being laid, but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of material, to within the specified range of minimum rolling temperature and maximum temperature at any stage for the material, for a width not less, Am 75 mm, The Contractor shall have equipment available, for use in the event of a beater breakdown, to form joints by method (iii);
- 3.5.11.6.3. By using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling;
- 3.5.11.6.4. By cutting back exposed for a distance equal to the specified layer thickness to vertical face, discarding all loosened material and coating the vertical face completely, with 80/100 penetration grade hot bitumen, or cold-applied bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.
- 3.5.11.6.5. All joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

3.5.12. Preparation of Surface**3.5.12.1. Scope:**

- 3.5.12.1.1. This work shall consist of preparing an existing granular or black-topped surface bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean, and treated with Prime or Tack coat as shown on the drawings as otherwise stated in the Contract.

3.5.12.2. Materials:

- 3.5.12.2.1. For scarifying and re-laying the granular surface: The material used shall be coarse aggregate salvaged from the scarification of the existing granular base course supplemented by fresh coarse aggregate and screenings so that aggregates and screenings thus supplemented correspond to Clause – 4.4: Water Bound Macadam or Clause-4.6: Wet Mix Macadam of the Ministry's Specification for Road and Bridge Works (third revision) 1995.

- 3.5.12.2.2. For patching potholes and sealing cracks: Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in as directed by the Engineer.
- 3.5.12.2.3. For profile corrective course: A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings, or as indicated in the Contract Documents. The profile corrective course shall be laid to tolerances and densities as specified for wearing course if a single layer, or base course, if it is to be covered with a wearing course layer.
- 3.5.12.2.4. Profile corrective course and its application: The type of material for use as profile corrective course shall be as shown on the drawings or as directed by the Engineer. Where it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/ strengthening course. However, if provided as a separate layer, it shall be of the specification and details given in the contract drawings.
- 3.5.12.2.5. Any high spots in the existing surface shall be removed by a milling machine or other approved method, and all loose material shall be removed to the satisfaction of the Engineer.
- 3.5.12.2.6. Where the maximum thickness of profile corrective course will be not more than 40 mm, the profile corrective course shall be constructed as an integral part of the overlay course. In other cases, the profile corrective course shall be constructed as a separate layer, adopting such construction procedures and using such equipment as approved by the Engineer, to lay the specified type of material, to thickness and tolerance as specified, for the course, to be provided.
- 3.5.12.3. **Construction Operations:**
- 3.5.12.3.1. Preparing existing granular surface: Where the existing surface is granular, all loose material shall be removed to the satisfaction of the Engineer. Where the profile corrective course to be provided as a separate layer is also granular. Where the profile corrective course of bituminous material is to be laid over the existing granular surface, the latter shall, after removal of all loose material, be primed in accordance with Clause – 5.2.
- 3.5.12.3.2. The surface finish of all granular layers on which bituminous works are to be placed, shall, unless otherwise specifically instructed by the Engineer, be free from dust. All such layers must be capable of being swept, after the removal of any non- integral loose material, by means of a mechanical broom, without shedding significant quantities of material and dust removed by air jet, washing, or other means approved by the Engineer.
- 3.5.12.3.3. After cleaning the surface shall be correct to line and level, within the tolerances specified for base course.

3.5.12.3.4. Scarifying existing bituminous surface: Where specified or shown on the drawings, the existing bituminous layer in the specified width shall be removed with care and without causing undue disturbance to the underlying layer, by a suitable method approved by the Engineer. After removal, all loose and disintegrated material, the underlying layers which might have been disturbed should be suitably reworked and compacted to line and level. After supplementing the base material as necessary with suitable fresh stone, the compacted finished surface shall be primed. Reusable materials shall be stacked as directed by the Engineer within 1000 m of their origin.

3.5.12.3.5. Patching of potholes and sealing of cracks: Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with Clause (MORTH) s 3004.2 and 3004.3, or as directed by the Engineer.

3.5.12.4. Laying the profile corrective course

3.5.12.4.1. **Laying on granular base:** After preparing the granular surface in accordance with Clause -5.1.8.3 the profile corrective course shall be laid using material as described in Clause -5.1.8.2, or as otherwise described in the Contract, and compacted to the requirements of the particular Specification.

3.5.12.4.2. **Laying on existing bituminous surface:** The existing bituminous surface shall be prepared in accordance with Clause-5.1.8.3 and after applying a tack coat conforming to Clause-5.3, the bituminous profile corrective course shall be laid and compacted to the requirements of the particular Specification.

3.5.12.4.3. **Correction of local depressions:** Where local sags or depressions occur in the existing pavement, a specific filling operation shall be instructed by the Engineer, which should be laid in accordance with Figure 500-1. Normally, the maximum layer thickness at any point should not exceed 100 mm. In placing multiple lifts, they should be arranged according to the correct method as illustrated.

3.5.12.4.4. For correction of camber or super -elevation of the existing carriageway, the method shown in MORTH 500-2 shall be adopted, depending on the profile of the existing carriageway.

3.5.12.4.5. **Covering the profile corrective courses:** Profile corrective course particularly shall be so planned that the layer shall be covered by the designed base/wearing course at the earliest opportunity, before opening to regular traffic.

3.5.12.4.6. **Surface finish and quality control of work:** The relevant provisions of Section 900 shall apply.

3.5.12.4.7. **Arrangements for traffic:** During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause-1.12 of the Ministry's Specification for Road and Bridge Works (third revision) 1995.

3.5.12.4.8. Environmental protection: The provisions of Clause -1.11 of the Ministry's Specification for Road and Bridge Works (third revision) 1995 and the provision of Annexure 2 (to Clause (MORTH) 5.1) shall apply.

3.5.12.5. Measurements for Payment

3.5.12.5.1. **Potholes and cracks:** The work of filling potholes shall be measured separately and be paid for in square meters. The work of filling cracks by applying fog spray or emulsion slurry seal shall be measured in square meters, for the area covered by the spray.

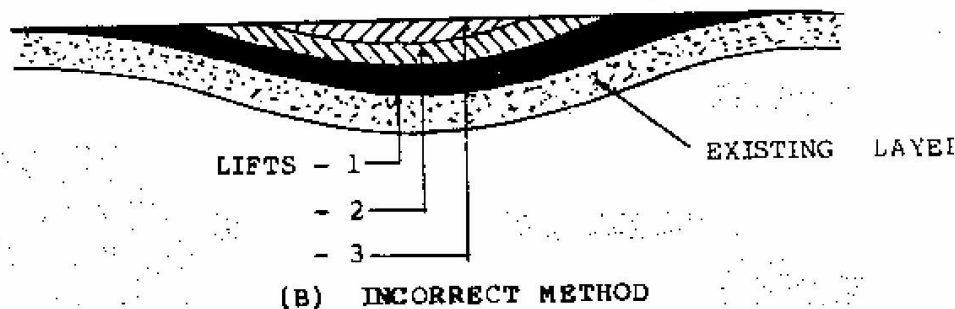
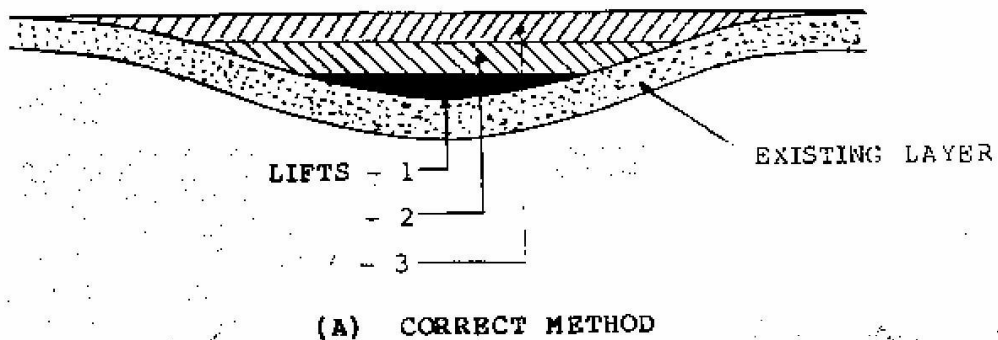


Figure 3 Methods for providing corrective course for short sags and depressions

Note: Profile corrective course material to be in accordance with the lift thickness

3.5.12.5.2. The work in filling-cracks larger than 3mm in width shall be measured and paid for- on a linear meter basis.

3.5.12.5.3. **Scarifying:** Scarifying the existing bituminous surface shall be measured on a square meter basis.

3.5.12.5.4. **Profile corrective course:** Profile corrective course shall be measured as the volume instructed and compacted in position and measured in cubic meters, or in tonnage, as stipulated in the Contract. The volume shall be calculated by plotting the exact profile of profile corrective course as required, and laid, superimposed on the existing pavement profile. Cross-sectional areas of the profile corrective course shall be measured at intervals as used in the design, or as determined by the Engineer, and the volume shall be calculated using the method of end areas.

3.5.12.5.5. **Prime coat:** Prime coat is to be measured and paid for on a per square meter basis.

3.5.12.5.6. **Tack coat:** This is to be a PROVISIONAL item, which may be used in-part or not at all, at the Engineers direction, and is to be measured and paid if used, on a square meter basis.

3.5.12.6. Rates

3.5.12.6.1. Rate for scarifying:

3.5.12.6.1.1. The contract unit rate for scarifying existing bituminous surfaces, including repairing / reworking disturbed underlying layers and removing and stacking reusable / unusable materials, shall include for but not necessarily be limited to, the cost of all labour, supply of materials needed for repair /reworking, hire charges of tools and plant, and transportation of scarified materials within 1000 m of their origin.

3.5.12.6.2. Rate for premixed bituminous material:

3.5.12.6.2.1. The contract unit rate for premixed bituminous material shall be payment in full for carrying out the required operations including full compensation for, but not necessarily limited to:

3.5.12.6.2.2. Making arrangements for traffic except for initial treatment to verge, shoulders and construction of diversions;

- Preparation of the surface to receive the material.
- Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees rents where necessary and all leads and lifts;
- Mixing, transporting, laying and compacting the mix, as specified.
- All labour, tools, equipment, plant including installation of hot mix plant, power supply units and all machinery, incidental to complete the work to these Specifications;
- Carrying out the work in part widths of the road where directed; (vii) Carrying out all tests for control of quality, and

- The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and the payment adjusted accordingly.
- The rates for premixed material are to include for all wastage in cutting of joints etc.
- The rates are to include for all necessary testing, mix design, transporting and testing of samples, and cores. If there is not a project specific laboratory, the Contractor must arrange to carry out all necessary testing at an outside Laboratory, approved by the Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.
- The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed to be included in the Contractor's rates for the material.

3.5.12.6.3. Rate for potholes and crack sealing:

- 3.5.12.6.3.1. The rate for patching potholes shall include for breaking out, trimming edges, cleaning out, painting edges and bottom with bitumen, and filling and compacting the excavation with the specified material. The rate should be inclusive of all plant, tools, labour and materials, transport, and disposal of surplus material, the contract unit rate for sealing cracks by applying fog spray shall be inclusive of providing all materials, tools, labour and plant and carrying out the work. The contract unit rate for sealing cracks by providing emulsion slurry seal.
- 3.5.12.6.3.2. The contract unit rate for crack sealing 3mm to 6mm cracks with straight run or other specified bitumen shall be based on either a square meter basis, or linear meter of cracks as measured, as stipulated by the Contract.
- 3.5.12.6.3.3. The contract unit rate for cracks between 10mm and 40mm is to be measured on a linear meter basis, and the rate is to include for all materials, tools, plant, labour, and transport.

3.5.13. PRIME COAT OVER GRANULAR BASE

3.5.13.1. Scope

- 3.5.13.1.1. 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.

3.5.13.2. Materials

3.5.13.2.1. Primer:

- 3.5.13.2.1.1. The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:
- Surfaces of low porosity; such as wet mix macadam and water bound macadam,
 - Surfaces of medium porosity; such as cement stabilized soil base

- Surfaces of high porosity; such as a gravel base

3.5.13.2.2. Primer viscosity:

- 3.5.13.2.2.1. The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table 11.

Table 5 Viscosity Requirement and quantity of liquid bituminous primer

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

3.5.13.2.3. Choice of primer:

- 3.5.13.2.3.1. The primer shall be bitumen emulsion, complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

3.5.13.2.4. Weather and Seasonal Limitations

- 3.5.13.2.4.1. Bituminous primer shall not be applied to a wet surface (see 5.2.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

3.5.13.3. Construction

3.5.13.3.1. Equipment:

- 3.5.13.3.1.1. The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small & areas, inaccessible to the distributor, or in narrow strips shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

3.5.13.3.2. Preparation of road surface:

- 3.5.13.3.2.1. The surface to be primed shall be prepared in accordance with Clause -5.1.8. and 902 (MORTH) as appropriated immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not, to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

3.5.13.3.3. Application of bituminous primer:

- 3.5.13.3.3.1. The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. Where a geosynthetic is proposed for use, the requirements of Clause (MORTH)s 704.3.2 and 704.4 of the Ministry's Specification for Road and Bridge Works (third revision) 1995 shall apply. The bituminous primer shall be sprayed uniformly in accordance with Clause-5.1. 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.

3.5.13.3.4. Curing of primer and opening to traffic:

- 3.5.13.3.4.1. A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

3.5.13.3.5. Tack coat:

- 3.5.13.3.5.1. Over the primed surface, a tack coat should be applied in accordance with Clause – 5.3.

3.5.13.4. **Quality Control of Work**

- 3.5.13.4.1. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 (MORTH) shall apply.

3.5.13.5. **Measurements for Payment**

- 3.5.13.5.1. Prime coat shall be measured in terms of surface area of application in square meters.

3.5.13.6. **Rate**

- 3.5.13.6.1. The contract unit rate for prime coat with adjustments shall be payment in full for carrying out the required operations including full compensation for all components, 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 0.6 kg per square meter, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials

3.5.14. SPECIFICATIONS CONCRETE PAVER BLOCKS

- 3.5.14.1. The concrete blocks should be procured from manufacturer approved by Engineer-In-Charge and satisfying the following criteria. IRC SP 63 2004 shall be used as guideline for Paver Block work.
- 3.5.14.2. Manufacturer shall have fully automatic vibro pressing plant with vertical vibration system to ensure maximum compaction to achieve required strength.
- 3.5.14.3. The grade of concrete should be M – 40, thickness 80mm M – 30, thickness 60mm and M – 50, thickness 100mm.
- 3.5.14.4. Manufacturer shall have adequate capacity mixer with digital water meter / moisture control system to maintain constant water/ cement ratio.
- 3.5.14.5. Manufacturing plant shall have complete automation with computerized weigh batching system for consistent quality of paving blocks.
- 3.5.14.6. Blocks shall be moist cured for initial 24 hours and then water cured for at least 15 days before dispatch to site.
- 3.5.14.7. Manufacturer shall have complete laboratory setup for testing blocks as per IS 15658-2006 and should be on approved list of SMC Manufacturer shall possess excise registration certificate.

3.5.15. Median**3.5.15.1. Scope**

- 3.5.15.1.1. The work shall consist of constructing shoulder (hard/paved/ earthen with brick or stone block edging) on either side of the pavement, median in the road dividing the carriageway into separate lanes and islands for channelizing the traffic at junctions 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.

3.5.15.2. Materials

- 3.5.15.2.1. Shoulder on either side of the road may be of selected earth/ granular material/ paved conforming to the requirement and the median may be of selected each conforming to the requirements of Clause 305.
- 3.5.15.2.2. Median/Traffic islands shall be raised and kerbed at the perimeter and the enclosed area filled with earth and suitably covered with grass turf/shrubs
- 3.5.15.2.3. Paved shoulders shall consist of sub-base, base and surfacing courses, as shown in the drawings and materials for the same shall conform to relevant Specifications of the corresponding items. Where paved or hard shoulders are not provided, the pavement shall be provided with brick/stone block edgings as shown in the drawings. The bricks

shall conform to Clause (MORTH)-1003 of these Specifications. Stone blocks shall conform to Clause (MORTH)-1004 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

3.5.15.3. Size of Shoulder/Median/Islands

3.5.15.3.1. Shoulder (earthen/hard/paved/median/traffic island dimensions shall be as shown on the drawings or as directed by the Engineer.

3.5.15.4. Construction Operations

3.5.15.4.1. Shoulder:

3.5.15.4.1.1. The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

3.5.15.4.1.2. Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of earth shoulder layer. The adjacent layers having same material shall be laid and compacted together.

3.5.15.4.1.3. In all cases where paved shoulders have to be provided along side of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause -3.1.3.7. Under no circumstances, box cutting shall be done for construction of shoulders. Compaction requirement of earthen shoulder shall be as per Table 300-2. In the case of bituminous courses, work on shoulder (earthen/ hard/paved), shall start only after the pavement course has been laid and compacted.

3.5.15.4.1.4. During all stages of shoulder (earthen/hard/paved) construction, the required crossfall shall be maintained to drain off surface water.

3.5.15.4.1.5. Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned,

3.5.15.4.2. Median

3.5.15.4.2.1. Median shall be constructed in a manner similar to shoulder up to the road level. Thereafter the median and islands, if raised, shall be raised at least 300 mm by using kerb stones of approved material and dimensions and suitably finished and painted as directed by the Engineer. If not raised, the median and islands shall be differentiated from the shoulder/ pavement as the case may be, as directed by the Engineer. The confined area of the median and islands shall be filled with local earth

or granular material or any other approved material and compacted by plate compactor/power rammer. The confined area after filling with earth shall be turfed with grass or planted with shrubs and in case of granular fill it can be finished with tiles/slabs as directed by the Engineer.

3.5.16. Visual Improvement- Signage & Street Furniture

3.5.16.1. TRAFFIC/ ROAD SIGNS

3.5.16.1.1. General

3.5.16.1.1.1. The three types of road signs viz., mandatory/regulatory signs, cautionary/warning signs and informatory signs shall be provided as given in IRC: 67 and Section 800 of MORTH Specifications. Proper signs shall be provided for main carriageways, service and slip roads, toll plaza and other project highway facilities. Clustering and proliferation of road signs shall be avoided for enhancing their effectiveness.

3.5.16.1.1.2. The signs shall be either reflectorized or non-reflectorized as shown on the drawings or as directed by the Engineer. When they are of reflectorized type, they shall be of retro-reflectorized type and made of encapsulated lens type reflective sheeting vide Clause 801.3, fixed over aluminum sheeting as per these Specifications.

3.5.16.1.1.3. In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

3.5.16.1.2. Materials

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

- a. **Concrete:** Concrete shall be of the grade shown on the Contract drawings or otherwise as directed by the Engineer.
- b. **Reinforcing steel:** Reinforcing steel shall conform to the requirement of IS: 1786 unless otherwise shown on the drawing.
- c. **Bolts, nuts, washers:** High strength bolts shall conform to IS: 1367 whereas precision bolts, nuts, etc., shall conform to IS: 1364.
- d. **Plates and supports:** Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS Specifications.
- e. **Aluminum:** Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminum alloy conforming to IS: 736-Material designation 24345 or 190.

- f. Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.
- g. In respect of sign sizes not covered by IRC67, the structural details (thickness, etc.) shall be as per the approved drawings.

3.5.16.2. Traffic Signs Having Retro -reflective Sheeting

3.5.16.2.1. General requirements:

3.5.16.2.1.1. The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

3.5.16.2.1.2. **High intensity grade sheeting:** This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E: 810) as indicated in Table below.

Table 6 ACCEPTABLE MINIMUM COEFFICIENT OF RETRO- REFLECTION FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX PER SQUARE METRE)

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green/ Red	Blue
0.2	- 4	250	170	100	45	20
0.2	+ 30	150	100	60	25	11
0.5	- 6	95	62	30	15	73
0.5	+ 30	65	45	25	10	5.0

3.5.16.2.1.3. When totally wet, the sheeting shall not show less than 90 per cent of the values of retro-reflectance indicated in Table above. At the end of 7 years, the sheeting shall retain at least 75 per cent of its original retro-reflectance.

- 3.5.16.2.1.4. **Engineering grade sheeting:** This sheeting shall be of enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical reflecting system. The retro- reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard : E-830) as indicated in Table below;

Table 7 ACCEPTABLE MINIMUM COEFFICIENT OF RETRO- REFLECTION FOR ENGINEERING GRADE SHEETING (CANDELAS PER LUX PER SQ.M)

Observation angle (in degrees)	Entrance angle (in degrees)	White	Yellow	Orange	Green	Red	Blue
0.2	- 4	70	50	25	9.0	14.5	4.0
0.2	+30	30	22	7.0	3.5	6.0	1.7
0.5	- 4	30	25	13.5	4.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

- 3.5.16.2.1.5. When totally wet, the sheeting shall not show less than 90 per cent of the values, of retro-reflection indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50 per cent of its original retro-reflectance
- 3.5.16.2.1.6. **Messages/borders:** The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut-outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.
- 3.5.16.2.1.7. For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50 per cent of the values of corresponding colour in Tables 800-1 and 800-2, as applicable.
- 3.5.16.2.1.8. Cut-out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per Clause 801.3.2 or 801.3.3 as applicable), except those in black which shall be of non-reflective sheeting.
- 3.5.16.2.1.9. **Colour:** Unless otherwise specified, the general colour scheme shall be as stipulated in IS: 5 "Colour for Ready Mixed Paints", viz.

Table 8 Color Scheme

Blue	-IS	Colour	No. 166: French Blue
Red	-IS	Colour	No. 537: Signal Red
Green.	-IS	Colour	No. 284: India Green
Orange	IS- IS-	Colour	No. 591: Deep Orange

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

3.5.16.2.1.11. **Adhesives:** The sheeting shall either have a pressure- sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a lack free adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's Specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

3.5.16.2.1.12. **Refurbishment:** Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminum backing pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

3.5.16.2.2. **Fabrication:**

3.5.16.2.2.1. Surface to be reflectorized shall be effectively prepared to receive the retro-reflective sheeting. The aluminum sheeting shall be de-greased. Either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

3.5.16.2.2.2. Complete sheets of the material shall be used on the signs except where it is unavoidable; at splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

3.5.16.2.2.3. **Warranty and durability:** The Contractor shall obtain from the manufacturer a seven-year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of high intensity grade and a five year warranty for the adhesive sheeting of engineering grade, and submit the same to the Engineer. In addition, a seven year and a five year warranty for satisfactory in-

field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive-of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the Contractor/supplier and passed on to the Engineer, The Contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty.

- 3.5.16.2.2.4. Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 per cent of the specified minimum reflective intensity values (Tables 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

3.5.16.2.3. Installation

- 3.5.16.2.3.1. Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sq. m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanized iron (G.I). Post- end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.
- 3.5.16.2.3.2. All components of signs and supports, other than the reflective portion and G.1. posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.
- 3.5.16.2.3.3. The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or G.1. posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

3.5.16.2.4. Measurements for Payment

- 3.5.16.2.4.1. The measurement of standard cautionary, mandatory and information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square meters.

3.5.16.2.5. Rate

- 3.5.16.2.5.1. The Contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

3.5.17. Visual Improvement- Landscape Works**3.5.17.1. LANDSCAPE WORK****3.5.17.1.1. Scope of work:**

3.5.17.1.1.1. The planting contractor shall provide all horticultural operations and services specified on the drawings/ schedule of quantities as specified herein or both, as instructed by the Executive Engineer(Hort.)/ including :-

- a. Provide all equipment services and transport i.e. at least 4 Nos. Tractors with Trolleys, Water Tankers, Levelers, Spray Pumps, and Augers etc as required for the project.
- b. Provide all plant material
- c. Provide topsoil for all plants
- d. Provide fertilizers, chemicals and manure as specified
- e. Preparation of planting locations
- f. Prepare plants pits, back filling, and prepare “saucers” at least 5” deep for watering, adding soil after settlement.
- g. Spraying before planting
- h. Staking supporting, wrapping and tying plant materials
- i. Transplanting, if any
- j. Disposal of debris and unused materials
- k. Guarantee of trees and plants for a period as per the tender requirement
- l. Plant material – Trees, Shrubs etc.
- m. Plant list – plants are listed in the drawings. The plants list is enclosed herein.
- n. Nomenclature – The names of the plants species confirm to standardize botanical names.

3.5.17.1.2. Quality and general requirements of plants

3.5.17.1.2.1. Plants shall be typical of their species and varieties have normal growth habits, well developed branches, densely foliated with vigorous and fibrous root systems. Plant shall be free from disease and insects. Bark shall be free from abrasion.

- 3.5.17.1.2.2. Plants shall be grown in pots/bags. Plants shall have been grown under climatic conditions similar to those in locality of project. Nursery grown plants shall have been at least once transplanted. Plants growing in natural ground prior to supply shall not be accepted.
- 3.5.17.1.2.3. Each plant shall be properly identified by weather-proof labels securely attached there to before delivery to project site. No plant shall be delivered to the project site, except for required samples, until inspection has been made in the field or at the nursery or unless specifically authorized in writing by the Executive Engineer(Horticulture)/Landscape Architect
- 3.5.17.1.2.4. Baled and Burlap plants must be moved with the root system as solid units in balls of earth firmly wrapped with burlap. The diameter and depth of the balls of earth must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of the plant. No plant shall be used when the ball of earth surrounding its roots have been badly cracked or broken prior to or during the process of planting or after the equipment required in connection with its transplanting has been removed. The plant and earth ball shall remain intact as one unit during all operations.
- 3.5.17.1.2.5. Container grown stock shall have been grown in container long enough for the root system to have developed sufficiently to hold its soil together, firm and whole. No plant shall be loose in container.
- 3.5.17.1.2.6. All plants shall be hardy under climatic conditions similar to those in the locality of the project. When plants of kinds or sizes specified are not available, substitution may be made upon request by the contractor if approved by the Project Engineer/Landscape Architect.
- 3.5.17.1.2.7. All plants should be strong sufficiently to stand straight without any support, but exceptional trees, soon after planting shall be properly supported to ensure their safety against wind or other factor which may affect it adversely.

3.5.17.1.3. Size of Plants:

- 3.5.17.1.3.1. All plants shall be equal to or exceed the sizes given in the plant list, which are minimum acceptable sizes plants shall be measured before pruning, with branches in normal position. Trees shall be minimum length as specified and shall be straight and symmetrical with a crown and having a persistent main stem. The size of the crown shall be in good overall proportion to the height of the tree. The height of the tree shall be measured from the top of foliage including the root ball.
- 3.5.17.1.3.2. Shrubs shall be well foliated with a crown typical of the species and variety. Shrub height dimension shall be taken from the top of foliage and up to, and including the root ball.

3.5.17.1.4. Sweet Earth :

- 3.5.17.1.4.1. Shall be friable foam material, fertile, typical of the cultivated top soil of the locality , containing at, least 2% of decay organic matter sweet earth shall be taken from well drained arable sites, it shall be reasonably free of subsoil ,. Stones, weeds, earth, clods, sticks, roots or other objectionable extraneous matter or debris and shall contain no toxic materials. Representative samples shall be tested for fertility and general texture by the contractor or by a recognized commercial or government Contractor. No sweet earth shall be delivered in frozen or muddy condition.

3.5.17.1.5. Manure:

- 3.5.17.1.5.1. Shall be well – rotted, unleached (“Cow Dung Manure”) free of harmful chemicals and other substances which may affect plant life. Manure shall be free of weeds, straw leaves or inorganic debris.

3.5.17.1.6. Planting Operations

- 3.5.17.1.6.1. **Time of planting:** Planting operations shall be conducted under favorable weather conditions, the contractor will be notified by the Engineer-In-Charge when areas of work are sufficiently clear of construction work for the contractor to commence work on planting.
- 3.5.17.1.6.2. Planting shall be done by experienced workmen familiar with planting procedures under the supervision of a qualified foreman.
- 3.5.17.1.6.3. Planting pits shall be excavated with vertical sides, except for those designated to be planted in beds. Plants pits shall be of the following sizes 0.90 m x 0.90m x 0.90m depth minimum for trees. Tree points shall be large enough to accommodate the root ball + 1/3 root ball depth on all sides shrubs - 0.45m x 0.45m x 0.45m depth excluding 5” depth for watering for both trees and shrubs .
- 3.5.17.1.6.4. Executive Engineer (Hort.)/Landscape Architect shall inspect and approve plants pits before the contractor proceeds with placing of plants. Topsoil shall be made ready for planting before plants are delivered to the site. The pits/beds shall be given anti termite treatment @ 20 ml. Radar per pit after back filling.
- 3.5.17.1.6.5. **Placing of plants:** Plants shall be placed at the centre of pits, plumb and straight. The Executive Engineer (Hort.)/Landscape Architect shall inspect and approve placing of plants before the contractor proceeds with further operations.
- 3.5.17.1.6.6. **Final Consideration:** Sweet earth shall be compacted around basin of balls to fill all voids. Roots shall be properly spread out and sweet earth carefully worked in among them.
- 3.5.17.1.6.7. **Watering:** Immediately after plants pit is backfilled a shallow base slightly larger than pit shall be formed with a ridge of soil tone facilitate and contain watering. After

planting cultivate the soil between plant pit and rake smooth. Spray the soil with water to settle.

- 3.5.17.1.6.8. **Guying and Staking:** All plants shall be inspected for injury to trunks, evidence of insect done immediately after planting. Trees shall stand straight without staking. Executive Engineer (Hort.)/Landscape Architect shall inspect and approve plant pits before the contractor proceeds with placing of plants.
- 3.5.17.1.6.9. **After Planting care Watering:** Water tree and other plants by flooding within two hours of the time of planting.
- 3.5.17.1.6.10. **Guarantee Period:** All plants shall be guaranteed by the contractor for a period as per the tender requirement, after the certified date of completion. During this time any plant which dies due to natural causes or does not grow sufficiently shall be replaced free of cost by the contractor. Trees which perish due to unnatural causes such as human interference, cattle grazing etc. shall not be replaced free of cost but under instructions from engineer in charge and landscape architect shall be replanted and repaid for.
- 3.5.17.1.6.11. **Replacement:** All replacements of plants shall be made by the same species/variety and sizes as specified in the plant list. The cost of replacement shall be borne by the contractor.

3.5.18. ROAD MARKING

3.5.18.1. General

3.5.18.1.1. The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer. 803.2.

3.5.18.1.2. Materials Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorized paint as specified in the item and the material shall meet the requirements as specified below.

3.5.18.2. Hot Applied Thermoplastic Road Marking

3.5.18.2.1. General :

3.5.18.2.1.1. The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.

3.5.18.2.1.2. The thermoplastic compound shall be screened / extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic,

3.5.18.2.1.3. The colour of the compound shall be white or yellow (IS colour No. 556) as specified in the drawings or as directed by the Engineer.

3.5.18.2.1.4. Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

3.5.18.2.2. **Thermoplastic Material**

3.5.18.2.2.1. **General:** The thermoplastic material shall be homo generously composed of aggregate, pigment, resins and glass reflectorizing beads.

3.5.18.2.2.2. **Requirements:**

- a. **Composition:** The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table below.

Table 9 PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	—
Calcium Carbonate and Inert Fillers	42.0 max.	See
Yellow Pigments	—	Note

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met

3.5.18.2.2.3. **Properties:** The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3 262-(Part 1), shall be as below:

a. **Luminance:**

- White : Daylight luminance at 45 dcgrees-65 per cent min. as per AASHTO M 249
- Yellow: Daylight luminance at 45 degrees-45 per cent min. as per AASHTO M 249

- b. **Drying time:** When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set LO bear traffic in not more than 15 minutes.
- c. **Skid resistance:** not less than 45 as per BS 6044.
- d. **Cracking resistance at low temperature:** The material shall show i-o cracks on application to concrete blocks.
- e. **Softening point:** $102.5 \pm 9.5^{\circ}$ C as per ASTM D 36.
- f. **How resistance:** Not more than 25 per cent as per AASHTO M 249.
- g. **Yellowness index (for white thermoplastic paint):** not more than 0.12 as per AASHTO M 249

3.5.18.2.2.4. **Storage life:** The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted panicles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.

3.5.18.2.2.5. **Reflectorisation:** Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.3.

3.5.18.2.2.6. **Marking:** Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

- The name, trade mark or other means of identification of manufacturer
- Batch number
- Date of manufacture
- Colour (white or yellow)
- Maximum application temperature and maximum safe heating temperature.

3.5.18.2.3. **Reflectorizing glass beads**

3.5.18.2.3.1. **General:** This Specification covers two types of glass beads 10 be used for the production of reflectorized pavement markings.

- a. Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table above and Type 2 beads are those which are to be sprayed on the surface

- b. The glass beads shall be transparent, colorless and free from milkiness, dark particles and excessive air inclusions.

3.5.18.2.3.2. Specific requirements

- a. **Gradation:** The glass beads shall meet the gradation requirements for the two types as given in below;

Table 10 GRADATION REQUIREMENTS FOR GLASS BEADS

Sieve size	Per cent retained	
	Type 1	Type 2
1.18 mm	0 to 3	
850 micron	5 to 20	0 to 5
600 -do-	-	5 to 20
425 -do-	65 to 95	-
300 -do-	-	30 to 75
ISO -do-	0 to 10	10 to 30
below 180 micron	-	0 to 15

- b. **Roundness:** The glass beads shall have a minimum of 70 per cent true spheres.
- c. **Refractive index:** The glass beads shall have a minimum refractive index of 1.50.
- d. **Free flowing properties:** The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.
- e. **Test methods:** The specific requirements shall be tested with the following methods:
- i. **Free-flow test-** Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccator which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution {specific gravity 1.10}. Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.

- ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per B3 6088 and BS 3262 (Part I).

3.5.18.2.3.3. The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification. However, if so required, these tests may be carried out as directed by the Engineer.

3.5.18.2.4. **Application properties of thermoplastic material**

3.5.18.2.4.1. The thermoplastic material shall readily get screened / extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges. 803.4.4.2. The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

3.5.18.2.4.2. **Preparation:**

- a. The material shall be melted in accordance with the manufacturer's instructions in a heater filled with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating; the material shall not be maintained in a molten condition for more than 4 hours.
- b. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.
- c. The material shall be melted in accordance with the manufacturer's instructions in a heater filled with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating; the material shall not be maintained in a molten condition for more than 4 hours.
- d. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

3.5.18.2.4.3. Properties of finished road marking:

- a. The stripe shall not be slippery when wet.
- b. The marking shall not lift from the pavement in freezing weather.
- c. After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures up to 60°C.
- d. The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- e. The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f. The colour of yellow marking shall conform 10 IS Colour No. 356 as given in IS: 164.

3.5.18.2.5. Reflectorized Paint

3.5.18.2.5.1. Reflectorized paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorizing glass beads for Reflectorizing paints where used shall conform to the requirement of Clause of Reflectorizing glass beads.

3.5.18.2.5.2. Application

- a. Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.
- b. The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.
- c. The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint. The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place. Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters

are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square meter area.

- d. The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS - 3262 (Part 3).
- e. The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks

3.5.18.2.6. Measurements for Payment

- 3.5.18.2.6.1. The painted markings shall be measured in sq. meters of actual area marked (excluding the gaps, if any). In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers

3.5.18.2.7. Rate

- 3.5.18.2.7.1. The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.