

**Manual**  
**for**  
**Specifications and Standards**  
**for**  
**Four Laning**  
**of**  
**National Highways**  
**through**  
**Public Private Partnership**

**Government of India**  
**Department of Road Transport & Highways**  
**Ministry of Shipping, Road Transport & Highways**

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## **MANUAL FOR SPECIFICATIONS AND STANDARDS**

### **FOR FOUR LANING OF NATIONAL HIGHWAYS**

**[See Clause 2.1(a) of Concession Agreement]**

#### **SECTION – 1: GENERAL**

**1.1** This Manual, forming part of Annex-I to Schedule -D of the Concession Agreement (refer Article 2.1(a) of the Concession Agreement), sets forth the Specifications and Standards to be followed for development of the Project Highway as described in Schedule B and construction of project facilities as described in Schedule C on the project site as described in Schedule A. The concessionaire shall make himself fully aware of the Project Site with regard to the existing features of the site (such as location, layout, geometry, right of way, intersecting roads, existing accesses , etc) including the constraints at the site (such as limitation of right of way, existence of adjoining property, existing structures, plantation, utilities, etc), plan, design and construct the Project Highway comprising its various features (such as four-laning, service roads, underpasses, overpasses, grade separators, widening/reconstruction of bridges, etc) and the project facilities(such as toll plazas, rest areas, lighting, landscaping, wayside amenities, etc) meeting the standards, specifications and quality specified in this Manual.

**1.2** Any project report and other information provided by the Authority shall be used by the concessionaire only for reference purpose and for carrying out further investigations. The concessionaire shall be solely responsible for undertaking all necessary surveys, investigations and other due diligence and shall have no claim against Authority for any loss, damage, risk, costs, liabilities or obligations arising out of or in relation to the project report and other information provided by the Authority.

**1.3 General consideration of planning, design and construction**

The Project Highway shall be planned as a “partially controlled access highway” where access to the highway shall be provided only at pre-determined locations. In doing so, the concessionaire shall take measures to overcome the physical and operational constraints and plan, design and construct the Project Highway using appropriate methods, management techniques and technologies. General consideration shall, without being limited to, be as follows:-

**(a) The constraints**

The physical constraints in the existing highway are in the form of limitation of right of way, un-regulated access, inadequate service roads and underpasses, numerous at-grade

junctions, lack of physical separation between local and through traffic etc. The operational constraints arise out of the necessity or possibility of closing a portion of the road for construction and/or diverting the traffic to temporary diversions, thereby reducing the capacity and safety of the existing highway. The solutions evolved by the concessionaire shall be such that these operational constraints are overcome through appropriate planning, design and construction method, techniques and technologies and by adopting suitable traffic management measures.

(b) **Safety of design**

All designs shall be safe to ensure that the Project Highway or any part thereof (for example embankment, pavement, retaining structures, bridges, culverts, etc) does not collapse nor its serviceability/performance (for example settlement, roughness, undulations, deflections, etc) deteriorates below acceptable level as prescribed in Schedule K of the Concession Agreement.

(c) **Durability**

The Project Highway shall not only be safe but also durable. This would mean that the deteriorating effects of climate and environment (for example wetting and drying, freezing and thawing, if applicable, temperature differences, aggressive environment leading to corrosion etc) shall be duly considered in design and construction to make the Project Highway durable.

(d) **Mitigating disruptive effects of construction**

The planning, design and construction of the highway shall be such that the construction of Project Highway does not disrupt the lives and business activities of the people living close to the highway.

## 1.4 Acceptable Standards

1.4.1 The concessionaire shall follow latest version, issued at least 60 days before the last date of bid submission, of following Indian Standards, Specifications, Codes of Practice, Guidelines, etc for planning and design in the following order of priority:

- i) Technical circulars issued by MOSRTH and published by Indian Roads Congress/available on MOSRTH website in so far as they relate to design and construction.
- ii) Specifications for Road and Bridge Works issued by the Ministry of Shipping, Road Transport & Highways hereinafter referred as MOSRTH or Ministry's Specifications.
- iii) Indian Roads Congress (IRC) Codes and Standards; as per *Appendix D-1*.
- iv) Bureau of Indian Standards (BIS) in the absence of any specific provision/issue in the aforesaid Codes and Specifications as per *Appendix D-1*.

1.4.2 Wherever Indian standards are either not available or if available but not adequate, the concessionaire shall be permitted to adopt international standards and specifications as followed in United States of America, United Kingdom, European Union, Japan, Germany or Australia.

The concessionaire shall submit proposal in this regard to the Independent Engineer (IE - see Article 23 of Concession Agreement) for review and comments.

- 1.4.3 All items of building works shall conform to Central Public Works Department (CPWD) specifications and norms stipulated in the National Building Code (NBC) as amended from time to time. In case of conflict between CPWD and NBC norms, NBC norms shall prevail. To the extent specific provisions for building works are provided in IRC/MOSRTH specifications, the same shall prevail over the CPWD and NBC provisions. For this purpose, building works shall also deemed to include roadside facilities, landscape elements and/or any other works incidental to the building works. All items of lighting works of the building shall conform to CPWD Specifications for Electric Works (Part I and II).
- 1.4.4 The concessionaire shall also be permitted to use proprietary or patented designs subject to the condition that the concessionaire shall be solely responsible for their performance and durability.

## **1.5 Overall Scheme**

The concessionaire shall prepare and submit, in accordance with provisions of this Manual and in compliance with Article 12.1 of the Concession Agreement detailed design, construction methodology, quality assurance procedure and operation of the Project Highway and project facilities to the IE for his review. If, on review, the scheme is not found to conform to the provisions of this Manual, the concessionaires shall modify the scheme to make it conform to the provisions of the Manual. Increase in cost due to any modification suggested by the IE shall not be a reason for the concessionaire objecting to or contesting these modifications. The concessionaire shall proceed with the implementation of the project as per the scheme so modified.

## **1.6 Clarificatory role of Manual**

Where the provisions of the Concession Agreement are general in nature, the provisions of this Manual shall be deemed to clarify or amplify these provisions.

## **1.7 Drawings to have comprehensive meaning**

“Drawings” referred to in Article 12.3 of the Concession Agreement shall not have a restrictive meaning but shall include charts, sketches, explanatory notes and documents explaining the design assumptions, designs, construction methodologies, etc which can demonstrate that “Drawings” conform to the provisions of this Manual. All drawings specifically referred to in this Manual shall form part of Schedule H of the Concession Agreement.

## **1.8 Interpretation of the Manual**

- (1) In case of any conflict between provisions of this Manual and IRC codes or Ministry’s specifications, provisions of this Manual shall prevail.

(2) Decision with regard to conformity or otherwise of the provisions of this Manual shall rest with the IE.

- 1.9** The concessionaire shall keep the existing utilities in continuous satisfactory use as per Article 11 of the Concession Agreement. Wherever existing utilities are to be shifted and/or new utilities are to be provided during the concession period, the same shall be accommodated within the utility corridor of 2.0 m width identified at the edges of the ROW subject to approval by the Authority.
- 1.10** This Manual is applicable for four laning of the Project Highway. However, some sections of the Project Highway, as specified in schedule B, are required to be widened to six lanes, which should not be construed to six laning of the Project Highway. For six laning of such sections, design shall be finalized based on review & comments of IE.
- 1.11** The terms ‘Ministry of Surface Transport’, ‘Ministry of Road Transport and Highways’ and ‘Ministry of Shipping, Road Transport & Highways’ or any successor or substitute thereof shall be considered as synonymous.
- 1.12** The terms ‘Inspector’ and ‘Engineer’ used in MOSRTH Specification shall be deemed to be substituted by the term ‘Independent Engineer’; to the extent its duties and functions are consistent with the provisions under ‘ARTICLE 23’ of the Concession Agreement and this Manual. For avoidance of doubt, it is clarified that the role of ‘Independent Engineer’ is to ‘review and comment’, whereas approval will be accorded by the ‘Concessionaire’/ ‘Engineer’ appointed by the ‘Concessionaire’ taking into account comments of ‘Independent Engineer’.

## **SECTION – 2: PLANNING THE PROJECT HIGHWAY**

### **2.1 GENERAL**

The concessionaire shall plan for capacity augmentation and design the Project Highway in a manner that will ensure safe operation of the Project Highway as a “partially controlled access highway”. The concept of providing forgiving highway to the road users shall be kept in mind while planning and designing the Project Highway. For safe operation, high speed traffic and slow traffic/local traffic shall be separated by constructing parallel service roads wherever required and/or specified under Schedule B.

### **2.2 Operational Objectives of the Project Highway**

The Project Highway will be operated as a partially controlled access highway so as to substantially improve the safety and operational efficiency of the existing highway. The partial control for the Project Highway shall be achieved through measures such as service road with physical separation for local traffic, intersections, acceleration/deceleration lanes, vehicular and pedestrian underpasses, median openings with shelter lane as described in succeeding paragraphs.

#### **2.2.1 Service road for separation of local traffic:**

Local traffic in built up areas as specified in Schedule B of the Concession Agreement or identified subsequently shall be separated with provision of service roads. Built up area shall mean all sections of the Project Highway, which are situated within the limits of municipal town(s) and shall also include those sections having continuous length of 200 m or more in non-municipal areas where dwellings / shops have been built on one or both sides of the Project Highway on at least 50 percent of the total length of each such section.

The service roads shall be provided with end treatment so that the local traffic is able to diverge from and merge to the highway in a safe & efficient manner. Two common situations to be dealt are as below:

(i) Service road not terminating at intersection:

Acceleration / deceleration lane shall be provided for exit/entry of traffic from/to the Project Highway as the case may be. For allowing two-way traffic on service road, a separate channeliser shall be provided for U-turns at the end(s) of service road. Suggestive layouts are given in fig. 2.1(A) & 2.1(B).

(ii) Service road terminating at intersection:

The right turning traffic from the service road wanting to merge/cross the traffic on highway shall be through a priority intersection between the service road and the cross road with give way signs and markings. The left turning local traffic from the service road shall join the cross road through acceleration lane. The acceleration and the give way lane shall be separated through a channeliser. A suggestive layout is given in fig. 2.2.

### 2.2.2 **Intersection:**

(i) Grade separated intersections:

Grade separated intersections shall be provided at all intersections of Project Highway with National Highways and State Highways. Grade separated intersections shall also be provided at all other intersections of Project Highway with other category roads as per warrants specified in IRC 92 and at locations specified in schedule B.

(ii) At grade intersection;

All intersections other than those covered in (i) above shall be designed as at-grade intersections in following manner:

- a) All merging and diverging movements to / from the Project Highway shall be either through service road with end treatment or acceleration and deceleration lanes except for the traffic allowed to cross Project Highway at predetermined locations.
- b) If the road is crossing the Project Highway, the four arm at-grade intersection shall be designed in accordance with MOSRTH standard drawings. In case the standard drawing has not provided the right turning lane, the same would be provided to accommodate the peak hour right turning traffic.
- c) If the road meets the Project Highway at T- intersection, this would be designed as “left in left out”. The right turnings from such cross roads shall be permissible at the next intersection or median opening.

### 2.2.3 **Access from private property:**

Ingress/egress to/from commercial and industrial properties including retail outlets shall be provided through acceleration/deceleration lane in accordance with MOSRTH guidelines.

### 2.2.4 **Pedestrian/cattle underpasses:**

In urban / built up areas, pedestrian / cattle crossing facility shall be provided such that pedestrians do not have to walk more than 0.5 km to reach the underpass for crossing the Project Highway. In case the existing slab culverts and minor bridges with span length equal to or more than 5.0 m allow a vertical clearance of more than 2m, these can also be used for pedestrian and cattle crossings by providing necessary flooring, provided the culverts/minor bridges do not cater to perennial flow. In rural stretches, under passes shall be provided at the locations of existing crossing points.

### 2.2.5 **Median openings:**

Median openings shall be provided at four or more arm intersection and at other locations to facilitate the U-turn for vehicles and not for leading directly to any cross road. The average spacing of median openings shall be around 2 kms. If a number of roads are meeting the Project

Highway, then they would be joined together through a service road and an at-grade ‘T’ intersection would be provided such that the spacing of 2 kms for median openings is maintained.

#### 2.2.6 **Traffic signs and road markings for guidance to user:**

- (i) The Project Highway shall be provided with elaborate system of traffic signs and markings. The traffic signs for various situations/location would be in accordance with IRC 67 in terms of location, configuration and colour scheme.
- (ii) Pavement marking shall also be carefully planned depending upon the requirement for each location and shall conform to IRC-35. The Project Highway shall incorporate all such safety features such as elaborate system of signs and markings, cat’s eyes, delineators, hazard markers, safety barriers at hazardous locations, pedestrian guardrails so that the Project Highway operates as a “Forgiving Highway”.

### 2.3 **User Facilities:**

#### 2.3.1 **Rest Areas:**

The Project Highway shall have rest areas as specified in Schedule C and be provided with facilities for the users so as to provide safe and comfortable journey. For this purpose, rest areas shall be planned with composite facilities for long distance travelers through personal cars, buses and goods vehicles. Due consideration shall be given to the requirements of different class of road users including truck drivers.

Wherever some eateries or informal rest area exist and cannot be relocated or accommodated within the planned rest area, they would be provided with safe entry and exit with signs and markings.

#### 2.3.2 **Bus-Bays:**

If the Project Highway has regular movement of buses either through Government or through private sector, bus bays shall be planned, designed and provided for the convenience of bus commuters and safe and unimpeded travel on Project Highway.

#### 2.3.3 **Advanced Traffic Management Systems (ATMS):**

The Project Highway shall be provided with ATMS so as to have enhanced safety for the users / travellers, collect information for the traffic operations, provide information to the users on real time basis for the traffic flow conditions and incidents ahead. For this purpose, there would be a control centre and outdoor equipment connected through a transmission medium.

#### 2.3.4 **Highway Patrol:**

The Project Highway shall be provided with highway patrol unit(s) for round the clock patrolling so as to provide assistance to the users in case of any need, monitor the travel conditions to provide information to the control section and to undertake immediate measures for managing the traffic flow in case of any incident.

**2.3.5 Ambulance(s):**

The Project Highway shall be provided with ambulance services so that the response time is not more than 10 minutes of the call.

**2.3.6 Crane(s):**

The Project Highway shall be provided with crane(s) with capacity to tow-away the disabled vehicles.

**2.4 Avenue/median plantation:**

The Project Highway shall have plantation of trees along the highway and low height shrubs on the medians.

**2.5 Drainage:**

The Project Highway shall be provided with an elaborate drainage system to drain the storm water from the roadway and embankment and to ensure minimum disturbance to natural drainage of surface and subsurface water of the area.

**2.6 Toll Plaza:**

The Project Highway shall have toll plaza(s) as per the requirements and stipulations contained in Schedule C of the Concession Agreement.

**2.7 Operation and maintenance centre:**

The Project Highway shall have operation and maintenance centre(s) for carrying out operation and maintenance activities of the Project Highway.

**2.8 New concepts, technologies and materials:**

The Concessionaire would be permitted to adopt new technologies and materials as per the requirements of either design or result of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) (e.g. noise barriers) or providing cost effective solutions. These shall be subject to the review by I E for their design and adoption.

**2.9 Planning drawings:**

The concessionaire shall plan the Project Highway conforming to the requirements spelt out above and submit Kilometre-wise strip plan for the entire project length schematically depicting therein the location of all features specified in Schedule B as well as the project facilities specified in Schedule C clearly indicating the existing features and proposed improvement plan to the IE for review and comments. The submissions shall also include a 3-D animated perspective (To give a drive through vision) of the Project Highway showing the proposed improvements and main features.

### **SECTION -3: SURVEY AND INVESTIGATIONS**

Detailed topographic survey, traffic survey, hydraulic & drainage survey, road and bridge inventory and condition survey, subsurface investigation, material survey and pavement investigation shall be carried out in accordance with IRC: SP:19,IRC: SP: 35 & IRC: SP:54 and best industry practices. Latest technologies and equipments shall be used for undertaking these surveys and investigations. The data generated from these surveys and investigations shall be documented and presented in the form of drawings, tables and charts in electronic as well as hard copy formats in accordance with above said IRC publications and shall along with the detailed drawings prepared in accordance with section 4 of this Manual form part of Schedule H to the Concession Agreement. The data generated from these surveys shall be used for detailed design in accordance with section 4 of this Manual.

## **SECTION - 4: DESIGN**

### **4.1 General**

The designs shall be based on the detailed survey and investigation data collected by the concessionaire in accordance with Section 3 of this Manual. The drawings prepared on the basis of these designs along with the drawings required as per Section 3 of the Manual shall form part of Schedule H of the Concession Agreement.

All the designs and drawings shall be submitted to the I E for review and comments. The work shall be carried out in accordance with these drawings and such other additional drawings prepared or modified as per comments of the I E.

### **4.2 Geometric Design:**

Geometric design of the highway, except for cross sectional requirements, shall be in accordance with IRC: 73, IRC: 86, IRC: 38 and IRC SP: 23. Uniformity of design standards shall be maintained throughout the length of Project Highway. All deficiencies in the existing highway geometry shall be rectified to meet the minimum standards specified in this Manual. The detailed plans, L-sections, cross-sections, strip plans and plans of other facilities of the existing highway to be prepared by the concessionaire shall be used for developing the layout of various features of the Project Highway.

#### **4.2.1 General cross-sectional requirements:**

The design of cross section of the four lane highway shall take into account the following general requirements:

- (i) The developed cross sections for both the highway as well as the service road shall have operational safety in focus such as segregation, separation, turning radii, gradients, etc and provisions for various types of movements and maneuvers like merge, diverge, weave, etc shall be comprehensively considered and provided for.
- (ii) Provisions shall be made in the cross-section for accommodating utilities both over as well as underground as the case may be. A 2.0 m wide strip of land at the extreme edge of ROW may be kept for accommodating utility services. Provisions contained in IRC 98 shall be followed to accommodate utility services for Project Highway in built up areas.

#### **4.2.2 Specific cross sectional requirements**

The cross section shall provide for the following:

#### 4.2.2.1 Rural Sections

(i)	Minimum width of median	
	(a) Raised median with mountable kerb (as per IRC: 86)	4.5 m
	(b) Depressed median with crash barriers on both sides	7.0 m
(ii)	Paved carriageway on both sides of median	
	(a) 2-lane carriageway with each lane of 3.5 m width	7.0 m
	(b) Median side paved strip adjacent to carriageway having same specification as main carriageway in case of	
	(i) Raised median	0.50 m
	(ii) Depressed median	0.50 m
	(c) Paved shoulder on left side of the pavement having same specification as main carriageway	
	(i) Plain and rolling terrain	1.50 m
	(ii) Mountainous and steep terrain	
	- Both carriageways side by side	1.50 m
	- Two carriageways with separate alignments	
	(On both sides of carriageway)	1.00 m
(iii)	Width of earthen shoulder	
	(a) Plain and rolling terrain	2.00 m
	(b) Mountainous and steep terrain	
	- Both carriageways side by side	2.00 m
	- Two carriageways with separate alignments –on valley side	2.00 m
(iv)	Side drain	
	Cross section shall be designed to cater for effective drainage of estimated peak hour run off.	
(v)	Width of utility corridor on both sides	2.0 m

#### 4.2.2.2 Urban/ Built up Sections

(i)	Minimum width of median	
	(a) Flush median with central crash barrier	2.0 m
	(b) Raised median with central crash barrier	1.2 m

(ii)	Paved carriageway on both sides of median	
(a)	2-lane carriageway with each lane of 3.5 m width	7.0 m
(b)	Median side paved strip adjacent to carriageway of same specification as main carriageway in case of	
(i)	Raised median	0.50 m
(ii)	Flush median excluding crash barrier	full width
(c)	Paved shoulder on left side of the pavement having same specification as main carriageway	
(i)	Plain and rolling terrain	1.50 m
(ii)	Mountainous and steep terrain	
-	Both carriageways side by side	1.50 m
-	Two carriageways with separate alignments (On both sides of carriageway)	1.00 m
(iii)	Width of earthen shoulder	
(a)	Plain and rolling terrain	1.50 m
(b)	Mountainous and steep terrain	
-	On valley side with no habitation at road level	2.00 m
-	On hill side and valley side with habitation at road level: may be dispensed with	
(iv)	Width of service roads	7.0 m
(v)	Minimum width of separation-island between main carriageway and service road	1.5 m
(vi)	Minimum width of footpath	1.5 m
(vii)	Side drain	
	Cross section shall be designed to cater for effective drainage of estimated peak hour run off.	
(viii)	Width of utility corridor on both sides	1.5 m

Side drain and utility corridor can be accommodated either under footpath or separation-island depending upon local situation.

#### 4.2.3 Design Speed:

The design speeds given in following table shall be adopted for various terrain conditions.

Nature of Terrain	Cross slope of the country (per cent)	Design speed (km/hr)	
		Ruling	Minimum
Plain	0 - 10	100	80
Rolling	> 10 - 25	80	65
Mountainous	> 25 - 60	50	40
Steep	> 60	40	30

Short stretches (say less than 1 km) of varying terrain in the project stretch shall not be taken into consideration while deciding the terrain classification for a given section of Project Highway.

In general, the ruling design speed shall be adopted for geometric design of the highway. Only in exceptional circumstances minimum design speed may be adopted where site conditions are extremely restrictive and adequate land width is not available. Abrupt changes in design speed shall be avoided.

#### 4.2.4 Horizontal Alignment:

- (a) While designing the horizontal alignment, the following general principles shall be kept in view.
- i. Alignment should be fluent and blend well with the surrounding topography.
  - ii. On new roads, the curves should be designed to have largest practical radius but in no case less than ruling value corresponding to ruling design speed.
  - iii. As a normal rule, sharp curves shall not be introduced at the end of long tangent since these can be extremely hazardous.
  - iv. The curves shall be sufficiently long and have suitable transitions to provide pleasing appearance.
  - v. Reverse curves may be needed in difficult terrain. Sufficient length between two curves shall be provided for introduction of requisite transition curves, and required superelevation.
  - vi. The curves in the same direction separated by short tangents known as broken back curves should be avoided as far as possible. Wherever possible, such portion may be designed with longer single curve.
  - vii. To avoid distortion in appearance, the horizontal alignment should be coordinated carefully with the longitudinal profile.
- (b) All horizontal curves shall consist of circular portion flanked by spiral transitions at both ends.

**(c) Radii of Horizontal Curves**

The radius of horizontal curves for various terrain conditions shall not be less than the ruling minimum values as per IRC: 73 for the National Highways and the terrain of the project area except where site conditions are restrictive and adequate land is not available. Where such restrictions exist, the radius of curve shall not be less than the specified absolute minimum values in IRC: 73.

**(d) Transition curves**

Minimum length of transition curve shall be as per IRC: 73 for the specified design speed.

**4.2.5 Camber/Cross fall**

Camber / unidirectional cross fall shall be provided for each carriageway including paved shoulders in accordance with stipulations of IRC: 73. The cross fall for earthen shoulder shall be 0.5% steeper than that of the carriageway subject to a minimum of 3.0%. On curves, the shoulder on the high side of superelevated portion shall be provided with reverse slope from the superelevated carriageway portion. At the same time, it should not be too great to give break in the cross slope. The rate of change between pavement cross slope and outside shoulder should not exceed 5%.

**4.2.6 Super elevation**

4.2.7 Super elevation shall be provided on curves as per details given in IRC: 73 corresponding to the design speed and radius of horizontal curve adopted.

**4.2.8 Sight Distance**

The design shall provide for values of intermediate sight distance as per details given in IRC: 73 corresponding to the design speed adopted unless there are site constraints, where a minimum of stopping sight distance shall definitely be available. The requisite site distance shall be available across the inside of horizontal curves. Where horizontal and summit curves overlap, the design shall provide for the required sight distance both in the vertical direction along the pavement and in the horizontal direction on the inside of curve.

**4.2.9 Vertical Alignment:**

- (i) The vertical alignment shall provide for a smooth longitudinal profile. Grade changes shall not be too frequent as to cause kinks and visual discontinuities in the profile. In this regard, directions given in IRC: 73 shall be kept in view.
- (ii) There shall be coordination between horizontal alignment and vertical profile of the Project Highway and guidelines given in IRC: 73 in this regard shall be followed.
- (iii) Gradients up to the value corresponding to ruling gradient as per IRC: 73 shall be adopted as far as possible. Value corresponding to limiting gradient shall be adopted only in very difficult situations and for short lengths.
- (iv) Long sweeping vertical curves shall be provided at all grade changes. These shall be designed as square parabolas.

- (v) The vertical profile of the two carriageways shall be designed in such a manner that difference in road level between the two carriageways at the locations of median openings would not be more than 0.25m.
- (vi) The aspect of efficient drainage shall also be kept into consideration while designing vertical profile and cross-sections of the highway as stipulated in IRC: SP: 42 and IRC: SP: 50.

#### 4.2.10 Geometric design requirement of additional features:

a. Acceleration Lane:

- (i) Length: Designed for a speed differential of 60 kph  
(ii) Width: 5.5 m  
(iii) Taper at merge: 1 in 15 beyond design length.

b. Declaration lane:

Same as 'acceleration lane'

c. Median Openings:

Length of median opening: Not less than 20 m

Shelter lane: Width 3.5 m; Length based on maximum number of right turning vehicles in peak hour

d. Service Roads:

Design Speed: 40 km/hr (minimum)

Width: Carriageway 7.0 m

Paved shoulder 0.5 m on both sides (may be dispensed with in exceptional circumstances)

Camber/ Super elevation: As per IRC (Unidirectional camber towards drain shall be provided)

Extra widening: To be provided at flares for underpass approaches, adequate turning radius, U-turn facility etc as per requirement.

Gradient: 1 in 30 (ruling min) underpass approaches – 1 in 50 generally, max 1 in 30.

e. Bridges for service road:

(i) If total length of bridge required to be constructed is less than 60 m, on a stream, the service road shall continue across the stream through separate bridge structures, which may be vented causeway structure with vents designed to cater for ordinary flood discharge.

(ii) In cases involving bridges of length 60 m or more, separate bridge structures shall not be provided and service roads on both side of the stream shall be merged with the Project Highway. In such cases, width of bridge to be constructed for main highway

shall be increased by one traffic lane (i.e. 3.5 m) on both sides of carriageway to accommodate merging traffic of service road. For this purpose, service roads shall be merged by tapering of the road (1 in 20) with detailed system of signs and markings.

(iii) In cases of ROBs, the service roads on both the sides shall be joined through one of the viaducts of ROB. This arrangement shall be on either side of the railway crossing if the situation demands. For some proportion of service road traffic, safe entry and exit shall be provided from service roads to the ROB.

(iv) Bridges in built up area will invariably accommodate footpath unless specified otherwise in Schedule-B.

f. Junctions at Service Roads:

(i) With minor merging roads: Flaring at the junction like a 'left-in left-out' configuration but with provision for right turning through painted channelising island.

(ii) At underpasses: Flaring at the junction with provision of painted channelising island to guide traffic movement to / from the underpass.

g. Vehicular Underpasses:

Width	:	7.5 m minimum
		10.5 m (with footpath of 1.5 m on both sides) desirable
Vertical Clearance	:	5.0 m

h. Pedestrian / Cattle Underpass:

Width	:	4.0 m minimum
Vertical Clearance	:	2.5 m minimum; to be increased to 4.5m, in case certain categories of animals such as elephant/camel are expected to cross the Project Highway.

i. At Grade Intersection : At-grade intersections shall be designed as per IRC SP: 41 and layout as per MOST Type Design for intersections on National Highways. However, these typed designs shall be modified to provide for right turning lanes in the median, dropped kerbs and gap in channelisers to facilitate pedestrian crossing.

j. Grade Separated Intersection: The layout and design of grade separated interchanges shall be as per IRC: 92.

### **4.3 Embankment**

#### **4.3.1 General**

The height of the embankment shall be based on the final road levels. The following principles shall be followed for fixing the road level:

- i) The top of sub-grade is at least 1.0 m above the high flood level/high water table/pond level. However, in exceptional circumstances not covered in the scope of work specified in Schedule-B, where it is found difficult to fulfill this criterion without needing reconstruction or raising in substantial length, the criteria may be relaxed depending on site conditions, ensuring a minimum difference of 0.6 m between the top of sub-grade and HFL/high water table/pond level.
- ii) The road level of the new two-lane carriageway is not lower than the existing carriageway unless it improves vertical profile and also satisfies all other requirements set out in this Manual.
- iii) To fulfill the minimum free board requirement and provide smooth vertical profile for portions forming approaches to structures.
- iv) To raise the level of stretches of the existing road from drainage considerations as indicated in Schedule B of the Concession Agreement.

#### **4.3.2 Structural features and design of embankment**

- i) Embankment shall be designed to ensure the stability of the roadway and shall incorporate only those materials, which are suitable for embankment construction as per Section 5 of this Manual.
- ii) Side slopes shall not be steeper than 2H:1V unless duly designed slope protection measures are provided.
- iii) Where the embankment is to be supported on a weak stratum it shall be necessary to specially design the embankment and also adopt appropriate remedial / ground improvement measures.
- iv) High embankments (height 6 m or above) in all soils shall be designed from stability considerations. For design of high embankments IRC: 75 and MOSRTH – Guidelines for Design of High Embankments may be referred to.
- v) The side slopes shall be protected against erosion by providing turfing / vegetative cover, stone/C.C. block pitching, geo-synthetics, gabion walls or any other measures depending on the height of the embankment, type of soil involved and susceptibility of soil to erosion as per IRC: 56. Pitching works on slopes shall be as per MOST Specifications.

#### **4.3.3 Use of Fly Ash for Embankment Construction**

- (i) Fly ash shall be used for construction of embankment in accordance with guidelines of MOSRT&H. The embankment shall be designed and constructed in accordance with IRC: SP-58. The thickness of soil cover shall not be less than 1 m for embankments up to 3 m height. For high embankments the thickness of soil cover shall be increased as per design.

- (ii) The side slopes of the embankment shall be protected against erosion as stated in para 4.3.2 (v) above.
- (iii) The stability analysis of the embankment shall be carried out as per IRC: 75.

#### **4.4 Pavement Design**

##### **4.4.1 Type of Pavement.**

- (i) Unless specified otherwise in Schedule-B, the concessionaire may adopt any type (flexible/rigid) pavement structure for new construction.
- (ii) The concessionaire shall submit proposal with regard to the type of pavement proposed for strengthening of the existing pavement to IE for review and comments and finalize the proposal taking into account comments of IE.

##### **4.4.2 Design traffic**

Pavement of the main highway shall be designed for the cumulative number of standard axles of 8.16 tonnes over the design life of 20 years. Service roads shall be designed for repetition of 10 million standard axles. Base year traffic, axle load distribution, and vehicle damage factor for design shall be determined on the basis of survey and investigation to be carried out by the concessionaire in accordance with section 3 of this Manual. The cumulative axle load for the purpose of design shall not be less than the number of standard axles obtained if the base year traffic is cumulated at a rate of growth, which is the highest of the following in the initial 5 years:

- (a) 7.5 % per annum for all vehicles
- (b) Trend growth of various vehicle categories
- (c) Projected Growth rate of revenue assumed in the concessionaire's cash flow
- (d) Growth determined from secondary socio economic data and elasticity factors.

and then reduces by 2 (two) percentage points for every 5 year subject to a minimum rate of growth of 5 % at any point of time.

##### **4.4.3 Design procedures**

- (i) For widening of the existing flexible pavement to meet the geometric design requirements specified in this Manual, the thickness and composition of layers for widening shall be same as that of existing pavement and further deficiencies in thickness shall be made up by overlay on the entire width of the pavement including paved shoulders. If the

condition of existing pavement is so deficient that it cannot be improved by overlays, it will be scarified and the pavement shall be designed afresh.

- (ii) In case the existing cement concrete pavement is to be widened, the widened pavement shall be of the same thickness and specification not inferior to that of the existing pavement. The widened pavement shall be joined with the exiting pavement by providing longitudinal joints of the same design and specification as that of the existing pavement. Similarly, the transverse joints with dowel bars of the same design as provided in the existing pavement shall be provided.

(iii) **Flexible Pavement**

The new flexible pavement shall be designed in accordance with IRC: 37 and strengthening of the existing flexible pavement in accordance with IRC: 81.

(iv) **Rigid Pavement**

The new rigid pavement shall be designed in accordance with IRC: 58. The existing rigid pavement may be rehabilitated / strengthened either by rigid or flexible overlays in accordance with good industry practice subject to review by the IE.

#### 4.4.4 **Pavement Performance Indicators and Requirements**

- i) The pavement performance and structural capacity shall be measured in terms of objective measurable performance and strength indicators, i.e., roughness, rutting, cracking and deflection.

- ii) The new or strengthened flexible pavement surface on completion shall satisfy the following standards:

a. **Roughness**

In each lane measured by Bump Integrator (BI): Not more than 2000 mm/km for each  
lane in a km length

b. **Rutting**

In wheel path measured by 3 m. Straight Edge. No Rutting

c. **Cracking**

No Cracking

d. **Deflection**

Not more than 0.5 mm characteristic deflection to be determined as per IRC: 81

e. **Other distresses**

Nil

- (iii) The new or strengthened rigid pavement surface on completion shall satisfy the following standards:

**a. Roughness**

In each lane measured by BI                      Not more than 2000 mm/km for each lane in a km length

**b. Cracking**

No Cracks other than shrinkage cracks

**c. Other distresses such as**

**scaling, raveling, spalling at edges**                      Nil

## **4.5 Design of structures**

### **4.5.1 General**

- i) The complete structure shall be designed to be safe against collapse and to maintain at all times an acceptable serviceability level. These shall be also designed to be durable to withstand the deteriorating effects of climate and environment.
- ii) All bridges shall have independent superstructure for each direction of travel. Culverts may have single or independent structure. Width of median in structural portion shall be kept same as that in the approaches.
- iii) In cases where median is kept open to sky, suitable provision shall be made for retaining the earth likely to spill from median portion of immediate embankment behind abutment either by extending the abutment wall or constructing a new retaining wall. Care shall also be taken to merge the wing wall /return wall and flooring of the old bridge with that of the new bridge.
- iv) All bridges shall provide for carriageway width as per para 4.5.5 below. Wherever specified in Schedule B, the superstructure shall also provide for pedestrian footpath.
- v) Utility service, if any, to be taken on the structures shall be as specified in Schedule B of the Concession Agreement.
- vi) Concessionaire is encouraged to adopt innovative/latest techniques in design, construction and use of new materials. However, in all such cases Concessionaire shall submit all relevant details along-with guidelines and propriety literature proposed to be followed to IE for review and comments.

#### 4.5.2 Type of Structure

- i) The concessionaire may choose any type of structure and structural system. Design and layout of structures shall be aesthetically pleasing to local environment.
- ii) Bridge superstructure, substructure and foundation may be of plain or reinforced concrete, pre-stressed concrete or steel-concrete composite construction.
- iii) The following types of structures shall not be accepted
  - a) Drop in spans with halved joints (articulations)
  - b) Trestle type frames for substructures

#### 4.5.3 Pipe Culverts

- (i) Minimum diameter of pipes for new pipe culverts shall be 1200 mm.
- (ii) Existing culverts of diameter 900 mm and above, which are in sound condition and functioning satisfactorily, may be retained and extended.
- (iii) All existing culverts of diameter less than 900 mm shall be dismantled and reconstructed.
- (iv) Minimum depth of earth cushion over pipe including road crust shall not be less than 1000 mm for new / reconstructed culverts. In case of existing sound and safe culverts a minimum cushion of 600 mm may be acceptable.

#### 4.5.4 Design Period

The design discharge shall be evaluated for flood of 50-year return period for calculation of waterway and design of foundations.

#### 4.5.5 Width of structures

The width of the culverts and bridges shall be adopted as below:

- i) New culverts and bridges
  - (a) The pipe / slab / box bridges / culverts shall have the same overall width as of the approach road. Overall width of these structures shall be such that the outer face of railing/parapet shall be in line with the outer edge of the shoulder. The median side inner edge of the safety barrier/kerb shall be at a minimum distance of 250 mm from the edge of the carriageway.
  - (b) All other new bridges shall be constructed to accommodate for six lane carriageway. In case existing bridge is retained, as mentioned below, for traffic in one direction, a new three lane bridge shall be constructed for plying of traffic in other direction. Width of immediate approaches shall be adjusted to provide smooth transition from approaches to bridge.

ii) Existing culverts and bridges:

The pipe / slab / box bridges / culverts shall be widened preferably on the outer side so as to make the deck width same as specified in sub-para 4.5.5 (i) above. The bridges having 2-lane carriageway and deep foundations, T-beam or box type superstructure, which are difficult to widen may be retained and proper transition between approach and bridge shall be provided with the help of crash barriers. The wearing coat, damaged bearings and rubberized component of expansion joints older than 15 years shall be replaced before commissioning of the Project Highway.

- (iii) In cases where bridges are constructed with footpath as per requirement specified in Schedule B, cross section of immediate approaches shall have extra width and provide for footpath.

#### 4.5.6 Design loading and stresses

- (i) The design loads shall be as per IRC: 6 appropriate for the width of carriageway, type and properties of stream, location, altitude, etc.
- (ii) In Seismic Zones IV & V, necessary precautions against dislodgement of superstructure shall be taken by provision of reaction blocks or other type of seismic arresters and increased width of pier/abutment cap.

#### 4.5.7 Analysis and design of structures

All structures and their individual components shall be analysed and designed as per IRC:5, IRC:18, IRC:21, IRC:22, IRC:24, IRC:40, IRC:78 and IRC:83 (all parts) depending upon the type of structure / individual component proposed to be provided. The minimum cross sectional dimensions of each component shall be provided so as to satisfy the requirements specified in relevant IRC Code. The design shall take into account long term durability, serviceability, constructability, construction methodology and environmental factors. All river training and protection works shall be designed in accordance with IRC: 89.

### 4.6 Earth Retaining Structures

- 4.6.1 The concessionaire may adopt any type of earth retaining structure keeping in view the site conditions. The type of earth retaining structure shall be aesthetically pleasing and compatible with the adjoining structures. Earth retaining structures shall be designed for lateral earth pressure including inclined surcharge and hydrostatic pressure, if any.
- 4.6.2 If the retaining structure is a reinforced earth system, the basic design shall be provided by the system provider and the design shall conform to BS: 8006 in respect of limit state of collapse and serviceability. Complete design calculations and drawings showing layout of reinforcement and other details such as drainage arrangements shall be submitted to the IE for review and comments, if any.

#### 4.7 Drainage System

The design of drainage system such as surface and sub-surface drainage for pavement, median, shoulder, high embankment shall be carried out in accordance with IRC: SP: 42 and IRC: SP: 50. Surface runoff from the main highway, embankment slopes and the service roads shall be discharged through longitudinal drains, which shall be designed for adequate cross section, bed slopes, invert levels and the outfalls. If necessary, the walls of the drains shall be designed to retain the adjoining earth. Where drains are required to be covered, the cover of the drain shall be designed for carrying the maximum expected wheel load. The covered drains shall be provided with iron gratings, strong enough to withstand expected loading.

#### 4.8 Safety Barrier

Safety barrier of concrete/metal beam/wire rope in accordance with MOSRTH guidelines/circular shall be provided at following locations:

- (i) Where height of embankment is 3 m or more,
- (ii) Where embankment is retained by a retaining structure,
- (iii) Where median is depressed, flushed or having the width less than 4.5 m. The barriers shall be for both directions of travel,
- (iv) On valley side of highway in mountainous and steep terrain.
- (v) Between main carriageway and footpath in bridges.
- (vi) At hazardous locations identified in schedule B or through safety audit.

#### 4.9 Toll Plazas

4.9.1 Toll plazas shall be designed for projected peak hour traffic of 20 years. The total number of toll booths and lanes shall be such as to ensure the service time of not more than 10 seconds per vehicle at peak flow regardless of methodology adopted for fee collection. For purpose of guidance following parameters are suggested as a capacity of individual toll lane for design purpose:

- |       |   |               |
|-------|---|---------------|
| (i)   | Semi-automatic toll lane<br>(Automatic vehicle identification but manual money transaction)                   | 240 veh/hour  |
| (ii)  | Automatic toll lanes<br>(Automatic vehicle identification and money transaction – smart card)                 | 360 veh/hour  |
| (iii) | Electronic toll collection (ETC lanes)<br>(Toll collection through on board unit and no stoppage of vehicles) | 1200 veh/hour |

- 4.9.2 Two toll lanes in each direction of travel shall be provided with the system of payment through smart card and their configuration would be such that one lane in each direction could be upgraded in future to the system of Electronic Toll Collection (ETC). The implementation of ETC will be treated as change of scope when concessionaire would be asked to provide for the same. Not less than 2 middle toll lanes shall be capable of being used as reversible lane to meet the demand of tidal flow.
- 4.9.3 The width of each toll lane shall be 3.2 meters, except for the lane for over dimensional vehicles, where it shall be 4.5 m.
- 4.9.4 Between each toll lane of the toll plaza, traffic islands are required to accommodate toll booth. These islands shall be of minimum 25 m length and 1.8 m width. Protective barriers of reinforced concrete shall be placed at the front of each island to prevent out of control approaching vehicles crashing into the toll booth. They would be painted with reflective chevron markings.
- 4.9.5 Toll booth shall be placed at the centre of each traffic island with dimensions to accommodate toll collector's desk for toll equipment such as key board and console, video screen, card reader, note and coin storage, telephone and environmental control system. The toll booth shall have large glass window to provide the toll collector with good visibility of approaching vehicles. The bottom of the toll window should be placed at such a height (0.9 m) above ground level so as to provide convenience of operation. The Toll booths shall be ergonomically designed and vandal proof. There shall be CCTV camera installed at each booth.
- 4.9.6 For the movement between toll office and toll booth of each toll lane, an underground tunnel across all toll lanes shall be provided. Its dimension would be sufficient to accommodate the required wiring/cable system and for convenient movement of personnel. It should also be provided with lighting and ventilation system so that the movement is convenient.
- 4.9.7 The area of toll plaza covering the flared portion shall be provided with concrete pavement. All the toll lanes and toll booths shall be covered with a canopy. The canopy shall be wide enough to provide weather protection to toll operators, drivers and facilities. The canopy shall be of aesthetically pleasing design with cylindrical support columns located at traffic island so that there is no restriction on visibility and traffic movement. The vertical clearance shall be as prescribed in this Manual.
- 4.9.8 The toll plaza shall have lighting system to provide visibility to drivers for the use of facility especially to access the correct service lane and also to the toll collector. Indian Standard IS: 1944 shall be followed. The minimum requirement of illumination on the road surface of 30 lux shall be ensured. This would be done by providing high-mast lighting (minimum 25 m height), lighting at canopy, and lighting inside toll booths. Street lighting shall also be provided on both side approaches of toll plaza for a minimum length of 500 metres on each side. Power supply shall be from public power supply system but stand by generating set of the capacity to supply the required power shall be provided at toll plaza.

- 4.9.9 The toll plaza shall be provided with surface and sub surface drainage system so that all the storm water is drained off efficiently and no ponding or stagnation of water takes place at any area of the toll plaza.
- 4.9.10 Toll Plaza shall have fire fighting equipment including smoke detectors and auto visual alarm system as per section 4.17.1 of National Building Code so that the personnel working in the complex and the office are not subjected to hazardous situation due to fire.
- 4.9.11 The semi automatic toll collection system shall be equipped in each entry lane with a vehicle detector for counting the number of vehicles and their axle number and for identification of the category of vehicle. The system shall also have a ticket issuing machine for issue of the tickets for user fee at the press of a button on a touch panel and entry lane controller for controlling the equipment of the entry lane and for sending the data to the data processing equipment at toll plaza office. Each toll lane shall have electronically operated boom barrier along with synchronised system for traffic lights.
- 4.9.12 The smart card system would comprise the system for vehicle identification, barrier and synchronize traffic light and payment through smart card. The smart card would comprise reader/writer conforming to ISO Standards: 1443-A sealed to a National Electrical Manufacturers Association (NEMA) for Ingress Protection (IP) - 65 having transmission frequency of 13.56 MHz.
- 4.9.13 The Electronic Toll Collection system shall consist of an on board unit fitted on a vehicle and an antenna to receive communication for identification of its code and other stored data and a system for transmitting the data from the on board unit to the reader and from reader to the customer information management system.
- 4.9.14 Toll plaza location shall also be provided with system for checking and preventing overloading of vehicles at toll plaza. For this purpose, weigh in motion systems at each toll lane are to be installed. Separate space for static weigh bridge and accommodation to store off-loaded goods from overloaded vehicles shall be provided after the toll barriers for each direction of travel.
- 4.9.15 Toll plaza shall have a separate office building so as to provide comfortable office space for manager, cashier & other staff. There shall be separate rooms for T.V. monitors, meetings, toilets, and for the sale of passes, smart cards, on board units and public interaction. The building shall have a strong room for keeping the money and a garage to accommodate the security van (during operation of loading the collected revenue). There shall be parking space in the same campus for vehicles for the staff and workers and other vehicles engaged in the operation of the Project Highway.
- 4.9.16 The toll plaza shall have toll audit system and fraud protection measures. The operations for toll collection, supervision, auditing and money handling shall be done through the qualified personnel with numbers so that each operation is efficiently handled.

4.9.17 Suggestive lay out of toll plaza showing the service lanes, office space, parking space, weigh bridges is given in fig. 4.1A and that for toll booth in fig. 4.1B.

#### **4.10 Operation and Maintenance Centre**

4.10.1 There shall be operation and maintenance centre(s) either at the toll plaza (s) or at any other location along the highway as identified by the concessionaire. The land for the same shall be acquired by the concessionaire at his cost and risk. The operation and maintenance centre would have following minimum facilities:

- (i) Main control centre and Administrative block
- (ii) Equipment for operation and maintenance and storage space for them.
- (iii) Storage space for equipment and material for traffic signs and markings
- (iv) Workshop
- (v) General garage and repair shop
- (vi) Testing laboratory
- (vii) Parking space for minimum 4 no. of large vehicles and for other expected vehicle during peak hours including those for working staff and visitors

4.10.2 All building works shall be designed to meet the functional requirements and shall be compatible with regional architecture and micro climate. Locally available materials shall be given preference but not at the cost of construction quality.

4.10.3 The circulation roads and parking spaces in the O&M centre shall be paved to withstand vehicle loads and forces due to frequent acceleration and deceleration of vehicles. Parking bays / lots shall have proper cross slope and drainage. The marking of the parking bays shall be as per IRC: 35 to demarcate parking and circulation space. Parking lots shall have illumination as provided in IS: 1944 (Parts I and II).

4.10.4 The whole campus of operation and maintenance centre shall have system for security with safe entry and exit.

#### **4.11 Traffic Signs**

Unless otherwise provided in this Manual, road signs shall be provided in accordance with IRC: 67.

4.11.1 There shall be corresponding road markings with stop signs, give way signs, merging or diverging traffic signs, lane closed signs, road narrowing signs, slip roads/ diversion signs, compulsory keep left/right signs, or any other signs as per IRC-67 and/or as reviewed by IE.

4.11.2 Wherever Project Highway alignment is on a curve, there shall be an advance cautionary signs for sharp curves (depending whether it is on left or right) and chevron signs (rectangular in dimension with traffic yellow background and black arrow) at the outer edge of the curve. The sign for the

curve ahead particularly in mountainous and steep terrain shall always be accompanied with chevron signs at the outer edge of the curve and appropriate delineation.

- 4.11.3 Roads signs such as chevron, overhead etc. not covered by IRC-67 will be as given in this document would be as per BIS/British Standard/AASHTO/ASTM.
- 4.11.4 All road signs shall be with retro-reflective sheeting of high intensity grade with encapsulated lens fixed over aluminum sub-strata as per clause 801 of MOSRTH specification.
- 4.11.5 Kerb mounted signs shall be supported on GI pipes. Overhead signs shall be placed on a structurally sound gantry or cantilever structure made of GI pipes. Its height, lateral clearance and installation shall be as per MOST specifications. The pedestal supporting the gantry or cantilever structure of the overhead signs shall be flushed at the ground level and in no case shall protrude more than 15 cm above ground level.
- 4.11.6 It shall be ensured that any sign, signal or any other device erected for traffic control, traffic guidance and/or traffic information shall not obscure any other traffic sign and shall not carry any advertisement.
- 4.11.7 Each exit ramp shall have signs mounted on posts indicating the name of the place and the important roads it would lead to.
- 4.11.8 For toll plaza(s) advance direction signs shall be provided at 1 km and 500 m ahead of toll plaza. These signs are rectangular in shape, bilingual, gantry, cantilever mounted as illustrated in fig. 4.2 A and fig. 4.2 B. Wherever the local language is other than Hindi, local language instead of Hindi shall be used for sign at 500 m.
- 4.11.9 It is necessary that user be informed before using the road that a section of National Highway is a Toll Road. Similarly the user be also informed of the end of the Toll Road. Over head sign panels indicating that the toll road is ahead and that the toll road ends is illustrated in fig. 4.2 C and fig. 4.2 D.
- 4.11.10 At the start of flare of the toll plaza, a sign displaying the fee rates shall be erected. Suggestive configuration is given in fig. 4.3. The colour of words and panels shall follow IRC: 67.
- 4.11.11 It shall be ensured that any sign, signal or any other device erected for traffic control, traffic guidance and/or traffic information shall not obscure any other traffic sign.

#### **4.12 Pavement Marking**

- 4.12.1 Pavement markings on the Project Highway shall be in accordance with IRC: 35. These markings shall be applied to road centre line, edge line, continuity line, stop line, give way lines, diagonal/chevron markings, zebra crossing and at parking areas by mean of an approved self propelled machine which has a satisfactory cut off value capable of applying broken line automatically.

- 4.12.2 Road markings shall be of hot applied thermoplastic paints with reflectorising glass beads as per relevant clauses of Section 803 of MOST specifications.
- 4.12.3 At toll plaza, transverse bar lines be used across the flared approach to toll gate to reduce the speed of approaching traffic. The width of these lines shall be 300 mm and details as given in fig. 4.4.
- 4.12.4 Concessionaire shall ensure that a detailed plan scheme and plan for traffic signs and pavement markings covering all length and features of Project Highway shall be prepared and submitted to IE for review and comment.

#### **4.13 Rest Areas**

- 4.13.1 Project Highway shall have Rest Area(s) planned such that they are spaced at the intervals of 90 minutes to one hour of driving time between two important cities/towns. They would not be located between 5 km of a town or city or near interchange where entrance and exit ramps could cause weaving conflict.
- 4.13.2 Rest areas shall be planned to cater for traffic moving in both directions such that there is no need for the vehicles on one carriageway to cross over to the other carriageway. The entry to Rest Area(s) would be through deceleration lane and exit through acceleration lane. The minimum width of these lanes shall be 5.5 m.
- 4.13.3 Rest Area(s) shall be designed for the expected peak hour long term clientage and shall provide facilities for parking, restaurant, cafeteria, toilets, telephone and shops for selling items normally required for traveling, fuel and garage for minor repair, telephone, first aid. The parking should include parking for expected peak hour truck traffic and cafeteria suitable for fulfilling the need for Indian truck drivers and shall be paved by CC blocks strong enough to withstand expected loadings. The whole area shall be elaborately landscaped to provide a pleasing environment. A suggestive lay out is given in fig. 4.5. This can be modified to accommodate location specific requirements.
- 4.13.4 At locations along the Project Highway where some existing eateries (Dhaba) or other informal rest areas are located, concessionaire shall make every attempt of shift the business of such establishments to the identified planned rest area location(s) failing which a safe entry and exit to these establishment and parking spaces for expected peak hour vehicles shall be provided with proper signs and markings.

#### **4.14 Pick Up Bus Stops**

- 4.14.1 Pick up Bus Stops shall be designed as defined in schedule C or as per the actual peak hour demand at identified location(s). However, the actual location shall be decided based on the general principles of location given in IRC: 80. Bus stops shall be provided on both sides of the Project Highway for either direction of travel so as to minimize the need for the crossing by

commuters. The bus stop lay out shall provide safe entry and exit of buses from the Project Highway and safe movement of passengers. The shelter structure shall be aesthetically pleasing, structurally safe and functional so as to protect the waiting passengers adequately from sun, rains etc.

- 4.14.2 The bus bay and shelter shall be designed to provide for safe and convenient use by physically challenged passenger as well.
- 4.14.3 In rural areas the bus shelter shall be located at least 1.0 m away from the edge of the bus bay which shall be typically 30 m long. The plinth height of the bus stop shall be 0.3 m from the bus bay level and shall be 2 risers high. The minimum ceiling height of the structure shall be 2.1 m and the height of seating shall be 0.4 m from floor level.
- 4.14.4 The bus bay shall have length to accommodate the expected no. of buses in the peak time. The length and lay out shall be based on those given in IRC: 80 considered suitably modified for four lane dual carriageway highway. It shall be paved with pre-cast cement concrete (M-40) Blocks. The area of the bus stop used by pedestrians shall also be paved with pre-cast concrete blocks.
- 4.14.5 The barrier fences /pedestrian safety guard rails shall be erected between the bus loading area and the through lanes to prevent pedestrian crossings.
- 4.14.6 Pick up Bus Stop would be provided with litter bins. These would be simple in shape and their colour and finish shall make them conspicuous. Litter bin shall be post-mounted and/or swivel type. The mounting and fixing components shall be robust. The bin shall have drainage holes for periodic flushing. It shall also be theft, vandal-and fire-proof. It shall be resistant to wear and tear, and the material and design shall be such as to require minimal maintenance.

#### **4.15 Pedestrian crossing facility**

The Project Highway shall be provided with safe crossing facilities for the pedestrians. These shall be only at identified locations such as part of at-grade intersections, pedestrian /vehicular underpasses (in accordance with para 2.2.4). Pedestrian safety guardrail shall be provided to guide the pedestrian to the selected crossing /identified locations. For this purpose some of the common locations could be bus stops or other such locations with a possibility of peoples congregation from where the pedestrian safety guardrail be provided up to the nearest at-grade intersection or sub-way. The design of these facilities shall be in accordance with IRC:103. At the crossing points drop in the curve shall be provided to facilitate crossing of physically challenge users. Similarly, the gaps in the channeliser shall be provided so as to avoid the need for frequent climbing and getting down from the channelisers.

#### **4.16 Highway Landscaping**

- 4.16.1 Trees shall be planted in rows and on either side of the Project Highway with a staggered pitch as per IRC: SP: 21. A range of 10-15 m c/c is recommended for spacing of trees (parallel to the road). Setback distance of trees in different situations shall be as per IRC: SP: 21 and IRC: 66.

The distance between the kerb, if any, and the nearest edge of tree trunk shall be at least 2 m. The plantation in median shall comprise shrubs whose height would normally not exceed 1-1.5 m and shall be as per IRC SP: 21.

4.16.2 The scheme for landscaping shall be part of the overall Environmental Mitigation Plan (EMP) as spelt out in Schedule C. In case of a discrepancy between the spacing for trees to be planted parallel to the road as specified in the IRC standards and the EIA Report, the lesser of the two distances shall be adopted.

4.16.3 For safe traffic operation, vertical clearance between the crown of the carriageway and lowest part of the overhang of the tree available across the roadway shall conform to the standards laid down in IRC: SP: 21. The pit size, fencing, watering and manuring requirements shall also conform to the above standard. Planting shall be such that it does not obstruct the visibility of traffic from any side and shall be pleasing in appearance.

**4.17 Advertisement/ Hoarding:**

No advertisement/ hoarding shall be allowed to be erected on the Project Highway.

**4.18 Advanced Traffic Management Systems (ATMS):**

4.18.1 A real time system working round the clock shall be established for informing the road users of the road, traffic, and weather conditions on the Project Highway; for making interventions as required for smooth, safe and efficient traffic operation; and for providing rescue and relief to the users in distress. The system shall be capable of (i) acquisition of data from various sources such as the road, the users, the maintenance and operation patrol, the ambulance, and the intervention team (ii) three way communication between the data source and a Central Control Room, the Control Room and the data sources and display units, and between the maintenance and operation teams, through a transmission system, and (iii) A Central Control Room to process all data and control the highway operation.

4.18.2 The systems and equipment of ATMS shall meet the following main climatic and environmental requirement as specified in IS-9000

(i) Temperature Range of Operation – Low of 0° Celsius ( $\pm 3^\circ$  C) to high of 60° Celsius ( $\pm 2^\circ$  C)

(ii) Relative Humidity of 95%

(iii) Vibration Frequency Range of 10 Hz – 55 Hz

4.18.3 Data acquisition system: This shall consist of (a) Automatic Traffic Counter and Classifier (ATCC), with an in-road loop detectors and treadles. (b) Video cameras installed on road with such pan and tilts that a length of 2 km road is captured for video monitoring of traffic, (c) Emergency Call Boxes installed at every 2 km to enable any user to be instantly in contact with the Control Room, (d) Meteorological sensors for capturing data on temperature, weather, wind, (e) Mobile radios for patrol vehicles and ambulances to be in communication with Central Control Room and among themselves.

- 4.18.4 Emergency call boxes (ECBs) with loud speaker, micro phone, activation button with LED indicating conversation, shall be housed in a vandal proof casing and operate in full to play mode in noise level of up to 95 decibels with in built diagnostic features for automatic detection in case of damage by any object. Mobile communication system shall comprise the mobile radio base stations and control centre equipments. It shall have provision for mounted mobile set on ambulances, trains & patrolling vehicles. The system shall have the facility to connect mobile to mobile, mobile to controller, and controller to mobile along with the systems for waiting, holding, and transfer of calls. The system shall use a pair of frequencies to be allotted to the concessionaire with the approval of wireless planning & coordination (WPC), Deptt. of Telecommunications and shall operate for full duplex mode.
- 4.18.5 The design for the Variable Message Signs (VMS) will be modular with sign panels using LEDs / High-Gain Trans-Reflective LCDs for outdoor ambient lights. The sign panel should be such that a display is legible from a distance of about 200 m. For this purpose, panels shall have minimum dimensions of 3m length x 1.8 m depth. The minimum height of the characters shall be 300 mm. The contrast ratio shall be more than 30 perpendicular to the bold face and more than 10 at an angle of  $\pm 70$  degrees to the perpendicular. The equipment shall be capable of storing minimum 10 frames that can be triggered on receiving the tele-command. The sign panels shall be installed on the structure in such a manner that they are aesthetically pleasing and can withstand wind pressures. The equipment shall be capable of storing minimum semi-duplex mode and other known forces. The minimum vertical clearance available at VMSs shall be 5.5 m from the road surface. Power supply shall be fed from the integrator locations.
- 4.18.6 The meteorological sensors shall comprise thermocouple /pyrometer, humidity meter, anemometer , visibility meter and sensor for measuring pavement surface temperature. They shall be installed on a single pole with a specific attachment and power supply fed from the integrator. They shall have the facility to communicate on Polythene Insulated Jelly Filled copper cables (PIJF) /Optical Fibre Cable.
- 4.18.7 The Automatic Traffic Counter-cum-Classifer (ATCC) shall be capable of detecting and recording all categories of vehicles plying on the Project Highway based on their length and no. of axles. The system shall be robust and capable of operating with minimum maintenance and may be either piezo-electric or infrared. It should have minimum accuracy level of 99%. The logic units shall be microprocessor based. The system should be able to record and store vehicle data for a period of at least two weeks with a Daily Traffic Volume of up to 1,00,000 vehicles. The system shall have compatibility to transfer the data on PIJF/Optical Fibre Cable/by using any of the available communication mode like GSM (Global System for Mobile Communications) / GPRS (General Packet Radio Service), landline modem, CDMA (Code Division Multiple Access) depending upon the effective and economic operation of the particular mode available at the site. The system shall be electric/solar power operated depending upon the availability of source.
- 4.18.8 The Closed Circuit Television (CCTV) Surveillance shall comprise video camera, its housing and pan, and Tilt Heads. The video camera shall be mounted at a height so as to cover the target

length of highway and the housing shall be able to withstand adverse weather conditions. It shall have a 360 degree angular travel in the horizontal plane and a tilt of 90 degrees down from 0 degrees horizontal. It shall have zoom lens with minimum power of 30 X, auto iris and infrared filter, infrared compatibility for night operation and remotely selectable operating modes. It shall have compatibility with co-axial cable/optical fibre cable.

- 4.18.9 The main control centre shall be designed for round-the-clock operations of monitoring, on-line information acquisition and processing the same for decision making. The Main Control Centre shall have equipment of central computer, call centre, terminal junction box, uninterrupted power supply (UPS) , counsel operator with monitors and joy sticks, rack accommodation, large display board, line printer and general purpose office computer with monitor, printer, fax and telephone. The system shall also have Network Management system (NMS) or real-time monitoring of Emergency Call Boxes (ECBs) and network diagnostics.
- 4.18.10 Transmission System: This shall consist of a backbone Optical Fiber Transmission system, cable system, interface system, network management system, repeater/ amplification system, and power supply system. There shall be 3 or 4 sub-centres (as appropriate) housing all the interface equipment apart from the Control Centre, provided with, as appropriate, cables, interface, terminals (such as optical line terminals and interface, network management system equipment, optical fiber cable interface equipment and control centre interface equipment, data acquisition system interface, etc). The cables from ECBs, VMS, meteorological data systems, ATCC shall be Polythene Insulated Jelly filled (PIJF) copper cables and those from CCTV cameras shall be coaxial cables. Repeaters/ amplifiers shall be used to maintain the quality of signals. All the cables shall have at least 20 % spare capacity to allow for expansion. The interface system shall be capable of handling the composite audio, video and data signals at various interface levels and process them.
- 4.18.11 Central Control Room (Control Centre): The Central Control Room (CCR) shall be the repository of all the data acquired from the field and their processing, storing, and archiving. All the information for real time monitoring of the Project Highway shall be generated at the CCR and the relevant information shall be disseminated to the users through Variable message signs, and to the operation and management teams through mobile radio communication system for appropriate intervention. Another important function to be performed at the Control centre shall be the operation and management of the ATMS itself along with its various sub systems.
- CCR shall have the following minimum equipment, hardware and software:
- (1) A Central Computer Server with integrated ATMS and ATMS software
  - (2) A Traffic Manager's Terminal for operation of the integrated traffic management system
  - (3) Call system equipment comprising Operator PC along with sub-systems and digital voice recorder.
  - (4) Mobile radio terminal comprising Operator PC and engineering terminal
  - (5) Computers for Network Management System (NMS) for Fiber Optic Communication System.

- (6) CCTV Console Equipment
- (7) Computers for VMS, AVCC, MET, Traffic Control
- (8) A large size screen
- (9) A line Printer
- (10) An Office Computer
- (11) A Power Supply and back up system

4.18.12 Dissemination of information: Information generated at the Control Centre shall be disseminated in the following manner:

- (a) To the users: By displays on the Variable Message signs, via internet web pages, and by creating a node at the way side amenities to display the relevant information.
- (b) To the Operation and maintenance teams: By mobile phones
- (c) To the ambulances: By mobile phones
- (d) To the Trauma centres: Via ambulances

#### **4.19 Highway patrol**

Highway patrol unit(s) manned by at least two persons apart from the driver for every unit shall continuously patrol the highway in a stretch not exceeding 50 km and shall remain in contact with the Control Room on a real time basis. The patrol shall render assistance to users in distress and disabled vehicles through own intervention or by calling for assistance from Control Room, Crane operators or ambulance as required. The patrol shall promptly clear the road of any obstruction. Where the obstructions take time to be cleared, the section shall be cordoned off by placing traffic cones, which shall be illuminated during night. The patrol vehicle shall be large enough for seating at least four personnel besides the driver and space to carry essential traffic management and safety tools. It shall also have a light on its top and a siren on board. It shall be equipped with traffic cones and other accessories for traffic control which are fully visible during night time.

#### **4.20 Ambulance(s)**

Ambulance(s) manned by at least two trained paramedics shall be available on the Project Highway so that the response time is not more than 10 minutes of call. Each ambulance shall be equipped with first aid, life saving medical services and support system implements for transporting the victims to the nearest trauma hospitals, and providing emergency medical aid during transportation of victims from accident site to the nearest trauma hospital.

#### **4.21 Crane(s)**

Crane(s) shall be available within an hour of an incident to clear the disabled vehicle off the carriageway.

**4.22** All intervention teams comprising patrol, ambulances and cranes shall be in communication with each other and the Control Room all the time and shall intervene within the stipulated time.

**4.23 Lighting system**

All light posts erected on the railings of bridges, structures shall have adequate height such that a uniform illumination of 40 lux is available.

All high mast lights in the interchange area shall illuminate the interchange with intensity of 40 lux.

All entry and exit ramp areas shall be uniformly illuminated with 40 lux intensity

All underpasses shall be illuminated with minimum intensity of 30 lux.

**4.24 Design Report and Drawings**

The concessionaire shall furnish the detailed report including designs and drawings for each component of the Project Highway such as geometry, pavement, structures, drainage, barriers, protective works, traffic control devices and other user facilities etc. as per the requirements specified above to the IE for his review and comments, if any. The drawings to be submitted shall satisfy the requirements (including scale and the size) specified in IRC: SP: 19 and IRC: SP: 54.

## SECTION -5: MATERIALS

### 5.1 General:

Sourcing of all materials as well as compliance with environmental requirements under the applicable laws in respect of all works to be executed under the Concession Agreement shall be the sole responsibility of the concessionaire. All materials, whether natural (such as earth, gravel, sand, aggregates, etc), processed (such as bituminous and concrete mixes), or manufactured (such as cement, steel, bitumen, etc) shall be incorporated in the work only if they are tested and found to meet the requirements of this Manual or, in the absence of any provision in this Manual, conform to the best industry practice.

### 5.2 Natural materials

5.2.1 Physical requirements of earth, gravel, sand, and aggregates shall conform to the requirements of the provisions of those clauses of MOST specifications as are relevant to the intended use of the materials.

5.2.2 Natural aggregates when crushed and blended for various uses, different size fractions shall be proportioned to form grading conforming to those clauses of the MOST specifications as are relevant to the intended use of the material. Where clauses of the specifications provide more than one option, the option which provides the closest grading shall be provided.

### 5.3 Processed materials

5.3.1 Fly ash: Fly ash to be used in embankment construction shall meet the requirements specified in IRC: SP: 58.

5.3.2 Concrete mixes: Concrete mixes, plain or reinforced, shall be design mixes, designed in accordance with the provisions of IS: 456. Concrete of M20 grade or higher shall be used for the project except for leveling course in foundation and dry lean concrete for Cement concrete pavement where M15 grade concrete shall be used. Specific requirements of the mixes (such as workability, water cement ratio, use of admixtures, grades of cement and steel, minimum and maximum cement content, ratios of 7 and 28 days strengths, etc) shall be as per those provisions of MOST specifications as are relevant to the intended use of the concrete mix.

5.3.3 Bituminous mixes: Bituminous mixes shall be hot mix type and shall be designed in accordance with Asphalt Institute Manual series MS 2 with the ingredients of the mix (such as aggregates, fillers, bitumen, etc) conforming to the provisions of MOST specifications as relevant to the type of mix intended to be used.

### 5.4 Manufactured materials

5.4.1 Cement: Ordinary Portland cement grades 33, 43 and 53 conforming to IS: 269, IS: 8112, and IS: 12269 respectively shall be used subject to the condition that the design cement content does not exceed 540 kg per cum and the minimum requirement of cement from durability considerations are provided. Use of Portland slag cement or Portland pozzolana cement shall not be permissible

for any structural concrete. Other grades of cement such as Rapid hardening cement conforming to IS: 8041 and Sulphate resistant cement conforming to IS: 12330 shall be permissible in specific situations subject to the provisions of clause 1000 of MOST specifications.

- 5.4.2 Bitumen: Paving grade bitumen conforming to IS: 73 shall be used. Crumb rubber modified bitumen (CRMB) and Polymer modified bitumen (PMB) conforming to IRC: SP: 53 shall be used.
- 5.4.3 Steel: High Yield Strength Deformed (HYSD) reinforcing bars of S 415 grade conforming to IS: 1786 and High Tensile Strength pre-stressing tendons conforming to IS: 6006 shall be used.
- 5.4.4 Sheathing, anchorages, void formers, bearings, expansion joints, geo-textile and geo-grid, metallic strips, bars, grids for reinforced earth, metal beam crash barriers, prefabricated vertical drains, retro-reflective sheetings and road marking paints: These shall meet the relevant provisions of the MOST specifications, recommendations of the system providers, manufacturers' testing and certification, and the designers' design assumptions
- 5.5** Concessionaire may use other construction materials for example stabilized soil for which a detailed design procedure to be adopted shall be furnished to IE for review and comments.

## **SECTION -6 : CONSTRUCTION**

### **6.1 General**

Construction planning, techniques, technologies and equipment shall be planned in a manner not to compromise on the efficiency and safety of the existing highway. Efficient and safe operation of the existing highway without reducing its capacity and safety shall be ensured during construction of the Project Highway. Construction shall meet the environmental safety norms, and ensure safety of temporary and permanent works, safety of traffic, pedestrian (if any) and workman during construction, meet the access needs of the population living close by and shall not cause any damage to their property.

### **6.2 Construction specifications**

Unless not specifically provided for in the MOST specifications, construction of various components of the Project Highway shall be carried out in accordance with these provisions of specifications to the extent they are relevant. For avoidance of doubt, such provisions of the specification as relate to approval from Engineer, refer to contract drawings, provide for measurement for payment and unit rates, etc which are generally applicable to item rate contracts shall not be considered relevant to this agreement. However, provisions relating to material specifications, construction methods, equipment, processing of materials, laying, compaction, testing, quality control/assurance, etc shall be considered relevant to this agreement. The final decision with regard to which provisions are relevant and which are not shall rest with the IE.

Where construction specification for any component of work is not provided for in MOST specifications, construction shall be carried out in accordance with international specification, or best industry practice, or the specifications provided by the manufacturer or provider of the system subject to review by IE. The concessionaire shall remain responsible for construction with regard to its adequacy, safety, and durability regardless of any review and comments by the IE. In case, concessionaire chooses to adopt new material, technology and construction methodology, he shall first sample test the same to demonstrate that the proposed material/technology/methodology can be successfully implemented to achieve the specified performance levels of the Project Highway. These processes shall be subject to the review and comments of the IE.

All the construction equipment shall have the required capacity to meet the output requirements of works under the agreement and shall have mechanical, hydraulic, electronic and other controls, Manual or automatic, as required for meeting the construction requirements.

### **6.3 Construction planning**

Prior to actual commencement of construction, a construction plan shall be drawn up and submitted to the IE for review and comments. The plan shall be prepared to meet the requirements of this section of the Manual and contain, *inter alia*, the following:

- (1) Sequence of construction activities to be undertaken with time line on a PERT chart
- (2) At each construction site, the areas to be cordoned off for construction and logistics of movement of construction equipment.
- (3) Arrangement for movement of main line traffic near construction sites and assessment of capacity and safety of the alternative arrangement. If capacity augmentation is necessary as per the assessment, suggested measures to restore the original capacity of the main highway on the alternative arrangement.
- (4) If construction activities affect the access to properties or movement of cross traffic, alternative arrangements during construction.
- (5) A detailed plan for safe and efficient movement of existing traffic through the construction zones along with required signs and markings for cautions and guidance.

### **6.4 Base Camp for Construction**

The concessionaire shall establish base camp(s) for the construction of Project Highway at the location from where construction sequences and processes can be efficiently performed. The land for the base camp shall be acquired by the concessionaire at his cost and risk and its size shall be such that it accommodates the plants, equipments, materials, laboratories, offices, residences and space for movement/circulation of construction vehicles/machinery. The space should also have space for recreation and sporting facilities for the staff and workers.

### **6.5 Traffic diversion**

Where it is necessary to close the traffic on the existing highway for construction and divert the traffic on to an alternative route, such diversion shall have the width equal to the width of the road closed. The diversion road shall have fluent geometry and maintained in traffic worthy condition such that traffic can safely negotiate.

### **6.6 Access to private property**

If existing access to private property is to be closed due to construction, alternative access shall be provided before construction is undertaken.

### **6.7 Cross road Traffic**

If existing cross road is to be closed due to construction, alternative approach and crossing facility shall be provided before construction is undertaken.

## **6.8 Temporary work**

Temporary work shall not be erected on the main highway if traffic is allowed to ply on it while construction is in progress. Similarly, erection equipment for erection of temporary or permanent work shall not be allowed on the main highway if the portion of the highway remains under use of the main line traffic.

The concessionaire shall be responsible for safe, workable design and methodology for all temporary forms, staging and centering required for construction of structures in accordance with IRC: 87.

## **6.9 Traffic management during construction**

In order to ensure that the construction activities do not disrupt the movement of the existing traffic, comprehensive traffic management plan shall be drawn up by the concessionaire. Wherever construction shall be undertaken, it shall be declared a construction zone. The length of the construction zone shall be reasonable, neither too short which will put the traffic to frequent inconvenience nor too long, which is difficult to manage.

Traffic in construction zones shall be managed in accordance with the provisions of IRC SP 55. All transitions, ingress/ egress to and from the main highway, shall have proper and smooth geometry and traffic shall be guided by road signs, markings, delineation and other appropriate means as required for safe and efficient operation.

After construction is completed in a particular zone, it shall be opened for normal operation. Prior to the beginning of normal operation, those parts of the diversions as will not eventually form part of the Project Highway shall be closed to prevent any movements not permitted under the normal operation of the Project Highway.

## **6.10 Improvement and maintenance of roads other than Project Highway**

The concessionaire shall be responsible for improvement of all roads to be used for carrying construction material and/or machinery for construction of the Project Highway. The level of improvement shall be commensurate to the requirements for carrying the expected traffic during construction period. These roads shall also to be maintained by the concessionaire up to the level of improvement carried out throughout the construction period and until commissioning of the Project Highway.

## **6.11 Social disruption**

The concessionaire shall take all measures to mitigate any disruptive effects of construction such as noise and dust pollution, closure of local accesses, intrusion to the lives and business activities of the people, threat to their property, or any other disruption. These measures shall be taken after due consultation with the local people, local administration and authority's local establishment.

## SECTION -7 : QUALITY ASSURANCE

- 7.1 At least 2 weeks prior to commencement of the work, the Concessionaire shall draw up a Quality Assurance Manual (QAM) covering the Quality System (QS), Quality Assurance Plan (QAP) and documentation for all aspects of the bridge and road works as per IRC: SP 47 and IRC: SP: 57 respectively and furnish to the IE for review and comments. The quality assurance plan shall duly provide therein for conducting tests on the quality of materials, construction of temporary and permanent works, and the finished works. He shall enable the IE to inspect the Quality Assurance Plan, the test results, and witness the conduct of such tests. The IE shall, in his inspection report in compliance with the provisions of clause 13.2 of the Concession Agreement, bring out the non-conformities in the tests and quality procedures in his inspection report.
- 7.2 The quality of materials and work shall meet the requirement of Clause 900 of MOST specifications to the extent relevant and applicable. The decision with regard to the relevance and applicability of the Clause shall rest with the IE. The quality of materials and work that are not relevant to the MOST specifications shall meet the requirements of other relevant standards that are followed for the work. Always provided that manufacturer's testing and certification shall be essential for the manufactured materials.
- 7.3 Remedying the defects and deficiencies required as per Clause 13.2 of the Concession Agreement shall be carried out in the following manner:
- (1) Improving, modifying, changing the Quality Assurance Plan and its implementation
  - (2) Replacing the non-conforming material by materials conforming to the standards by changing the material source, material processing, construction equipment or technique before incorporation of the material in work.
  - (3) In case a nonconforming material has been incorporated in the work, by removing the work to the extent of non-conformities and replacing it by a work meeting the requirements of the quality.
  - (4) In case a work or any of its component exceeds the limits of tolerances specified in the quality standards, by rectifying the work and bringing it within the limits of tolerance.

**List of IRC Codes / Standards / Acts for Road/Bridge Works**

IRC:	2	-1968	Route Marker Signs for National Highways (First Revision)
IRC:	3	-1983	Dimensions and weight of Road Design vehicles. (First Revision)
IRC:	5	-1998	Standard Specification & Code of Practice for Road Bridges, Section I – General Features of Design (7 <sup>th</sup> Revision)
IRC:	6	-2000	Standard Specifications & Code of Practice for Road Bridges, Section II – Loads and Stresses (Fourth Revision)
IRC:	7	-1971	Recommended Practice for Numbering Bridges and Culverts (First Revision)
IRC:	8	-1980	Type Designs for Highway Kilometre Stones (Second Revision)
IRC:	9	-1972	Traffic Census on non urban roads (First Revision)
IRC:	10	-1961	Recommended Practice for Borrow pits for Road Embankments Constructed by Manual Operation
IRC:	15	-2002	Standard Specifications & Code of Practice for Construction of Concrete Roads (Third Revision)
IRC:	16	-1989	Specification for Priming of Base Course with Bituminous Primers (First Revision)
IRC:	18	-2000	Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned Concrete) (Third Revision)
IRC:	19	-1977	Standard Specification and Code of Practice for Water Bound Macadam (Second Revision)
IRC:	20	-1966	Recommended Practice for Bituminous Penetration Macadam (Full Grout)
IRC:	21	-2000	Standard Specifications and Code of Practice for Road Bridges. Section-III Cement Concrete (Plain and reinforced) (Third revision)
IRC:	22	-1986	Standard Specifications and Code of Practice for Road Bridges. Section-VI Composite Construction (First Revision).
IRC:	23	-1966	Tentative Specification for Two Coat Bituminous Surface Dressing
IRC:	24	-2001	Standard Specifications and Code of Practice for Road Bridges. Section-V Steel Road Bridges (First Revision)
IRC:	26	-1967	Type Design for 200-Metre Stones
IRC:	30	-1968	Standard Letters and Numerals of Different Heights for Use on Highway Signs
IRC:	32	-1969	Standard for Vertical and Horizontal Clearances of Overhead Electric Power and Telecommunication Lines as Related to Roads
IRC:	33	-1969	Standard procedure for evaluation and condition surveys of stabilised soil roads.
IRC:	34	-1970	Recommendations for road construction in waterlogged area.
IRC:	35	-1997	Code of Practice for Road Markings (with Paints) (First Revision)
IRC:	36	-1970	Recommended Practice for Construction of Earth Embankments for Road Works

**List of IRC Codes / Standards / Acts for Road/Bridge Works**

IRC:	37	-2001	Guidelines for the Design of Flexible Pavements (Second Revision)
IRC:	38	-1988	Guidelines for Design of Horizontal Curves for Highways and Design Tables (First Revision)
IRC:	40	-2002	Standard Specifications and Code of Practice for Road Bridges, Section IV - Brick, Stone and Block Masonry (Second Revision)
IRC:	41	-1997	Type designs for check barriers (First Revision)
IRC:	42	-1972	Proforma for record of test values of locally available pavement construction materials.
IRC:	45	-1972	Recommendations for Estimating the Resistance of Soil Below the Maximum Scour Level in the Design of Well Foundations of Bridges
IRC:	47	-1972	Tentative specifications for built up spray grout.
IRC:	52	-2001	Recommendation about the alignment survey and geometric design of hill roads. (Second Revision)
IRC:	54	-1974	Vertical Clearances at Underpasses for Vehicular Traffic.
IRC:	56	-1974	Recommended Practice for Treatment of Embankment Slopes for Erosion Control
IRC:	57	-1974	Recommended Practice for Sealing of Joints in Concrete Pavements
IRC:	58	-2002	Guidelines for the design of plain jointed Rigid pavements for highways (Second Revision)
IRC:	59	-1976	Tentative Guidelines for the design of gap graded cement concrete mixes for road pavements.
IRC:	61	-1976	Tentative Guidelines for the construction of Cement Concrete Pavements in Hot Weather
IRC:	65	-1976	Recommended practice for traffic rotaries.
IRC:	67	-2001	Code of Practice for Road Signs (First Revision)
IRC:	69	-1977	Space Standards for Roads in Urban Areas
IRC:	70	-1977	Guidelines on regulations and control of mixed traffic in urban areas.
IRC:	71	-1977	Recommended practice for preparation of notations.
IRC:	73	-1980	Geometric Design Standards for Rural (Non-Urban) Highways
IRC:	75	-1979	Guidelines for the Design of High Embankments
IRC:	78	-2000	Standard Specifications and Code of Practice for Road Bridges. Section-VII Foundations & Sub-structure (Second Revision).
IRC:	79	-1981	Recommended Practice for Road Delineators
IRC:	80	-1981	Type Designs for Pick-up Bus Stops on Rural (i.e., Non-Urban) Highways
IRC:	81	-1997	Tentative Guidelines for Strengthening of Flexible Road Pavement Using Benkelman Beam Deflection Technique (First Revision)
IRC:	83	-1999	Standard Specifications and Code of Practice for Road Bridges. Section-IX Bearings Part-I: Metallic Bearings

**List of IRC Codes / Standards / Acts for Road/Bridge Works**

			Bearings, Part-I: Metallic Bearings.
IRC:	83	-1987	Standard Specifications and Code of Practice for Road Bridges, (Part-II) Section-IX Bearings, Part-II : Electrometric Bearings
IRC:	83	-2002	Standard Specifications and Code of Practice for Road Bridges, (Part-II) Section-IX Bearings, Part-III : POT POT-CUM-PTFE, PIN AND METALLIC GUIDE BEARINGS
IRC:	84	-1983	Code of Practice for Curing of Cement Concrete Pavement
IRC:	85	-1983	Recommended practice for accelerated strength testing and evaluation of concrete for Road and Airfield Constructions.
IRC:	86	-1983	Geometric Design Standards for Urban Roads in Plains
IRC:	87	-1984	Guidelines for the design and erection of false work for road bridges.
IRC:	88	-1984	Recommended practice for lime fly ash stabilised soil base/ sub base in pavement construction.
IRC:	89	-1997	Guidelines for Design & Construction of River Training & Control Works for Road Bridges (First Revision)
IRC:	91	-1985	Tentative guidelines for construction of cement concrete pavement in cold weather.
IRC:	92	-1985	Guidelines for the Design of Interchanges in Urban Areas
IRC:	93	-1985	Guidelines on Design and Installation of Road Traffic Signals
IRC:	98	-1997	Guidelines on Accommodation of Underground Utility Services Along and Across Roads in Urban Area (First Revision)
IRC:	101	-1988	Guidelines for design of continuously reinforced concrete pavement with elastic joints.
IRC:	102	-1988	Traffic studies for planning bypasses around towns.
IRC:	103	-1988	Guidelines for Pedestrian Facilities
IRC:	104	-1988	Guidelines for Environmental impact assessment of Highway projects.
IRC:	SP:	4	-1966 Bridge Loading Round the World
IRC:	SP:	11	-1988 Handbook of Quality Control for Construction of Roads and Runways (Second Revision)
IRC:	SP:	13	-2004 Guidelines for the Design of Small Bridges and Culverts.
IRC:	SP:	14	-1973 A Manual for the Application of the Critical Path Method to Highway Project in India
IRC:	SP:	15	-1996 Ribbon Development Along Highways and its Prevention
IRC:	SP:	16	-2004 Guidelines for surface evenness of Highways Pavements (First Revision)
IRC:	SP:	17	-1977 Recommendations About Overlays on Cement Concrete Pavements
IRC:	SP:	18	-1978 Manual for Highway Bridge Maintenance Inspection.

- IRC: SP: 19 -2001 Manual for Survey, Investigation and Preparation of Road Projects (First Revision)
- IRC: SP: 21 -1979 Landscaping of Road
- IRC: SP: 22 -1980 Recommendations for the Sizes for each Type of Road Making Machinery to Cater to the General Demand of Road Works
- IRC: SP: 23 -1983 Vertical Curves for Highways
- IRC: SP: 25 -1984 Gopi and his Road Roller-Guidelines on Maintenance of Road Roller
- IRC: SP: 27 -1984 Report Containing Recommendations of IRC Regional Workshops on Highway Safety
- IRC: SP: 32 -1988 Road Safety for Children (5-12 Years Old)
- IRC: SP: 33 -1989 Guidelines on Supplemental Measures for Design, Detailing & Durability of Important Bridge Structures.
- IRC: SP: 34 -1989 General Guidelines About the Equipment for
- IRC: SP: 35 -1990 Inspection and Maintenance of Bridge.
- IRC: SP: 37 -1991 Guidelines for Evaluation of Load Carrying Capacity of Bridges
- IRC: SP: 39 -1992 Guidelines on Bulk Bitumen Transportation & Storage Equipment
- IRC: SP: 40 -1993 Guidelines on techniques for strengthening and rehabilitation of bridges.
- IRC: SP: 41 -1994 Guidelines on Design of At-Grade Intersections in Rural & Urban Areas
- IRC: SP: 42 -1994 Guidelines on Road Drainage
- IRC: SP: 44 -1994 Highway Safety Code
- IRC: SP: 46 -1997 Steel Fibre Reinforced Concrete For Pavements
- IRC: SP: 47 -1998 Guidelines on Quality System for Road Bridges (Plain, Reinforced, Prestressed and Composite Concrete).
- IRC: SP: 48 -1998 Hill Road Manual
- IRC: SP: 50 -1999 Guidelines on Urban Drainage
- IRC: SP: 51 -1999 Guidelines for Load Testing of Bridges
- IRC: SP: 52 -1999 Bridge Inspector's Reference Manual
- IRC: SP: 53 -2002 Guidelines on Use of Polymer and rubber Modified Bitumen in Road Construction (First Revision)
- IRC: SP: 54 -1999 Project Preparation Manual for Bridges
- IRC: SP: 55 -2001 Guidelines for Safety in Construction Zones
- IRC: SP: 56 -2000 Guidelines for Steel Pedestrian Bridges
- IRC: SP: 57 -2001 Guidelines for Quality Systems for Road Construction
- IRC: SP: 58 -2001 Guidelines for Use of Fly ash in Road Embankments
- IRC: SP: 59 -2002 Guidelines for Use of Geotextiles in Road Pavements and Associated Works
- IRC: SP: 60 -2002 An Approach Document for Assessment of Remaining Life of Concrete Bridges

### III Ministry of Surface Transport Publications

MORT&H Pocketbook for Bridge Engineers, 2000 (First Revision)

MORT&H Pocketbook for Highway Engineers, 2002 (Second Revision)

MORT&H Specifications for Road and Bridge Works, 2001 (Fourth Revision)

MOST Standard Plans for 3.0 m Span Reinforced Cement Concrete Solid Slab Superstructure with and without Footpaths for Highways, 1991

MOST Standard Plans for Highways Bridges R.C.C. T-Beam & Slab Superstructure - Span from 10 m to 24 m with 12 m width, 1991

MOST Standard Plans for Highway Bridges PSC Girder and RC Slab Composite Superstructure for 30 m Span with and without Footpaths, 35 m Span with Footpaths and 40 m Span without Footpaths, 1991

MOST Standard Drawings for Road Bridges - R.C.C. Solid Slab Superstructure (15\* & 30\* SKEW Span 4.0 m to 10.0 m (with and without Footpaths), 1992

MOST Type Designs for Intersections on National Highways, 1992

MOST Computer Aided Design System for High Embankment Problems, 1993

MOST Addendum to Ministry's Technical Circulars and Directives on National Highways and Centrally Sponsored Road & Bridge Projects (Aug. 88 to Dec. 92), 1993

MOST Standard Drawing for Road Bridges R.C.C. Solid Slab Superstructure (22.5\* SKEW) R.E. Span 4M to 10M (with and without Footpath), 1996

MOST Addendum to Ministry's Technical Circulars and Directives on National Highways and Centrally Sponsored Road & Bridge Projects (Jan. 93 to Dec. 94), 1996

Standard Plan for Highway Bridges - Prestressed Concrete Beam & RCC Slab Type Superstructure - Volume –II

MOST Addendum to Technical Circulars & Directives on National Highways & Centrally Sponsored Road & Bridge Works Projects (Jan. 1995 to Dec. 1997)

MOST Standard Plans for Single, Double and Triple Cell Box Culverts with and without Earth Cushion

Manual for Safety in Road Design

MORT&H Manual for Construction and Supervision of Bituminous Works, 2001

### BIS PUBLICATIONS

IS: 1944 (Part-I & II) 1970 Code of Practice for lighting of Public thoroughfare: Parts Land 2 For Main and secondary roads (Group-A and B) (First revision) (Amendments No. 1 and 2) Parts – I and 2 in one volume) (Amendments-2).

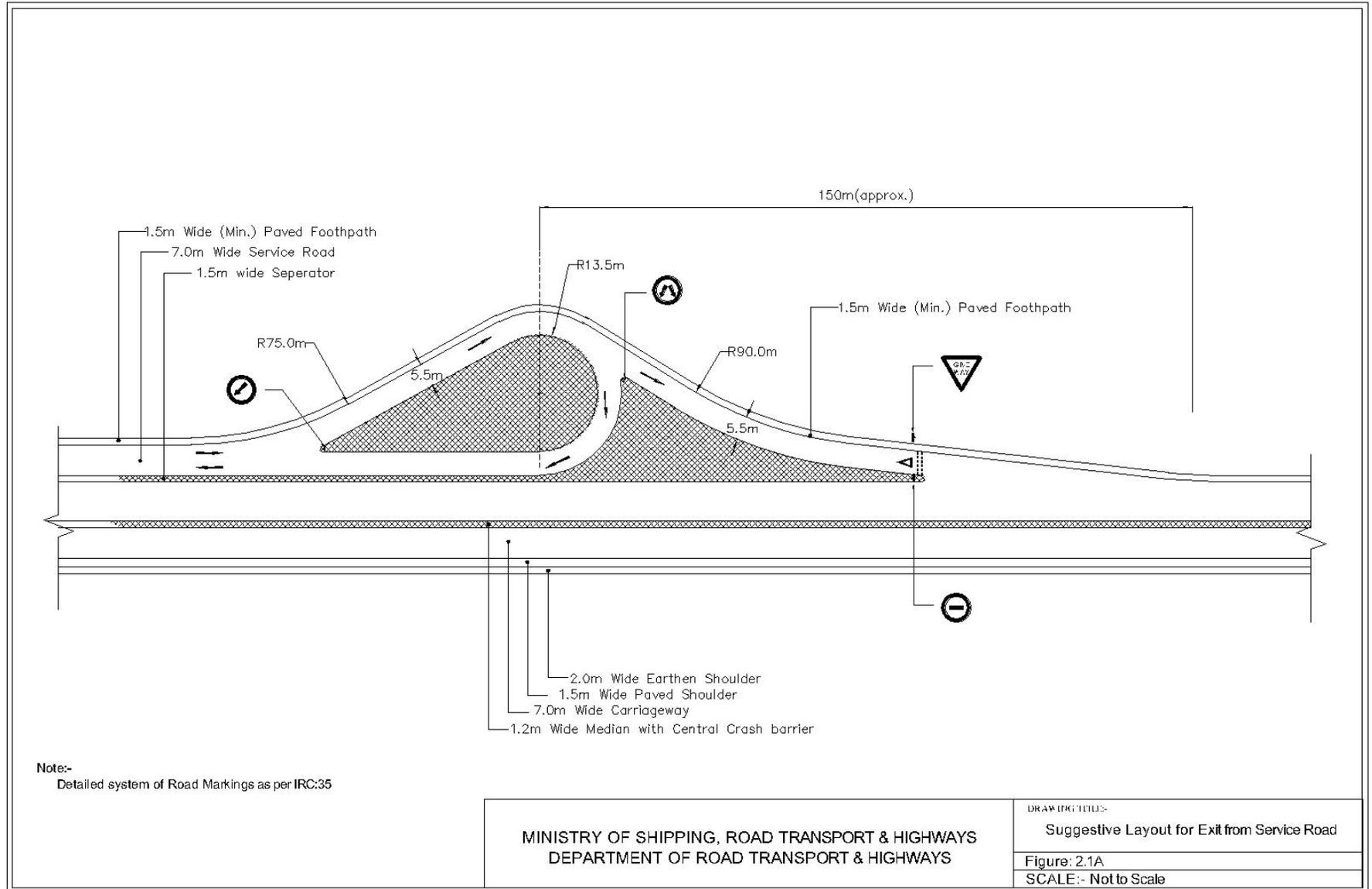
IS: 1944 (Part-V) 1981 Code of Practice for Lighting of Public Thoroughfares: Parts 5 Lighting for Grade separated junctions, Bridges and Elevated roads (Group – D).

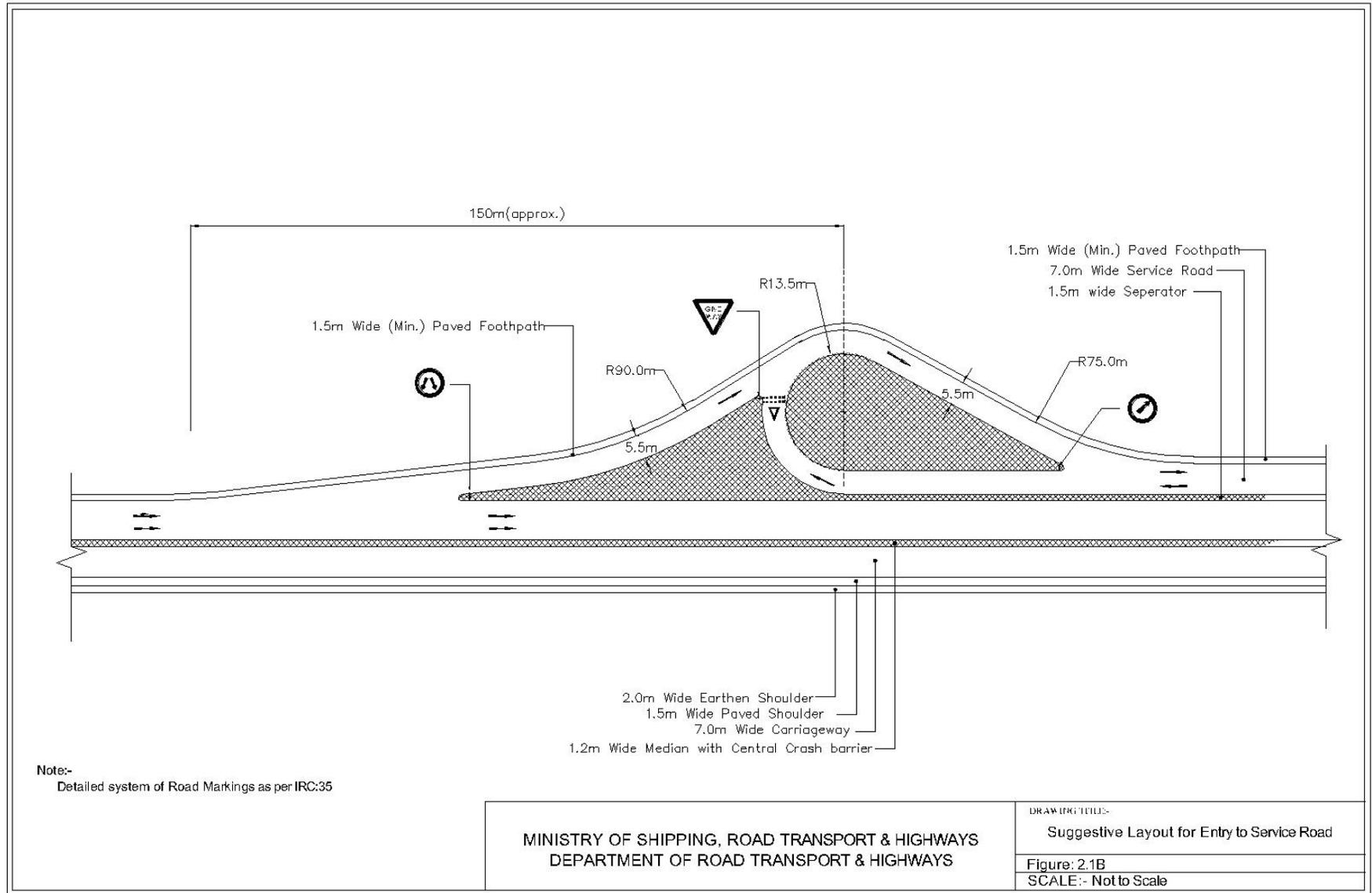
IS: 1944 (Part-VI) 1981 Code of Practice for lighting of Public thoroughfare: Part-6 Lighting for Towns and city centres and areas of civic Importance (Group-E).

IS: 10748 – 1995 Hot rolled steel for welded tubes and pipes (First Revision)

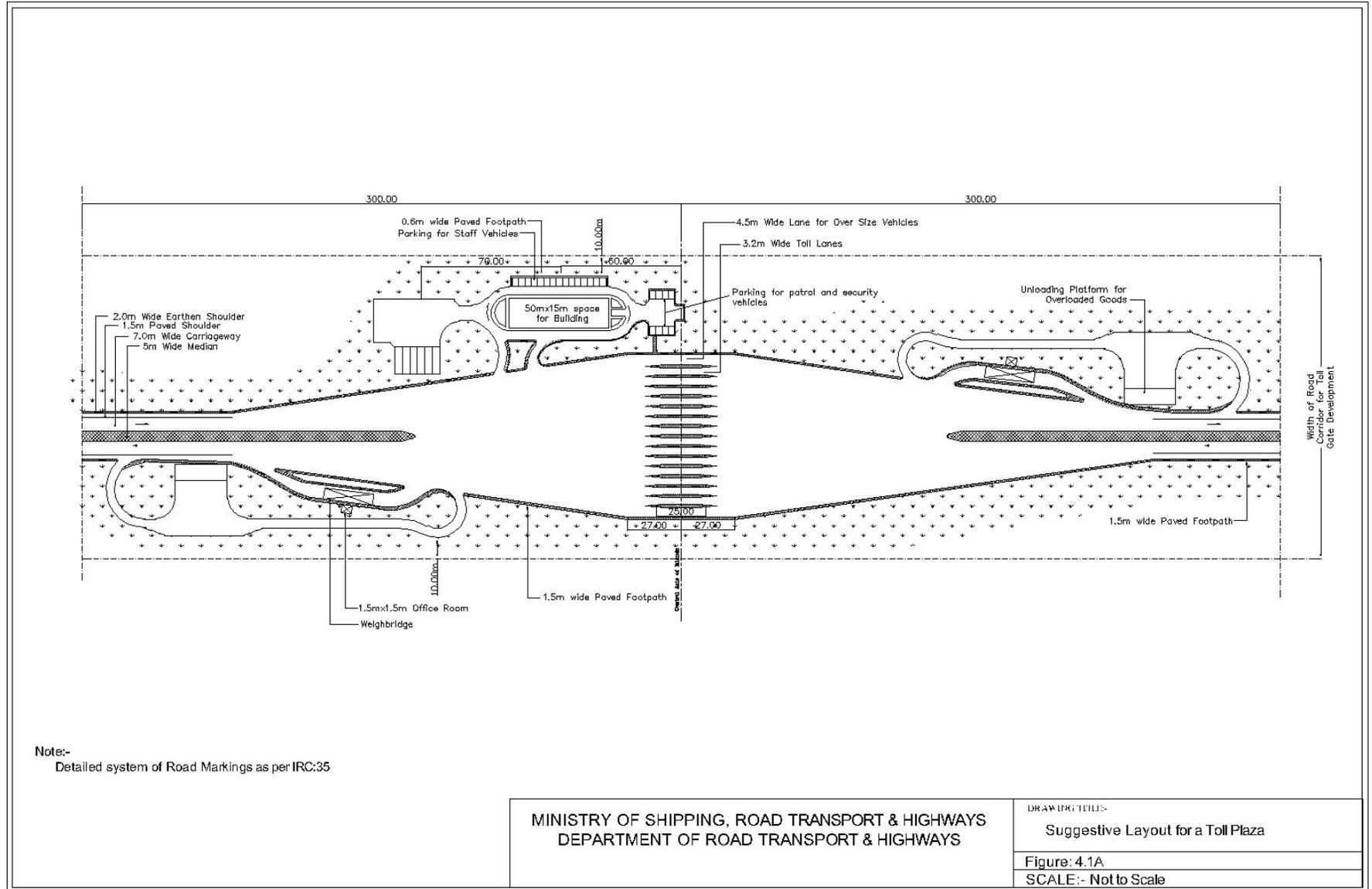
NBC National Building Code

Part-III, NBC:	Development Control rules and general building requirements.
Part-IV, NBC:	Fire Protection
Part-VI, NBC:	Structural Design
Part-VIII, NBC:	Building Services
Part-IX, NBC:	Plumbing Services







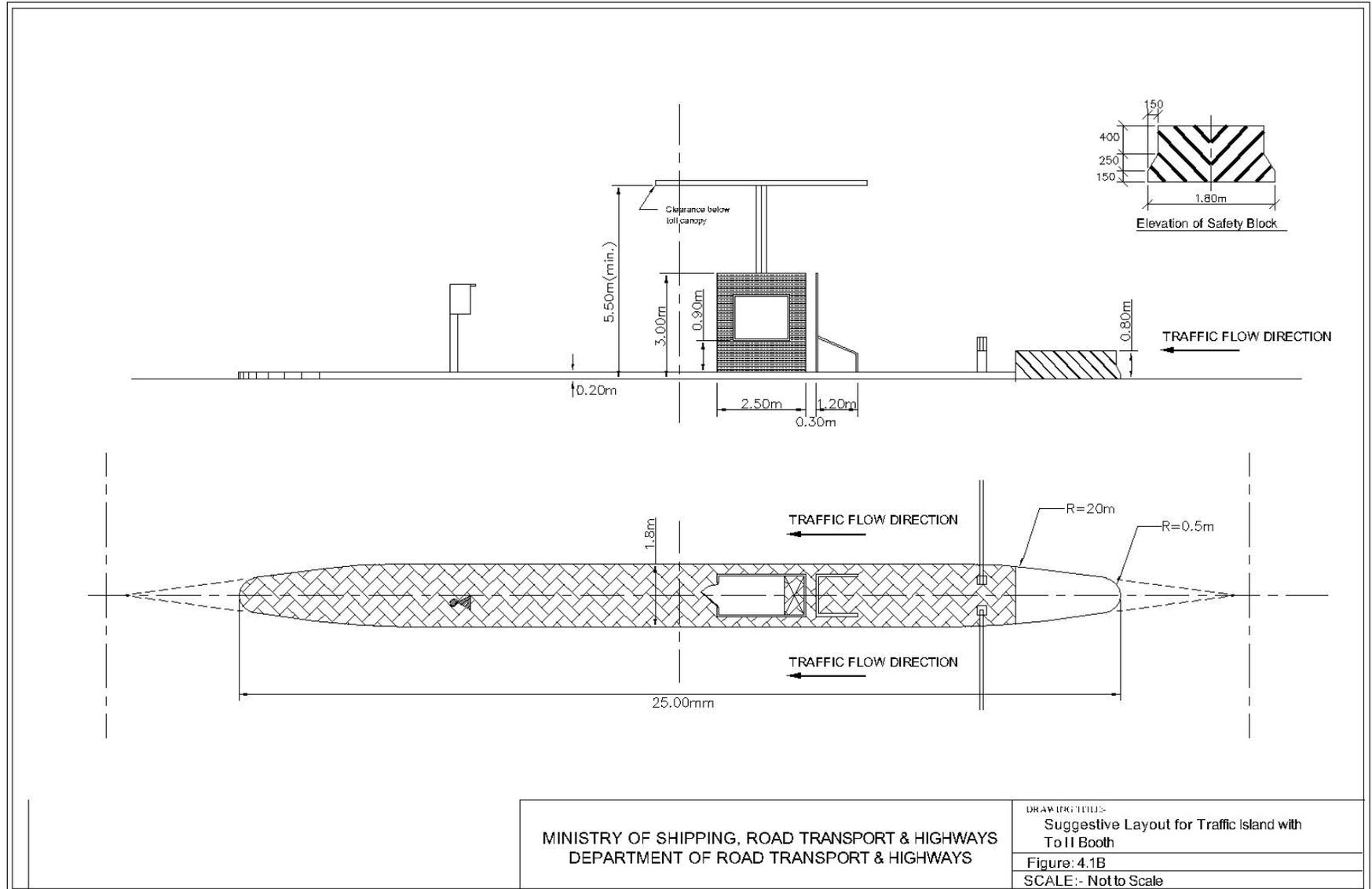


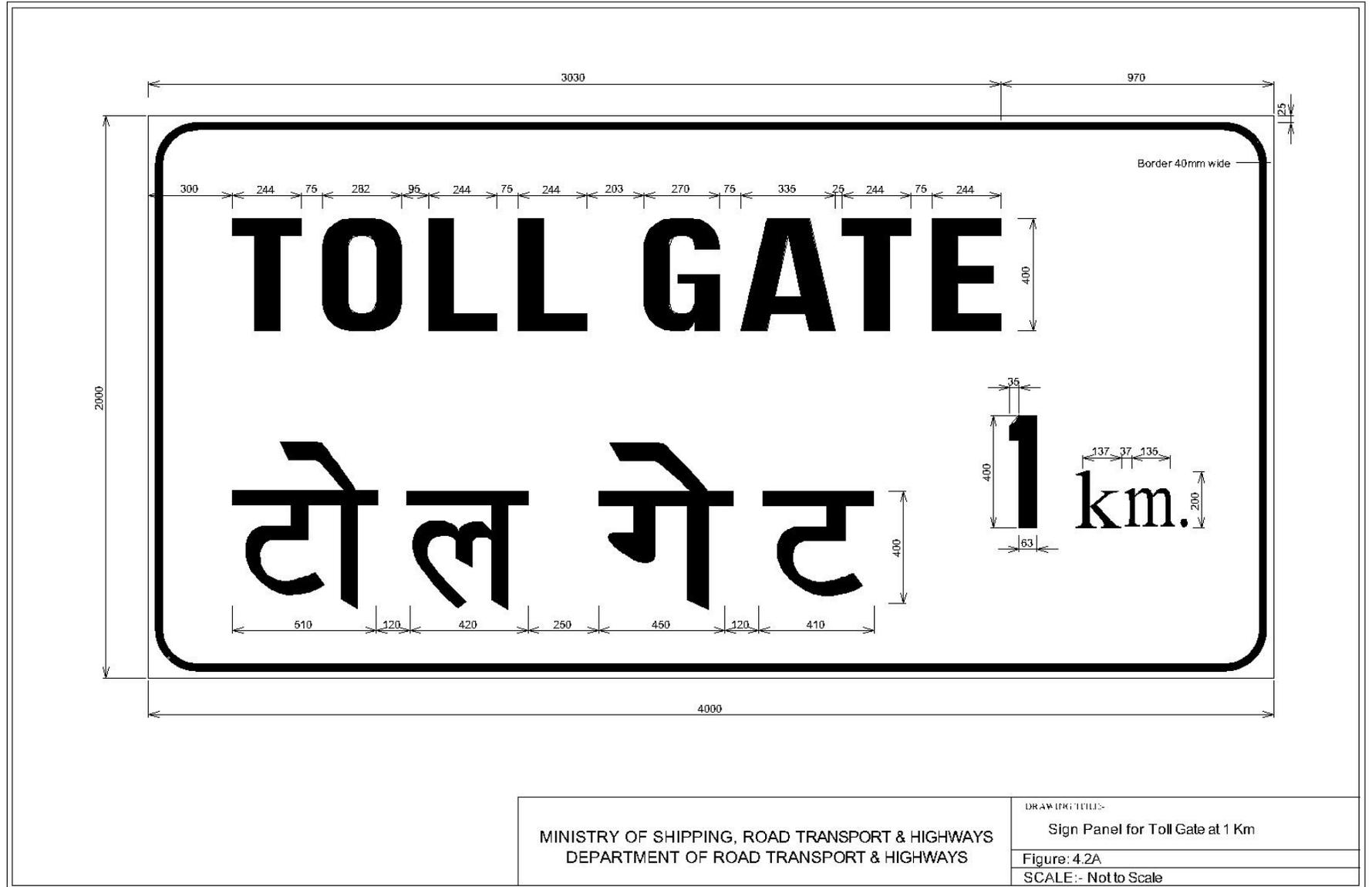
Note:-  
Detailed system of Road Markings as per IRC:35

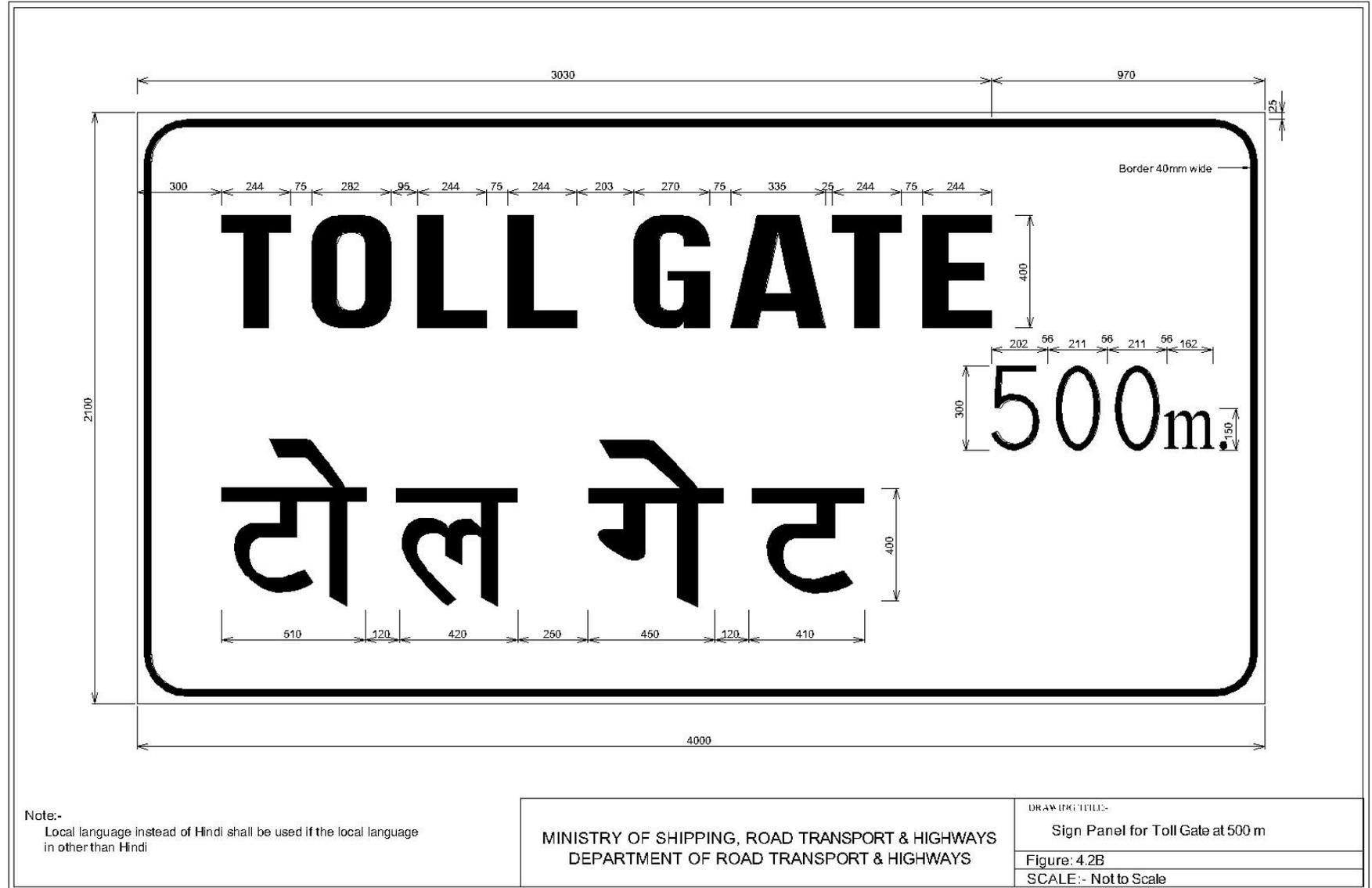
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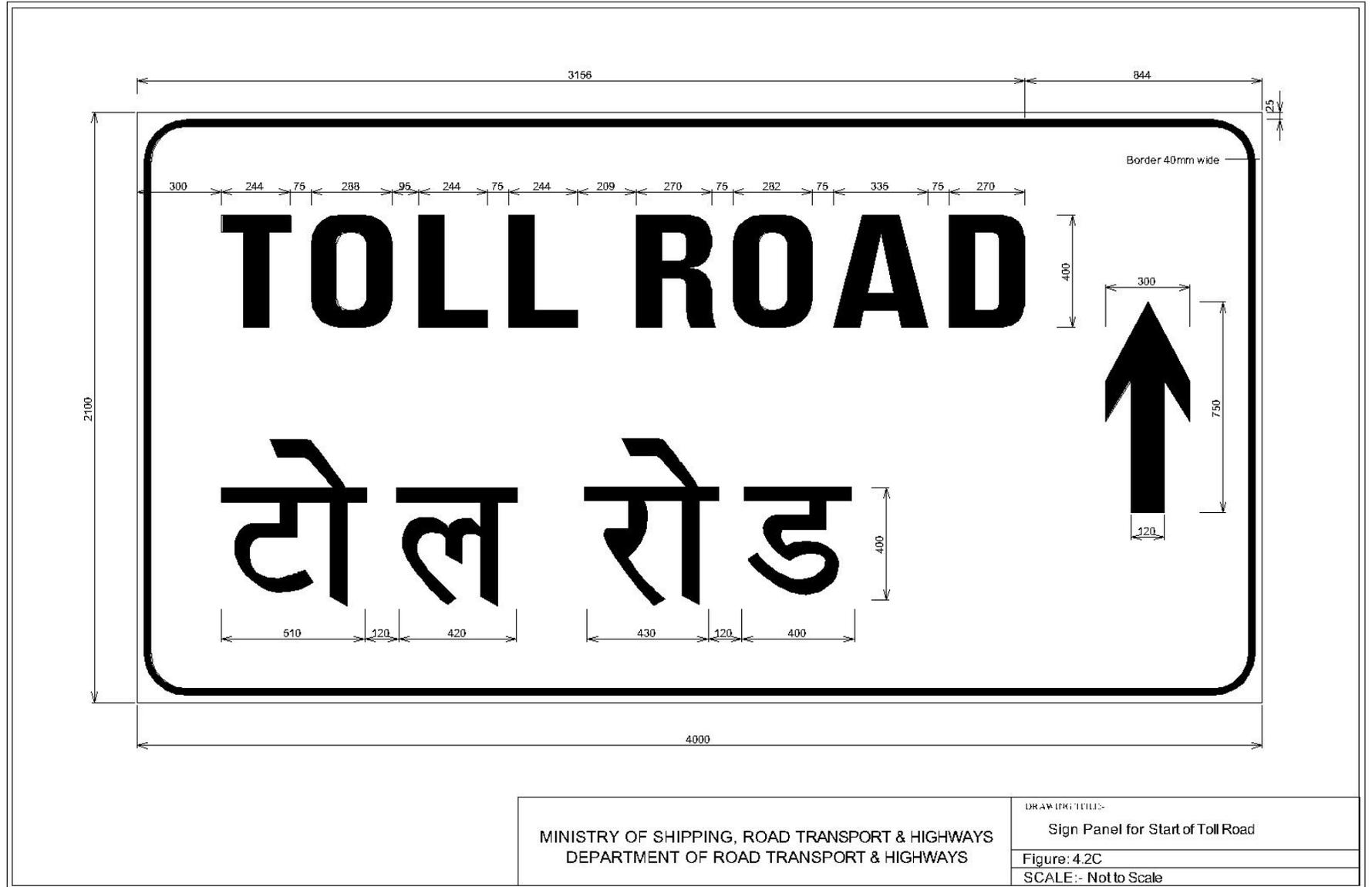
DRAWING TITLE:-  
Suggestive Layout for a Toll Plaza

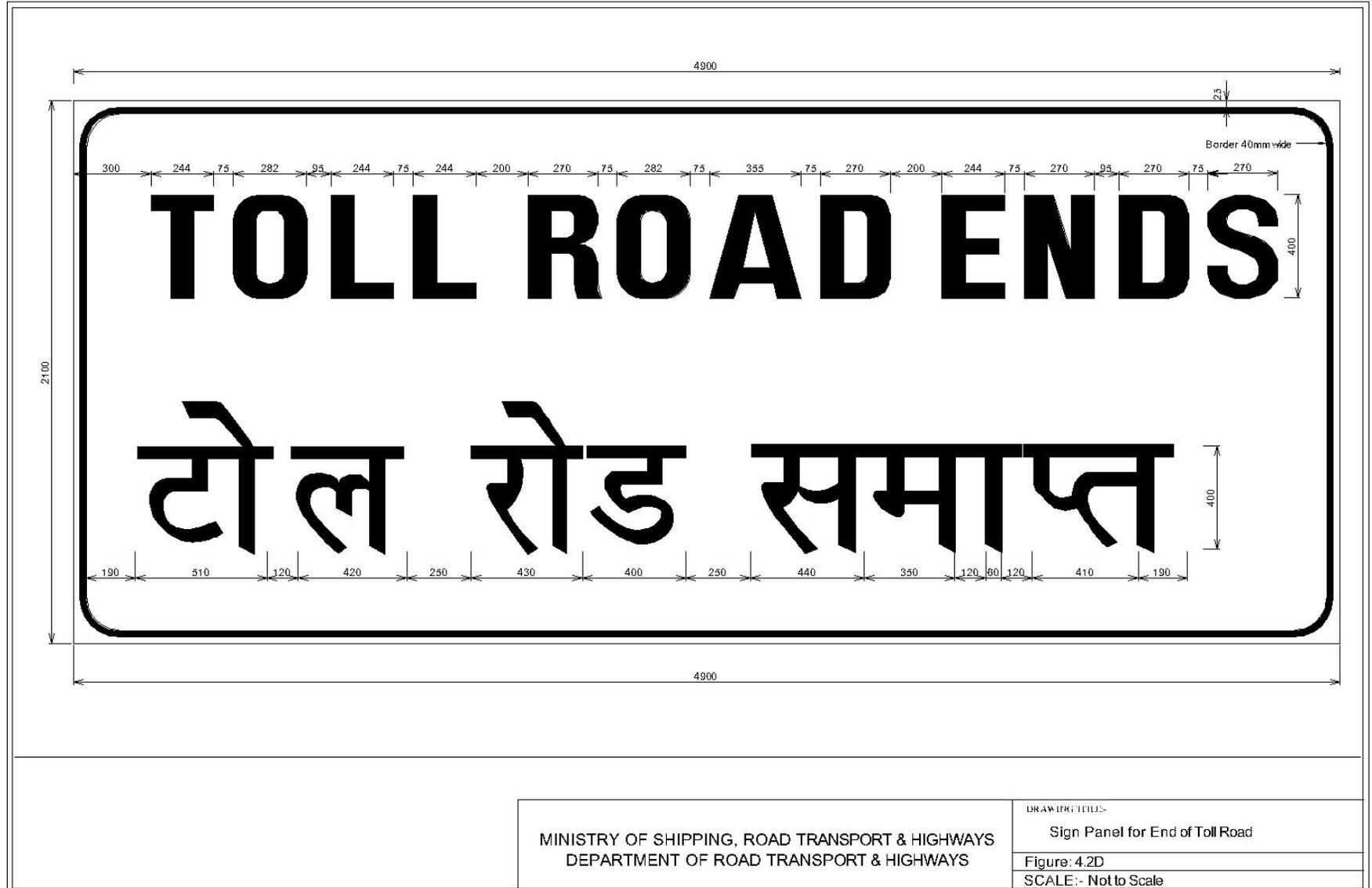
Figure: 4.1A  
SCALE:- Not to Scale

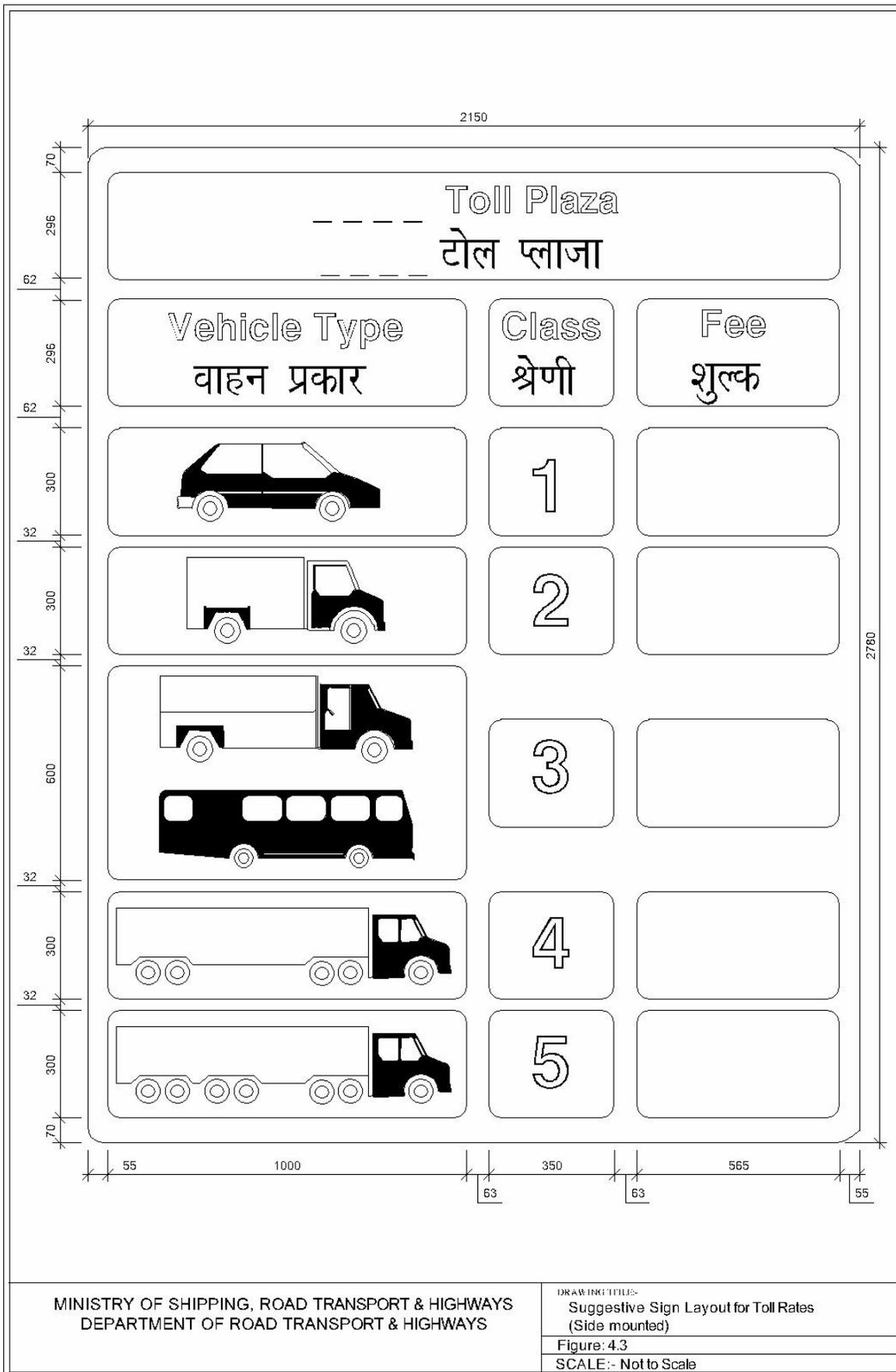


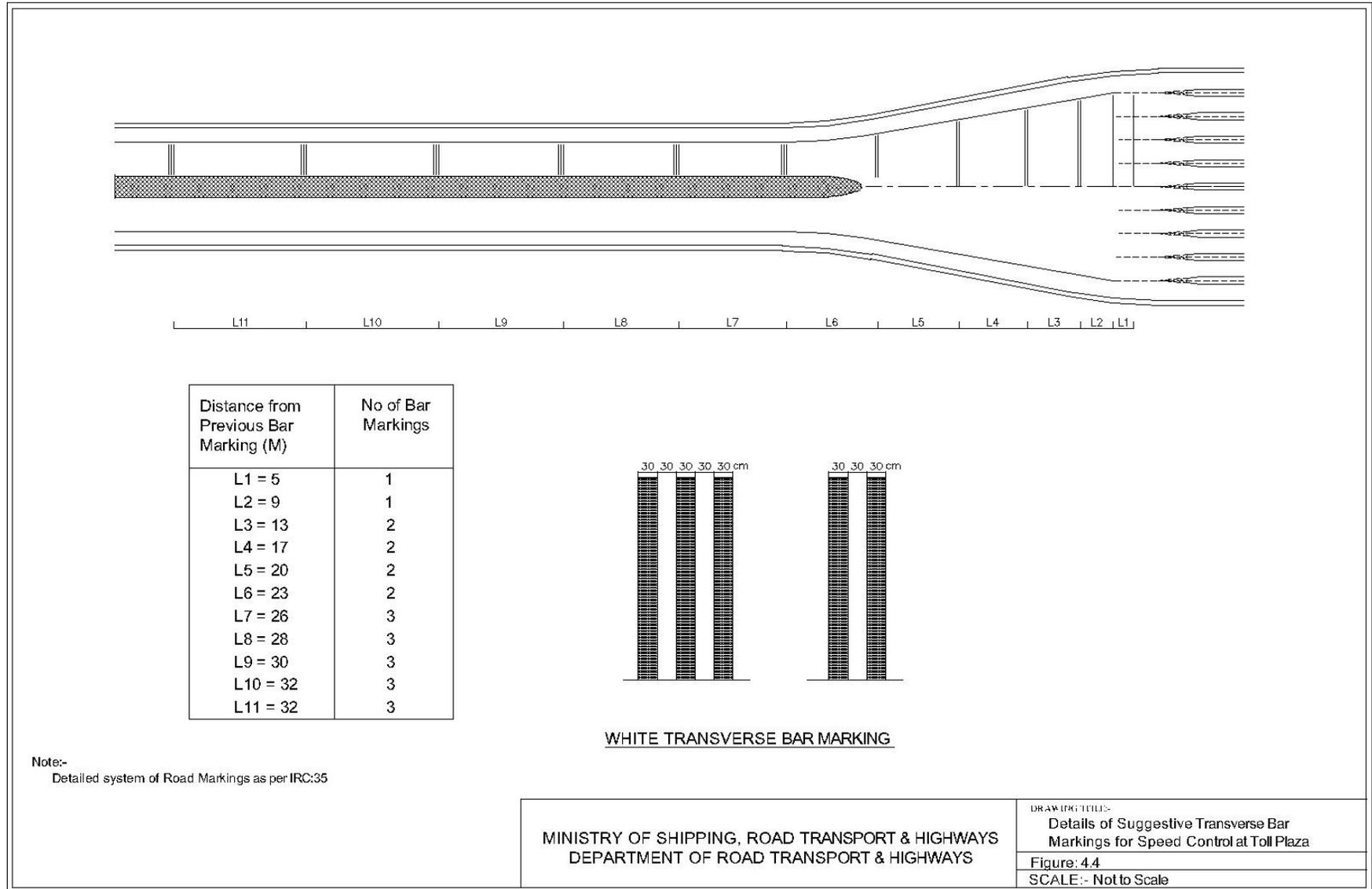


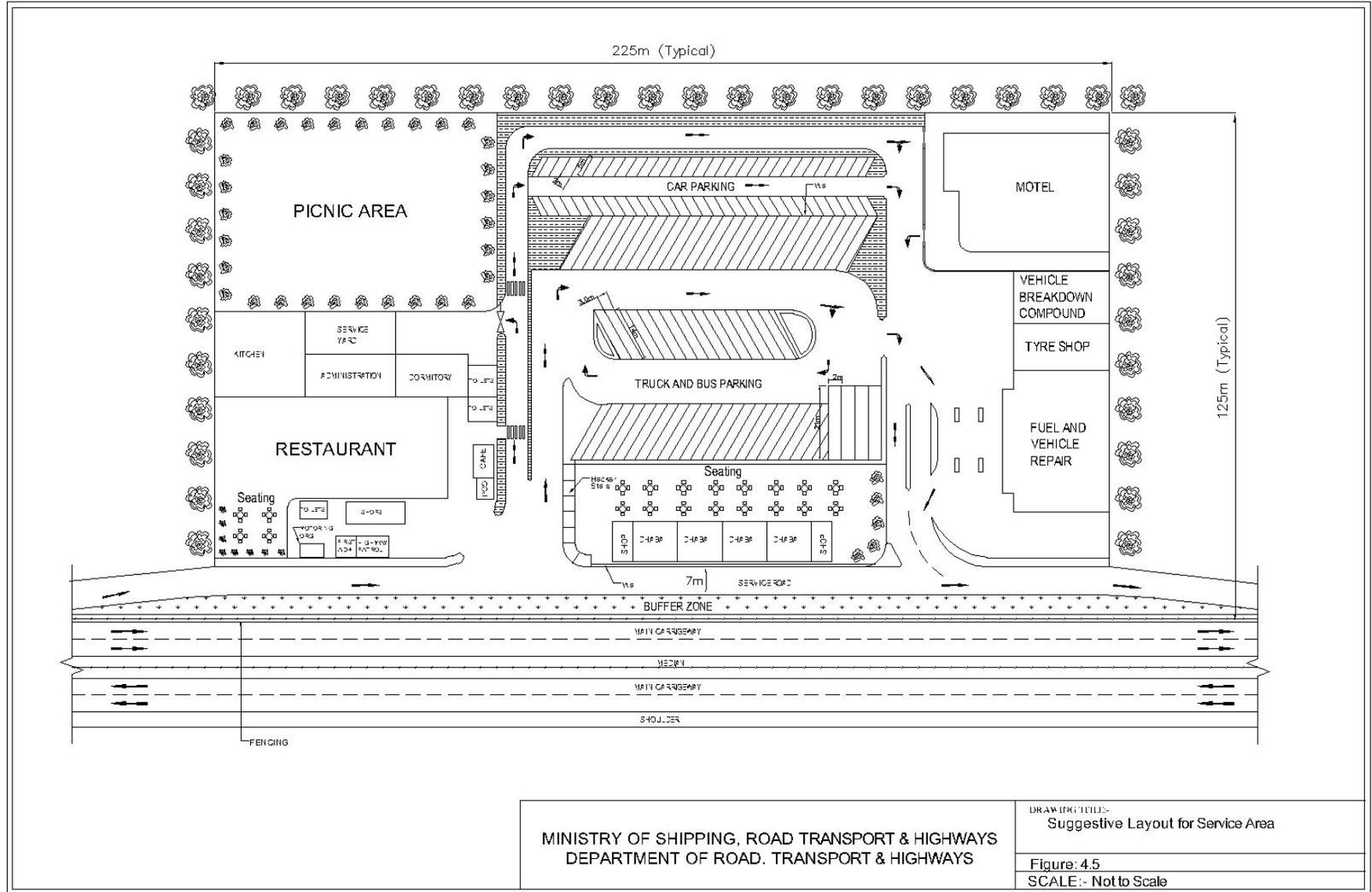












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DRAWING TITLE:-  
 Suggestive Layout for Service Area

Figure: 4.5  
 SCALE:- Not to Scale