Request for Proposal (RFP)

For

Retrofitting and Redevelopment of Smart Road Network including Operation & Maintenance and Defects Liability Period for a period of Five (05) Years on Engineering, Procurement & Construction (EPC) basis under Smart City Mission

Under

SMART CITY MISSION (SCM)

In

Bhagalpur, Bihar

Volume - 3/3

Issued By:
Chief Executive Officer,
Bhagalpur Smart City Limited.
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Scope of Work

Scope of work includes applying the design principles, objective and expected outcomes illustrated in drawings. The Implementing Agency shall review the proposal and details for betterments or improvements if any which may be incorporated to better achieve the employer’s goals and objectives. These betterments, if any, shall be submitted by the Implementing Agency to the Employer for review and for the approval before the commencement of on ground working stage. The Implementing Agency must make itself aware of general and specific site conditions, topography and any existing landscape prior to commencement of any works on site. The on-site execution scope of work comprises of preparation of detailed engineering design execution drawings, full, final and entire installation and completion of road works to a ‘best practice standard’ for such works, (inclusive of road surface, road section elements, hardscape, soft-scape, street furniture, signage and lighting) and associated services (leveling, drainage etc.) based on the proposal design developed by the Employer and Implementing Agency’s good for construction drawings and handing over of the same in full accordance with the Employer’s requirements.

As per the Bhagalpur Smart City Proposal, the scope of work is to re-design certain important roads for improving traffic flow. The key features of the project include road improvement, road markings, street furniture, junction improvement, traffic signs and user information sign boards, street furniture like public benches, waste bins, ducts for underground utilities, improving geometric design, streetscape and landscaping, improving road illumination and night time visibility etc. This report is meant to provide a brief about existing situation and proposed design interventions on some important roads in ABD area. The Detailed Project Report is prepared for the identified roads under the project. Required surveys and field activities have been done to collect primary data. Proposed design drawings including layout and cross sections for each road are prepared incorporating various components based on site feasibility. Cost estimates are worked out for the proposed design. IRC guidelines and other street design guidelines are referred during design process. The scope of this work is improvement of road stretch, construction of side drains, footpath and, fixing of smart elements such as seating benches, dustbins, bollards, railings, tabletop crossings, and landscaping work as per the drawing/design.

“Scope of Work” means the Improvement of Roads consisting of Up gradation and Augmentation of Foot path & Traffic Junctions and other Miscellaneous works along with Operation and Maintenance of Tendered works for Period of Five Years on Design, Build, Operate Basis for Bhagalpur smart city.
The project of Smart Roads has been considered under smart city for showcasing the pilot development to the rest of the city, which makes the area livable and better eco-friendly environment. The scope of Work for infrastructure is explained in the following section.

- Development and Strengthening of Carriage way with uniform lane widths. This would require removal of existing median and relocating it at a new defined road center with street lighting and landscape elements as shown in drawings.
- Development of footpath wider and pedestrian friendly ways.
- Reserving the space for utilities in a specified corridor.
- Rehabilitation of tertiary storm water road side drain for easing out of rain water with proper shoulders etc. Development of junction across entire road.
- Construction Bus bays, Auto bays wherever essential.
- In this project, the above said points have been considered/ incorporated for the standard development of roads. The objective of these standards is to make road for longer duration usage and to be free from zig-zag movement of vehicles, to ease out the pedestrian movement and for the safety of school children and elderly. Further, this project should ensure to avoid un-necessary road cuttings by various utility agencies.
- The entire electrical works should be carried out in accordance with the specifications without any extra cost. The work shall conform to latest edition of Indian Standard Specifications & Indian Electricity Rules.
- The works shall be completed as per the requirement of ISO: 9002 & all required documents for the same shall be made available.
- The Technical specification of all the equipment and the quantities required of various accessories & auxiliaries. The contractor shall also ascertain the quantities of items such as HT/LT cables, earthling material, supporting steel pipes etc. and procure the material as per requirement. Excess material brought to site & not installed shall not be accepted by the Authority nor will it be paid for.
The various components included (but not limited to) in this area – wide footpaths, cycle tracks, landscape corridor with trees, bus bays, on street parking, road markings, median, hawker zone, improved junctions, table tops, universal accessible design by introduction of ramps, benches and planting beds, provision for future bus stops, etc.

- Topography survey of entire road stretch and preparation of detailed design engineering and execution drawings.
- The cleaning, scarifying and laying overlay layer on the existing main carriageway and shifting of median as per revised layout.
- Dismantling of existing drain on both ends of main carriageway, construction of new drain and related works but should be taken Approval by the BSCL.
- Dismantling and demolition of existing footpath on both sides near building line as well as at edges of main carriageway. Required earthwork excavation. Excavation of unpaved/paved areas on both sides. The excavation to be done in a manner that existing trees are not damaged or uprooted. Caution to be taken for underground utilities.
- Dismantling, demolition and disposal of existing elements like temporary structures, bus stops, road junctions, median, signage, etc.
- Dismantling and demolition of compound walls of properties as suggested by Employer and construction of new boundary walls.
- Installation and commissioning of light fixtures and support systems.
- Fixing of electric cables, OFC, transformers and support systems.
- Construction of utility ducts as per Employer’s directions.
- Junction improvement as per approved design drawings.
- The Employer will supervise and monitor the progress and Implementing Agency will provide necessary coordination.

The Implementing Agency will do necessary coordination with various government departments and agencies related to road works like RCD, BCD, BRPNNL, BSNL etc. on timely basis to ensure successful project implementation.

- The details of the man power deployment for the project are to be monitored on regular basis.
- Implementing agency should ensure that there is least disturbance to the existing traffic flow, nearby structures and also ensure safety of the workers while working. Safety of workers and their timely payment, their on-site accommodation arrangements to be done as per law.

The Implementing Agency will prepare GFC for the project works in coordination with the Employer and other stakeholders.

- Beautification and landscaping of the footpath, central median as per Approved Design by BSCL.
- Visual Improvement and Information through -Signage’s, Lane marking, artistic Features etc.
- Provision for Bus bays, Urinals and Public convenience, Dust Bins, Tree grating, Auto stands, Ornamental Balustrade lighting for Foot paths.
- Solid waste collection with Bins location at regular Interval
- Provision for Signage’s, Traffic signals, Smart/multipurpose poles, street light poles, CCTV, fiber cable etc. for enabling/facilitating other service provider.
- 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.
- Installing RPM, making road markings along the road edge, road center line & as per IRC guidelines, bus stop & junction improvements as per the drawings & in accordance with the Employer’s requirements and to the satisfaction of the Engineer in charge.
- 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.
- Construction of Bus Shelter at locations as approved by BSCL.
- 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.
- 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.
- All other works and services ancillary or related to the full completion of the Works in accordance with the Employer’s requirements
- 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
- 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.
- Contractor is responsible for clarifying any discrepancy between the Drawings and actual condition on Site.
- 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
- 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.
Construction, management and quality of the Works shall comply with the Drawings, Specifications and Employers requirement.

1.1 Objective and Scope of Work

Primary objective is to redevelop identified 12 Km. approx. road network considering Urban Street Design Guidelines to achieve the following goals:

- Reallocation of available Right of Way space to various cross section elements
- Improve road geometrics and junctions
- Provide walkable footpaths
- Provide dedicate NMV lane wherever feasible
- Improve road aesthetics and beautification
- Design the landscape retaining existing trees and proposing additional plantation thereby increasing the green cover.
- Provision of space for underground utilities and their improvement
- Provision of street furniture like waste bins, public benches, signage etc.
- Improve the visibility and night time illumination by cost effective street lights

Operation and Maintenance - Comprehensive Operation and Maintenance of the above work including repair works, provision of manpower & original spares, replacement with original or better component in case one turns faulty/ damaged/ defective during the course of entire contract period in order to maintain the upkeep intact. Post Commissioning O&M of the new system for 5 years will be in the scope of the agency who executes the project and the SLAs will be signed in that regard.

Project Phasing, Operation & Maintenance - The project should be executed in phased manner. It is recommended that roads having purely residential land use and moderate traffic flow be taken up in first phase such that traffic movement is less affected during construction period. Traffic movement planning will be required while taking up roads having commercial land use and higher traffic volumes. Clearance of ROW is also a challenge. The execution can only start once a decision regarding vendors and encroachment is taken by BSCL jointly with Municipal Corporation. The implementing agency will have to carry out maintenance activities on the completed roads including maintenance of landscaping, minor and major repairs of civil infrastructure including like kerbs, paver blocks, street furniture etc. during construction period till the entire work is completed and during the Defect Liability Period of 3 years. Repainting of road markings will also be required to be done once the entire work is completed. The operation & maintenance of the road stretch will be liability of BSCL or Bhagalpur Nagar Nigam once the site is handed over by the implementing agency. The following maintenance activities are anticipated:

- Regular maintenance and finishing of footpaths, paver blocks, kerbs etc.
- Maintenance of street furniture including dustbins, benches, signage, tree guards etc
- Painting of road marking including kerbs, zebra crossings, lane marking etc.
- Adequacy of street lighting and related maintenance
- Replacement of dilapidated civil works
- Maintenance of landscaping and beautification works
### Proposed Smart Roads under ABD Area of Bhagalpur Smart City Limited

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Road Details</th>
<th>Length (meters)</th>
<th>Avg. Width Available (meters)</th>
<th>Carriage Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjoining to Lajpat Park</td>
<td>235</td>
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<td>Behind Lajpat Park</td>
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<td>3</td>
<td>Zila School Road</td>
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<td>Naya Bazar Chowk to Kotwali Chowk</td>
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<td></td>
<td></td>
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<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Shankar Talkies Chowk to Khalifa Bag Chowk</td>
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<td>12</td>
<td>7</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Kachehri Chowk to Manali Chowk</td>
<td>540</td>
<td>17</td>
<td>11.5</td>
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<td></td>
<td></td>
<td></td>
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<td>11.5</td>
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<td>Radharani Sinha Road</td>
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<tr>
<td>8</td>
<td>Adampur Chowk to Hotel Galaxy</td>
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<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Hotel Galaxy to Manali Chowk</td>
<td>260</td>
<td>12</td>
<td>6.5</td>
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<td></td>
<td></td>
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<td></td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>Naya Bazar Chowk to Shankar Talkies Chowk</td>
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<td></td>
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<td></td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>Shankar Talkies Chowk to Adampur Chowk</td>
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<td>12</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>Adampur Chowk to Manali Chowk</td>
<td>650</td>
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<td>7</td>
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<td>13</td>
<td>Manali Chowk to Tilakmanjhi Chowk</td>
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<td></td>
<td></td>
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<td>Manik Sarkar Chowk to Ghantaghar</td>
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<td>8</td>
<td>6</td>
</tr>
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<td></td>
<td></td>
<td></td>
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<td>7</td>
</tr>
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<td>15</td>
<td>Kotwali Chowk to Khalifabag Chowk</td>
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<td></td>
<td></td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>16</td>
<td>Khalifabag Chowk to Ghantaghar</td>
<td>510</td>
<td>15</td>
<td>10</td>
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<td></td>
<td></td>
<td></td>
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<td>10.5</td>
</tr>
</tbody>
</table>
Tentative Details of Carriage Way (CW) ROW and widening portion varies as per site situation

1.3 Traffic Management Plan:
   During construction work for road improvement road, Under ABD Area of Bhagalpur Smart City there are probabilities of disruption or delay to existing traffic and resultant inconveniences to road users. There is need to ensure continued effective function of the carriage way during such works for which necessity plan and traffic management measures are to be prepared and implemented during construction activities. This document outlines broad scope of activities to be undertaken by the contractor.

   i. To conduct trialed run on the identified stretch of road in the ABD area.
   ii. To prepare/follow traffic management plan during construction of road network including special arrangement for special days/ festive season.
   iii. The contractor shall be responsible for the control guidance in direction of traffic movement and protection of all roads and pedestrian traffic along the entire road improvement stretch which may be affected while work. These plan/ strategies need to be discussed and approved by traffic police, nagar nigam and other relevant authorities.

   The traffic management plan strategy involves various activities or staging of construction activities and should also include but not to be limited to such items as pedestrian walk ways signage, application, and/or removal of pavement markings, road way, lighting, methods and devices for delineation, channelization and placement with careful strategies.

   During construction traffic management plan should include:

   - Road user safety
   - Traffic flow
   - Reduction in delay
   - Access arrangement for adjoining properties
   - Pedestrian and cyclist
   - Parking for construction vehicles
1.4 Development of Junctions.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adampur Chowk</td>
</tr>
<tr>
<td>2</td>
<td>Khalifabag Chowk</td>
</tr>
<tr>
<td>3</td>
<td>Ghantaghar Chowk</td>
</tr>
<tr>
<td>4</td>
<td>Kachehri Chowk</td>
</tr>
<tr>
<td>5</td>
<td>Manali Chowk</td>
</tr>
<tr>
<td>6</td>
<td>Tilakamanjhi Chowk</td>
</tr>
</tbody>
</table>

The following major junctions along the identified road network shall be improved in design. Existing situation of these junctions are shown below.

1) **Adampur Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Vehicle movement is continuous and haphazard and no traffic signals observed. Pedestrians face difficulty while crossing the road.

![Adampur Chowk Existing Pic](image1.jpg)  ![Khalifabagh Existing Pic](image2.jpg)

2) **Khalifabag Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Vehicle movement is continuous and haphazard and no traffic signals observed. Pedestrians face difficulty while crossing the road. The existing small circle can be re-designed.

3. **Ghantaghar Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Vehicle movement is continuous and haphazard and no traffic signals observed. Pedestrians face difficulty while crossing the road. Due to presence of clock tower in the centre, this junction cannot be designed as signalized.


4 **Kachehri Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Vehicle movement is continuous and haphazard and no traffic signals observed. Pedestrians face difficulty while crossing the road.

5 **Manali Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Vehicle movement is continuous and haphazard and no traffic signals observed. Pedestrians face difficulty while crossing the road.
6 **Tilakamanjhi Chowk** This junction requires resurfacing as well as proper lane marking. As can be seen below, there are no zebra crossing painted. Pedestrians face difficulty while crossing the road. Signals have been installed and are functional; however their location is not as per standard. The entire junction geometrics require to be redesigned. Presence of informal labor market and vending zone as well as service roads and access roads from different directions and visibility issues due to long boundary walls makes this junction design and functionality

1.5 **Components of Smart Roads**

The following components can be accommodated in design of smart roads:

1) Construction of walkable footpaths
2) Landscaping
3) Junction improvement and safe pedestrian crossings
4) Traffic signage and adequate user information sign boards
5) Lane markings
6) Uniformity in cross section, space allocation, lane distribution
7) Provision of vending spaces wherever site permits
8) Street furniture like public benches, waste bins, etc.
9) Improving adequate night time lighting
10) Resurfacing of the top surface of main carriageway

1.6 LANDSCAPE WORKS:
Design, construct & develop Landscape for the road comprising execution of Architectural, Landscape work (including Softscape / Horticulture and Hardscape) complete in all respect. The softscape works consist of works such as restoring top soil, excavation, site cleaning, Grading & drainages, mound & slope preparation, designing and planting shrub, trees & ground covers, designing and planting of lawn, street furniture’s, dustbins, etc. as per the approved drawings by Employer. The hardscape works consist of Site leveling of entire pathway, demolition of existing elements, construction of new elements, Construction of new boundary walls, Realignment of stretch, creating space for street furniture, Hardscape, pathways and sit-out spaces, dustbin, Painting of all the structure works etc. as per the approved drawings by Employer. Item complete in all respect to the satisfaction of engineer in charge.

1.7. Design Features in Development of Smart Roads

1.7.1 General Specifications and Design Basis
Preparation of detailed design and engineering construction drawings comprising of Civil, Structural work complete in all respect. The civil works consist of works excavation, site cleaning; trenching, Plain Cement and Reinforced cement concrete works, bituminous concrete works, and Reinforcement steel works, centering and finishing works etc. as per the approved drawings by the BSCL.

1.7.2 The design criteria / method applied for important components of the project are as follows:

- **Structure Design:** IRC Codes, MORTH, RCD Bihar & other relevant codes required
- **Geometric Design:** IRC Codes, MORTH, RCD Bihar & other relevant codes required
- **Pavement Design:** New Pavement
  - IRC and AASHTO Design guide for design of flexible pavement
  - IRC for Design of Rigid Pavement
  - Relevant codes required

Bhagalpur Smart City Limited wishes to improve the geometrics and functionality of certain roads in ABD area to retrofit them as Smart Roads. The key design features that can be incorporated are enlisted as below:

1. Improved Design & Geometrics for all users
2. Efficient Road Use
3. Improved Mobility
4. Increased Green Cover
5. Parking Management
6. Informal Market
7. Street Furniture
8. Improved Signage
9. Well Illuminated
10. Junction Improvement

1.7.3 ROAD FIXTURES
The provision of following road fixtures has been considered for the project road;
• Street Furniture, Bollards
• Tree Planter, Medians
• Electric Pole, Shifting, Utility Duct
• Drain, Footpath, Glow Studs
• Information Sign Board, Mandatory Signs, Cautionary Signs
• Landscaping, Table top,
• Marking, painting
• Solar lights/Blinkers/Road Studs

1.7.4 Guidelines and Best Practice Examples

Urban Street Design is an approach to re-design the city roads from ‘Non-motorized Modes’ point of view rather than designing them for vehicles and increased speeds. The practice allows equitable allocation of road space for all types of transport modes and road users. This concept also allows creating public spaces on streets, install street elements like public benches, toilet blocks, waste bins, bus stops, signage along with improving road geometric features and landscaping.

Challenge of Development in cities have a common character of Urban Streets which includes inadequate space for pedestrians, encroached footpaths by vendors and utilities, lack of footpaths, inadequate public amenities like bus stops, toilet blocks and public benches, inappropriate footpath and kerb heights, lack of pedestrian safety and refuge islands etc.

There is a need for adopting a prospective and equitable design that benefits all class of society, all road users and all types of transport modes whether be motorized or non- motorized. Routine practice is to widen roads as much as possible, wall to wall, so that they facilitate faster mobility to motor vehicles. This approach overlooks the need for providing basic infrastructure for safety of pedestrians. The Indian Road Congress (IRC) Guidelines, which are mostly based on Highway Design & Standards for high speed roads, are commonly followed by urban local bodies in designing urban roads. However, the IRC has published a recent edition of its code ‘103:2012 Guidelines for Pedestrian Facilities’ which is a revision done after 24 years.

Smart City Mission which mainly focuses on improving the urban road geometry and upgrading the basic infrastructure to facilitate non-motorized transport modes. The prospective benefits of Urban Street Designs are; increase in comfort for current walking population, equitable allocation of right of way and space for all road users and all modes, provision of basic public amenities, adequacy of road signage, road safety, creation of public places, provision for organized on-street vehicle
parking, designing for underground utilities, ensuring adequate night time illumination and daytime visibility, providing aesthetic landscaping and increasing green cover along the road stretch etc. This chapter presents some of the best practice examples adopted in design of infrastructure on Urban Roads.

For the design of Smart Roads in Bhagalpur, available information and guidelines on urban street design have been referred. Guiding principles in design of urban street elements and certain best practice examples are covered in this chapter. The basic thumb rule ‘mobility for all’ and ‘Pedestrian and Non-Motorized Vehicles are one of the important road users’ is at the core of the design process.

1.8 Ideal Elements of Smart Road

1.8.1 Footpaths
Pedestrian facilities should be planned in an integrated manner so as to ensure a continuous pedestrian flow. It should be useful therefore to look at pedestrian needs for an area as a whole. The basic aim should be to reduce pedestrian conflicts with vehicular traffic to the minimum. Efforts should be made to create such conditions that pedestrian are not forced to walk in unsafe circumstances, and that the motorists respect the position of pedestrian. The overall objective is continuity of footpath with comfort and safety. Footpaths are meant for pedestrians to walk. Minimum recommended width for footpaths is 1.8 meters.

Un-interrupted movement of pedestrians must be ensured by providing continuous footpaths which also facilitates mobility of people with disabilities. Breaking the continuity of footpaths discourages people from using footpaths and forces them to walk on carriageway sideways along with moving vehicles. This increases chances of risk of pedestrian-vehicle accident. Footpaths must be continuous at property entrances by providing ramp access from carriageway to property gate.

1.8.2 Clearing walking zone for Footpaths
IRC: 103-2012 - Guidelines for Pedestrian Facilities is followed. In the natural and tempered landscapes, paths should be at least 1800 mm wide in order to accommodate wheel chair users and persons with vision impairments assisted by a sighted person. The minimum 1.8 m (width) x 2.2 m (Height) Walking Zone should be clear of all obstructions- both horizontally and vertically. No utility ducts, utility poles, electric water or telecom boxes, trees, signage or any kind of obstruction should be placed within the "Walking Zone" as explained in figure above.
1.8.3 Access Ramp for Disabled

Access ramp should be provided at all pedestrian crossings and areas where footpaths intersect each other from two different directions and spots where carriageway is to be accessed to cross the road. The ramp should have a gradual and gentle slope in order to facilitate wheel chair access and mobility. The slope must be provided towards the direction of zebra crossing.

1.8.4 Pedestrian Crossings at Mid-blocks
Mid-block and un- signalized pedestrian crossings should be raised in form of table-top crossing as shown in the picture here. This facility ensures speed reduction and allows pedestrians as well as disabled to cross the road at same level to footpath. This practice is adopted in case ramps for disabled are not provided by lowering the footpath level.

1.8.5 Frontage & Zoning System
Footpaths should always be protected by adjoining green verge and street furniture zone in order to segregate the ‘slow zone’ (pedestrians zone) from ‘fast mobility zone’ (carriageway with motor vehicles).

1.8.6 Compact Junction:-
Junctions should be designed as compact such that distance between two zebra crossings is reduced which facilitate easy and quick crossing of pedestrians. Compact junctions require less clearance time and provide smooth vehicle flow with controlled speeds. Large junctions attract
motor vehicles for over speeding, overtaking while crossing and require more time for clearance.

1.8.7 Traffic Islands
Traffic islands are meant to serve as refuge islands for pedestrians while crossing the road. They should not be fenced by decorative railings and plantation. Instead, they should be designed for heights matching footpath level and should also have a cut-through to facilitate wheel chair access.

1.8.8 Organized Parking and Multi-Utility Zone with Tree Pits
Parking of cars should be enforced to be in parallel direction to carriageway whereas two wheelers and cycles can be parked perpendicularly. Maximum dimension of a parking slot can be 5 x 3 meter wide. Enough buffer space should be available on left side of the parked car to accommodate door opening widths (0.8 meter max.) on-street parking should be clearly demarcated for type of vehicles allowed for parking. Tree pits can be installed at regular interval in this at-grade parking lane.

1.8.9 Pedestrian Refuge Island
A cut through should be given in the divider (protected by bollards) at pedestrian crossing to facilitate cross movement of pedestrians from one end to another as shown in image below.
1.8.10 Cycle Tracks
Cycle tracks provide a safe and segregated space for the movement of bicycles. Cycle tracks should be continuous along the corridor, and free from obstacles. There should be no breaks in cycle tracks for property access. Provision of a dedicated NMV lane is justified when there is considerable volume of cycles on the stretch.

1.8.11 Common Utility Duct
The concept of ‘CUD – Common Utility Duct’ is very much recent and being considered for implementation in Road Re-design projects under Smart Cities Mission. The idea is to bring together and fit all the types of underground utilities in a single channel made of cement concrete such that
their alignment is streamlined and are easily locatable along with protection from environmental effects. Generally, utilities in urban areas are laid independently. Various departments and service providers ranging from water supply, sewerage and storm water drainage by urban local bodies, Optical Fiber Cable Networks (OFC) and telephone cables by telecom service providers, Gas Pipeline for Residential areas by State Gas Supply Agencies, Television Cables by local service providers, Low and High Voltage electricity lines by electricity distribution companies etc. The Urban Street Design Guidelines published by UTTIPEC-Delhi Development Authority mentions about the need, importance, advantages and concept of Common Utility Duct for underground utilities. Typical cross section as per British Practice mentioned in the document is shown Fig-. Ducts should be designed based on cities requirements. 3 types of ducting systems are in practice: Duct Bank, Ducts with Utility Partitions & Fully Accessible Ducts (in which human can walk through for maintenance).

### 1.9 Streetscape Signage

The purpose of streetscape signage, including gateway markers and directional signage is to provide an overall image of a neighborhood, mark edges or entry points, and give information about directions, destinations, or the neighborhood in general. Two hierarchy in types of signage are proposed in the design, one street information signage which are meant to provide information's like-no parking, no vending zone, pedestrian crossing ahead, restricted parking zone, designated vending zone etc. and the Street directive signage is meant to give information about the location, direction of possible destinations. Signage points are proposed after every 100M to 150M in the MUZ lane and median where possible as per site condition. The below images are just some reference images to visualize the concept. Any other alternate signage can be selected depending on the cities preference, choice, pattern etc. Below are images of few modern signage designs that can be adopted for direction and street information sign boards.

### 1.10 Design Process

Design of road network has been done considering available Right of Way and topographic survey details. The existing carriageway widths have been retained and no road widening or tree cutting has been proposed. On-street parking strip is provided wherever feasible in the design. The design process is explained in brief below with stepwise activities undertaken.

- Road Inventory Survey to assess RoW availability and sectional details.
- Topography survey of entire road network covering all physical elements
present above ground level.

- Vehicle traffic counts for assessment of traffic character
- Existing RoW sections were identified and the reallocation of RoW space was planned based on available and specified guidelines/standards for road design. The need of the road stretch was considered.
- Centre line based on available RoW was drawn and proposed sections were designed based on RoW variation as per site conditions.
- Proposed sections were accommodated in the design drawing layout
- Cost estimates were worked out based on proposed design layout and cross sections, street elements and beautification with landscaping proposed.

### 1.10.1 Technical Design Proposals

Detailed designs for each road stretch will be prepared during project execution by the executing agency. At this stage, the proposed cross sections for varying RoW for different roads have been prepared with layout. These sections are presented below. The road widths vary from 8 to 30 meters and therefore no standard cross section can be applied uniformly. Carriageway widths also vary by road. Some roads have variations in RoW in terms of changing widths and therefore such roads will have different cross sections. However, efforts are made that carriageway widths widths remain constant throughout the road length. Paved area made of paver blocks is proposed to be developed in additional space available between footpath and carriageway. New drain are required on all the roads. Overlay is proposed for majority of the roads whereas some of the roads having a possibility of widening the carriageway will have new road construction along with overlay on existing. Centre lines will be redesigned for all the roads. Some footpaths will have drain underneath, while in most cases the electricity cables are proposed under footpaths. Drain can be provided under paved area and carriageway. Signage and markings are to be provided on all the roads. Pedestrian crossings are to be provided on major junctions. Adequate street lighting is a must for making roads safer.

### 1.10.2 Design Elements

This section explains about various design elements that can be considered while designing smart road network.

#### 1.10.3 Traffic (Refuge) Islands at Crossings

A cut through should be given in the divider (protected by bollards) at pedestrian crossing to facilitate cross movement of pedestrians from one end to another as shown in image above. Minimum height of bollards is about 1 m and spacing between two bollards must be minimum 45 cm to prevent two wheelers to pass through it.

#### 1.10.4 Access to properties and adjoining streets

As shown in the image below, access to property and streets can be given by means of a ramp in a manner that footpath remains continuous. Vehicles can always cross the ramp and have entry/exit movements.
1.10.5 Planters
Planters can be proposed next to the pedestrian walkway where ever possible to give a visual harmony with street lighting and sidewalk amenities and the building context. Specific trees and plants vary in their aesthetic appearance should be selected as per local climate. These areas can be designed as public spaces green or semi paved as per design.

NMV Lane
The NMV lane consisting of bitumen should have 2% camber towards property line to drain the rain water. The lane should be painted with markings as shown here at some intervals. The paint is cold plastic/thermoplastic based.

1.10.6 Trees with Seating
Certain trees can be provided with seating made out of brickwork around in order to create public place on the road. The locations can be selected based on site requirements, land use and space availability.

Drain Cover and Manhole

1.10.7 Manhole Cover
The finishing of the manhole and drain cover provided under footpath should be perfect and of descent quality as shown in the image below.
1.10.8 Public Benches
Stone benches are recommended over wooden or steel benches for easy installation and long life. Seat width should be at least 0.5m.

1.10.11 Parking and Non Parking Sign
These signs should be installed on the dedicated parking slots created along the roads. The pole should be installed at the edge of the parking lane.
1.11 Streetscape signage
The purpose of streetscape signage, including gateway markers and directional signage is to provide an overall image of a neighborhood, mark edges or entry points, and give information about directions, destinations, or the neighborhood in general. Two hierarchy in types of signage are proposed in the design, one street information signage which are meant to provide information’s like-no parking, no vending zone, pedestrian crossing ahead, restricted parking zone, designated vending zone etc. and the street directive signage is meant to give information about the location, direction of possible destinations. Signage points are proposed after every 150M to 250M in the furniture zone/planter/footpath edge and median where possible as per site condition. The below images are just some reference images to visualize the concept. Any other alternate signage can be selected depending on the cities preference, choice, pattern etc. Below are images of few modern signage designs that can be adopted for direction and street information sign boards.

1.12 Tree Guard
Pre-cast RCC tree guard can be provided at specified locations during execution. The guard to be placed in a manner to protect soil erosion and wash off.

Junction Electric Boxes
To be covered by designer outer cover with operable door as shown in the image here. The designed outer cover gives aesthetic appearance and hides the presence of electrical junction box from the road thereby giving a pleasant appearance of streetscape.

1.13 Pedestrian Lights
Variety of options is available in market in form of decorative architectural lights to modern looking simple lights. LED based lights are preferred. For lights poles between footpath and planter/parking, the poles of height about 3 meter can be installed as shown below. For regular carriageway light poles of length 9 meter spaced at about 30 meter apart can be installed.
1.14 Cross Section Elements

Carriageway: - Minimum camber to be provided shall be 2 to 2.5% for main roads. Minimum lane width can range from 3 to 3.5m. Space availability decides lane provisions.

Median: - Median width based on the ROW availability and design cross sections ranging from 0.5m to 1.0m with landscaping and simple kerb medians of 0.2 to 0.5m.

Landscaping/Green belt/Planter The minimum width for Planter can be 0.5 m & a desirable width can be of 1.5 m or more. The essence to provide a green belt is to have vegetation that will improve aesthetic & safety that will help in lowering air temperatures and provide shade and oxygen and consume Co2.

Other Features- Street Furniture & Support Facilities
Street furniture comprising of light poles, bollards, traffic signs, seating, trash bins, sign boards etc. are planned at appropriate locations as per design. These elements are planned & placed away from pedestrian pathway to provide clear walkway. In urban scenario, street vendors operating on major streets become part of service providers to bus commuters, cyclists & pedestrians, and most of the time, and they occupy the space on pathways as encroachment. This forces pedestrians & cyclists into the MV lanes causing major safety hazards. Vending zones may be provided at appropriate places where space is available to accommodate street vendors.

Mandatory / Regulatory signs
Violation of these signs is legal offence e.g. stop signs, speed limits near schools, etc.

Warning / Cautionary signs
These signs are to warn the road users of existence of certain restrictions / hazardous conditions like work in progress, pedestrian crossing etc.

Informatory signs: -
These signs are for information purposes e.g. petrol pump, hospitals, direction signs, route number etc.
Section -2

Technical Specification
## Electrical Works Scope & Specification

### 2.0 Existing Distribution Scenario:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Road Name</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
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<td></td>
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<tr>
<td></td>
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</tr>
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<td>Kachehri Chowk to Tilkamanjhi Chowk Road</td>
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</tr>
<tr>
<td>4</td>
<td>Manali Chowk to Adampur Chowk via Khanjarpur Road</td>
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</tr>
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<tr>
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<td>Ghantaghar Chowk to Kachehri Chowk Road</td>
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### 2.1 Existing electrical infrastructure details Road wise

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<th>HT: Double Run Cable one side of the road (m)</th>
<th>LT: Single Run cable Both Side of Road (m)</th>
<th>Distribution Transformer</th>
<th>Feeder Pillar Box both side of the road</th>
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<td>611</td>
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<td>1976</td>
<td>3</td>
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</table>
2.2 Dismantling existing OH Infrastructure System

In addition, Underground cable project also envisage to decommission and dismantle all existing overhead infrastructure (includes overhead conductors, cable, insulators, straight and V cross arms, stay wires, poles, power and distribution transformers along all associated accessories), after the commissioning of the newly laid underground cable network. BHAGALPUR VIDYUT VITARAN LIMITED/ Municipal Corporation Bhagalpur intend to redeploy usable in its other overhead operational areas elsewhere and scrap the unusable materials through approved vendors. The existing overhead infrastructure under project area, which will be decommissioned and dismantled after commissioning of the Underground cable project, is given in Table

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<td>Road behind Lajpat Park</td>
<td>408</td>
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</tbody>
</table>
2.3 Activity for underground Cable Laying

1. Site cleanup.
2. Transportation of site cleanup materials/debris, if any
3. Transportation of dismantled material to central plant for recycling or approved disposal location
4. Cable Pull out & pilling into cable duct over rollers using pulling machine
5. Testing of cables prior to pull out
6. Laying cable in cable duct/HDPE pipe
7. Testing of cable after pullout
8. Cable jointing at cable jointing chamber along Cable route
9. Testing of joints
10. Connection and termination etc of cable
11. Dismantling of existing overhead infrastructures (poles, conductors, transformers etc)
12. Stacking of reusable infrastructure at designated stores for redeployment in other area where overhead system.
13. Disposal of non-reusable or scrapped infrastructure (with no reuse value)

Electrical Scope

Design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer’s works or at any accredited agency, supply, packing, forwarding and delivery from manufacturer’s works/ place of storage to erection site including transit insurance, unloading, storage at site, assembly, erection, testing, installation, commissioning & performance demonstration and handing over of electrical works as per the direction of the engineer, new wiring and illumination of entire area (Landscape Lighting) related to the landscape development within the project area as of original ratings & specifications.

The scheme covers the complete Electrification in form of street lights, side walkway lights and High mast light in the proposed development. The utility shifting and electric works to be supervised by Bihar electricity department. All Electrical work shall be done as per code of practice for Electrical installations and meeting the requirements of Indian Electricity Rules/Act, applicable I.S. Codes/Rules and relevant I.S. Specifications as below.

a) Indian Electricity Act & Rules
b) Standard practices of Bhagalpur Nagar Nigam, Electricity Department
c) IS:732 Code of practice for Electrical Wiring Installations
d) Special requirements of Bihar State Electricity board.

2.4 Street Light

The Lighting design intents to perception of safety as important criteria for urban road. Lighting has been used to enhance the perceptions of safety and increase road usage. A good Lighting scheme
can clarify the layout of outdoor spaces by emphasizing walkways, focal points, gathering places and open spaces. Ample lighting also boosts safety. Lighting as a strategy to ensure children and families are safe from violence in the road. Modern lighting technology and fixtures will be used by maximizing road components and making it easier to adopt energy-efficient, cost-saving strategies. Use of LED lights and energy star rated lighting fixtures are to be used for saving energy in the median street lights. Necessary outdoor lighting arrangements will be covered as per the prevailing rules within the project area. Electric supply for the road shall be received from Bihar electricity supply on Street light Pillar DB. from the nearest Feeder Pillar Box through Underground Cable upto the Feeder Pillar Box or as decided by BSEB. The No. of lights, pole, feeder DB and cable length proposed in the project are as below:

Lighting has been used to enhance the perceptions of safety and increase road usage. A good Lighting scheme can clarify the layout of outdoor spaces by emphasizing walkways, focal points, gathering places and open spaces. Lighting as a strategy to ensure children and families are safe from violence in the road. Modern lighting technology and fixtures can be used by maximizing road components and making it easier to adopt energy-efficient, cost-saving strategies. Outdoor solar lights use solar cells to light areas such pathways, and they are both easy to install and almost maintenance free. Use of LED lights and energy star rated lighting fixtures can be used for saving energy in the street lights. Necessary outdoor lighting arrangements can be covered as per the prevailing rules within the project area. The types of lights that can be proposed for the project are as below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type</th>
<th>Specifications</th>
<th>Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L1-Street Post Top lights</td>
<td>LED light about 9m high MS post with two arms, 120 Watt</td>
<td>Along the median at 30m C/C or in staggered way</td>
</tr>
<tr>
<td>2</td>
<td>L2-Solar Pole lights</td>
<td>3m high on pole with inbuilt solar panel above Led light with star rated. Lux lavel-100, 20-24 Watt</td>
<td>Alongside walkways near building line</td>
</tr>
<tr>
<td>3</td>
<td>L3- Street Post Top lights</td>
<td>LED light above 6m high MS post with one arm LED 90 watt</td>
<td>Along Pathways</td>
</tr>
</tbody>
</table>

Work includes applying the design principles, objective and expected outcomes illustrated in drawings. The Implementing Agency shall review the design and details for betterments or improvements if any which may be incorporated to better achieve the employer’s goals and objectives. These betterments, if any, shall be submitted by the Implementing Agency to the Employer for review and for the approval before the commencement of on ground working stage. The Implementing Agency must make itself aware of general and specific site conditions, topography prior to commencement of any works on site. The on-site execution scope of work comprises of preparation of detailed engineering design execution drawings, full, final and entire installation and completion of electrical works to a „best practise standard and compliances“ and handing over of the same in full accordance with the Employer’s requirements. The scope of work which
shall be adhered during construction activities would include:
Scope for materials and work covers engineering, Design, drawing, manufacture, factory testing, supply, delivery to site, unloading, handling and storage at site, complete installation including cement concrete foundation and supporting steel structure wherever necessary, final check-up, painting, performance testing and commissioning of power supply system
The complete Electrification in form of street lights, side walkway lights, utility shifting and electric works in the proposed development will be done under supervision of Bihar electricity department and Local Municipal Corporation.
All supplied equipment, components, materials and entire work shall be carried out in conformity with applicable and relevant IS/BIS/IEC/CPWD/Bihar State Electricity board Standards and Codes of Practice. In addition, relevant clause of Indian Electricity Act 2003 and Indian Electricity Rule 1956 amended up to date shall apply.

2.5 Specifications for 1.1 kV grade, Aluminium/Copper conductor, Power cables:
This section covers the technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer’s works, packaging and delivery (properly packed in non-returnable drums), 1.1KV grade, Multi-stranded Aluminium/Copper conductor, XLPE insulated, extruded PVC inner sheathed, GI round/flat wire/Strip armoured, extruded FRLS PVC ST2 outer sheathed. Power Cables for effectively grounded system, conforming to the latest revisions of IS: 7098 (Part –I), 1988 & as per the technical specifications given below. Standards The design, manufacture inspection and testing of the cable shall comply with the latest editions/amendments of the following Indian Standards unless otherwise specified. Equipments complying with equivalent standards shall also be acceptable.

| IS-7098,(Part-I) | Cross linked polyethylene insulated PVC sheathed cables for working voltages upto 1100V. |
| IS-3961 | Recommended current ratings for cables |
| IS 8130-1984 | Specification for conductors for insulated electric cables and flexible cords. |
| IS-3975, 1999 | Low Carbon galvanized steel wires, formed wires & tapes for armouring of cables |
| IS-4759 | Specifications for Hot dipped galvanized coating on round steel wires |
| IS-5831 | PVC insulation and sheath of electric cables. |
| IS-10418 | Drums for electric cables. |
| IS-10810 (Part 0 to 64) | Method of test for cables. |

2.6 Service Condition
The cable shall be designed with the following service conditions into consideration:

i. Cables shall be capable of satisfactory operation under a power supply system frequency variation of +3% and voltage variation of ±10%.
ii. Cables shall be suitable for laying in conduits, ducts, trenches, channels, trays, racks or for direct buried in ground in both dry and wet locations with chances of flooding by water.
iii. The cables shall be suitable for Ambient Air temperature: 40 °C
iv. Also The cables shall be suitable for Ambient ground temperature: 30 °C
v. The current rating shall be based on maximum conductor temperature depending on the type of insulation for continuous at the rated current.
vi. The one second short circuit current rating values shall be furnished and shall be subjected to the purchaser’s approval.
vii. The cables will have current ratings and de-rating factors as per relevant Indian Standards.

2.7 Design and Construction:

General:

The cables supplied under this specification shall be adequate insulated to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of the cables. The sheathing material shall be high quality PVC based compound. The construction of cable shall be as per IS: 7098 (Part I) of latest editions/amendments. Cable shall be designed and manufactured to prevent damage during transportation, installation & operation under all climatic & operating conditions to which cable may be subjected to.

2.8 Technical Parameters:

<table>
<thead>
<tr>
<th>Packaging</th>
<th>Steel/Wood drum packaging, each having single length cable ≥ 500 metres.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Type</td>
<td>Refer Technical Specification</td>
</tr>
<tr>
<td>No. of Cores</td>
<td>1/2/3/3.5/4 (refer BoM)</td>
</tr>
<tr>
<td>Voltage Level</td>
<td>1.1kV</td>
</tr>
<tr>
<td>System Grounding</td>
<td>Solidly Grounded</td>
</tr>
<tr>
<td>Nominal System voltage</td>
<td>433V ±10%</td>
</tr>
<tr>
<td>Nominal System Frequency</td>
<td>50Hz ±3%</td>
</tr>
<tr>
<td>Maximum temperature at rated current</td>
<td>90 °C</td>
</tr>
<tr>
<td>Maximum temperature at Short-circuit</td>
<td>250 °C</td>
</tr>
<tr>
<td>Conductor</td>
<td>As per IS:8130 / IEC 60228/ BS 6360</td>
</tr>
<tr>
<td>Conductor Material</td>
<td>H2/H4-Grade Aluminium of purity &gt; 99.6%</td>
</tr>
<tr>
<td></td>
<td>Electrolytic grade Copper of Purity &gt; 99.97%</td>
</tr>
<tr>
<td>Conductor Class</td>
<td>Class 1/2 which is applicable</td>
</tr>
<tr>
<td>Conductor type</td>
<td>Stranded/Compact as per IS 8130 (Part-I)</td>
</tr>
<tr>
<td>Filler &amp; Binding Tapes</td>
<td>Non Hygroscopic PVC / Poly propylene Fiber, If required</td>
</tr>
<tr>
<td>Insulating material</td>
<td>Cross-Linked-Polyethylene (XLPE) Compound as per IS: 7098, 8130, 14494 / IEC: 60502 / BS: 6622/BS: 7835.</td>
</tr>
<tr>
<td>Core Identification Strips</td>
<td>Red, Yellow, Blue for Phase &amp; Black for neutral</td>
</tr>
<tr>
<td>Material of Inner Sheath</td>
<td>FRLS, PVC ST-2 Compound</td>
</tr>
<tr>
<td>Armour</td>
<td>Single layer of Galvanized Steel Round Wire/Strip according to IS-3975</td>
</tr>
<tr>
<td>Outer Sheath</td>
<td>FRLS, PVC ST-2 Compound according to IS-5831</td>
</tr>
</tbody>
</table>

2.9 Conductor:

**ALUMINIUM:** The Aluminium conductor used shall be of H2/H-4 grade (Tensile strength above 150 N/mm2). High conductive aluminium, stranded (Class-II, stranded circular shaped), uniform in quality and free from scale, inequalities, spills, splits and other defects.
COPPER: The conductors shall be made from high conductivity copper rods complying with IS: 613-1964. The conductor material used shall be electrolytic grade with high purity.

Insulation: The insulating material for power cables shall be extruded cross linked polyethylene (XLPE) compound as per IS-7098(Part-I). The minimum thickness of insulation shall not be less than the values specified in Table-2 of IS-7098 (Part-I). No negative tolerance shall be applicable for the thickness. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions.

Inner Sheath: The inner sheath shall be extruded FRLS PVC, Type ST2, compatible with thermal rating of insulation conforming to IS-6380-1984. The sheath shall have adequate thickness, mechanical strength and elasticity, as specified in IS 5831. The material shall be soft thermoplastic type, applied by extrusion method. The thickness of the inner sheath shall be as per IS: 7098 (Part I) and the color of the inner sheath shall be Grey. The inner sheath shall be so formed that it fits closely on the laid up cores and could be easily removed without damaging insulation. One or more layer of proofed plastic tape shall be provided over the laid up core before extrusion.

Armouring: The armouring arranged over the inner sheath shall consist of one layer of galvanized round steel wires/Strip for all sizes of cable. The armour round wire used on the cable shall conform to IS: 3975 for all requirements. The direction of lay of armour shall be opposite to that of the cores. The zinc coating on the galvanized steel strip shall comply with relevant standards.

Outer Sheath: Extruded outer sheath shall be provided over the armouring. The material used for sheathing shall be FRLS PVC sheath, Type ST-2 base compound conforming to IS 1554/ IS 5831 for power cable. The outer sheath shall be so formed that it fits closely on the laid up armour and could be easily removed without damaging the intermediate sheath and insulation. The colour of the outer sheath shall be black or choice of engineer in-charge. The thickness of 12 outer sheath shall be in accordance with the IS 1554 (Part-I)-1988. Suitable additives shall be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment.

Cables shall have suitable fillers laid up with the conductor to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the temperature of the cable and compatible with the insulating material. The material shall be of the best quality and workmanship. The fillers and sheath material shall be non-hygroscopic. All materials shall be new, unused and of the finest quality.

Tests: All the tests specified below shall be carried out in accordance with the Indian Standards by the manufacturer in the presence of Purchaser’s representative. If the cable fails to pass the test specified, the Purchaser shall have the option to reject it. Shipping release shall be obtained from the Purchaser’s representative. The Purchaser, however reserves the right to waive off the inspection. The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards, in addition any test called for by the Purchaser or his representative to ensure that the equipment being supplied fulfils the requirement of the specification. For test not covered by any code or specifically mentioned in this specification, the test procedures are to be agreed with the Purchaser.

Pre Dispatch Inspection:- The manufacturer shall be given at least 15 days advance notice prior to the commencement of testing, so that Purchaser’s representative can plan to witness the tests. All the tests indicated in the test clause of this specification shall be carried out in the presence of Purchaser’s representative by the manufacturer and shall provide all the facilities and equipment for testing. Six copies of the Test Certificate shall be furnished to the Purchaser for approval prior to dispatch of cables.
from factory.
Visual check to conform the details given in this specification is to be done. In addition to the above, the
general workmanship of the cable drums and cables laid in drums shall be checked. Manufacturer shall have
proper test set up for testing all the routine tests & type tests on finished cables as per IEC.
List of type tests mentioned in the tender specifications shall be conducted on four drum irrespective of type
test certificates given or not.

**Type Test:** Type tests randomly selected cable drums will have to be conducted in the presence of the
department’s representative. The test samples will be taken from finished cables. This test shall be in

**Technical Specifications for 33/11 kV grade, Aluminium conductor, Power cables** The specification covers
the design, manufacture, testing, supply and delivery in proper packed condition of 3 core, 300 sq. mm,
aluminium Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, Armoured, screened
Power Cables.

**2.10 Standards**
The Cable shall conform amended of following standards.

<table>
<thead>
<tr>
<th>IS/IEC Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS: 7098 (Part-II)</td>
<td>Specification for cross-linked polyethylene Insulated PVC Sheathed Cables for working Voltages 11 KV and 33 KV</td>
</tr>
<tr>
<td>IS: 8130-1984</td>
<td>Specification for Conductors for insulated electric cables and flexible Cords</td>
</tr>
<tr>
<td>IS: 5831-1984</td>
<td>PVC insulation &amp; sheath of electric cables</td>
</tr>
<tr>
<td>IS: 3975-1970</td>
<td>Armour for cables (for 3 Core)</td>
</tr>
<tr>
<td>IS: 10810-1984</td>
<td>Methods of test for Cables.</td>
</tr>
<tr>
<td>IS: 10418-1982</td>
<td>Cable Drums for Electric Cables.</td>
</tr>
<tr>
<td>IS: 3961 (Part 2)</td>
<td>Recommended current ratings for cables of PVC insulated and PVC sheathed heavy duty cable</td>
</tr>
<tr>
<td>IS: 1885</td>
<td>Electric Cables</td>
</tr>
</tbody>
</table>

The cable, joints, outdoor termination and their accessories and fittings may conform to other Indian
and/or equivalent Standards or important publications to improve upon their performance but shall
not fall short of the requirement of this specification.

**Cable Details**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Voltage grade (KV) of cable required</th>
<th>19/33, 6.35/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Voltage</td>
<td>33 KV, 11 KV</td>
<td></td>
</tr>
<tr>
<td>Highest Voltage</td>
<td>36 KV, 12 KV</td>
<td></td>
</tr>
<tr>
<td>Earthing System</td>
<td>Delta connected system with earthing</td>
<td></td>
</tr>
<tr>
<td>Earthing of Transformer</td>
<td>Solidly earthed</td>
<td></td>
</tr>
<tr>
<td>Basic insulation Level For Cable</td>
<td>170 KV for 33 KV Grade 75 KV for 11 KV Grade</td>
<td></td>
</tr>
<tr>
<td>Fault Level (Max.)</td>
<td>It part of design</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>50 /S, 50 C/S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>strip armoured not wire armoured. The design shall fully conform to IS:7098 (Part-II)</td>
<td></td>
</tr>
<tr>
<td><strong>Voltage Grade</strong></td>
<td>19/33KV (For 33 KV System) 6.36/11KV (For 11 KV System)</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Size Of Cable</strong></td>
<td>400 sqmm (For 33 KV System) 300 sqmm (For 11 KV System)</td>
<td></td>
</tr>
<tr>
<td><strong>Service of Voltage</strong></td>
<td>33 KV, 11 KV</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Conductor temp</strong></td>
<td>90 degree C at max. Continuous current. 33KV System, 11KV system</td>
<td></td>
</tr>
</tbody>
</table>
| **Short circuit. Current** | 1) 28.2 KA for 1Sec for 33 KV 400 Sqmm  
2) 17.39 KA for 1Sec for 11KV 300 Sqmm |
| **Maximum Permissible short circuit Temperature** | 250 degree C for one second |
| **Conductor Material** | Material to IS: 8130, H2/H4 Grade Aluminium Conductor, stranded compacted circular |
| **Conductor screen** | Extruded, cross linked, semi-conducting compound of 1.0 mm. thickness for 33 KV and 0.5 mm. thickness for 11 KV |
| **Insulation** | XLPE thickness, 8.8 (Minimum) for 33 KV and 3.6 mm. (Nominal) for 11 KV |
| **Insulation Screening For 33 KV, For 11 KV** | Combination of black extruded semi-conducting compound & Semiconducting tape as the non-metallic part and annealed copper 0.06 mm (minimum) thick tape lapping as metallic part. It is same but semi-conducting tape is not required |
| **Inner Sheathing** | Black extruded PVC Type ST-2 compound for 33 KV and wrapped PVC tape for 11 KV as per IS 7098: Part 2 |
| **Armouring** | Single layer of round galvanized steel wires/strips as per IS 7098: Part 2 both for 33 KV and 11 KV |
| **Overall Sheathing** | Coloured PVC Type ST-2 compound to IS:5831, extruded for both 33 KV and 11 KV thickness shall be as per relevant IS code |
| **End Sealing** | Heat Shrinkable Caps |
| **Impulse Tests** | 170 KV for 33 KV, 75 KV for 11 KV |
| **H.V. Tests between Conductors & Screen/Armour** | 48 KV (rms) for 33 KV for 5 minutes and 24 KV for 11KV as per IS Standard |

**Weather Condition**
Monsoon prevails generally from the month of June to October with showers sometimes heavy, acidic, smoky, industrial and foggy.

### Electrical Characteristics & Performance

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/33 KV Grade</td>
<td>Standard compacted circular Aluminium (H2/H4 Grade) Conductor, shielded with black extruded semi-conducting compound XLPE insulated, core shielded with black extruded semi-conducting compound, black semi-conducting tape and a copper tape, coloured strips having Red, Yellow &amp; Blue for core identification, shielded cores laid up with fillers, binder taped and Black extruded PVC (Type ST-2) inner sheath, single layer of round galvanized steel wire armoured and black extruded PVC</td>
</tr>
<tr>
<td>6.35/11KV Grade</td>
<td>Same as above but insulation shielding with black semiconducting tape not necessary. Inner sheath to be wrapped not extruded and</td>
</tr>
</tbody>
</table>

### Cable Manufacturing

XLPE Underground Cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPE main insulation and XLPE semi-conducting Insulation & XLPE screen. The inner and outer semiconducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during the Triple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unfilled. The XLPE Cable in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour wires which shall be ensured by guarding against corrosion.

#### Conductor Screening

A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with the elimination of the so called “Strand Effect” prevents to a great extent air ionization on the surface of the conductor.

#### Insulation

The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of ISS: 7098(Part-II).

#### Insulating Screen

The screen shall be made up as per relevant IS code. The metal screen eliminates tangential stress of rotating electrostatic field surrounding the conductor and uniform electrical stress in the insulation. The semi-conducting polyethylene (XLPE) screen shall be extruded over the main polyethylene insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3 core cables. The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration. For single core

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum ambient temperature</td>
<td>50 degree C.</td>
</tr>
<tr>
<td>Minimum ambient temperature</td>
<td>4 degree C</td>
</tr>
<tr>
<td>Maximum Daily average ambient temp</td>
<td>35 degree C</td>
</tr>
<tr>
<td>Maximum relatively humidity</td>
<td>95.00%</td>
</tr>
<tr>
<td>Average rainfall per annum</td>
<td>100 cm</td>
</tr>
<tr>
<td>Maximum height above the Sea level</td>
<td>2000 Meters</td>
</tr>
</tbody>
</table>
cable, Aluminium wire armouring shall constitute the metallic part of insulation screen. Conductor screening, insulation and insulation screening shall be extruded in triple extrusion processes so as to obtain continuously smooth interfaces. The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting screens and the main polyethylene insulation between the screens shall be simultaneously extruded during the manufacturing process known as “triple extrusion”.

LAYING UP
The phase identification of the cores shall be either by colour or numerals as per IS Specifications for 3 core cables only.

INNER SHEATH
The cable core shall be supplied with bedding of PVC (inner sheath) in the form of extruded PVC sheath for 33KV cables. Wrapped PVC tapes shall be used for 11 KV thickness as per relevant IS code.

ARMOUR
The cable shall be wire armoured/Steel strip in case of 33KV and wire/Strip armoured in case of 11 KV, 3 Core cables to ensure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. The Steel Wires/Aluminium Wires/Steel Strips of required size in requisite number shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross sectional area for flow of maximum fault current within limits of specified temperature rise and duration of fault. The direction of the lay of the armour shall be opposite to that of the cable cores.

a. OUTER SHEATH
A reliable serving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. The cable shall therefore be finished with an extruded PVC oversheath of thickness as per relevant IS code. The quality of PVC oversheath (Jacket) shall be ensured for service reliability against moisture intrusion and shall conform to type ST-2 of IS: 5831. The colour of the outer sheath shall be as follows: For 33 KV Cable: Red & For 11 KV Cable: Black The sheaths shall be protected against white ants, vermin and termites by suitable, reliable and durable measures. The implementing agency shall suggest suitable materials for use, in the event of damage to the over sheath to prevent passage of moisture along the cable.

b. CABLE IDENTIFICATION
The following shall be embossed on the outer sheath for the identification.

- Manufacturer’s Name or Trade Mark.
- Voltage Grade.
- Nominal section & Material of conductor and number of cores.
- Year of manufacture.
- Inscription for length of cables at 1.0 meter interval.
- Type of insulation i.e. XLPE.

c. SEALING OF CABLE ENDS
The cable ends in the wooden drums for delivery shall be sealed with heat shrinkable caps.
d. **WOODEN DRUMS**

The Cable shall be packed in non-returnable wooden drums. Drums shall be proofed against attack by white ants or termite conforming to IS: 10418. The Drums may also be marked with ISI Certificate Mark, if applicable. Safe Pulling Force: 30 N/mm² (for Conductor).

The following information shall be marked on each drum:

- i. Drum identification No.
- ii. Manufacturer’s Name, Trade Name/Trade Mark, if any.
- iii. Nominal sectional area of the conductor of the cable.
- iv. No. of Cores.
- v. Type of Cable and Voltage Grade with Cable Code.
- vi. Length of the Cable in Cable Drum.
- vii. Direction of rotation of Drum (by means of an arrow)

### 2.11 Type Test

Relevant tests are to be made as per details given in IS:10810

#### 2.11.1 RMU Specification

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design, Manufacture Supply, installation, testing and commissioning of SCADA compatible 11 KV Ring Main Unit (Both sides extensible) motorized for remote switching outdoor type with 1 No. 11 KV Load Break Switch (12KV, 630A, 21 KA) suitable for mounting on footpath/edge of carriage way at Bhagalpur smart city. Degree of protection IP 67. The RMU has to be designed to operate accordingly.</td>
</tr>
</tbody>
</table>
| 2 | The following should form the part of the switchgears.  
   a) 1 No Isolator  
   b) Internal bus earthing with flat GI strip of size 50x6mm.  
   c) Copper busbar.  
   d) Motorized mechanism.  
   e) Front access & bottom entry of HT cables.  
   f) The cable box should have bottom gland / base plate for cable entry and front cable covers for cable access.  
   g) The live line indicators should be of LCD display type, due to their higher life; taking the Required power form the capacitive coils situated at the cable bushings.  
   h) Manometer with presser digital contact for remote monitoring.  
   i) Operating Handle.  
   j) The complete switchgear shall be tested for internal arc of 21 kA for 1 sec. |
| 3 | Load break switch – C  
   The switching-unit is designed as a three-position-switch. This three-position-switch combines the functions of switch-disconnector and earthing-switch. The switch-disconnector as well as the earthing-switch is equipped with a separate drive-unit. |
- Cable switch 12 kV, 630 A, 21 kA.
- Snap action mechanism for Manual operation with integrated earthing switch.
- Cable bushing 630 A, standard C bushings.
- Cable cover standard.

- Capacitive voltage indication fixed type - LED display.
- ON, OFF, EARTH indication on the front mimic of the panel.
- Cable box for termination of cable up to 300 sq. mm.
- Cable entry bottom, front/side

**SPECIFIC REQUIREMENTS:**
The switchgear enclosure shall confirm to the degree of protection IP 3X (Indoor) or IP 54 (Outdoor).
The cable connection compartment must be successfully tested according to IEC 62271-200 for behavior in the event of an internal defect. No insulating material on metal surface of the cable box is allowed to ensure arc proof resistance in the cable connection compartment. The cable connection compartments must be fitted with front covers. The front covers must be integrated in the comprehensive interrogator interlocking system. The cable doors should be removable / detachable type so as to facilitate easy connection of cables and to allow maximum flexibility to the maintenance staff while doing maintenance work.

No cable covers should be hinged type. The cable termination access for the functions (eg: Isolator/Load break Switch or Vacuum circuit breaker) should be from the front. Termination access from the sides and rear are not acceptable.

Suitable venting arrangement shall be provided to release the gas pressure developed due to the operation of the breaker or due to live arc of fault. The pressure relief must ensure that the escaping gases are dissipated downwards and to the rear of the equipment.

Each breaker cubicle shall be provided with at least 2 NO & 2 NC contacts. All fixing bolts, screws, etc. appearing on the panel shall be so arranged as to present a neat sequence.

Acceptable Makes for the RMU/VCB: ABB/ Siemens/ AREVA/ or Approved Brand as per Local Discom.
CABLE TERMINATION

Switchgear shall be designed for cable entry from the bottom and access from the front. Termination access from the sides and rear are not acceptable. The cable connection compartment must be successfully tested according to IEC 62271-200 for behavior in the event of an internal defect. No insulating material on metal surface of the cable box is allowed to ensure arc proof resistance in the cable connection compartment. The cable connection compartments must be fitted with front covers to the front. The cable doors should be removable/detachable type so as to facilitate easy connection of Cables and not to allow any hindrance to the maintenance staff while doing maintenance. No cable covers should be hinged type. The cable compartment of LBS module shall be able to accommodate 2 runs of 3 core X 300sqmm XLPE cable.

FACTORY TESTING The following tests should be carried out mandatorily on each RMU in the factory of the manufacturer at one location.
1. Withstand Voltage at power Frequency for all current carrying parts including wiring.
3. Gas Leakage Test
4. PARTIAL DISCHARGE TEST
5. Withstand Voltage on Auxiliary Circuit.
7. Suitability & correct operation of Protection, Control Instruments and electrical connections of the circuit breaker operating mechanism (PRIMARY & SECONDARY INJECTION)
8. Verification of Wiring.

2.11.2 LT FEEDER PILLAR BOX SPECIFICATION:

IP 54 outdoor canopy type, weather, dust and vermin proof suitable for outdoor installation on footpath LT feeder pillar Box of 440 VAC, 50 HZ, 400 Amp consisting of 400 Amp, FP/TP MCCB as incomer with thermal magnetic relay, 3P&N aluminium Bus bar 40 amp. 20 no’s outgoing fuse HRC fuse system. The feeder pillar box shall suitable for loop IN Loop output 3.5 core 185 sq. mm armoured cable and other service cable like 4 core 35, 25, 16, 10 sq mm. The feeder pillar box should be high class insulated between live part and box body for the public safety during internal fault condition. The box shall fabricated with 14 gauge CRC steel sheet duly pre-treated and pure polyester thick powder coated 80 micron thickness using Siemens grey colour shade no. RAL-7032 / any other colour if required by client. The feeder pillar shall be single door with concealed hinges and shall be earthed. The door shall have heavy duty door locks, and shall be sealed with neoprene gaskets. As per approved GA diagram. Panels shall have base channel of suitable size. Compliance with IEC 61439 and CPRI approved.
**FEEDER PILLER BOX DESCRIPTION**

<table>
<thead>
<tr>
<th>Sl.</th>
<th>ITEMS DESCRIPTION</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14/16SWG CRCA FABRICATED AND POWDER COATED RAL 7032 SIEMENS GREY, OUTDOOR TYPE WITH CANOPY SIZE: H=1200, W=900, D=250 MM (TENTATIVE)</td>
<td>1</td>
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<tr>
<td>1.1</td>
<td>MAIN INCOMMER FEEDER</td>
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<td></td>
<td>400 A FP/TP 36KA MCCB TM RELEASED WITH ADJ. O/L PROTECTION</td>
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<td></td>
<td>EXTENDED ROTARY HANDLE FOR MCCB</td>
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<td></td>
<td>SPREADER TERMINALS FOR MCCB (SET OF 6)</td>
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<td>INDICATING LAMP RED, YELLOW, BLUE 230 VAC</td>
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<td></td>
<td>POWER SOCKET 230V AC</td>
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<td>1.2</td>
<td>ALUMINIUM BUSBARS 3 PHASE AND NEUTRAL FOR 500 A INCOMMER CURRENT DENISTY : 0.8A/SQ.MM</td>
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<td>1.3</td>
<td>OUTGOING FEEDER</td>
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<td></td>
<td>40A HRC FUSES FEEDER (QTY: 20 NOS)</td>
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<td>63A FUSE BASE</td>
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<td></td>
<td>40A FUSE LINK</td>
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<td></td>
<td>POWER TERMINALS</td>
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<td></td>
<td>END PLATE FOR ABOVE TERMINALS</td>
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**2.12 Specifications for Streetlight Poles**

This specification covers the requirements of design, manufacture and testing of street light pole complete with all accessories and fittings conforming to relevant Indian standard or equivalent for efficient and withstand Indian atmosphere.

**Service Conditions:**
- Ambient Temperature: 50 Deg C
- Relative Humidity up to 95%
- Altitude of Installation up to 1000m
- Maximum Wind Speed 50 m/s

**Design:** The Octagonal/Conical Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.

**Pole Shaft:**
The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

**a. Door opening:**
The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the...
Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

b. **Material:**
Octagonal Poles HT Steel Conforming to grade S355JO. Base Plate Fe 410 conforming to IS 226 / IS 2062 Foundation Bolts EN.8 grade

c. **Welding:**
The welding shall be carried out confirming to approve procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

d. **Pole sections:**
The Octagonal Poles shall be in single section (up to 11 Mtr). There shall not be any circumferential weld joint.

e. **Galvanization:**
The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

f. **Fixing Type:**
The Octagonal Poles shall be bolted on a foundation with a set of four foundation bolts for greater rigidity

g. **Top Mountings:**
The Octagonal Poles shall be bolted on a foundation with a set of four foundation bolts for greater rigidity. The galvanized mounting bracket shall be supplied along with the Octagonal Poles for installation of the luminaries.

h. **Installation of Poles:**
Installation of poles shall be done as per design and drawing. RCC pedestal using M-20 grade concrete, tor steel shuttering etc are envisaged, scope also includes supply and embedment of 2 no’s -50 mm dia bent GI pipes for taking cables. The other consumable required to complete the job in all respects.

i. **INSTALLATION OF STREET LIGHT FIXTURES:**
This includes fixing of street light fitting complete with accessories and lamps at the end of the pole/bracket, connecting it with designed capacity and size copper conductor, PVC insulated cable from terminal block mounted in bottom of pole, testing and commissioning. The third core shall be connected to earth point of pole.

### 2.12.1 Specification of street light
Street light should be integrated with driver,

a. **Standards**
- IEC 60598-1: General requirement and tests
- IEC 61000-3-2: Limits for Harmonic current emission - THD < 10%
- Energy Meter with accuracy < 1%
- Stand by wattage of <1W
- Astronomical Clock
- Memory to retain no less than 7 days energy data

b. **Technical data:**

<table>
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<tr>
<th>Input voltage</th>
<th>100 V to 270 V</th>
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<tr>
<td>LED lamp efficacy</td>
<td>&gt; 120 Lm/W for 65/70 watt and 80 Lm/W for 20 W</td>
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<tr>
<td>Specification</td>
<td>Requirement</td>
</tr>
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<td>-------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Power factor</td>
<td>&gt;0.90</td>
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<tr>
<td>Life expecting (L70B50)</td>
<td>50,000 burning hours</td>
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<tr>
<td>No of hours usage / day</td>
<td>10 to 12 hours / day</td>
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<tr>
<td>Rated watt</td>
<td>10/20/70 W (cool white)</td>
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<tr>
<td>Luminous flux</td>
<td>1000 to 9000 Lm</td>
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<tr>
<td>LED type</td>
<td>High power LED (1 Watt)</td>
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<tr>
<td>Working Humidity</td>
<td>0 to 95%</td>
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<td>Colour Temperature</td>
<td>4000 to 6500 K with test certificate</td>
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<tr>
<td>Ingress protection</td>
<td>IP 65 as per IS/IEC60529-2001 or up to date amendment with test certificate</td>
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<tr>
<td>Impact Resistance (IK Rating)</td>
<td>Min IK08</td>
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<tr>
<td>Total harmonic distortion (THD)</td>
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<tr>
<td>Surge Protection</td>
<td>Min. 4kV inbuilt and 10kV external</td>
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<tr>
<td>Colour rendering index</td>
<td>Ra &gt; 70</td>
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<tr>
<td>Working Temperature</td>
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<tr>
<td>Average lighting/ beam angle</td>
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<tr>
<td>Avg. Horizontal illuminances (lux)</td>
<td>As per IS1944</td>
</tr>
<tr>
<td>Overall Uniformity (Emin/Eavg)</td>
<td>As per IS1944</td>
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<tr>
<td>Transverse Uniformity (Emin/Emax)</td>
<td>As per IS1944</td>
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<tr>
<td>Control Circuit</td>
<td>Integrated individual control driver, Compatible to LED</td>
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<tr>
<td>Lamp starting time</td>
<td>Not more than 5 second</td>
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<tr>
<td>System power efficiency</td>
<td>&gt; 85 %</td>
</tr>
<tr>
<td>Driver Type</td>
<td>BIS approved Potted LED Driver</td>
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<tr>
<td>Luminary Casing</td>
<td>Pressure die cast Aluminum with toughened glass cover and water proof fixture</td>
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<tr>
<td>LED thermal management</td>
<td>LED shall be mounted on heat sink conductive aluminum with fins to dissipate the heat to ambient air</td>
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<tr>
<td>Pole entry/ Retro fitting</td>
<td>Suitable for fixing in existing lighting pole (30 mm to 60 mm dia with bracket and locking bolt &amp; nut.</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IESNA LM 79 for fixture and with stand to wind velocity 150 mph with test certificate</td>
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<tr>
<td>Electrical connector</td>
<td>Connecting wires with minimum one meter length</td>
</tr>
<tr>
<td>Fixture</td>
<td>CE compliance.</td>
</tr>
</tbody>
</table>

i.
ii. Chemical composition IS:4072(1975)
iii. For Galvanised steel wire:
iv. As per IS:280(latest addition)
v. Testing as per IS:7887Grade-III

All materials shall comply in all respect with the requirement of latest addition of relevant Indian Standard Specification except as modified in this Specification.

### 2.14 Details of Characteristics/ Inventory of the 17 different within the ABD Area

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<th>#</th>
<th>Road Name</th>
<th>Length (in Kms.)</th>
<th>Location</th>
<th>LHS Drain/Footpath</th>
<th>Paved/Unpaved Area</th>
<th>RHS Drain/Footpath</th>
<th>Paved/Unpaved Area</th>
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<th>RO W</th>
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<td>Kachehri Road (Kachehr i Chowk to Manali Chowk)</td>
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<td>Description</td>
<td>Distance</td>
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<td>daffodils preschool</td>
<td>SBI nayabazar branch, before budhanath</td>
<td>jogsar police chowki</td>
<td>Shankar talkies to Adampur Chowk</td>
<td>Sharda sangit sadan, near lajpat auditorium</td>
<td>near water tank manik sarkar chowk</td>
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<td>1.3</td>
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<td>10.8</td>
<td>10.5</td>
</tr>
<tr>
<td>1 4</td>
<td>Khalifa bag to Shankar talkies chowk</td>
<td>0.83</td>
<td>1</td>
<td>1.9</td>
<td>5.6</td>
<td>1.3</td>
<td>1</td>
<td>10.8</td>
<td>10.5</td>
</tr>
</tbody>
</table>
2.15 Cost Estimate, Revenue Generation & Potential PPP

Some revenue is expected to be generated through advertisement rights on street light poles as additional lights are being installed alongside of pathways and planters on some roads as per standard norms of center to center spacing requirements. The entire revenue from advertisement rights may come to BSCL if the rights are transferred by Bhagalpur Municipal Corporation. The locations for providing advertisement rights on light poles will be decided during execution stage. Street furniture like street benches, smart street signage and kiosks, etc. can be installed on the road stretch under CSR activity or PPP.

Way Forward

1. The design proposal for road network has been done keeping in mind, local context, need of the area, Right of Way availability, existing cross section and road use, road design guidelines and standards, recommendations prescribed for smart roads under Smart Cities Mission and stakeholder consultation.
2. The design has focus on equitable RoW space distribution and allocation to various component and street elements.
3. Junctions shall be redesigned keeping in view traffic volumes, turning requirements, pedestrian’s safety aspects, visibility criteria, minimum disturbance to traffic flow and enhancement of streetscape with improved landscaping.
4. Existing trees have been retained and in addition to that, extra landscaping has been proposed to enhance the streetscape and beautification.
5. Existing drain have been considered for reconstruction.
6. Space under roads and road sides is available for lying of utilities like Gas Line, Electricity Line, OFC cables etc.
7. The existing alignment has been re-designed along with Junction Improvement. No major changes are proposed. Street furniture like benches, dustbins, new street and traffic signage’s etc.
ROAD WORKS: Civil Work Specifications, Cross Sectional Elements.

The materials have been selected strategically with considerations of climate, design requirement and aesthetical value of city and surrounding region. The specifications and approved make shall be as per Bihar RCD SOR 2018 or latest edition of SOR. The list of approved makes/agency of materials will be as per Bihar RCD SOR 2018 & BCD, SOR 2018 or latest edition of SOR. In absence of available rate in the said SOR, the rate of NCR, Delhi, or CPWD has been followed.

The following Specifications, codes and standards, as well as their addenda, updating and reference standards shall be followed.
1. Institute of Urban Transport (IUT) Guidelines for Smart Cities.
2. NUTP Guidelines
3. RCD Bihar Guidelines.
4. MoRTH Specifications
5. IRC & BIS Codes and Standard Practices
6. BCD Bihar Specifications.
7. CPWD Specifications.
8. Technical Specifications mentioned in any part of this document & Other required relevant codes and specification.

3.1 APPLICABLE CODES AND STANDARDS

- IRC 11-1962: Recommended practice for design and layout of cycle tracks
- IRC 30-1968: Standard letter and numerals of different heights
- IRC 32-1969: Standard for vertical and horizontal clearances for overhead electric power and telecommunication lines related to roads
- IRC 35: 1997: Code of practice for Road Markings (with paints)
- IRC 67:2001- Code of practice for Road Signs
- IRC 69-1977: Space standards for roads in urban areas
- IRC 70-1977: Guidelines on regulation and control of mixed traffic
- IRC 86-1983: Geometric design standards for urban roads in plains
- IRC 103-2012: Guidelines for pedestrian facilities
- IRC 106-1990: Guidelines for capacity of urban roads in plain areas
- IRC SP 12-1973: Tentative recommendation on provision of parking space for urban areas.
- IRC SP 21-1979: Guidelines for landscaping of road.
- IRC SP 42-1994: Guidelines for road drainage
- IRC SP 43-1994: Guidelines for low cost traffic management techniques for urban areas
- IRC 16-1989: Specification for Priming of Base Course with Bituminous Primers
- IRC 23-1966: Tentative Specification for Two Coat Bituminous Surface Dressing
- IRC 27-1967: Tentative Specifications for Bituminous Macadam (Base & Binder Course)
- IRC 29-1988: Specification for Bituminous Concrete (Asphaltic Concrete) for Road Pavement
- IRC 37-2001: Guidelines for the Design of Flexible Pavements
- IRC 82-1982: Code Practice for Maintenance of Bituminous Surface of Highways
- IRC 90-1985: Guidelines of Selection, Operation and Maintenance of Bituminous Hot Mix Plant
- IRC 94-1986: Specification for Dense Bituminous Macadam
- IS 73-2013: Paving Bitumen
- IS 1200(Part 1)-1992: Methods of measurement of building and civil engineering works: Part 1 Earthwork
- IS 1200(Part 2)-1974: Method of measurement of building and civil engineering works: Part 2 concrete works
- IS 1200(Part 4)-1976: Method of measurement of building and civil engineering works: Part 4 stone masonry
- IS 1200(Part 8)-1993: Method of measurement of building and civil engineering works: Part 8 steel work and iron work
- IS 1200(Part 9)-1973: Method of measurement of building and civil engineering works: Part 9 roof covering (including cladding)
- IS 1200(Part 11)-2013: Method of Measurement of Building and Civil Engineering Works Part 11 Paving, Floor Finishes, Dado and Skirting
- IS 1200(Part 15)-1987: Method of measurement of building and civil engineering works: Part 15 painting, polishing, varnishing etc
- IS 15658-2006: Precast concrete blocks for paving

### 3.2 Material & Item Specification

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Name of the Item</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Brick</td>
<td>Bricks shall be as per IS 1077 of grade</td>
</tr>
<tr>
<td>2.</td>
<td>Cement</td>
<td>For construction of structures 43 grade ordinary Portland cement conforming to IS: 8112 and 53 grade ordinary Portland cement conforming to IS: 12269 will be used.</td>
</tr>
<tr>
<td>3.</td>
<td>Aggregates</td>
<td>Aggregates will consist of clean, hard, strong, dense, non-porous and durable crushed stone for coarse aggregates and natural particles for sand. The aggregates will conform to IS: 383:1970 and will be tested to conform to IS: 2386 parts I to VIII. Size of coarse aggregate will be selected as per mix design requirement.</td>
</tr>
<tr>
<td>4.</td>
<td>Sand</td>
<td>Sand and stone aggregate shall be as per IS code 383:1970</td>
</tr>
<tr>
<td>5.</td>
<td>Admixture</td>
<td>To improve workability of concrete, admixtures conforming to IS: 9103 will be used. Aggregates will consist of clean, hard, strong, dense, non-porous and durable crushed stone for coarse aggregates and natural particles for sand. The aggregates will conform to IS: 383 and will be tested to conform to IS: 2386 parts I to VIII. Size of coarse aggregate will be selected as per mix design requirement.</td>
</tr>
</tbody>
</table>
6. **Water**

   Water used for mixing and curing will be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water will not be less than 6 and not more than 8.

7. **Concrete**

   The grade of concrete will be as per design requirement and mentioned in execution drawings for each component of the structure. Cement and water content will be as per mix design requirement.

8. **Reinforcement**

   Deformed or TMT reinforcement bar conforming to IS: 1786 will be used for components of the structures. The reinforcement grade will be Fe500.

9. **Cast Iron railing:**

   Providing and fixing of Cast iron railing with bands on top and bottom of approved design, height 750mm including grout in cement Concrete block etc. all complete in direction of Engineer-In-Charge. (to be placed on medians and footpath at pedestrian Crossing)

10. **Cement Concrete Curb Stone:**

    Material: Construction of cement concrete kerb with top and bottom width 115 and 165 mm respectively, 250 mm high in M 20 grade PCC on M-10 grade foundation 150 mm thick, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually, all complete.

    Workmanship: work shall include all labour sundries and T&P etc as required for proper execution of work.

    Measurement: the measurement shall be in RM.

11. **ROAD WORKS**

   All the road works shall be carried out as per specification for road and streetscape work as per detailed in following order

   Bihar RCD , BCD SOR Specification,

   MoRTH , CPWD and as per the Specifications given in Detailed Bill of Quantities.

12. **Clearing walking zone for Footpaths**

    IRC: 103-2012 - Guidelines for Pedestrian Facilities is followed. In the natural and tempered landscapes, paths should be at least 1800 mm wide in order to accommodate wheelchair users and persons with vision impairments assisted by a sighted person. The minimum 1.8 m (width) x 2.2 m (Height) Walking Zone should be clear of all obstructions- both horizontally and vertically. No utility ducts, utility poles, electric water or telecom boxes, trees, signage or any kind of obstruction should be placed within the "Walking Zone". The footpath surface should be even and without any irregularities. The use of guiding and warning blocks
should be used

13 Safe Pedestrian Crossing: Restricted crossing at required areas with safe passage for pedestrian by provision of road marking on carriageway and provision of Bollards on Shoulder area. At such pedestrian crossing points provision of Traffic calming provisions by VMS and reflective signage are to be provided.

14 Bus stop 5 no’s - Construction of Bus Shelter at locations & Design Layout as approved by BSCL

15 Traffic Islands Traffic islands are meant to serve as refuge islands for pedestrians while crossing the road. They should not be fenced by decorative railings and plantation. Instead, they should be designed for heights matching footpath level and should also have a cut-through to facilitate wheel chair access.

16 Road Signs: To ensure safe and efficient flow of traffic in the project corridor, traffic shall be regulated through system guidance and control systems. Accordingly traffic signs, both post and gantry- mounted, of retro-reflective types, as per IRC: 67:2012.

17 Planters Planters are also proposed next to the pedestrian walkway where ever possible to give a visual harmony with street lighting and sidewalk amenities and the building context. Specific trees and plants vary in their aesthetic appearance should be selected as per local climate. These areas can be designed as public spaces green or semi paved as per design.

18 Cross Drainage Work Approved nos & Quantity as per site condition, survey Specification Approved as per norms and condition of IS Codes or relevant Standard Latest Codes.

Before Execution requires approval from Drawing and Design by BSCL.

19 SWD Pipes Approved nos & Quantity as per site condition, survey Specification Approved as per norms and condition of IS Codes or relevant Standard Latest Codes.

Before Execution requires approval from Drawing and Design by BSCL.

20 BUS Stop Approved nos & Quantity as per site condition, survey Specification Approved as per norms and condition of IS Codes or relevant Standard Latest Codes.

Before Execution requires approval from Drawing and Design by BSCL.

21 Road Markings Road markings including vehicle lane marking, painting of kerbs, road edge line, zebra crossing etc. to be done as per prevailing IRC 35:1997 guidelines and standards.

22 Common Utility Duct The concept of ‘CUD – Common Utility Duct’ is very much recent and being considered for implementation in Road Re-design projects under Smart Cities Mission. The idea is to bring together and fit all the types of
underground utilities in a single channel made of cement concrete such that their alignment is streamlined and are easily locatable along with protection from environmental effects. Generally, utilities in urban areas are laid independently. Various departments and service providers ranging from water supply, sewerage and storm water drainage by urban local bodies, Optical Fiber Cable Networks (OFC) and telephone cables by telecom service providers, Gas Pipeline for Residential areas by State Gas Supply Agencies, Television Cables by local service providers, Low and High Voltage electricity lines by electricity distribution companies etc. The Urban Street Design Guidelines published by UTTIPEC-Delhi Development Authority mentions about the need, importance, advantages and concept of Common Utility Duct for underground utilities. Typical cross section as per British Practice mentioned in the document is shown Fig in Drawing.

Ducts should be designed based on cities requirements. 3 types of ducting systems are in practice: Duct Bank, Ducts with Utility Partitions & Fully Accessible Ducts (in which human can walk through for maintenance).

23  Bolards

Bolards to be painted with Two Paints fixed with M-25 garde of concrete

24  Sitting Benches

3 seater FRP benches with cast iron side support of approved make and quality or cement concrete benches.

25  Bituminous works, shall be tested immediately after laying/finishing for

Bituminous works shall be tested immediately after laying/finishing for

   a) Thickness (compacted) measured by extracting cores and shall be dealt in accordance with MORT&H Specifications or relevant Standard C

   b) Density (compaction) test as performed on the extracted cores.
c) Workmanship test by measuring roughness of the finished layer by duly calibrated Towed Fifth Wheel Bump integrator.  

Note: Contractor shall arrange the core extraction machine at his cost and shall take cores of the executed bituminous works jointly with Engineer without any extra cost.

26 Streetscape Signage

The purpose of streetscape signage, including gateway markers and directional signage is to provide an overall image of a neighborhood, mark edges or entry points, and give information about directions, destinations, or the neighborhood in general. Two hierarchy in types of signage are proposed in the design, one street information signage which are meant to provide information's like-no parking, no vending zone, pedestrian crossing ahead, restricted parking zone, designated vending zone etc. and the Street directive signage is meant to give information about the location, direction of possible destinations. Signage points are proposed after every 100M to 150M in the MUZ lane and median where possible as per site condition. The below images are just some reference images to visualize the concept. Any other alternate signage can be selected depending on the cities preference, choice, pattern etc. Below are images of few modern signage designs that can be adopted for direction and street information sign boards.

27 Public Toilet Block

A modular toilet block for both men and women (namma toilet in the image below) can be installed at spots having space. Provide as per Requirement on site as per direction of Engineer In Charge.
28 Landscaping

Different varieties of plants and shrubs can be used to create a sense of aesthetics, sense of enclosure in some places, define boundaries etc. Large trees provide shade and also public sitting areas. Small shrubs can be used in buffer zones to create a separation between two different use areas like carriageway and footpath.

29 1. Cement

Concrete Curb

Stone:

Material: Construction of cement concrete kerb with top and bottom width 115 and 165 mm respectively, 250 mm high in M 25 grade PCC on M-15 grade foundation 150 mm thick, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually, all complete.

30 Signage’s:

The signage’s will be embedded and camouflaged with surrounding materials. The signage will be integrated into its structures like benches, pillars of kiosks or boundary walls. The modern signage would be metal finish pre-fabricated to be as per the landscape of the site. The samples and design shall be approved by BSCL before execution.

31 Footpath:

Construction of footpath and parking area to be done as per IRC SP 63:2004- Guidelines for use of interlocking concrete block pavement. 60mm thick paver blocks are used for footpaths whereas 80mm thick paver blocks are used for vehicle parking areas.

Note: -
1. Scope of Work includes Construction a client office at site with air Conditions as per Direction of Bhagalpur Smart City Limited
2. Prior approval of materials are required as per direction of Bhagalpur Smart City Limited.
   i. Wearing course:-Asphaltic concrete wearing course, 65 mm thick, as per the latest circular issued by SOR of BIHAR, RCD, and MORTH/NHAI for National Highways, or Relevant Standard Codes
   ii. Footpath Height:-

The height of footpath from ground level should be such that it is easily accessible by pedestrians and disabled and allows design modifications to address their accessibility issues.
iii. **Traffic Signs:**
All traffic signs to be as per IRC 67:2001 Code for Road Signs. The sign board pole should have black and white strips painted for length of 25-30 cm. The pedestrian crossing and speed breaker ahead warning signs are shown below

![Traffic Signs Example](image)

iv. **Dustbins:** Dustbins are to be provided at places as required which will be harmonized with design of the areas. The dustbins would be of pre-cast cc to be as per the landscape of the site. The samples and design shall be approved by BSCL before execution. Examples of sitting bench, dustbin and sign boards are shown below.

![Sitting Bench, Dustbin, and Sign Boards](image)

V. **STREET FURNITURE:**

i. Providing and fixing of **Plastic U shaped duel unit dustbins** of internal size (325mm x 250mm x 500mm) of make SYNETEX or equivalent model as per approved design and shape mounted with connecting rods on MS pole (dia 80mm) of height 1250mm with 150mm base plate dia including grout in cement concrete block etc all complete in direction of Engineer in charge.

ii. Material: Construction of sitting arrangement around the tree of required size made by brick wall of 750 mm height and PCC base of 1:3:6 with granite cladding/lining as per design and drawing complete in all respect.

iii. Construction of sitting arrangement along the road in required size made by brick wall and PCC base of 1:3:6 with granite cladding/lining as per design and drawing complete in all respect.

iv. Construction of Plantation arrangement at the Road side made of Brick wall with PCC base and Granite Cladding/lining as per design and drawing complete in all respect.
v. Precasting and placing in position 125 mm dia Bollards 600 mm high of required shape including providing M.S. Pipe Sleeve 50 mm dia 300 mm long in the Bollard and M.S. Pipes 40 mm dia and 450mm long with 150 x 150 x 6mm M.S. plate welded at bottom and embedded 150mm in cement concrete 1:3:6 (1 Cement: 3 coarse sand (zone-III): 6 graded stone aggregate 20 mm nominal size), including necessary excavation of size 250 x 250 x 450mm deep for the same in bitumen/ concrete pavement at specified spacing.

vi. Supply and fixing Decorative pole and lighting fixture made of galvanised Mild steel pipes duly paint polyurethane paint coated. As per site Requirement and required for proper completion of work as directed by engineer in charge.

vii. Construction of Pergola at footpath of 2.5 m height and 2 m wide and 5 m length made of steel structure as per design and drawing and required for proper completion of work as directed by engineer in charge.

**Colour and textured flooring on parking Zones and Entry/Exit points**

a). Material: "Providing and laying design mix cement concrete of M-30 grade, in roads/ taxi tracks/ runways, using cement content as per design mix, using coarse sand and graded stone aggregate of 20 mm nominal size in appropriate proportions as per approved & specified design criteria, providing dowel bars with sleeve/ tie bars wherever required, laying at site, spreading and compacting mechanically by using needle and surface vibrators, levelling to required slope/ camber, finishing with required texture, including steel form work with sturdy M.S. channel sections, curing, making provision for contraction/ expansion, construction & longitudinal joints (10 mm wide x 50 mm deep) by groove cutting machine, providing and filling joints with approved joint filler and sealants, complete all as per direction of Engineer-in-charge (Item of joint fillers, sealants, dowel bars with sleeve/ tie bars to be paid separately) (Cement concrete prepared with batch mixing machine).

**Development of Green Spaces**

a). Material: Providing and laying 500x500x40 mm thick Turf paver (Turf paver XD) on 150 mm thick sub grade of compacted bed of 20 mm thick nominal size stone aggregate and base course and filling with 150 mm thick sand, including spreading, well ramming, consolidating and finishing smooth etc. all complete as per direction of Engineer-in-charge.

b) Planting of trees by the road side (Avenue trees) in 0.60 m dia holes, 1 m deep dug in the ground, mixing the soil with decayed farm yard/sludge manure, planting the saplings, backfilling the trench, watering, fixing the tree guard and maintaining the plants for one year.

c) Planting permanent hedges including digging of trenches, 60 cm wide and 45 cm deep, refilling the excavated earth mixed with farmyard manure, supplied at the rate of 4.65 cum per 100 meters and supplying and planting hedge plants at 30 cm apart
d) Grassing with 'Doobs' grass including watering and maintenance of the lawn for 30 days or more till the grass forms a thick lawn free from weeds and fit for moving including supplying good earth if needed.

Following design consideration have been incorporated in street scape;

- **Coherent Designs** as per standard norms and guidelines.
- **Uniform Lane width**- Lane width determine the behavior of driver & safety of others
- **Universal Design**- Streets for All
- **Resilient Streets**- that provide infrastructure allowing safe walking experience in night through pedestrian lighting and clean public space
- **Accessibility**- Physically Handicapped and Wheel Chair Friendly - resting places, waste collectors bisect at intermittent 75-80 m spacing,
  - **Visual – Sensory** Signage's for Pedestrian Movements
- **Walkable Neighborhood**- promoting pedestrian & Student friendly avenues/promenade with shared Cycle track without disturbing the dedicated Carriageway.
  - **Aesthetic and Artistic** furniture with least Care and adaptable with surrounding.

**Colour and textured flooring on footpath**

a). Material: Supply and fixing of 60mm thick rectangular shaped Mechanically compressed inter locking cement concrete pavers block manufactured by high pressure & controlled vibration machine having plan dimension 200x(160+120mm) with minimum 5mm thick lopping of DP cement mixed with 25% marble powder. The compressive strength of concrete paver block shall not be less than 30 MPa & Including cost of all material, Labour, T&P etc. required for proper completion of work as directed by engineer in charge including base of 50 mm thick local sand.

2. **Parking Management:**
   Parking Lanes: - Parking lane width for parallel parking should be 2.5 m which may be reduced to 2 m where available space is limited. If sufficient RoW is available, angle parking may be adopted if required. As the current project mostly covers roads with varying RoW from 10 m to 30m, it is recommended to enforce parallel parking practice.
   2- Wheeler Parking provision along roads side at dedicated spaces and intervals with visual signage for controlled distribution of spaces. Material: Stamped Concrete

3. **Median Planters**: planters on median for visual Improvement and restricting pedestrian crossing by shrubs etc.

4. **Typical cross section of footpath and parking area**
   Kerb & Parking Areas: - Use of ‘Barrier Type’ kerb as per IRC 86:1983 Geometric design standards for urban roads in plains, is proposed to be used in planters between carriageway and footpath and in footpath edge between carriageway and parking/planter. Semi- barrier type kerb can be used in the planter.
Variety of colours is available in cement concrete interlocking blocks. The colour of these blocks should be different for footpath and parking area in order to easily differentiate. Slots as per type of vehicle can also be painted on these blocks as shown here.

Pedestrian Pathway

<table>
<thead>
<tr>
<th>Component</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradient</td>
<td>1:20</td>
</tr>
<tr>
<td>Width</td>
<td>Minimum 1.8m as per IRC 103:2012 Guidelines for Pedestrian Facilities</td>
</tr>
<tr>
<td>Maximum height from road level</td>
<td>150mm</td>
</tr>
<tr>
<td>Surface</td>
<td>60mm thick paver blocks of standard make and size.</td>
</tr>
</tbody>
</table>

4.0 Design Levels: - Level Taken as per GTS Benchmark or Approved Bhagalpur Level mean sea level Transferred.

3.3 MATERIALS

3.3.1 Stone Aggregate
For WBM construction stone metal grade – I& II of hard granite or equivalent as approved by Engineer-in-Charge shall be used. River borne or weathered stone metal shall not be used for the work. The stone metal and aggregates shall not be obtained from the rock which has been exposed to atmosphere for a long time. They shall be clean, hard, durable of fairly cubical shape and free from excess flat, elongated, soft & disintegrated particles, fracture, cleavage, dirt & other deleterious materials and organic impurities. The aggregates shall preferable be hydrophobic and low porosity. The aggregates shall satisfy the physical requirements as set forth in Table I.

Table – I (Physical Requirement of Coarse Aggregate)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Construction Requirement</th>
<th>Type of Construction Test</th>
<th>Test</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sub-Base (Maximum)</td>
<td>Los Angeles Abrasion Value</td>
<td>IS-2386 (Part-IV)</td>
<td>60%</td>
</tr>
<tr>
<td>Test Description</td>
<td>Standard</td>
<td>Requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles Abrasion Value</td>
<td>IS-2386 (Part-IV)</td>
<td>50% (Maximum)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or Aggregate Impact Value</td>
<td>IS-2386 (Part-IV)</td>
<td>*50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flakiness Index</td>
<td>IS-2386 (Part-I)</td>
<td>**15%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Aggregates may satisfy requirements of either of the two tests.

** The requirements of flakiness index shall be enforced only in case of crushed / broken stone.

*** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS:5640.

### 3.3.2 Sand / Stone Dust

Sand / Stone dust shall be clean, hard durable, uncoated, dry and free from injurious soft or flaky pieces and organic or deleterious substances. Quality of sand / stone dust shall conform to IS: 383.

### 3.3.3 ROLLING

Rolling shall be done by 80 / 100 KN smooth wheeled power roller (3 wheel or tandem) or vibratory roller of 80 – 100 KN static weight. Rolling shall start as soon as possible after the materials have been spread, deploying a set of rollers as the rolling is to be completed in limited time frame. Rolling shall be done with care to avoid unduly roughening of the pavement surface. The roller shall move at a speed not more than 5 km / hour.

Rolling of longitudinal joints shall be done immediately behind the paving operation. After this the rolling shall commence at the edges and progress towards the centre longitudinally, except that on super elevated and uni-directional cambered portions, where the rolling shall proceed from inner edge to the outer parallel to the centre line of the pavement. First the edge / edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping proceedings tracks by at least one-half width of WBM.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding mix material. The rolling shall be continued till the entire surface has been rolled to 95% of the Proctor’s density, there is no crushing of aggregates and all roller marks have been eliminated. Roller shall not stand on newly laid material while there is a risk that surface will be deformed thereby.
3.3.4 **SURFACE FINISH**

3.3.5 **CONTROL OF ALIGNMENT LEVEL & SURFACE REGULARITY**

**General**

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

3.3.5 **Horizontal Alignment**

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

3.3.6 **Surface Levels**

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

1. Sub-grade + 20 mm / - 25 mm
2. Sub-base
   a) Flexible Pavement + 10 mm / - 20 mm

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

3.3.7 **Surface Regularity**

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

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

For WBM Sub-base / Base Course 8 mm

3.3.8 **Rectification / Reconstruction of Defective Macadam**

Where the surface regularity of sub-grade and the various pavement courses fall outside the specified tolerances, the contractor shall be liable to rectify these at their own cost in the manner described below and to the satisfaction of the Engineer-in-Charge.

3.3.9 **Sub-Grade**

Where the surface is high, it shall be trimmed and suitably compacted. Where the surface is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and re-compacting to the required density.

3.3.10 **WBM (Sub-base / Base Course)**

Where the surface is either high or low, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material and re-compacted to the required density. In no case shall depressions be filled up with screenings or binding material.
3.4 EARTH WORK

3.4.1 EARTH WORK IN FILLING

Earth work in filling in banks shall be done in layers, each layer not exceeding 20 cm in thickness and should be properly watered to maintain the optimum moisture content. Consolidation of every 3rd layer (alternate layer) and the top-most layer should be done with power roller of minimum 80-100 KN capacity and got approved by Engineer-in-Charge before compacting the next layer. Required quantity of earth should be obtained from borrow-pits, the sites of which should necessarily be approved by Engineer-in-Charge. No borrow-pits should be dug within 4.5 m of toe of the final section of the embankment. Necessary witness should be left for the purpose of measurement of quantity of earth excavated and used in embankment. Proper profiles of embankment shall be maintained. Requisite allowance in height varying from 25 – 50 mm as directed by Engineer-in-Charge shall be left for settlement. Side slopes shall be maintained strictly as per drawings.

3.4.2 EARTH WORK IN EXCAVATION

General

All excavation shall be carried out in conformity with the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer-in-Charge. The contractor shall not excavate outside the limits of excavation. After excavation, the sides of excavated area shall be trimmed and the area contoured to minimize erosion and ponding, allowing for natural drainage to take place. Rock, when encountered in road excavation, shall be removed up to the formation level. Rocks and large boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in full formation width.

3.4.3 Slope in cutting and filling at hill side and valley side shall be as per direction of Engineer-In-Charge.

3.4.4 Disposal of Excavated Materials

All the excavated materials shall be the property of the Employer. The materials obtained from excavation shall be used for filling in the adjacent embankments as directed by the Engineer-in-Charge. All hard rocks, not intended for use shall be stacked neatly on specified land as directed by the Engineer-in-Charge.

Unsuitable and surplus materials not intended for use shall be transported and disposed clear of the site as directed by the Engineer-in-Charge.

3.5 PREPARATION OF SUB-GRADE

The optimum moisture content should always be maintained by sprinkling requisite quantity of water in order to keep the sub-grade in established condition in accordance with the direction of Engineer-in-Charge. The sub-grade must not be allowed to become dry and break-up for want of cohesion. The final sectioning should be done to proper camber, gradient and super elevation with the help of template and strings. The rate of preparation and consolidation of sub-grade includes earth work in cutting and filling up to 22.5 cm thickness, if necessary, in order to achieve the desired profile. The dressed surface should be properly consolidated by rolling with power road roller of minimum 80-100 KN capacity.

3.6 WATER BOUND MACADAM (SUB – BASE / BASE COURSE).

3.6.1 SCOPE

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

It is not desirable to lay Water Bound Macadam on an existing thin black topped surface without providing adequate drainage facility for water that would get accumulated at the interface of exiting bituminous surface and WBM.

3.6.2 MATERIALS

3.6.2.1 Coarse Aggregate: - Size of Aggregates, Sieve Analysis, Screenings of Stone, proportioning of materials, Grade, and required all applicable test before execution follow on site as per applicable Codes and approval of BSCL.

3.7 CONSTRUCTION OPERATIONS

3.7.1 Preparation of Base

The surface of the sub grade / sub-base base to receive the Water Bound Macadam course shall be prepared to the specified lines grades & camber and made free of dust and other extraneous material. Any soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base/base/surface irregularities, where predominant shall be made good by providing appropriate type of profile corrective course (leveling course)

3.7.2 Spreading Coarse Aggregates

The coarse aggregate shall be spread uniformly and evenly upon the prepared sub-grade to proper profile by using templates placed across the road about 6m apart in such quantities that the thickness of each compacted layer is not more than 100mm for Grade-I and 75 mm for Grade-II. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards.

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

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

3.7.3 Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled Power Roller of 80-100 KN capacity or Vibratory Rollers of 80-100 KN static weight. The type of roller to be used shall be approved by the Engineer-in-Charge based on trial run Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit the application of stone screenings.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired grade and camber. In no
Case shall be use of screenings be permitted to make up depressions. Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

3.7.4 Application of Screenings

After the coarse aggregate has been rolled completely, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders.

The screenings shall be applied at a slope and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical or hand brooms.

3.7.5 Sprinkling of Water and Grouting

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

3.7.6 Application of binder Material (Moorum / Stone Dust)

After the application of stone screening in accordance with Clauses 8.034 and 8.035 the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the roller if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids forms a wave ahead of the wheels of the moving roller.

3.7.7 Setting and Drying

After the final compaction of Water Bound Macadam course the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or bending materials as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set.
3.8 LIST OF APPROVED MAKE


2. Reinforcement Steel MS & TMT: M.S. bar shall conform to IS: 2062. TMT bar shall be as per IS: 1786 of grade Fe-415/500. Approved manufacturer for MS/TMT bar are SAIL/ TISCO/ ISPAT/ BISCON/ KAMDHENU or other reputed manufacturer with prior approval of the competent authority.


Note: The materials other than approved list shall also bear IS mark and/or to be approved by the Bihar Government before the use. Required tests of all Construction Materials, Design Mix, are to be conducted by the contractor before use at works and required approval by the BSCL.

3.9 SPECIFICATION FOR BITUMINOUS MACADAM

- This specification deals with the basic outline for the design, construction and controls needed while laying bituminous macadam course for Road.
- Bituminous macadam (BM) shall consist of mineral aggregate and appropriate binder, mixed in a hot mix plant and laid with a mechanized paver. It is an open graded mixture suitable for base course. It is laid in a single course or in a multiple layers on a previously prepared base. Thickness of the single layer shall be 50 mm to 100 mm.
- Since the bituminous macadam is an open-graded mixture there is a potential that it may trap water or moisture vapour within the pavement system. Therefore, providing proper drainage outlet to the BM layer should be considered to prevent moisture-induce damage to the BM and adjacent bituminous layers.
- The Specified Bitumen grade has to be tested as per Codes and specification as applied before execution of project and it has to be verified by BSCL or any other agencies as directed by Authority in Charge.
- MATERIALS: - The bitumen shall be viscosity graded paving bitumen complying with Indian Standard Specification for paving bitumen, IS: 73. The grade of bitumen to be used would depend upon the climatic conditions and the traffic. Guidelines for selection of viscosity grade of paving grade bitumen.
- Viscosity Graded (VG) bitumen and their General Applications

<table>
<thead>
<tr>
<th>Viscosity Grade (VG)</th>
<th>General Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>VG-40 (40-60 penetration)</td>
<td>Use in highly stressed areas such as those in intersections, near toll booths, and truck parking toll in lieu of old 30-40 penetration grade.</td>
</tr>
<tr>
<td>VG-30 (50-60 penetration)</td>
<td>Use of paving in most of India in lieu of old 60/70 penetration grade</td>
</tr>
<tr>
<td>VG-20 (60-80 penetration)</td>
<td>Use in cold climatic, high altitude regions of North India</td>
</tr>
<tr>
<td>VG-10 (80-10 penetration)</td>
<td>Use in spraying applications such as surface dressing and paving in very cold climatic region in lieu of old 80/10 penetration grade</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Daily Mean Air Temperature, C</th>
<th>Less than 20 C</th>
<th>20 to 30 C</th>
<th>More than 30 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than -10 C</td>
<td>VG-10</td>
<td>VG-20</td>
<td>VG-30</td>
</tr>
<tr>
<td>-10 C or lower</td>
<td>VG-10</td>
<td>VG-10</td>
<td>VG-20</td>
</tr>
</tbody>
</table>

3.9.1 COARSE AGGREGATE:
The coarse aggregate shall consist of crushed rock, crushed gravel or other gravel or other hard material retained on 2.36mm sieve. It shall be clean, hard, durable and cubical shape, free from dust and soft organic and other deleterious substances. The aggregate shall satisfy and physical requirements specified in Table

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Requirement</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness</td>
<td>Grain size analysis</td>
<td>Max. 5% passing 0.075 micron</td>
<td>IS 2386 Part I</td>
</tr>
<tr>
<td>Particle shape</td>
<td>Flakiness &amp; Elongation Index (combined)</td>
<td>Max. 40%</td>
<td>IS 2386 Part I</td>
</tr>
<tr>
<td>Strength *</td>
<td>Los Angeles Abrasion Value</td>
<td>Max. 40%</td>
<td>IS 2386 Part IV</td>
</tr>
<tr>
<td></td>
<td>Aggregate Impact Value</td>
<td>Max. 30%</td>
<td>IS 2386 Part IV</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness (Sodium or Magnesium), 5 cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Sulphate</td>
<td></td>
<td>Max. 12%</td>
<td>IS 2386 Part V</td>
</tr>
<tr>
<td>Magnesium Sulphate</td>
<td></td>
<td>Max. 18%</td>
<td>IS 2386 Part V</td>
</tr>
<tr>
<td>Water absorption</td>
<td>Water absorption</td>
<td>Max. 2%</td>
<td>IS 2386 Part V</td>
</tr>
<tr>
<td>Stripping **</td>
<td>Coating and Stripping of Bitumen Aggregate</td>
<td>Min Retained Coating 95%</td>
<td>IS 6241</td>
</tr>
</tbody>
</table>

Note:
* The coarse aggregate may satisfy either of the two strength tests.
** If the coarse aggregate fails this test, 2% hydrated lime shall be used in the mix.

- Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces resulting from crushing operation.

3.9.2 FINE AGGREGATE:
Fine aggregate shall consist of crushed or naturally occurring mineral material, or a combination of two, passing 2.36 mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, and free from dust and soft organic and other deleterious substances. The amount of rounded, natural sand in the total fine aggregate shall be limited to 10% if the BM is used within 100 mm from the road surface and to 50% if the BM is used more than 100 mm below the road surface.

3.9.3 AGGREGATE GRADING AND BITUMEN CONTENT:
The combined grading of the coarse aggregate and fine aggregate, when tested in accordance with IS 2386 Part I, wet sieving method, shall conform to limits. The type and quantity of bitumen and appropriate thickness is also given in Table

<table>
<thead>
<tr>
<th>Grading</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal maximum aggregate size*</td>
<td>40 mm</td>
<td>19 mm</td>
</tr>
<tr>
<td>Layer thickness</td>
<td>80-100 mm</td>
<td>50-75 mm</td>
</tr>
<tr>
<td>IS Sieve size (mm)</td>
<td></td>
<td>ve % by weight of total aggregate passing</td>
</tr>
</tbody>
</table>
### 3.9.4 CONSTRUCTION

**Cleaning of the surface:** The surface shall be cleaned of all loose extraneous matter by means of mechanical broom, high-pressure air jet received from a compressor or any other approved equipment / method.

**Prime Coat:** Prime Coat shall be as per IRC:16-2007 “Standard Specification and Code of Practice for Prime and Tack Coat”.

**Tack Coat:** Tack Coat shall be as per IRC: 16-2007 “Standard Specification and Code of Practice for Prime and Tack Coat”.

### 3.9.5 MIXING

Bituminous macadam shall be prepared in a hot mix plant (HMP) of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregate. The temperature range of bitumen and aggregate at the time of mixing for different grade and type of bitumen is given in as specified in the relevant codes. The difference in the temperature of aggregate and bitumen shall not exceed 15°C. In order to ensure uniform quality of mix the plan shall be calibrated from time to time.

### 3.9.6 TRANSPORTATION

Bituminous material shall be transported in clean insulated covered vehicles. An asphalt release agent such as soap or limewater, which does not adversely affect the bituminous mix, may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

### 3.9.7 LAYING

**Weather and seasonal limitations:**

Bituminous macadam shall not be laid:

a) in presence of standing water on the surface,

b) when rain in imminent and during rains, fog or dust storm,

c) when the base /binder course is damp.
d) when the air temperature on the surface on which it is to be laid is less than 10°C,
(e) When the wind speed at any temperature exceed the 40 km/h at 2-meter height.

3.10 Preparation of the base: Base shall be prepared by carrying out all or some of the of the operations refer to code or depending upon the site conditions.

**Spreading:** Except in areas where paver cannot have access, bituminous mixture shall be spread, levelled and tamped by self-propelled hydrostatic paver finisher preferably equipped with sensor. As soon as possible after arrival at site the asphalt mix shall be supplied continuously to the paver and laid without delay. The travel rate of paver and the method of operation shall be adjusted to ensure even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation.

Restricted areas (such as confined space, footways, irregular shape and varying thickness, approaches to expansion joints etc.) where paver cannot be used, the material shall be spread, raked and levelled with suitable hand tool by trained staff.

When laying bituminous macadam near expansion joint, the machine laying shall be stopped about 300 mm short of joint. The remainder of the pavement up to the joint and the corresponding area beyond it shall be laid manually. The laying of bituminous macadam shall be completed before the mix temperature reaches the values specified in the Table.

**Table Mixing, Laying and Rolling Temperatures for Bituminous Macadam (Degree Celsius)**

<table>
<thead>
<tr>
<th>Bitumen Viscosity Grade</th>
<th>Bitumen Temperature</th>
<th>Aggregate Temperature</th>
<th>Mixed Material Temperature</th>
<th>Laying Temperature</th>
<th>*Rolling Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>VG-40</td>
<td>160-170</td>
<td>160-175</td>
<td>160-170</td>
<td>150 Min</td>
<td>100 Min</td>
</tr>
<tr>
<td>VG-30</td>
<td>150-165</td>
<td>150-170</td>
<td>150-165</td>
<td>140 Min</td>
<td>90 Min</td>
</tr>
<tr>
<td>VG-20</td>
<td>145-165</td>
<td>145-170</td>
<td>145-165</td>
<td>135 Min</td>
<td>85 Min</td>
</tr>
<tr>
<td>VG-10</td>
<td>140-160</td>
<td>140-165</td>
<td>140-160</td>
<td>130 Min</td>
<td>80 Min</td>
</tr>
</tbody>
</table>

* Rolling must be completed before the mat cools to these minimum temperatures

Bituminous material, with temperature greater than 145°C shall not be laid or deposited on bridge deck, waterproofing system unless precautions against the heat damage have been taken.

3.10.1 **Compaction**

Compaction shall commence as soon as possible after laying and shall be completed before the temperature falls below the range specified in Table 4. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, the rolling shall commence at the edge and progress towards the centre longitudinally except at sections with unidirectional camber, where it shall progress from lower edge to upper edge parallel to centreline of the pavement.

All deficiencies in the surface after laying shall be made good by the attendant behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with an 8 to 10 tonnes dead weight or vibratory steel wheel roller. The intermediate rolling shall be done with 8 to 10 tonnes dead weight or vibratory roller with an amplitude 0.3mm to 0.8 mm and frequency between 30 to 50 hz. or with a pneumatic roller of 12 to 15 tones, with a tire pressure of at least 0.56 M Pa. The finished rolling shall be done with 6 to 8 tonnes smooth wheel roller. Rolling shall continue until at least 98% of the lab density obtained in the Marshall mould made using approved gradation and bitumen content is achieved. The number of roller passes should be established on a control strip prior to starting the main work. The mixtures with a maximum aggregate size upto 25 mm shall be compacted in a 4-inch Marshall mould with 50 blows on each side. The mixtures with a maximum aggregate size of more than 25 mm shall be
compacted in a 6-inch Marshall mould with 75 blows on each side in accordance with the Asphalt Institute MS-2 (Sixth Edition). For smaller works where no density is specified rolling shall continue until there is no further movement underroller.

The bitumen macadam shall be rolled in the longitudinal direction with the roller as close to the pave as possible. The overlap on successive passes should be at least one-third of the width of the rear roll or in the case of pneumatic wheeled rollers, at least the nominal width of 300mm. The roller should move at a speed of no more than 5 km/hour. The roller shall not be permitted to stand on pavement, which has not been fully compacted. All precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign material on the pavement. The wheel of the rollers shall be kept moist with the water or spray system provided with the machine to prevent the mixture from adhering to the wheels. Minimum moisture to prevent adhesion between wheels and mixture shall be used and surplus water shall not be allowed to stand on the partially completed pavement.

3.10.2 JOINTS

Where joints are made in bitumen macadam, the material shall be fully compacted and joint made flush in one of the following ways:

a) All joints shall be cut vertical to the full thickness of the previously laid mix. All loosened material shall be discarded and the vertical face be coated with any viscosity grade bitumen, or cold applied emulsified bitumen. While spreading the material along the joint the material spread shall overlap 25 mm to 30 mm on the previously laid mix beyond the vertical face of the joint. The thickness of the loose overlap material should be approximately a quarter more than the final compacted thickness. The overlapped mix should be bumped back with a lute just across the joint so that the excess material on the hot side can be pressed to obtain a high joint density.

b) By using two or more pavers in echelon, where this is practicable and in sufficient proximity for adjacent width to be fully compacted by continuous rolling.

c) By heating the joints with an approved infrared joint heater when the adjacent width is being laid, but without cutting back or coating with the binder. The heater shall raise the temperature of the full depth of material, to minimum rolling temperature for a width of 75 mm. The temperature shall not exceed the maximum allowed temperature. For transverse joints method a) above can apply. In multi-layer construction the joint in one layer shall offset the joint in the underneath layer by about 150mm.

3.10.3 ARRANGEMENT FOR TRAFFIC

It shall be ensured that the bituminous macadam surface is covered with the next pavement coarse within a maximum of 48 hours until which no traffic shall be applied. In case of delay, the course may be covered with the seal coat in accordance with the appropriate IRC standard prior to opening to traffic.

3.10.4 CONTROLS

3.10.4.1 SURFACE FINISH

1.1.1 The levels of the bituminous macadam shall not vary from those calculated with reference to longitudinal and cross profile of the roads as per the Contract beyond 6 mm over 3 m length when tested with a template and straightedge.

1.1.2 For checking the compliance with the above requirement measurements of the surface level shall be taken on a grid of points spaced 6.25 m along the length and 0.5 m from the edges and at the centre of the pavement. The compliance shall be deemed to have been met for the final surface only if the tolerance given above is satisfied for any point on the surface.

1.1.3 In case where surface level fall outside the specified tolerance, the Contractor shall be liable to rectify these by replacing the full depth of layer. In all cases of replacement the area treated shall not be less than 5 m length and not less than 4.5 m in width.

3.10.4.2 SURFACE EVENNESS
1.1.4 The measurement and checking of surface evenness shall be done by a 3-m straight edge in accordance with the procedure in IRC:SP16-2004.

1.1.5 The maximum permissible surface evenness using longitudinal profile 3-m straight edge shall be 6 mm. The maximum permissible evenness using transverse profile camber shall be 4 mm.

1.1.6 The maximum permissible frequency of surface evenness in 300 m length in longitudinal profile shall be as per Table 5.

<table>
<thead>
<tr>
<th>Table Maximum Permissible Frequency of Evenness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of layer</strong></td>
</tr>
<tr>
<td>Bituminous Macadam</td>
</tr>
</tbody>
</table>

Where the surface evenness falls outside the tolerance, the Contractor shall be liable to rectify these in the manner described below:

When surface is low the deficiency shall be corrected by adding fresh materials after applying tack coat if needed and re-compacting to specification. When the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to the specification.

### 3.11 QUALITY CONTROL DURING CONSTRUCTION

The material supplied and the work shall conform to the specifications prescribed in the preceding Clauses. To ensure the quality the material and the works shall be subjected to tests described hereunder. The tests and minimum frequency for each test

#### 3.11.1 ACCEPTANCE CRITERIA

The acceptance criteria for test on density (N=3) shall be subjected to the condition that the mean value of N samples is not less than the specified value plus $[1.65 \times \frac{1.65}{\sqrt{\text{No of samples}}}] \times$ standard deviation.

<table>
<thead>
<tr>
<th>Sl</th>
<th>Test</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality of bituminous binder</td>
<td>As per number of samples and tests per lot specified in IS 73</td>
</tr>
<tr>
<td>2</td>
<td>Aggregate impact value/Los Angles Abrasion value</td>
<td>One test per 50 m$^3$ of the aggregate</td>
</tr>
<tr>
<td>3</td>
<td>Flakiness &amp; Elongation Index</td>
<td>One test per 50 m$^3$ of the aggregate</td>
</tr>
<tr>
<td>4</td>
<td>Soundness test (Sodium or Magnesium Sulphate test)</td>
<td>1 test for each method for each source and when ever there is change in the quality of aggregate</td>
</tr>
<tr>
<td>5</td>
<td>Water absorption aggregate</td>
<td>1 test for each source and when ever there is change in the quality of aggregate</td>
</tr>
<tr>
<td>6</td>
<td>Percent of fractured faces</td>
<td>When crushed gravel is used as aggregate one test per 50m$^3$ of aggregate</td>
</tr>
<tr>
<td>7</td>
<td>Mix grading</td>
<td>One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant</td>
</tr>
<tr>
<td>8</td>
<td>Stripping (IS:6241)</td>
<td>1 test for each mix design and whenever there is change in the source or quality of coarse aggregate</td>
</tr>
<tr>
<td>9</td>
<td>Temperature of binder in boiler, aggregate in dryer and mix at</td>
<td>At regular interval</td>
</tr>
</tbody>
</table>
3.11.2 Features of Hot Mix Plants & Pavers for Bituminous Construction:

Hot mix plant shall be of suitable capacity of batch mix type. Total system for crushing of stone aggregates and feeding of aggregate fractions in required proportions to achieve the desired mix, must be capable of meeting the overall specification requirements under stringent quality control. The plant shall have the following essential features:

**General.**

(a) The plant shall have a coordinated set of essential units capable of producing uniform mix as per the job mix formula.

(b) Cold aggregate feed system with minimum 4 bins having belt conveyer arrangement for initial proportioning of aggregates from each bin in the required quantities. In order to have free flow of fines from the bin, bin should be fitted with vibrator to intermittently shake it.

(c) Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyer for measuring the flow of aggregates.

(d) Dryer unit with the burner capable of heating the aggregate to the required temperature without any visible un-burnt fuel or carbon reside on the aggregate and reducing the moisture content of the aggregate to the specified minimum.

(e) The plan shall be fitted with suitable type of thermometric instruments at appropriate places so as to indicate or record/register the temperature of heated aggregate, bitumen and mix.

(f) Bitumen supply unit capable of heating, measuring/metering and spraying of bitumen at specific temperature with automatic synchronization of bitumen and aggregate feed in the required proportion.

(g) A filler system suitable to receive bagged or bulk supply of filler material and its incorporation to the mix in the correct quantity wherever required.

(h) A suitable built-in dust control system for the dryer to contain /recycle permissible fines into the mix. It should be capable of preventing the exhaust of fine dust into atmosphere for environmental control wherever so specified by the Engineer.

(i) The plant should have centralized control panel/cabin capable of presetting, controlling/synchronizing all operations starting from feeding of cold aggregates to the discharge of the hot mix to ensure proper quality of mix. It should have indicators for any malfunctioning in the operation.

(j) Every hot mix plant should be equipped with siren or horn so that the operator may use the same before starting the plant every time in the interest of safety of staff.

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**For a Batch Type Plant.**

(i) Gradation control unit having minimum four decks vibratory screens for accurate sizing of hot aggregate and storing them in separate bins. This unit should be fully covered to reduce the maintenance of cost and for better environmental condition.

(ii) Proper arrangement for accurate weighing of each size of hot aggregate from the control panel before mixing.

(iii) Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of the mineral aggregate with binder.

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**C – For Continuous Type Plant.**

(i) Gradation control unit having vibratory screens for accurate sizing of hot aggregate and storing them in

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Binder content</td>
<td>One set for each 400 tonnes of mix subject to minimum of two tests per day per plant</td>
</tr>
<tr>
<td>11</td>
<td>Rate of spread of mix material</td>
<td>At regular interval</td>
</tr>
<tr>
<td>12</td>
<td>Density of compacted layer</td>
<td>One test per 250m² area.</td>
</tr>
</tbody>
</table>
separate bins. This unit should be fully covered to reduce the maintenance cost and for better environmental condition.

(ii) There should be appropriate arrangement for regulating and volumetric condition of the flow of hot aggregate from each bin to achieve the required proportioning.

(iii) Paddle mixer unit shall be capable of producing a homogenous mix with uniform coating of all particles of the mineral aggregate with binder.

**D – For Drum Mix Plant.**

(i) It is pre-requisite that only properly screened and graded materials are fed to the bins. If required, a vibratory screening unit shall be installed at the plant site to ensure the same. A primary 4-deck vibratory screening unit shall be installed before the multiple bin cold fed system for screening the aggregates and grading the same.

(ii) Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor in the main conveyer for measuring the flow of aggregate.

(iii) There should be arrangement to measure moisture content of the aggregate(s) so that moisture correction may be applied for working out requirements of binder and filler.

**Paver Finisher.**

(a) Loading hoppers and suitable distribution mechanism.

(b) All drives having hydrostatic drive/control.

(c) The machine shall have a hydraulically extendable screed for appropriate with requirement.

(d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.

(e) The pave shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

(f) The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within the specified tolerances.

(g) The screed shall have an internal heating arrangement.

(h) The paver shall be capable of laying either 2.5 to 4.0 m width or 4.0 to 7.0 m width as stipulated in the Contract.

(i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operations.

**Roadside Safety Barriers**

The following types of Road Safety Barriers will be provided on the Project Road Sections:

a) Semi-rigid type such as “W” Beam Type Steel Barriers will be provided on the high Embankment Section.

b) Rigid Type such as Concrete Crash Barriers will be provided on the bridges.
**Road Embankment**

a) Where the bottom of existing Subgrade is 0.60 m above the HFL, the existing height of embankment can be retained.

b) Where the bottom of existing Subgrade is less than 0.60 m from the HFL, the existing height of the embankment should be raised to ensure a minimum 1.0 m clearance of the bottom of Subgrade from HFL.

c) Where road is passing through an area not affected by floods and is free from any drainage problem/ water ponding/ overtopping situations with water table being quite deep, to the extent that Subgrade is not likely to be affected by the capillary saturation, then the minimum clearance of 0.6 m of the bottom of Subgrade from existing ground level is desirable.

d) For the new road, the bottom of Subgrade will be 1.0 m above the HFL.

e) High embankments (height 6 m or more) in all soils will be designed for stability.

f) On High embankments, the protection measures will consist of the following:
   - Vegetative Cover
   - Kerb Channels
   - Chute
   - Stone Pitching/Cement Concrete Block Pitching
   - In case of cut section slope stability measures such as Pitching, breast walls, etc. will be provided.

g) The Side Slopes of the cuttings will be provided as per the nature of soil encountered.

h) Side slopes should not be steeper than 2H: 1V unless soil is retained by suitable soil retaining structures.

**Road Drainage**

The general design guidelines for the Road Drainage will be as under:

a) The design of drains will be carried out in accordance with IRC: SP: 42 and IRC:SP:50

b) For surface drainage, the estimation of design discharge and the design of drain Sections will be as per the procedure given in IRC:SP:42.

c) The longitudinal slope of the drain will not be less than 0.5 % for lined drains and 1.0 % for unlined drains.

d) The side slopes of the unlined drains will not be steeper than 2H: 1V.

e) The drains on the paved areas will be provided with CC linings.

f) The drainage of high embankment will be provided with the provision of kerb channel and CC lined chutes.

g) The chute drains and drains at toe of the embankment will be of plain cement concrete (M-15 grade).

h) Necessary sub-surface drains will be provided as required.
### Deciduous Trees

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of tree</th>
<th>Location</th>
<th>Planting Height</th>
<th>Average full grown Height</th>
<th>Tree Type</th>
<th>Reference image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lagestromia speciosa</td>
<td>Road median</td>
<td>1.5m</td>
<td>15-20m ht</td>
<td>Type B1, DECIDUOUS TREES</td>
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</tr>
<tr>
<td>2</td>
<td>Pongamia Glabra</td>
<td>Road edge, parking area, green buffer</td>
<td>1.5m</td>
<td>15-20m ht</td>
<td>Type B2, DECIDUOUS TREES</td>
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</tr>
<tr>
<td>3</td>
<td>Peltopherum Africana</td>
<td>Road edge, parking area, green buffer</td>
<td>1.5m</td>
<td>20-25m ht</td>
<td>Type B3, DECIDUOUS TREES</td>
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</tr>
<tr>
<td>4</td>
<td>Terminalia Mantaly</td>
<td>Footpath, Median</td>
<td>1.5m</td>
<td>20-25m ht</td>
<td>Type B4, DECIDUOUS TREES</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ailanthus Excelsa</td>
<td>Road median</td>
<td>1.5m</td>
<td>15-20m ht</td>
<td>Type B5, DECIDUOUS TREES</td>
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<tr>
<td></td>
<td></td>
<td>Road edge, parking area, green buffer</td>
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<td>6</td>
<td>Delonix Regia</td>
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<td>20-25m ht</td>
<td>Type B6, DECIDUOUS TREES</td>
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<tr>
<td>7</td>
<td>Schleichera Oleosa</td>
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<td>50-60m ht</td>
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**Evergreen Trees**

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<tr>
<th></th>
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<th>Road edge, parking area</th>
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<tbody>
<tr>
<td>1</td>
<td>Cassia Siamia</td>
<td>1.5m</td>
<td>15-20m ht</td>
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<tr>
<td>2</td>
<td>Alistoni Scholaris</td>
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<td>4</td>
<td>Azadirachata indica (Neem Tree)</td>
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### Shrubs

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<tr>
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<th>Common Name</th>
<th>Botanical Name</th>
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<tr>
<td>1</td>
<td>Acalypha red</td>
<td>Acalypha hispida</td>
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<td>Acalypha wilkensiana</td>
<td>Acalypha wilkensiana</td>
<td>Road median, Road edge, Footpath</td>
<td>C2</td>
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<tr>
<td>3</td>
<td>Lantana blue</td>
<td>Lantana sellowiana</td>
<td>Road median, Road edge, Footpath</td>
<td>C3</td>
</tr>
<tr>
<td>4</td>
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<td>Ficus panda</td>
<td>Road Median</td>
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<td>No.</td>
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<td>Ground cover species</td>
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<td>Code</td>
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<td>Murraya exotica</td>
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<td>Iresene herbstii</td>
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<tr>
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<td>Alternenthra red</td>
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<td>Dianella</td>
<td>Dianella tasmanica</td>
<td>Road median, Road edge, Footpath</td>
<td>D3</td>
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</table>

**Ground covers**
3.13 Design Concept

The proposed section is indicative & it may vary as per CBR Value and Design of the section. **CBR Value**

The Above sectional Diagram is only indicative and for tendering Purpose this value may vary as per approved design and Drawing
The project preparation for underground cable project in project area has considered RCC Duct and DWC HDPE Pipe types of cable duct configuration for laying of underground cables as shown in Figure.

The cumulative length of cable, trenches and Pipe ducts under this project is 12 km, the Item wise break-up is given in Table below
Cross section of model road with footpath separated by planter. Model road developed with continuous footpath and planter. Footpath with cycle track on sides separated by planter.
Drawing Section
BSCL – RFP – Smart Road Network
Road Cross Section of 17 Road With Existing Pic

1) Road Adjoining to Lajpat Park (length – 235 meters, RoW – about 8 to 10 meters)

Property

6.00 Carriageway

2.00 Paved Area (varies)

Property

8.00

2) Zilla School Road (length – 440 meters, RoW – about 12 meters)

Property

2.00 Footpath (varies)

1.00 Buffer (varies)

6.00 Carriageway

1.00 Buffer (varies)

2.00 Footpath (varies)

Property
3) Road behind Lajpat Park (length —400 meters, RoW — 28 to 32 meters)

4) Nayabazar Chowk to Kotwalli Chowk (length —500m, RoW — about 11 meters)
5) Khalifabag to Shankar Talkies Chowk (length –830m, RoW – about 10 to 12m)

6) Kachehri Chowk to Manali Chowk (length –540 meters, RoW – about 17.5 meters)
7) Radharani Sinha Road (length – 750 meters, RoW – about 14 meters)

8) Adampur Chowk to Hotel Galaxy (length – 840 meters, RoW 8.5 to 18 m)
8a) Hotel Galaxy to Manali Chowk (length -260 meters, RoW about 13 m)

9) Nayabazar to Shankar Talkies Chowk (length -760 meter, RoW - 10 to 12 meters)
10) Shankar Talkies to Adampur Chowk (length – 700 meter, RoW – 10 to 12 meters)

11) Adampur Chowk to Manali Chowk (length – 650m, RoW – 10 to 17 meters)
12) Manali Chowk to Tilkamanjhi Chowk (length – 950 m, RoW – 18 to 23 meters)
13. Ghantaghar to Kacheri Chowk-III (length - 205 m, RoW - 20 meters)

14. Kotwali to Khalifabagh Chowk (length - 470 m, RoW - 13 meters)
15. Khalifabagh Chowk to Ghantaghar-I (length –300 m, RoW – 13 meters)

16. Khalifabagh Chowk to Ghantaghar-II (length –160 m, RoW – 17 meters)
17. Khalifabagh Chowk to Ghantaghar-III (length – 50 m, RoW – 20 meters)

Total Road Length: 50m

18. Ghantaghar to Kacheri Chowk-I (length – 265 m, RoW – 19 meters)

Total Road Length: 265m
19. Ghantaghar to Kacheri Chowk-II (length –190 m, RoW – 13 meters)

![Diagram of Ghantaghar to Kacheri Chowk-II]

20. Ghantaghar to Kacheri Chowk-IV (length –120 m, RoW – 17 meters)

![Diagram of Ghantaghar to Kacheri Chowk-IV]
21. Kacheri Chowk to Tilkamanjhi Chowk (length – 1200 m, RoW – 20 meters)
Cross Duct