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CODE OF PRACTICE FOR ROAD MARKINGS

(Second Revision)

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CODE OF PRACTICE FOR ROAD MARKINGS

INTRODUCTION

The Code of Practice for Road Markings; IRC:35 was first published by Indian Roads Congress in 1970 and thereafter was first revised in 1997. Since then, there has been development in current day traffic needs, technology, workmanship etc. Therefore, a need was felt to bring out revised version of the Code to include new concepts and materials for laying of road markings with latest technology so as to guide and control traffic on roads. Accordingly, the work of revision of this Code was taken up by the Transport Planning, Traffic Engineering and Road Safety Committee (H-1) during the tenure 2009-2011 under Convenorship of Shri S.C. Sharma. The first draft of revised document was prepared by the Sub-group comprising Dr. Geetam Tiwari (Chairman of Sub Group), Dr. Surinder Mohan, Shri Pawan Kumar Singh, and Shri Amandeep Singh. This draft was discussed in various meetings of H-1 Committee during the tenure 2009-2011.

The H-1 Committee was reconstituted in 2012 and was renamed as Transport Planning and Traffic Engineering Committee. The reconstituted H-1 formed a new sub-group comprising Dr. Geetam Tiwari (Chairman of Sub-Group), Dr. S. Velmurugan, Shri Jacob George, Shri Sudhir Kumar, Shri Pawan Kumar Singh and Shri Amandeep Singh. The draft prepared by the Sub-group was discussed in various meetings of H-1 Committee and the document was subsequently approved by the H-1 Committee in its meeting held on 26.07.2014 for placing before the HSS Committee.

The composition of the H-1 Committee is as given below:

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Velmurugan, Dr. S.	--------	Member Secretary

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(Das, S.N.), Director General (Road Development), Ministry of Road Transport & Highways
Secretary General,
Indian Roads Congress

The same draft was placed before the Highways Specifications and Standards Committee (HSS) during its meeting held on 9th August, 2014 and the HSS Committee approved this document subject to modifications in light of comments of members offered during the meeting. The Executive Committee in its meeting held on 18th August, 2014 approved the same document for placing it before the Council. The Council in its 203rd meeting held at New Delhi on 19th and 20th August, 2014 approved the document subject to incorporation of modifications in the light of comments offered during the meeting and authorized Convenor of HSS Committee to finalize the document for publishing.

SECTION : 1

1.1 General

1.1.1 Road Markings perform an important function of guiding and controlling traffic on a highway. The markings serve as a psychological barrier and thus help to signify the delineation of traffic path and its lateral clearance from traffic hazards facilitating safe movement. Further, the road markings channelize the pedestrians and cyclists movement into safe location and in effect, provide for an extension of the side walk/cycle track across the roadway. Road markings are therefore, indispensable to ensure smooth and orderly flow of traffic and for promoting road safety.

1.1.2 Notwithstanding some limitations, such as poor visibility when dusty or wet or obliteration by snow the frequent renewals of road markings have the advantage of conveying the required information to the road user without distracting the attention of the driver from

the carriageway. Unlike road signs, the road markings are not likely to be obscured and are not pruned to vandalism.

1.1.3 While some markings are provided in conjunction with road signs, most markings are provided independently. Road markings normally include longitudinal markings, transverse markings, text and symbols etc. on the road surfaces.

1.1.4 The road markings provided in existing roads should be subjected to safety audit to ensure their uniformity.

1.2 Scope

1.2.1 The objective of this code is to establish uniform system for road markings in India to provide guidance, procedures and recommendation on the type of road markings with details on dimensions including selection, installation and inspection procedure for different road marking materials.

1.2.2 The recommendation furnished in this Code is applicable to all categories of roads located in rural and urban areas.

1.3 Definition

Road markings are defined as lines, patterns, words except road signs which are applied or attached to the carriageway or kerbs or to objects within or adjacent to the carriageway for controlling, warning, guiding and informing the road users.

1.4 Authority

1.4.1 Markings where used, shall be uniform in design, position and application so that they may be recognised and understood immediately. A uniform set of markings applicable throughout the country may, therefore, be as prescribed by the Indian Roads Congress or updated by the Ministry of Road Transport and Highways from time to time.

1.4.2 The Authority to provide road markings on a particular stretch of public road should be decided by Road Authorities in consultation with police, wherever felt necessary.

1.4.3 Pavement and kerb markings being exclusively within the boundaries of public road should never be installed except by public authority. Installation of delineators and painting of objects, as a warning of hazardous locations should be performed under the control and approval of the authorities.

SECTION : 2
ROAD MARKING MATERIALS & GENERAL FEATURES

2.1 General

2.1.1 *The Commonly used Materials for Road Markings are:*

- Hot Applied Thermoplastic Compound
- Solvent borne and Waterborne Road Marking Paints

2.1.2 Other special material for road marking includes Cold Applied Plastics and Preformed Adhesive Tapes.

2.1.3 The Clause 803 of "Specification for Road and Bridge Works" published by the Ministry of Road Transport & Highways (MORTH) shall be referred for technical specifications of road marking materials.

2.2 Thermoplastic Markings

2.2.1 Thermoplastic is the most commonly used pavement marking material on roadways and is a mixture of plasticizer and resins that serves to hold all of the other ingredients together. The thermoplastics hot applied in molten state adheres to pavement and get solidified immediately at the ambient temperature.

2.2.2 Thermoplastic markings possess fast drying time and are highly durable. It has better retro reflective performance and service life than that of ordinary road marking paint. The service life of one application of thermoplastic can be upto 2 to 3 years, depending on traffic volumes.

2.3 Solventborne and Waterborne Road Marking Paints

2.3.1 Road marking paints are oldest form of pavement marking materials. It can be used for longitudinal line application in temporary work zone markings and also for those marking which are required for a very shorter period and can be removed thereafter easily.

2.3.2 The solvent-based and water-based are the two types of road marking paints. Water-based paint is environmentally friendly and is easier to handle compared to solvent-based paints and pose less safety hazards to workers. The road surface painted with water-based paints can be opened to traffic quicker than the road surface painted with solvent-based paints.

2.4 Cold Applied Plastics

2.4.1 For coloured pavement marking, the cold applied plastic is a better choice than road marking paints and thermoplastic materials. Cold applied plastics are the best means to provide audible raised pavement marking for edge lines.

2.4.2 Cold applied plastic is more durable than thermoplastic markings in retaining the original colour and luminance values. It can be applied to the surface in a variety of ways with

a superior finishing and has no need of large application equipment and can be easily carried in a medium sized van and a trailer.

2.5 Preformed Adhesive Tapes

2.5.1 Preformed tapes are available in continuous rolls of various lengths and widths, conforming to ASTM D4592-12 that is designed to provide service life of 3 to 6 months depending upon the wear and durability factor. Unlike road marking with sprayed or extruded materials, the preformed tapes do not require application equipment or experienced operators for applications and do not require drying or curing period.

2.5.2 The provision of preformed tapes would entail high initial cost than the other forms of road marking application, but would offer more service life in locations with high traffic volumes and are suitable for those locations that require frequent replacement of pavement markings.

2.5.3 Preformed tapes are also used for object markings and also for transverse lines in high-traffic areas.

2.6 Colour Pattern for Markings

The general colour pattern followed for road marking and various background surfaces are given below:

2.6.1 *White*

Because of the visibility and good contrast against the road surface, the white colour should be widely used for road markings.

2.6.2 *Yellow*

The longitudinal marking in yellow colour should be used to convey message where it is not permitted to cross the markings. Yellow colour is also used to show parking restrictions and to impose other traffic control. Yellow colour is defined as per IS Colour No. 356.

2.6.3 *Blue*

The blue colour should be used to indicate new and special markings which are not conventional. Blue is the colour of public transportation including three wheelers, scooter and rickshaws. The blue colour shall be used to indicate dedicated bus lanes in the Bus Rapid Transit (BRT) corridor on urban streets. In the bus lanes being marked across the intersection, the blue marking should be used to inform the road users that the lane is specifically meant for buses and other vehicle should not drive or stop in this lane.

2.6.4 *Green*

The green colour should be deployed to distinguish the bicycle and non-motorised transport facilities provided on the road. Green colour background should be marked at the intersection to give priority to the cyclists and pedestrians in crossing the road. When the motorized vehicles and non-motorized vehicles share the same carriageway, the green background

lanes are preferred. When dedicated non-motorized lanes are built, a special green cycle boxes should also be used.

2.6.5 *Red/Purple*

Where multiple road users are sharing the road space on hazardous locations, the red colour marking is primarily used to help people understand the danger. Red marking is highly recommended on hazardous intersections and also at places where pedestrians traffic conflict with the motorized traffic.

2.7 Visibility Related to Speeds

2.7.1 Road markings must be clearly visible both in day and night. Road markings become an important aid for drivers to follow the unlit roads at night where the visual cues on road sides are absent.

2.7.2 As a general requirement, the drivers need to be able to detect guidance markings at a distance equivalent to a minimum of two seconds of travel time. **Table 2.1** gives the minimum preview distance based on the criteria.

Table 2.1 Minimum Preview Distance for a Driver to React

Speed (kmph)	30	40	50	65	70	80	90	100	110	120
Preview Distance (m) 2 Seconds of Travel Time	17	22	28	36	39	44	50	56	61	67

2.7.3 Variety of factors influence the visibility distance of road marking. The visibility of the road marking gets enhanced when the line thickness is wider and with higher mark to gap ratio and also with higher coefficient of retro-reflective luminance. Therefore, larger pavement marking widths combined with higher coefficients of retro reflectivity are used to help drivers detect the lines according to design speed of roadway.

2.8 Retro Reflectivity

2.8.1 Retro reflection is accomplished in pavement-marking through the use of glass beads, partially embedded on the surface of the marking as binder material and also spread externally during application time as shown in **Fig. 2.1**. The quality of glass beads plays an important role in retro reflectivity of pavement-marking as the glass bead returns light from vehicle headlamp to a driver.

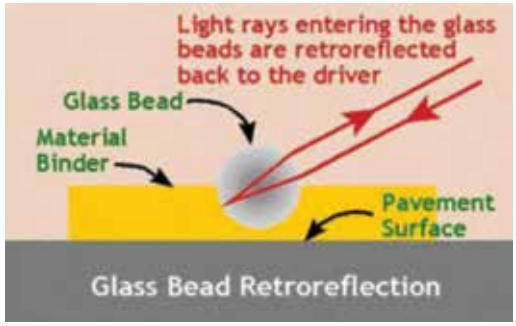


Fig. 2.1 Retro Reflectivity in Pavement-Marking using Glass Beads

2.8.2 Visibility distance is adversely affected by glare from oncoming vehicles, dirty head lamps or windscreen, especially during raining. The size of a glass bead can affect retro reflectivity, especially under wet conditions. Larger glass beads have slightly higher retro reflectivity than standard beads under dry conditions. When markings are wet, glass beads often turned out to be useless because the film of water that covers the marking causes light to scatter before it can enter the bead. This causes the wet markings to be nearly invisible at night. Large bead (minimum 1 mm thickness) is more effective when roads are slightly wet because the higher profile protrudes through the film of water better than small glass beads.

2.8.3 The requirements of night time brightness for road markings are given in Section 15 on Performance Assessment & Monitoring.

2.9 External Factors Influencing Marking Performance

2.9.1 Many factors influence the performance of a given pavement marking material. The major factors can be grouped into three categories such as i) roadway surface; ii) traffic and iii) environmental.

2.9.2 The factors influencing the performance of different pavement marking material should be considered in the material selection process. Prior to marking, the pavement surface shall be clean and dry to achieve proper pavement marking performance.

2.9.3 All types of materials are very sensitive to the variables governing the application and hence warrant strict quality control during application. The key variables that influence the durability and retro reflectivity performance of pavement markings are:

i) material composition;

ii) application procedure;

iii) application machines;

iv) roadway surface and

v) presence of immediate traffic.

SECTION : 3
CLASSIFICATION OF PAVEMENT MARKINGS

Pavement Markings are broadly classified into following seven categories based on the placement of markings with regard to vehicular movement and also based on the function of the markings.

i. Longitudinal Marking (LM)
ii. Transverse Marking (TM)
iii. Hazard Marking (HM)
iv. Block Marking (BM)
v. Arrow Marking (AM)
vi. Directional Marking (DM)
vii. Facility Marking (FM)

The pavement markings are accordingly abbreviated and given in **Table A.1 to A.7 of Annexure A**, presented as figures with details and dimensions along with colour pattern etc.

3.1 Longitudinal Marking (LM)

The longitudinal marking are generally provided along the traffic movement. The broken lines, single/double continuous lines and continuity lines are classified under Longitudinal Marking and abbreviated as LM01, LM02, LM03 etc. for easy referencing as given in **Table A.1**. The applications of these markings are described in respective sections.

3.1.1 As traffic moves forward, the broken longitudinal markings can be crossed, whereas continuous longitudinal markings shall not be crossed.

3.1.2 The purpose of longitudinal marking is to navigate the driver for forward movements and to prohibit overtaking manoeuvring at certain at hazardous locations. In a multi-lane road, the lane boundary established by longitudinal marking really guide to avoid side swipe and head on collision accidents.

3.1.3 The continuous longitudinal marking line can be single and double lines and are not expected to cross in normal condition. The double continuous lines are used to make the compliance prominent and to reinforce the message that it shall never be crossed. In urban roads having space constraints, the construction of raised median will reduce the traffic able width in roads and double prohibitive marking is always a solution to streamline the traffic, provided the road user behaviour is mature enough to have strict compliance.

3.1.4 The continuous longitudinal marking in yellow colour is to signify that the marking provided is strictly prohibitive in nature and not to be straddled by the vehicles.

3.2 Transverse Markings (TM)

The marking provided across the carriageway for traffic control with broken lines, single/ double continuous lines such as Stop marking and Give way marking are classified under

Transverse Marking (TM) and are abbreviated as TM01, TM02, TM03 etc. as given in **Table A.2**. The applications of these markings are described in respective sections.

3.2.1 The transverse marking establishes the traffic control, lest it would lead to crashes, and therefore, its compliance is vital. The road authority shall always ensure the installation of transverse marking and continued maintenance.

3.2.2 The transverse marking shall always be accompanied with corresponding sign.

3.3 Hazard Marking (HM)

The pavement marking that facilitating traffic merging/diverging, prohibiting to cross-over and to deflect the traffic ahead of hazardous situations, generally done with like chevron and diagonal marking, hatch marking and prohibitory marking and such markings are classified under Hazard Marking and are abbreviated as HM01, HM02, HM03 etc. as given in **Table A.3**. The applications of these markings are described in respective sections.

3.3.1 Since hazard marking are provided ahead of diverging and merging and around a hazardous location, its compliance is also vital. The hazard marking shall always be accompanied with appropriate sign.

3.4 Block Marking (BM)

The zebra crossing for pedestrians, triangular and checkered marking for speed breakers and Giveway symbol which are painted in blocks on carriageway are classified under Block Marking and are abbreviated as BM01, BM02, BM03 etc. for easy referencing as given in **Table A.4**. The applications of these markings are described in respective sections.

3.4.1 The application of thermoplastic paint for block marking is generally different from longitudinal marking. The quality of block marking with adequate visibility is of utmost importance.

3.5 Arrow Marking (AM)

The arrows painted on carriageway are meant to give direction for driver to take mandatorily and are classified under Arrow Marking and are abbreviated as AM01, AM02, and AM03 etc as given in **Table A.5**.

3.6 Directional Marking (DM)

The word message which are directional nature are classified under Directional Marking and are abbreviated as DM01, DM02, DM03 etc. for easy referencing as given in **Table A.6**. The applications of these markings are described in respective sections.

3.7 Facility Marking (FM)

The marking for parking, the word messages for buses, cyclists and disabled ones are classified under Facility Marking and are abbreviated as FM 01, FM 02, FM03 etc. for easy referencing as given in **Table A.7**. The applications of these markings are described in the respective sections.

3.8 Colour of Pavement markings

3.8.1 The colour of pavement upon bituminous surface of black colour shall be as given in **Table A.1 to A.7 of Annexure A**.

3.8.2 The marking upon concrete shall be yellow in colour in order to bring forth sharp contrast with natural colour of concrete surface to make them conspicuous.

3.8.3 The marking upon pavement of different colour or texture shall be as given in **Section 2.6.3 to 2.6.5** unless otherwise specified by road authorities.

3.9 Applications

3.9.1 The application of various markings categorised under Longitudinal Marking (LM), Transverse Marking (TM), Hazard Marking (HM), Block Marking (BM), Arrow Marking, (AM), Directional Marking (DM) and Facility Marking (FM) are covered under the following sections.

Section 4: Markings for Road Links

Section 5: Road Studs

Section 6: Stop & Giveway Markings

Section 7: Markings for Transition & Lane Change

Section 8: Arrows & Word Messages

Section 9: Marking for At-Grade Intersections

Section 10: Grade Separated Junctions

Section 11: Markings for Speed Reduction Measures, Pedestrian & Cyclist

Section 12: Markings for Buses, Truck Lay-by and Toll Plaza

Section 13: Parking and Restrictions

3.9.2 The clients, consultants and contractors while referring various pavement markings shall use these marking abbreviations with view to achieve uniformity and consistency in pavement marking both during design as well as implementation stages.

SECTION : 4
MARKINGS FOR ROAD LINKS

This section covers the line marking required for mid-block sections where the cross section remains the same either for at-grade location or for grade separated structures, which are provided to navigate drivers and guidance for the traffic movement. Various line markings include center line, warning line, edge line, no overtaking line and typically applied to various situations like undivided road, divided carriageway roads, and one-way street/ramp/slip roads.

4.1 Center Line

The center lines should be used only on single carriageway roads to separate the opposite streams of traffic and to facilitate their movements. Generally center line is placed at the centre of carriageway, but under following circumstances, the center line may not be located at the centre position:

- Carriageway width transition location
- Additional turning lanes at junctions
- Odd number of lanes on vertical and horizontal curves with limited sight distances
- Urban roads with parking permitted on one side only
- Urban roads with odd number of lanes with extra lanes allotted to the predominant direction of flow.
- On curves with extra widening

4.1.1 On unimportant roads with less than 5.5 metres wide carriageway, center lines are considered undesirable as these entail discomfort and hazard, where drivers might expect a road marked with a centre line to be wide enough for opposing lane of traffic to pass. However, for short sections, centre line can be provided like on approaches to busy intersections, pedestrian crossings, level crossings, horizontal and summit curves with restricted sight distance and on locations where driver's visibility is reduced e.g. due to frequent foggy weather conditions.

4.1.2 When the pavement is widened on curves, the center line should be placed in such a manner that the width of the traffic lanes on both approaches of the curves will be maintained around outside curve. This will necessitate the center line marking being off center as far as the total width of pavement is concerned, but at the same time it will give the traffic using the inner lane to have more manoeuvring width than outer lane and details are given in **Section 4.3.6**.

4.1.3 The line marking at the centre of a ramp or slip road or one-way street will be traffic lane line and shall be a broken line.

4.1.4 If the center line is to be painted on the pavement on the approaches to a bridge, it shall be continued over the bridge provided that the width between the kerbs is 6 m or more.

Otherwise the centre line marking on approaches should be discontinued at 30 m to 35 m distance from each abutment of the bridge.

4.1.5 On undivided carriageway where two lanes are available for one direction, double centre line should be used to separate the opposite stream of traffic. The double centre line with hatch marking will be effective in acute curves to avoid head on collision accidents, as it would be more appealing in separating the opposing traffic.

4.1.6 The width, length and spacing of marking segments depending on speed and category roads are presented for all types of roads in **Section 4.6**.

4.2 Traffic Lane Lines

4.2.1 The carriageway having two or more in one direction are divided into separate lanes by traffic lane line marking for vehicles to move in proper lanes and to discourage the meandering tendency of the drivers, thereby promoting safety and ensuring maximum capacity. At intersections and on approaches thereto, marking of traffic lanes eliminates confusion and facilitates through and turning movements. Traffic lanes should also be marked near pedestrian crossings and at other dangerous locations in rural and urban area, in congested area where the carriageway can accommodate more than one lane and also on important one way streets. Since respect for road markings grows with proper usage, traffic lane should not be marked indiscriminately.

4.2.2 Application of Traffic lane lines markings on divided carriageway and one-way or ramps are discussed in **Section 4.7 and Section 4.8**.

4.2.2 Traffic lane line markings are only provided where there is at least one lane width as per relevant IRC is available between two traffic lane lines or between a traffic lane and edge or centre line. Invariably, the traffic lane line shall be avoided if lane width cannot be accommodated between two longitudinal markings, lest it may lead to side swipe accidents.

4.3 No Overtaking Lines

4.3.1 No overtaking zones shall be established on summit curves, horizontal curves and elsewhere on two and three lane highways where overtaking manoeuvring must be prohibited because of restricted sight distances or other hazardous conditions.

4.3.2 On undivided highways with more than 3 lanes, there is hardly any need for vehicles to cross the center line for overtaking. The double solid centre line prescribed for such highways is to be regarded as continuous no-overtaking marking, which is not to be crossed on either side. The no-overtaking zone shall be marked by a solid line either single or double along the centre.

4.3.3 The ladder hatching is another effective way of center line marking to emphasis on the no-overtaking zone. The ladder hatch also will have two solid lines separated by minimum 600 mm and longitudinal marking shall be either 100 mm or 150 mm. The diagonal of 200 mm width shall be provided at 4 m for speed up to 65 kmph and 6 m spacing for speed exceeding 65 kmph. i.e. HM10/HM11/HM12/HM13.

4.3.4 No overtaking zone markings shall be marked when the sight distance available is less than the Minimum Visibility Distance (MVD) given in **Table 4.1**. A simple procedure to establish no-overtaking line in a 2-lane bi-directional road is given below.

4.3.5 *Procedure to establish No Overtaking Central Line*

The simple procedure given under using the sighting poles and shall be read in conjunction with **Fig. 4.1** and **Table 4.1**, where Minimum Visibility Distance (MVD) is defined and distance at which an object of 1.05 m above the carriageway can be seen by an observer, taking count of both vertical and horizontal curvatures. The steps involved are:

Step 1 – Determine 85th percentile speed for each direction of travel and find the Minimum Visibility Distance (MVD) from **Table 4.1**.

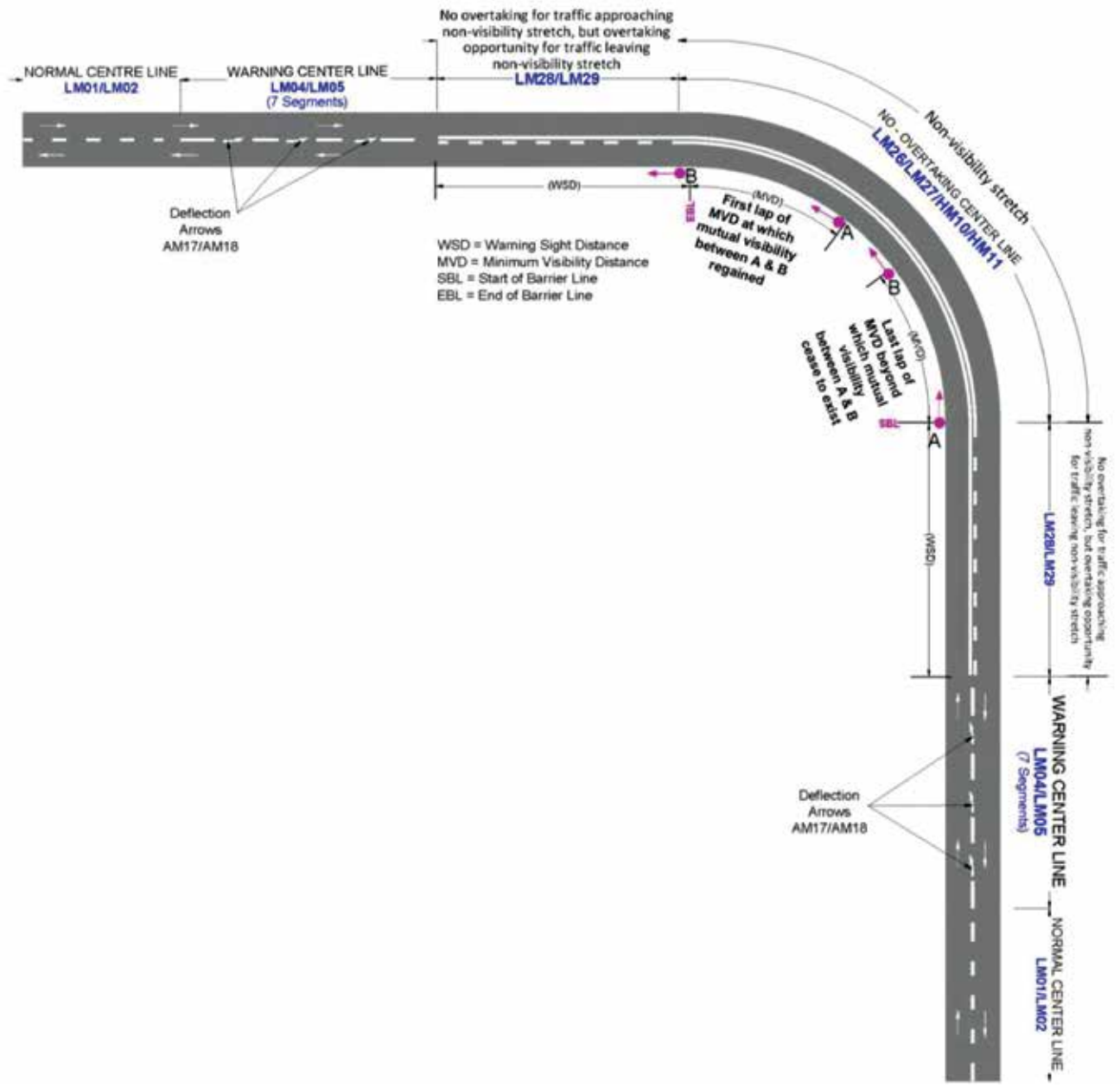


Fig. 4.1 Procedure to Establish No-Overtaking Center Line

Step 2 – As shown in **Fig. 4.1**, the Person A & Person B will be positioned and are mutually visible at a distance of MVD apart. Then they are allowed to move forward, retaining the same MVD distance between A & B always.

Step 3 – As they are walking in the inner edge of curve, identify the last lap of MVD, beyond which minimum mutual visibility between person A & B ceases to exist and the position of person A will be the one extremity of the No-overtaking centre line and marked as Start of Barrier Line (SBL).

Step 4 - Further when the persons A & B continue their walk, by still retaining the same MVD distance apart, one need to identify the first lap of MVD, in which the mutual visibility between A & B is regained, wherein the position of person B would be the other extremity of the No-overtaking centre line and marked as End of Barrier Line (EBL) and the same will be considered as non-visibility stretch for the speed considered.

Step 5 - There will not be any opportunity for traffic approaching curves for a length equivalent to Warning Sight Distance (WSD) from the start of non-visibility stretch. Hence as shown in **Fig 4.1,** a length of WSD in both approaches to non visibility stretch shall be marked with a double line comprising a continuous line and a broken line that prevent overtaking for those traffic approaching non-visibility stretch. However the same section would allow overtaking for those traffic leaving the non-visibility stretch and may be marked as LM28/ LM29 as appropriate.

Step 6 – The both approaches of No-overtaking centre shall be marked with seven segments of warning central line described in **Table 4.1** and defecting arrows.

Table 4.1 Minimum Visibility Distance and Warning Sight Distance

85th Percentile Speed (kmph)	Minimum Visibility Distance (MVD) in meters	Warning Sight Distance (WSD) in meters
Up to 50	75	120
51-65	120	180
66-80	170	240
More than 80	240	330

4.3.6 On horizontal curves, where the carriageway has been widened, the centre line shall not be so marked as to equally divide the carriageway in all the cases. Where radius of a curve is below 60 m, the placement of the centre line shall be as given in **Table 4.2** and also presented in **Fig 4.2**.

Table 4.2 Ratios in which Carriageway should be Divided on Either Side of the Centre Line at No-Overtaking Zones

Ri in metres	10-15	16-20	21- 30	31- 60	Over 60
ei/ea	1.4	1.3	1.2	1.1	1.0

Ri = Radius of inner edge of curve

(ei+ea) = Normal carriageway width plus extra widening required at curves

ei = Width of carriageway on inner side of the curve from the center line

ca = Width of carriageway on outer side of the curve from the center line.

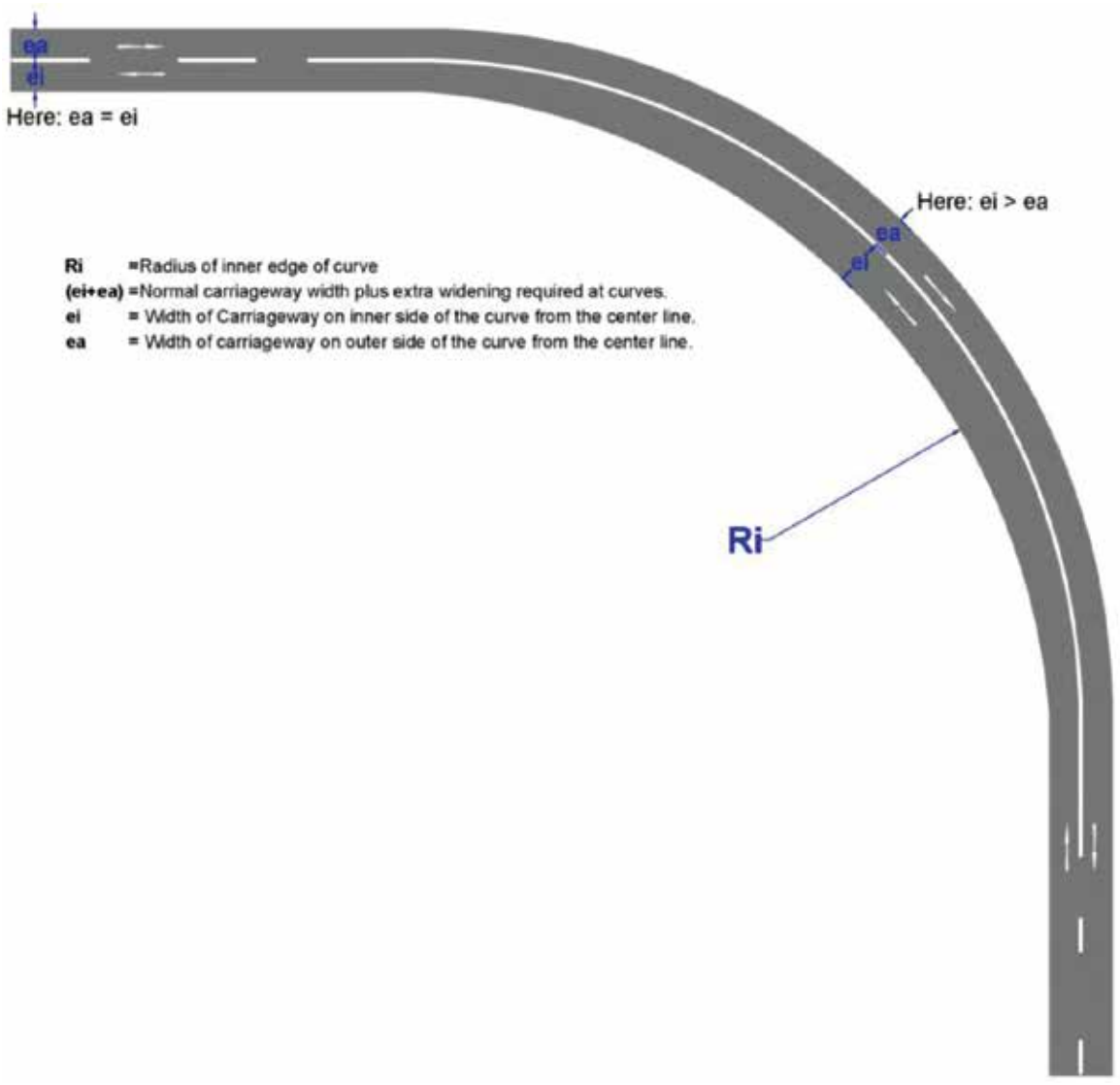


Fig. 4.2 Center Line in Extra Widened Curved Portion

4.3.7 On acute curves, if the paved portion is more than the extra widening required indicated above (i.e. carriageway width > (ei+ea)), thus enabling vehicles on both directions of travel to negotiate the bend with reasonable comfort without crossing the lines, the no-overtaking lines can be splayed to form a shape of central island with an internal width of at least of 600 mm. The area within the splay and parallel section must be hatched with inclined 150 mm thick lines at 4 m or 6 m spacing, as indicated in **Fig. 4.3**. It should be installed with unidirectional road studs to make the lines prominent to drivers.

4.3.8 The no-overtaking zone lines should be marked always with road studs.

4.4 Warning Lines

4.4.1 Warning lines are broken lines and are marked on horizontal and vertical curves where the visibility is greater than Minimum Visibility Distance (MVD), but less than the Warning Sight Distance (WSD) given in **Table 4.1**.

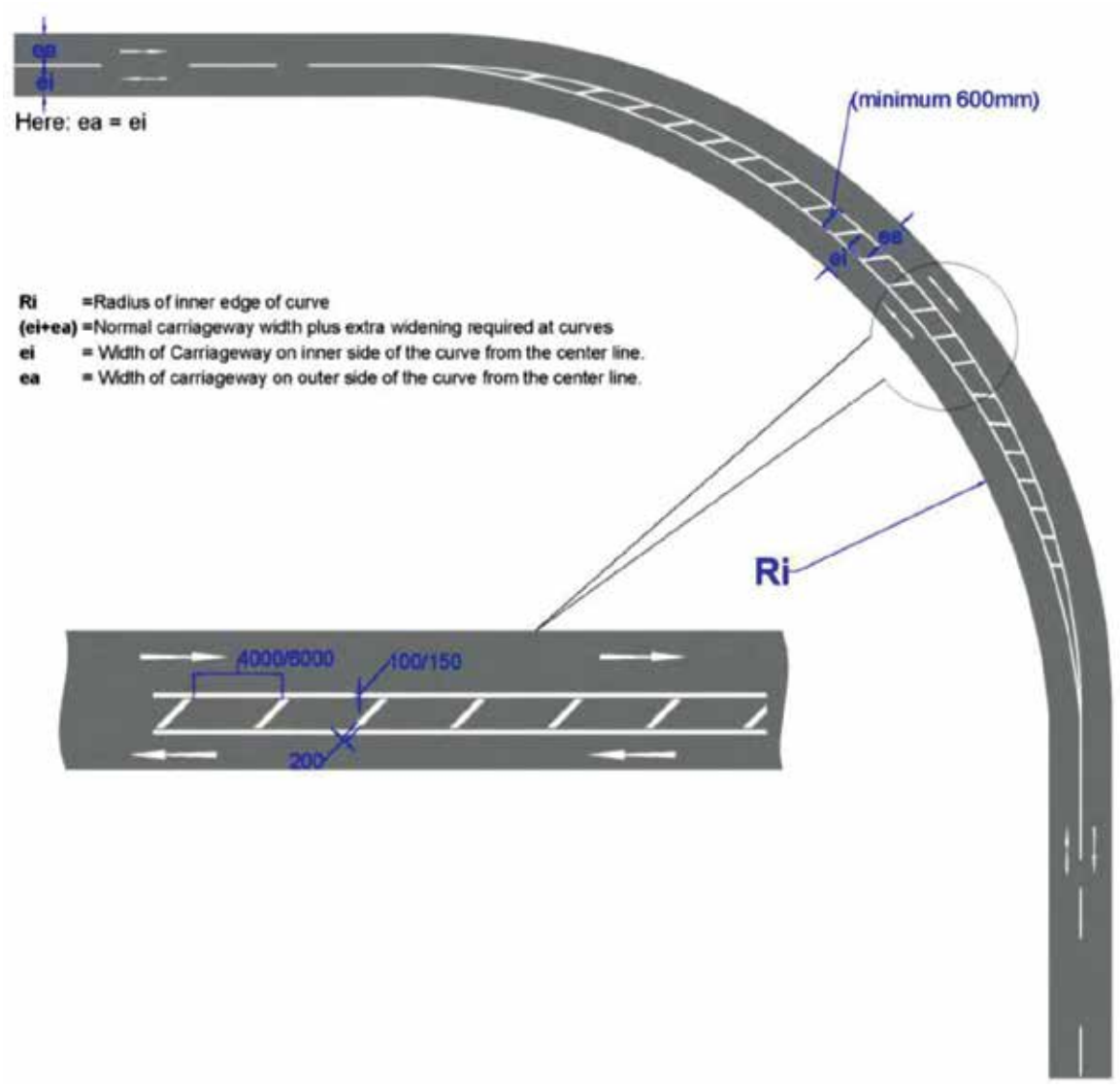


Fig. 4.3 Ladder Hatching as Center Line

4.4.2 Warning lines are always single and they should never be used as part of a double line installation (no overtaking zone). Ahead of any continuous barrier line, a minimum of 7 line segments of warning line shall be provided at all locations.

4.4.3 Warning lines are also used in lieu of centre lines and lanes lines at hazardous locations like approaches to intersections and sharp curves and obstruction approaches etc. and generally seven segments of warning lines are provided. The width of the warning line should be equal to the width of centre line/traffic lane line immediately preceding it, but length of the segment and gap are reversed to make them warning lines.

4.4.4 Warning lines are preferred at mid-block sections passing through urban and ribbon settlements and also at locations where by virtue of some external factors or the absence of street lighting minimise the visibility of normal traffic lane line or centre line. At such locations, normal broken lines (i.e. segment and gap can be reversed) to be warning lines in order to make the broken lines look more conspicuous.

4.5 Border or Edge Lines

The border or edge lines are intended to indicate end of the carriageways and thus help to delineate the limits up to which driver can safely venture. This continuous guideline makes night driving comfortable during inclement weather.

4.5.1 The pavement edge lines are desirable at the following locations:

- Where the shoulder is paved and is of similar texture and colour to the main carriageways:
- In advance of and near narrow bridges and around sharp curves;
- Where obstructions on the shoulder are close enough to constitute a hazard to the motorist;
- On pavement width transitions;
- On heavily trafficked two and three lane roads where head lamp dazzle is severe; and
- Along lengths which are prone to fog and mist.

4.5.2 Carriageway edge lines shall ordinarily be provided only on roads with two or more than two lanes. These shall be in the form of a single continuous white line placed on the carriageway 150 mm from the edge.

4.5.3 On multi-lane road with central median the carriageway edge line shall be 150 mm wide and on expressway the width shall be 200 mm. Where flush kerbs are provided, the edge lines should be superimposed.

4.5.4 Edge line provided all along the raised kerb, both median side or footpath/raised kerb on shoulder side shall always have the setback distance to the extent possible which shall not be not less than 200 mm from the vertical face of kerb. This is, to prevent the edge lines from generally getting buried beneath with mud and dust or sometimes witnessing water stagnation, as the water may get accumulated at the corner of raised kerb, lest the safety performance of such important alignment delineating edge lines would be nullified.

4.5.5 For two directional roads with less than 7m paved width, due to space constraints to place edge, it can be 100 mm.The edge line is preferable, as it would guide the driver to judge the alignment especially during the night time for locations with reduced visibility.

4.5.6 The border or edge line markings should not be carried across the mouths of side roads, but shall be continued with continuity line. Continues edge line shall be broken continuity line in case of merging/diverging for slip roads, auxiliary lanes, for bus and truck laybyes and at locations where median are discontinued for traffic turning. Invariably edge line shall be continued through and through either with continuous line or with broken continuity line.

4.6 Longitudinal Marking for Undivided Roads

4.6.1 The centre line markings of 3 m Mark + 6 m Gap of 100 mm/150 mm are used for normal sections. (i.e. LM01/LM02). However, when it entered into warning section, it shall be 6 m Mark + 3 m Gap of 100 mm/150 mm (i.e. LM04/LM05) and continued as single or double or ladder hatching on no-overtaking section.

4.6.2 The traffic lane line marking of 3 m Mark + 6 m Gap of 100 mm/150 mm are used for normal sections (i.e. LM01/LM02). However, when it entered into warning section, it shall be 3 m Mark + 3 m Gap of 100 mm/150 mm (i.e. LM11/LM12) and continued as single or double or ladder hatching on no-overtaking section.

4.6.3 **Table 4.3** along with **Figs. 4.4 to 4.8** presents a summary of line markings for undivided roads in mid-block sections. The longitudinal marking at other places will be dealt separately at respective sections like junctions, lay byes and merging and diverging locations.

Table 4.3 Longitudinal Marking for Undivided Roads

Description			Normal Section			Warning Section			No Overtaking Section			Reference
Road Category	Traffic Movement	Carriage Way	Centre Line	Edge Line	Traffic Lane Line	Centre Line	Edge Line	Traffic Lane Line	Centre Line	Edge Line	Traffic Lane Line	
Single/ Intermediate Lane Road	Two way	<5.5 m	NA	LM23	NA	NA	LM23	NA	NA	LM23	NA	Fig. 4.4
Two Lane Road	Two way	5.5 m to 7 m	LM 01	LM 23	NA	LM04	LM23	NA	LM23	LM23	NA	Fig. 4.5
Two Lane Road with Paved Shoulder	Two way	>7 m	LM02	LM24	NA	LM05	LM24	NA	LM23	LM24	NA	Fig. 4.6
Three Lane Road	Two way	>11 m	HM10/ HM11	LM24	LM02	HM10/ HM11	LM24	LM12	HM12/ HM13	LM24	LM23	Fig. 4.7
Four Lane Road	Two way	>14	HM10/ HM11	LM24	LM02	HM10/ HM11	LM24	LM12	HM12/ HM13	LM24	LM23	Fig. 4.8

Note: Refer Annexure A for details of markings abbreviated in the Table and Figures above and Refer **Table 5.1** for Road Studs details

4.6.4 **Fig. 4.4** presents longitudinal marking at mid-block section of single or intermediate lane roads, where the carriageway is less than 5.5 m and is given for normal, warning and no-overtaking sections. The centre line is not preferred for paved width less than 5.5 m, however can be considered for some critical sections based on the merits.

Fig. 4.4 Single/Intermediate Lane Bi-Directional Road (less then 5.5 m)

4.6.5 **Fig. 4.5** presents longitudinal marking at mid-block section for two lane roads, where the carriageway is 5.5 m to 7 m without any paved shoulder.

Fig. 4.5 Two Lane Bi-Directional Road

4.6.6 **Fig. 4.6** presents longitudinal marking at mid-block section for two lane roads with paved shoulder. If the carriageway is wide enough, double centre or ladder hatch marking can be considered at no overtaking zones.

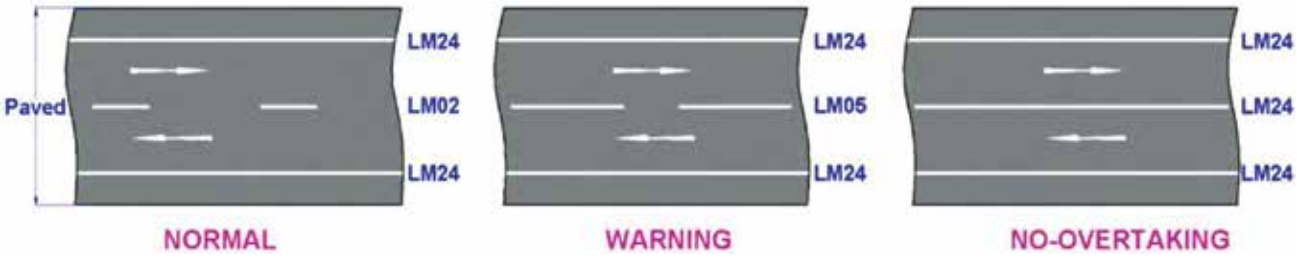


Fig. 4.6 Two Lane Bi-Directional Road with Paved Shoulder

4.6.7 There could be situations in an undivided road, especially at urban locations or due to huge difference traffic volume in opposite direction, two lanes movement is facilitated in one direction and one lane to other direction. The **Fig. 4.7** presents longitudinal marking at mid-block section for such road sections. The double centre line can be with or without hatch marking for normal, warning and no-overtaking sections. The colour of centre line is made yellow to make it distinguished with continuous traffic lane line marking in no-overtaking sections.

Fig. 4.7 Three Lane Bi-Directional Road

4.6.8 **Fig. 4.8** presents longitudinal marking at mid-block section for undivided four lane road sections. The double centre line can be with or without hatch marking for normal, warning and no-overtaking sections. The colour of centre line is made yellow to make it distinguished with continuous traffic lane line marking in no-overtaking sections. The principle herein can be applied if the road section is six lane undivided carriageway.

Fig. 4.8 Four Lane Bi-Directional Road

4.6.9 The width of centre line and traffic lane in urban section shall be more than 100 mm, as line marking gets distracted by drivers due to external factors. The width depicted for centre line in **Figs. 4.4, 4.5 and 4.6** are for a section of road passing through open country and the width shall be increased to 150 mm for urban sections.

4.7 Longitudinal Marking for Divided Carriageway

4.7.1 The longitudinal markings 3 m Mark + 6 m Gap of 100 mm/150 mm are used for traffic lane line marking at normal sections. (i.e. LM01/LM02). However, when it entered into warning section, it shall be 3 m Mark + 3 m Gap of 100 mm/150 mm (i.e. LM11/LM12) and continues as single on no-overtaking section.

4.7.2 The width traffic lane in rural section for design speed up to 100 kmph can be 100 mm and 150 mm for design speed more than 100 kmph and expressways. It shall be 150 mm in urban section as line marking gets distracted by drivers due to external factors.

4.7.3 **Table 4.4** along with **Figs. 4.9 to 4.12** presents a summary of line markings for divided roads in mid-block sections. The longitudinal marking at other places will be dealt separately at respective sections like junctions, truck lay byes and merging and diverging locations.

Table 4.4 Longitudinal Marking for Divided Carriageway

Road Category	Onside Carriageway Width	Normal Section			Warning Section			No Overtaking Section			Reference
		Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	
Four Lane Road	>7.3 m	LM 01/ LM 02	LM24	LM24	LM11/ LM12	LM24	LM24	LM23	LM24	LM24	Fig. 4.9
Six Lane Road	>10.8 m	LM 01/ LM 02	LM24	LM24	LM11/ LM12	LM24	LM24	LM23	LM24	LM24	Fig. 4.10
Four Lane Expressway	>9.5 m	LM 02	LM25	LM25	LM12	LM25	LM25	LM24	LM25	LM25	Fig. 4.11
Six Lane Expressway	>12 m	LM 02	LM25	LM25	LM12	LM25	LM25	LM24	LM25	LM25	Fig. 4.12

Note: *Refer Annexure A for details of markings abbreviated in the Table and Figures above and Refer* ***Table 5.2*** *for Road Studs details*

4.7.4 **Fig. 4.9** presents longitudinal marking at mid-block section of four lane roads (dual two lane roads) where one side carriageway is generally more than 7.3 m for normal, warning and no-overtaking sections. The traffic lane line marking is made continuous where stopping sight distance is not available at vertical and horizontal curves, but shall be applied for short sections to avoid provocations by restricting no-overtaking in a one directional multi-lane carriageway.

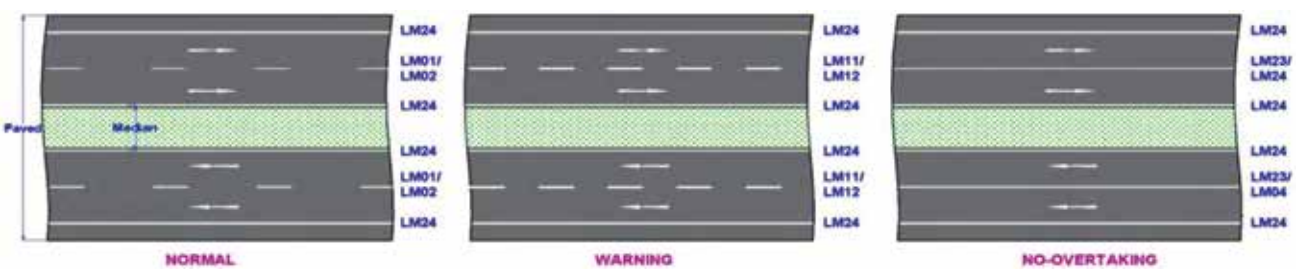


Fig. 4.9 Four Lane Divided Road (One Carriageway Width more than 7.3 m)

4.7.5 **Fig. 4.10** presents longitudinal marking at mid-block section of six lane roads (dual three lane roads) where one side carriageway can be more than 10.8 m for normal, warning and no-overtaking sections. The traffic lane line marking at no-overtaking section is made continuous where stopping sight distance is not available at vertical and horizontal curves, but shall be applied for short sections to avoid provocations by restricting no-overtaking in a one directional multi-lane carriageway. The principle laid out herein can be applied if the road section is eight lane (i.e. four lane dual).

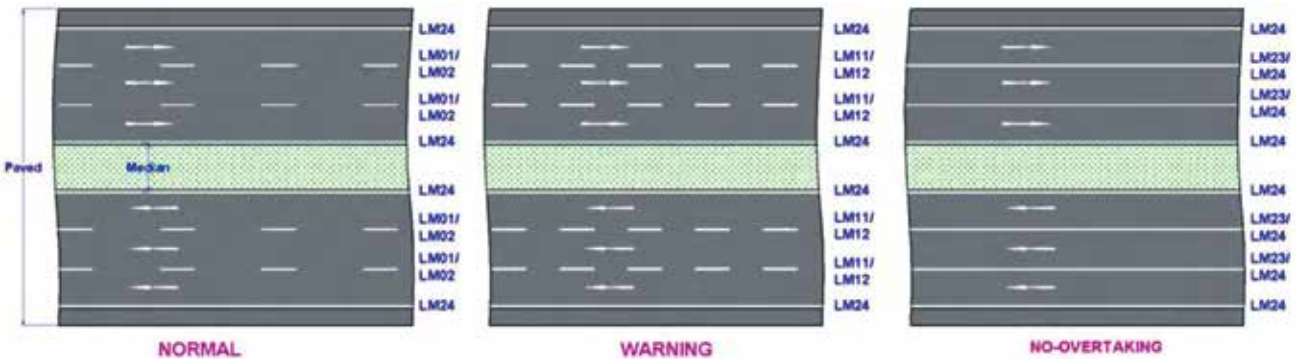


Fig. 4.10 Six Lane Divided Road (One Carriageway Width more than 10.8 m)

4.7.6 **Fig. 4.11** presents longitudinal marking at mid-block section of four lane expressway (dual two lane expressway) where one side carriageway can be more than 9.5 m including paved shoulder for normal and warning sections. At exceptional situations where overtaking to be prohibited due to skidding or any other external factors, the traffic lane line marking is made continuous and considered as no-overtaking sections.

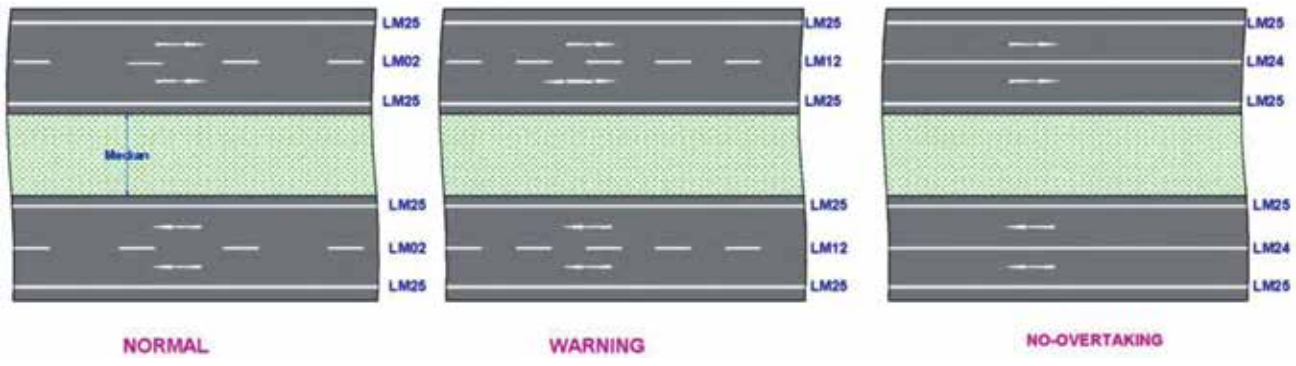


Fig. 4.11 Four Lane Expressway

4.7.7 **Fig. 4.12** presents longitudinal marking at mid-block section of six lane expressway (dual three lane expressway) where one side carriageway can be more than 12 m including paved shoulder for normal and warning sections. At exceptional situations where overtaking to be prohibited due to skidding or any other external factors, the traffic lane line marking is made continuous and considered as no-overtaking sections. The principle laid out herein can be applied if the expressway is eight lane (i.e. four lane dual expressway).

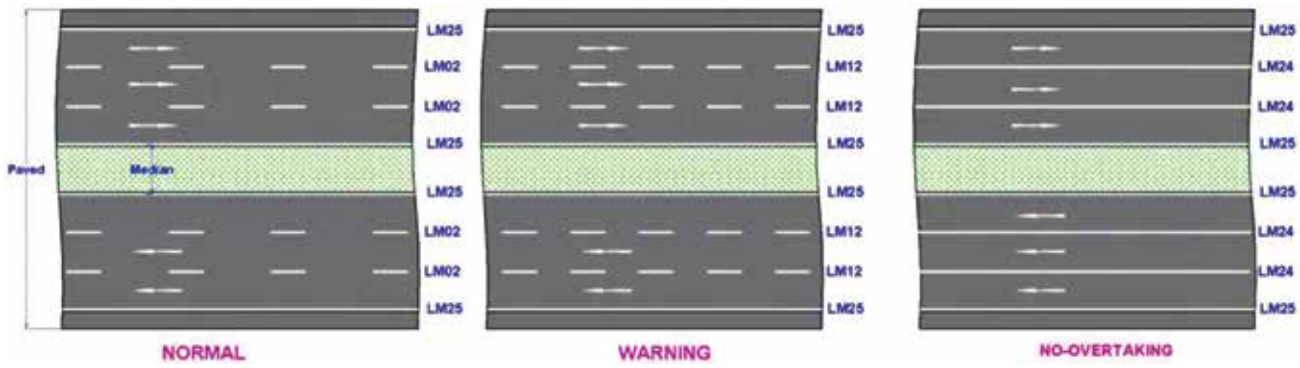


Fig. 4.12 Six Lane Expressway

4.8 Longitudinal Marking for Ramp/Slip Roads/One Way Streets

4.8.1 The longitudinal markings 1.5 m Mark + 3 m Gap of 100 mm/150 mm are used for traffic lane line marking at normal sections. (i.e. LM07/LM08). However, when it entered into warning section, it shall be 3 m Mark + 1.5 m Gap of 100 mm/150 mm (i.e. LM09/LM10) and continues as single on no-overtaking section.

4.8.2 The width of traffic lane in rural section for design speed up to 100 kmph can be 100 mm and 150 mm for design speed more than 100 kmph and expressways. It shall be 150 mm in urban section as line marking gets distracted by drivers due to external factors.

4.8.3 **Table 4.5** along with **Figs. 4.13 to 4.15** presents a summary of typical line markings for unidirectional ramps, loops, slip roads and one way street at mid-block sections. The longitudinal marking at other places will be dealt separately at respective sections like junctions, truck lay byes and merging and diverging locations.

Table 4.5 Longitudinal Marking for Ramp/Slip Road/One Way Street

Road Category	Traffic Movement	Paved Width	Normal Section		Warning Section		No Overtaking Section		Reference
			Traffic Lane Line	Edge Lines	Traffic Lane Line	Edge Lines	Traffic Lane Line	Edge Lines	
Single/Intermediate Lane Ramp/Slip Road/One way street	One way	<5.5 m	NA	LM24	NA	LM24		LM24	Fig. 4.13
Two Lane Ramp/ Slip Road/One way Street	One way	>7.5 m	LM 07/ LM 08	LM24	LM09/ LM10	LM24	LM23/ LM24	LM24	Fig. 4.14
Three Lane Ramp/ Slip Road/One way street	One way	>11 m	LM 08	LM24	LM10	LM24	LM24	LM24	Fig. 4.15

Note: *Refer **Annexure A** for details of markings abbreviated in the Table and Figures above and Refer **Table 5.3** for Road Studs details*

4.8.4 **Fig. 4.13** presents longitudinal marking at mid-block section of Single/Intermediate Lane Ramp/Slip Road/One way street where carriageway width is less than 7.0 m, and the width is not adequate enough to facilitate two lane movements for normal, warning and no-overtaking sections. The edge line on both sides shall be set back sufficiently in such a way that the hazardous parallel two lane movements can be discouraged.

Fig. 4.13 Single/Intermediate Lane Ramp/Slip Road/One Way Street (Paved Width upto 5.5 m)

4.8.5 **Fig. 4.14** presents longitudinal marking at mid-block section of two lanes Ramp / Slip Road/One way street where carriageway width is more than 7.0 m, but the width is adequate enough to facilitate two lane movements for normal, warning and no-overtaking sections. The edge line on both sides shall be set back sufficiently so that it will not be buried under dust and mud.

Fig. 4.14 Two Lane Ramp/Slip Road/One Way Street (Paved Width more than 7.5 m)

4.8.6 **Fig. 4.15** presents longitudinal marking at mid-block section of three lane Ramp / Slip Road/One way street where carriageway width is more than 11 m to accommodate three lane parallel movement. The edge line on both sides shall be set back sufficiently so that it will not be buried under dust and mud.

Fig. 4.15 Three Lane Ramp/Slip Road/One Way Street (Paved Width more than 11 m)

SECTION : 5
ROAD STUDS

5.1 General

5.1.1 Retro-reflective studs are used to supplement longitudinal/transverse reflectorized road markings, which would improve visibility in night time and adverse weather conditions. Road studs are also used across the carriageway to serve as Speed Arrestor coupled with eschewing warning through the creation of the rumbling sensation to the user. Series of such road reflector studs are to be laid in advance of junction/crossings/end of the flyover section wherein road crashes are prevalent.

5.1.2 The Clause 804 of 'Specification for Road and Bridge Works" by the Ministry of Road Transport & Highways (MORTH) and ASTM D4280-04 shall be referred for technical specifications of road studs.

5.1.3 The performance of road studs depends upon the amount of light from vehicle head lamps reflected back towards the source.

5.2 Types of Road Studs

5.2.1 Studs shall be made of plastic material with reflectors for all type of roads. These reflectors should have abrasion resistant protective coating. The studs with anchorage or without anchorage can be bonded to road surface with suitable epoxy/bitumen adhesive as recommended by the manufacturer

5.2.2 Uni-directional road studs shall be used on one directional carriageway of undivided roads, one way street or slip roads. Bi-directional road studs shall be used for two directional roads to delineate the centre line and edge line.

5.3 Lateral Placement of Road Studs

5.3.1 The road studs to be placed on broken longitudinal markings and it shall always be placed at the centre of gap and shall never be upon the line segment or by the side of line segment.

5.3.2 However, in the case of the road studs to be placed on carriageway having a paved shoulder, it shall be placed outside the shoulder side edge line and shall be set back by a distance of 50 mm from the edge line. When road studs are to be placed on shoulder edge line having no paved shoulder, it can be placed on edge line due to space constraints.

5.3.3 In the case of the roads studs provided on median side edge, it is to be again ensured that it shall not be on the median line marking, but shall be in hard strip or kerb shyness width, keeping at least 50 mm set back distance from median side edge line by ensuring a minimum 100 mm clearance distance from the vertical face of the raised kerb. This measure is expected to help in preventing road studs being covered by mud and dust which generally gets accumulated on the raised kerb corner on the median side as well as on the edge line side due to dust/mud accumulation emerging from the footpath.

5.3.4 However, in the case of flushed or depressed median, the minimum requirement of 100 mm clearance requirement will not prevail and hence will not be applicable and only 50 mm from the median side edge line will be applicable.

5.3.5 However, in extreme circumstances, if the width of hard strip or shyness is not adequate enough to accommodate the required set back distance of 50 mm from edge line, the road studs can be placed adjacent to edge line and even directly on the edge lines.

5.3.6 Road studs with anchorages are preferable for edge lines. If at all the road studs with anchorage are to be applied to road markings other than edge lines, the anchorage shall be applied ensuring proper workmanship so that pavement structure will not be affected during installation process. However, the road studs with anchorages are not recommended for concrete roads.

5.4 Colour for Road Studs

The studs with different colours of reflectors such as white, red and yellow are used for highways. The usage of different colours of studs is as follows.

5.4.2 *White Colour*

White road studs are to indicate traffic lane line and centre of carriageway.

5.4.3 *Red Colour*

Red road studs are to be used to indicate a line which should not be crossed and mainly to delineate left hand edge of the running carriageway i.e. for road studs to be used on shoulder side edge line. The road studs shall be omitted or can be replaced with green colour where the facility for exiting traffic are provided from the main carriageway like entry to Truck Lay Bye/Bus Bay, Start of Service Road, etc.

5.4.4 *Yellow Colour*

Yellow road studs are to be again deployed to indicate a line which should not be crossed with the aim to delineate the right hand edge of the running carriageway in case of the multi-lane divided carriageways i.e. median side edge line.

5.4.5 *Green Colour*

Green road studs are to be employed to indicate crossable edge line like the lay byes and to show the boundary of acceleration or deceleration line on left hand side of the carriageway in case of the multi-lane divided carriageways.

5.4.6 Uni-directional carriageways shall have one coloured face with the applicable colour given above, whereas the Bi-directional carriageways shall have two coloured faces which can be a combination of two colours such as Red-White bi-directional road studs or same colour on two faces like White-White bi-directional road studs or Yellow-Yellow bi-directional road studs.

5.5 Spacing of Road Studs

5.5.1 The colour and spacing pattern to be followed in an undivided carriageway is given in **Table 5.1** . The **Fig. 5.1** shows the road studs for bi-directional road for normal/ warning and no overtaking section.

5.5.2 The colour and spacing pattern to be followed in a divided carriageway is given in **Table 5.2**.

Table 5.1 Road Studs for Undivided Roads

Description	Traffic Movement	Carriage Way	Normal Section			Warning Section			No Overtaking Section			Applicable Figures
Road Category			Centre Line	Edge Line	Traffic Lane Line	Centre Line	Edge Line	Traffic Lane Line	Centre Line	Edge Line	Traffic Lane Line	
Single/ Intermediate Lane Road	Two way	< 5.5 m	NA	Red-White Bi-directional at 18 m interval (Optional)	NA	NA	Red-White Bi-directional at 9 m interval (Optional)	NA	NA	Red-White Bi-directional at 6 m interval (Desirable)	NA	Fig. 4.4
Two Lane Road	Two way	5.5 m to 7 m	White-White Bi-directional at 18 m interval (Optional)	Red-White Bi-directional at 18 m interval (Optional)	NA	White-White Bi-directional at 9 m interval (Desirable)	Red-White Bi-directional at 9 m interval (Desirable)	NA	Yellow-Yellow Bi-directional at 6 m interval (Desirable)	Red-White Bi-directional at 6 m interval (Desirable)	NA	Fig. 4.5
Two Lane Road with Paved Shoulder	Two way	> 7 m	White-White Bi-directional at 18 m interval (Optional)	Red-White Bi-directional at 18 m interval (Optional)	NA	White-White Bi-directional at 9 m interval (Desirable)	Red-White Bi-directional at 9 m interval (Desirable)	NA	Yellow-Yellow Bi-directional at 6 m interval (Desirable)	Red-White Bi-directional at 6 m interval (Desirable)	NA	Fig. 4.6
Three Lane Undivided Road	Two way	> 11 m	Yellow-Yellow Bi-directional at 18 m interval (Desirable)	Red-White Bi-directional at 18 m interval (Optional)	Not Required	Yellow-Yellow Bi-directional at 9 m interval (Desirable)	Red-White Bi-directional at 9 m interval (Desirable)	Not Required	Yellow-Yellow Bi-directional at 6 m interval (Desirable)	Red-White Bi-directional at 6 m interval (Desirable)	White-White Bidirectional at 6 m interval (Optional)	Fig. 4.7
Four Lane Undivided Road	Two way	> 14	Yellow-Yellow Bi-directional at 18 m interval (Desirable)	Red-White Bi-directional at 18 m interval (Optional)	Not Required	Yellow-Yellow Bi-directional at 9 m interval (Desirable)	Red-White Bi-directional at 9 m interval (Desirable)	Not Required	Yellow-Yellow Bi-directional at 6 m interval (Desirable)	Red-White Bi-directional at 6 m interval (Desirable)	White-White Bidirectional at 6 m interval (Optional)	Fig. 4.8

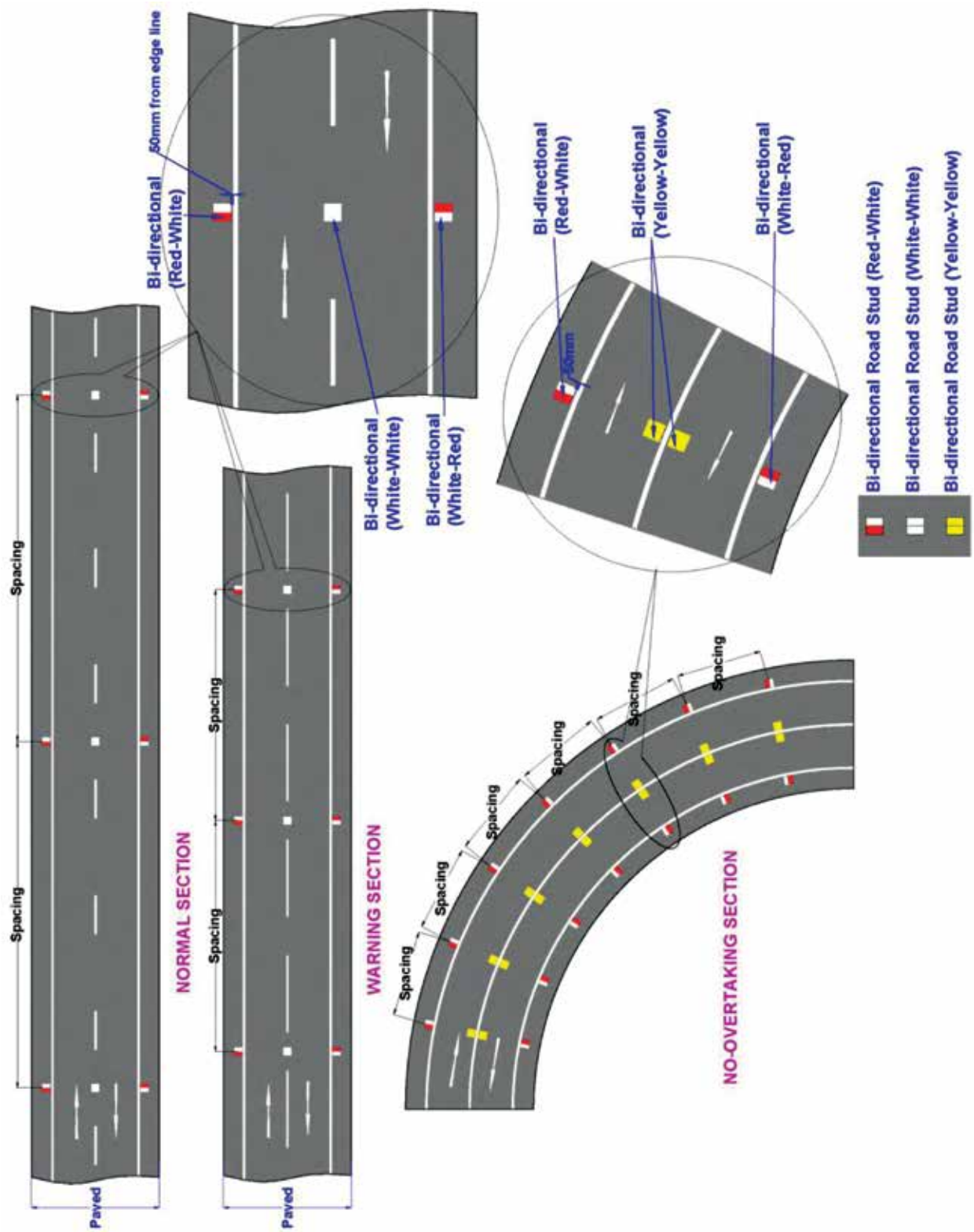


Fig. 5.1 Road Studs for a Bi-Directional Road

Table 5.2 Road Studs for Divided Carriageways

Description	One Side Carriageway Width (in m)	Normal Section			Warning Section			No Overtaking Section			Applicable Figures
Road Category		Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	Traffic Lane Line	Shoulder Side Edge Line	Median Side Edge Line	
Four Lane Divided Carriageways	> 7.3	Not Required	Red Unidirectional at 18 m interval (Desirable)	Yellow Unidirectional at 18 m interval (Desirable)	White-White Bi-directional at 9 m interval (Optional)	Red Unidirectional at 9 m interval (Desirable)	Yellow Unidirectional at 9 m interval (Desirable)	White Unidirectional at 6 m interval (Desirable)	Red Unidirectional at 6 m interval (Desirable)	Yellow Unidirectional at 6 m interval (Desirable)	Fig. 4.9
Six Lane Divided Carriageways	> 10.8	Not Required	Red Unidirectional at 18 m interval (Desirable)	Yellow Unidirectional at 18 m interval (Desirable)	White Unidirectional at 9 m interval (Optional)	Red Unidirectional at 9 m interval (Desirable)	Yellow Unidirectional at 9 m interval (Desirable)	White Uni directional at 6 m interval (Desirable)	Red Unidirectional at 6 m interval (Desirable)	Yellow Unidirectional at 6 m interval (Desirable)	Fig. 4.10
Four Lane Divided Expressway	> 9.5	Not Required	Red Unidirectional at 18 m interval (Desirable)	Yellow Unidirectional at 18 m interval (Desirable)	White Unidirectional at 9 m interval (Optional)	Red Unidirectional at 9 m interval (Desirable)	Yellow Unidirectional at 9 m interval (Desirable)	White Unidirectional at 6 m interval (Desirable)	Red Unidirectional at 6 m interval (Desirable)	Yellow Unidirectional at 6 m interval (Desirable)	Fig. 4.11
Six Lane Divided Expressway	> 12	Not Required	Red Unidirectional at 18 m interval (Desirable)	Yellow Unidirectional at 18 m interval (Desirable)	White-White Bi-directional at 9 m interval (Optional)	Red Unidirectional at 9 m interval (Desirable)	Yellow Unidirectional at 9 m interval (Desirable)	White-White Bi-directional at 6 m interval (Desirable)	Red Unidirectional at 6 m interval (Desirable)	Yellow Unidirectional at 6 m interval (Desirable)	Fig. 4.12

5.5.3 Figure 5.2 shows the colour matter and lateral placement of road studs in a divided carriageway road.

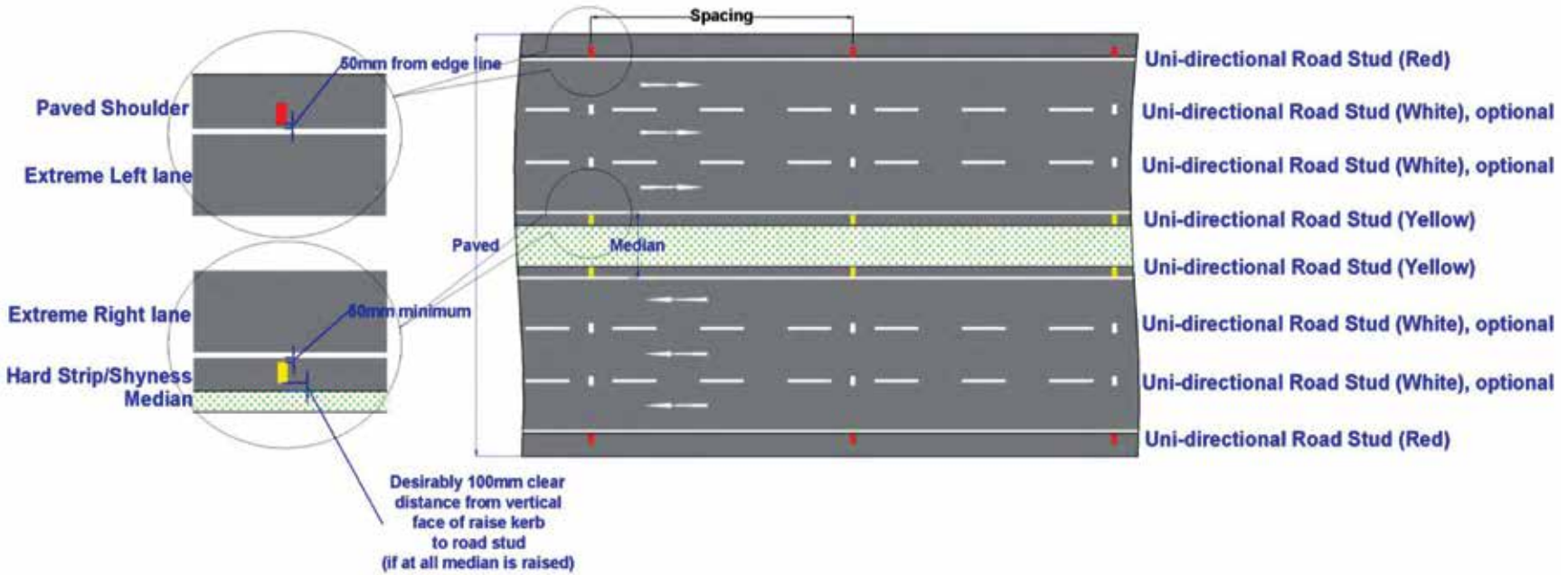


Fig. 5.2 Road Studs for a Divided Carriageway

5.5.4 Placement of Road Studs in one way ramp or slip road or street along with spacing and colour is given in **Table 5.3**.

Table 5.3 Road Studs for Ramp/Slip Road/One Way Street

Road Category	Traffic Movement	Paved Width	Normal Section		Warning Section		No overtaking Section		Applicable Figures
			Traffic Lane	Edge Lines	Traffic Lane Line	Edge Lines	Traffic Lane Line	Edge Lines	
Single/ Intermediate Lane Ramp/Slip Road/ One way street	One way	< 5.5 m	NA	Red Unidirectional at 18 m interval (Desirable)	NA	Red Unidirectional at 9 m interval (Desirable)	LM24	Red Unidirectional at 6 m interval (Desirable)	Fig. 4.13
Two Lane Ramp/ Slip Road/One way street	One way	> 7.5 m	Not Required	Red Unidirectional at 18 m interval (Desirable)	Not Required	Red Unidirectional at 9 m interval (Desirable)	White-White Bidirectional at 12 m interval (Optional)	Red Unidirectional at 6 m interval (Desirable)	Fig. 4.14
Three Lane Ramp/ Slip Road/One way street	One way	> 11 m	White Unidirectional at 18 m interval (Optional)	Red Unidirectional at 18 m interval (Desirable)	Not Required	Red Unidirectional at 9 m interval (Desirable)	White Unidirectional at 12 m interval (Optional)	Red Unidirectional at 6 m interval (Desirable)	Fig. 4.15

5.5.5 For Chevron/diagonal markings on gorge, red colour road studs shall be provided and spacing shall be the same as that for the spacing of diagonal and chevrons. The studs shall be placed to mark the continuous line of diagonal and chevron marking. Road studs shall be placed inside the continuous line marking at the midpoint of diagonal or chevron as shown in **Fig. 5.3**.

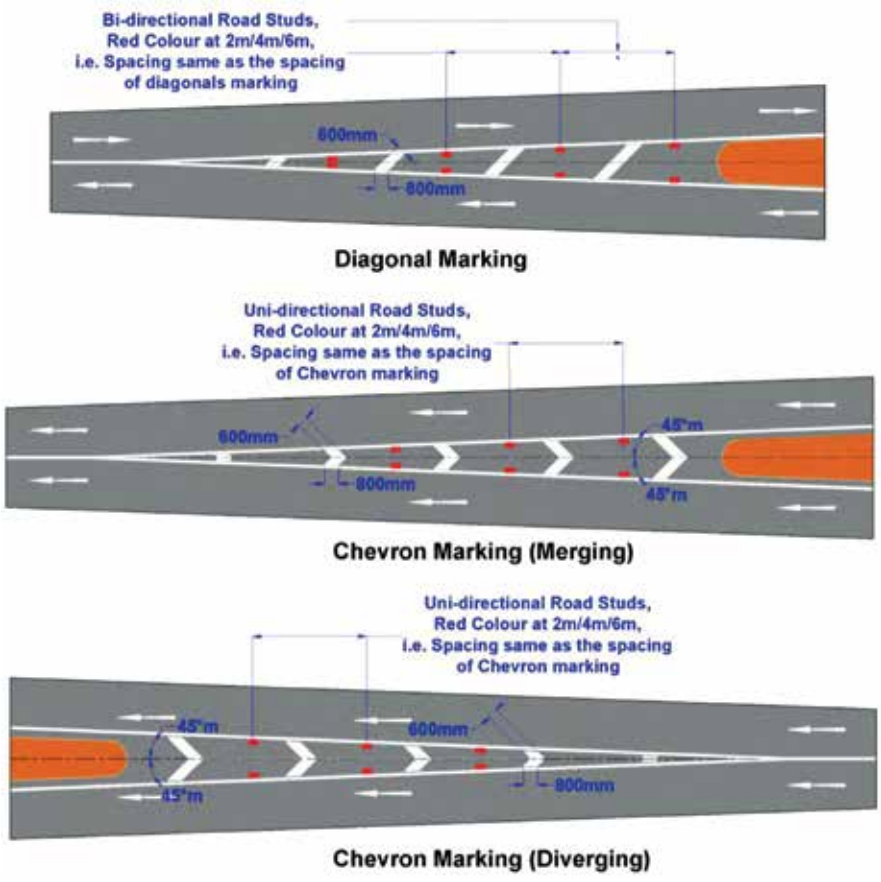


Fig. 5.3 Road Studs for Diagonal & Chevron Markings

5.5.6 For crossable continuous line like in acceleration/deceleration lanes involving lane changing, green colour road studs shall be provided at 8 m spacing as shown in **Fig. 5.4**.

Fig. 5.4 Road Studs for Crossable Continuity Lines

5.5.7 Two rows of Yellow road studs shall be provided for zebra crossing at 0.5 m spacing across the carriageway which can be achieved by installing road studs at four corners of each block of BM01/BM02/BM03. On approaches to any hazardous situation also, two arrays of road studs shall be provided at 0.5 m gap across the carriageway and the two arrays of road studs shall be placed at 0.5 m apart.

5.6 Solar Road Studs

5.6.1 Solar Powered Road Markers are more effective which can immediately draw the attention of drivers and shall be provided at locations like approach to road crash prone locations and highly hazardous locations like bridge, toll plaza, sharp curves, pedestrian crossing, lane transition, speed humps, junctions, channelizers, construction sites, rail road crossings, accident prone locations, median opening and lane changing where performance of normal road studs are not that effective due to street lightings and other roadside activities.

5.6.2 As the name signifies, the solar road studs functions automatically and obviously do not rely on vehicle head light. The intense brightness of the Light Emitting Diode (LEDs) makes them visible at distances of more than 800 m under favourable conditions. The solar studs are also more distinctly visible during rainy and foggy conditions where the road markings could be ineffective.

5.6.3 At locations where solar studs are intended to be used, the spacing shall be same as that indicated for conventional road studs.

SECTION : 6
STOP AND GIVEWAY MARKINGS

6.1 Stop Line

61.1 Stop line indicates the location on the ground beyond which the vehicles should not proceed where it is in laid such as at the vicinity of traffic signals, pedestrian zebra crossings and on minor road approaches merging with major roads it is provided in conjunction with the stop sign. Stop lines shall not be used unless traffic control by any one of these means exist. Stop lines should be either parallel to the intersecting roadway or at right angles to the direction of approaching vehicles. Stop line marking on side roads shall be supplemented with stop signs.

6.1.2 *Two Patterns are Prescribed:*

i) Single Stop Line

ii) Double Stop Line

6.1.3 Single Stop Line shall be applied in traffic signal and ahead of pedestrian crossing. Single Stop Line shall be solid white transverse line of 200 mm wide on urban roads and 300 mm wide on rural roads.

6.1.4 Single Stop Lines shall ordinarily be located not less than 2 metres and not more than 3 metres in advance from the desired location and shall be parallel to the nearest boundary of the pedestrian crossing marking. Where there is no pedestrian crossing, the Single Stop Line shall be placed not less than 1.25 metres and not more than 9 metres from the nearest carriageway edge of the intersecting road and shall extend across all approach lanes, usually to the centre line or in the case of one way streets to the right kerb or pavement edge. At traffic signals, the line shall be normally located 1 m before the nearest primary signal.

6.1.5 As far as possible, Stop Lines at intersection shall be equidistant from the centre of the intersection.

6.1.6 The Double Line is used exclusively at junctions controlled by “STOP” signs and in no circumstances should be used merely to give warning for the approaching traffic to the major road for which the “GIVE WAY” marking is more appropriate.

6.1.7 Double Stop Lines shall consist of two continuous lines each 200 mm wide spaced 300 mm apart and supplemented by a Stop Sign in accordance with IRC:67 (2012) and supplemented with the word message “STOP” encrypted on the carriageway as shown in **Fig. 6.1**. The size of the Stop Word message shall be as shown in **Table 6.1** based on the approach speeds prevailing on the road section and the placement of the same shall be between 2.5 m to 15 m from Stop marking.

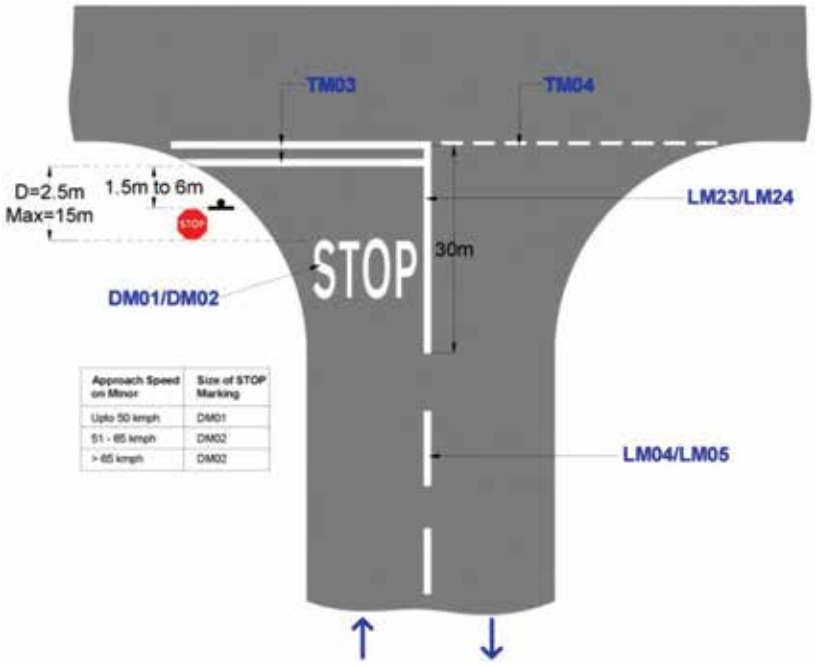


Fig. 6.1 Stop Marking

Table 6.1 Visibility Funnel

Speed on Major Road	Visibility Distances on Major Road (y)	Distance Measured Along the Centre Line of Minor Road from Edge Line of Major Road (x)
Up to 15 kmph	15 m	x = 4.5 m for medium traffic and 3.0 m for lightly trafficked side road
31- 50 kmph	30 m	
51-65 kmph	45 m	
66 -80 kmph	70 m	
81- 100 kmph	90 m	
> 100 kmph	120 m	

Note :

1) Visibility distance (y) is measured along the nearer edge of the major road from a point 1.05 m above the central line of the minor road (representing the driver's eye position).
2) x = 3 m for lightly trafficked side road measured from the edge of the major road carriageway along the centre line of the minor road, and 4.5 m when minor road has medium traffic volume.

6.1.8 The "STOP" sign/marking supplemented by the Double Line implies the adherence to the following traffic rules on the ground:

i) Every vehicle shall before entering the major road from the minor road, shall stop at the transverse lines (vide **Fig. 6.1**) and

ii) No vehicle shall proceed past these transverse lines in such a manner or at such a time as it is likely to necessitate any vehicle on the major road to change its speed or course in order to avoid collision with the vehicle emerging from the minor road.

6.1.9 On two-way minor roads, the Stop marking shall extend to the centre of the carriageway coupled with the remaining width shown in broken continuity line as illustrated in **Fig 6.1**. In such cases, transverse marking shall be accompanied by barrier line and warning line.

6.1.10 The Stop signs and markings should not be used in conjunction with the Give way Signs and Markings at the unsignalised Intersections can cause uncertainty as to which vehicle would have priority.

6.2 Give Way Lines

6.2.1 The Give way marking consists of two broken lines laid side by side, each comprising 600 mm line segments and 300 mm gaps. The lines are 200 mm wide and are spaced 300 mm apart the marking is laid across, the minor roads at intersections which are not controlled by stop signs, traffic signals or the police.

6.2.2 The Give way lines shall be supplemented by the hollow triangular Give Way approach marking and a Give Way roadside signs. The marking should normally be located with its base around 2.5 m to 12 m from the transverse marking.

6.2.3 On two-way minor roads, the Give way line normally extend to the centre of the carriageway and remaining width with broken continuity line as shown in **Fig. 6.2**. Also at intersections if the continuity of the kerb line of the major road needs special emphasis, the GIVE WAY markings may be extended across the entry half width of the minor road by providing continuous line. In such cases, transverse marking shall be accompanied with barrier line and warning line.

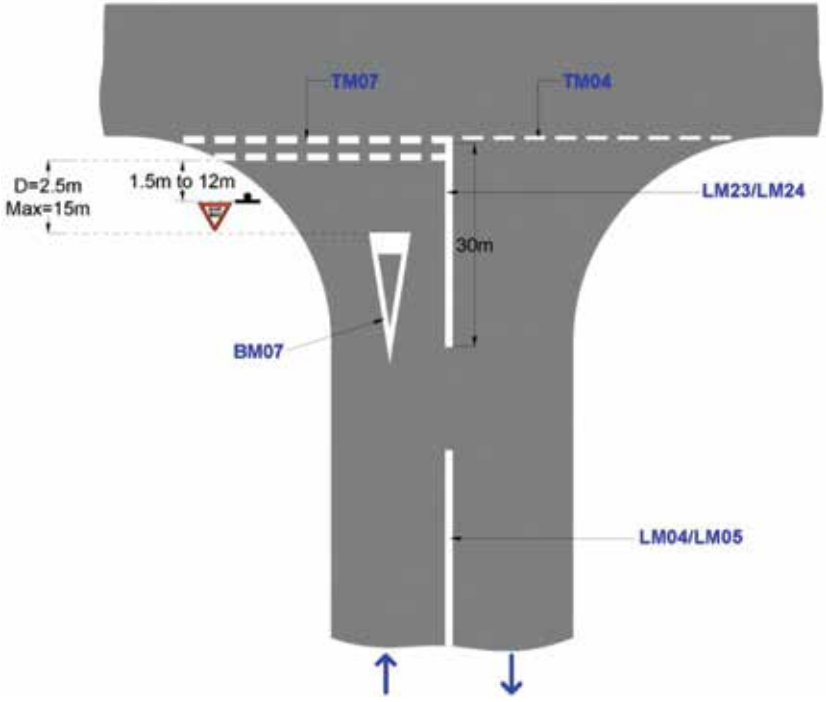


Fig. 6.2 Give Way Marking

6.2.4 On major roads having paved shoulders, the provision of Give way or Stop marking shall be in line with shoulder side edge line of the main carriageway and thus the continuity line can be ensured for shoulder edge line to navigate the main carriageway traffic as shown in **Fig 6.3**.

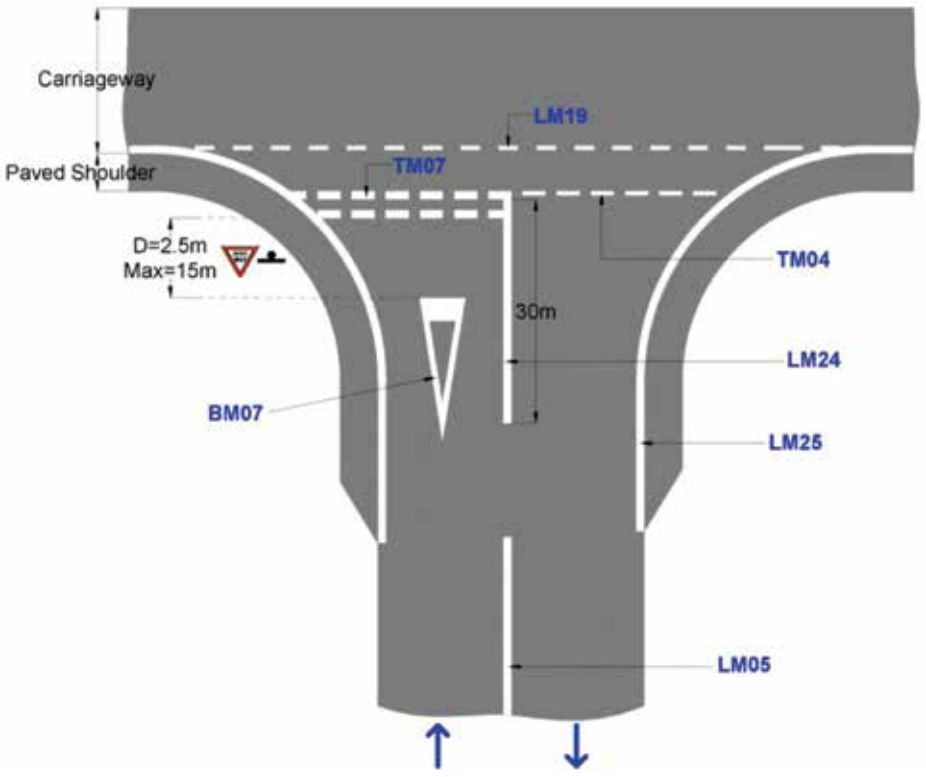


Fig. 6.3 Give Way Marking (Major Road with Paved Shoulder)

6.2.5 At the entry point of the roundabouts, it is prudent to provide Give way Marking and Sign which is detailed in **Fig. 9.14** in Section 9 under the Intersection Marking.

6.3 Guidance for Installation of Stop or Give Way Markings

6.3.1 Stop Marking and Stop Sign shall be used on a minor road at its intersecting point with a major road where conditions are considered to be unduly hazardous due to restricted visibility, bad alignment and high road crash record. If the visibility funnel shown in **Table 6.1** and **Fig 6.4** is not obstruction free due to geometric deficiency or climatic factors or traffic constraints, it is prudent to install Stop Marking and Stop Sign. If the visibility funnel is clear enough from both directions of travel, then the Give way Marking along with Give way Sign can be considered for installation on the Minor Road.

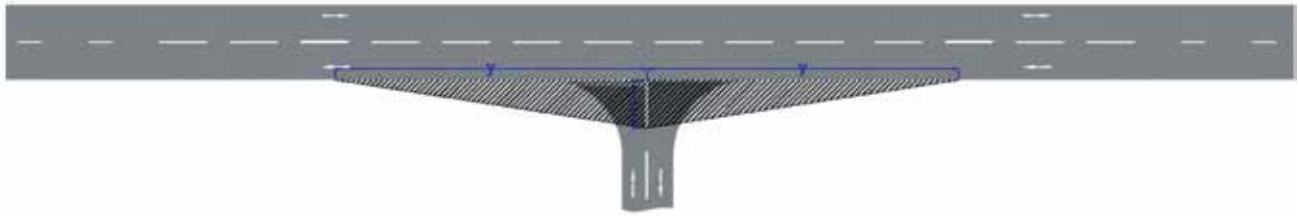


Fig. 6.4 Visibility Funnel

6.3.2 However, on inter-urban roads as well as on the rural roads, it is preferable to provide Stop Marking and Stop Sign as these are more familiar to road users than the provision of Give way Signs and Give way Marking.

SECTION : 7
MARKINGS FOR TRANSITION AND LANE CHANGE

7.1 General

The Road Markings designating the transition and lane change areas shall be applied on high speed and slip roads and at diverging and merging locations. Typically, these markings shall be laid at acceleration and deceleration lanes at appropriate locations at the intersections so as to direct the entering and exiting traffic at the intersections. The provision of such transition markings would facilitate the formation of safe negotiating angle to achieve smooth movements of divergence and convergence. In this regard, different types of road markings that can be deployed at appropriate locations to facilitate transition and lane change phenomenon are listed below followed by a brief on their application strategy:

i. Diagonal and Chevron Marking
ii. Continuity Markings
iii. Lane Change & Merging/Diverging Markings
iv. Hatch Markings

7.2 Diagonal & Chevron Markings

7.2.1 Channelizing markings like diagonal and chevron markings are utilized to demarcate the neutral area at the nose of a channelizing island which can help in reducing the incidence of collision with kerb nose. They direct the entering and exiting traffic into the proper angle for smooth movements of divergence and convergence. These markings provide for proper and safe use of acceleration and deceleration lanes. The basic function is to inform the driver about the area/lane(s) which is set aside for the exclusive use of traffic on the main highway and thus enable the driver to adequately distinguish between through traffic lanes and the acceleration and deceleration lanes.

7.2.2 The diagonal markings shall be marked where one of the traffic flows on either side of the marking is in opposite direction. The diagonal and chevron markings are generally placed at locations where traffic is expected to change position either to diverge or converge.

7.2.3 *Spacing between Diagonal and Chevrons*

The spacing between chevrons and diagonals depends on the total length of chevron provided at a given location. **Table 7.1** presents the spacing of Diagonal and Chevron depending on the total length of markings and the same is depicted in **Fig. 7.1**.

Table 7.1 Spacing Between Diagonals/Chevrons

Total Length of Diagonals/Chevron Marking (in m)	Spacing of Diagonal/Chevrons (in m)		
	Diagonal Markings	Chevron Markings (Diverging Situations)	Chevron Markings (Merging Situations)
< 10	2	2	2
10 m to 22	4	4	4
> 22	6	6	6

Note :
- All lengths and spacing in the table are measured parallel to road centre lane
- Width of all diagonals/chevrons measured at right angles to the diagonals or chevrons is 600 mm.

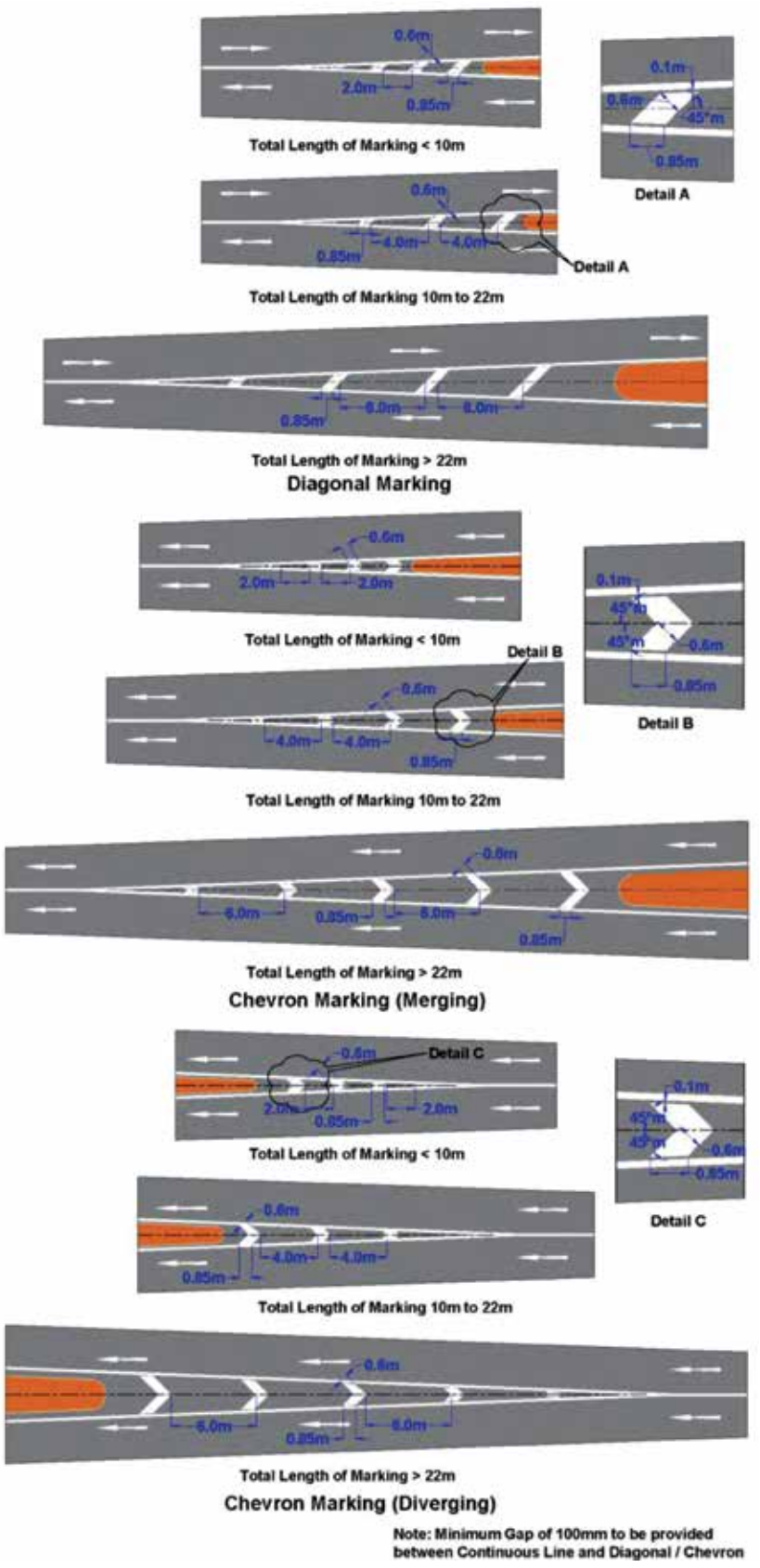


Fig. 7.1 Diagonal and Chevron Markings

7.2.4 The total length of diagonal and chevron markings depends on the lateral shift undertaken by a vehicle in motion. Also, the total length of longitudinal chevron and diagonal marking varies with site conditions and the length should be such that to accommodate at least two or three chevrons or diagonals.

7.2.5 The chevrons must always point towards approaching traffic and chevron should be reversed when traffic is merging. The gap between chevron and boundary line shall be 100 mm to facilitate drain of surface run off.

7.2.6 Various diagonals and chevrons are HM01 to HM09 as given in **Table A.3 of Annexure A**.

7.3 Continuity Lines

7.3.1 *Continuity Lines for Traffic Lane Line and Center Line*

The continuity of the lane marking and center line markings through the intersection areas and hazardous area will be warning pattern of preceding lane line or centre line markings.

7.3.2 *Continuity Lines for Medians and Islands*

At intersections where guidance through channelizer is warranted, broken line markings in continuation of the outer edges of the central channelizers or separators, etc. may be provided to help the vehicles in negotiating the area safely. They shall be 600 mm segment and 300 mm gap (i.e. LM17/LM18) in white colour and width shall be same as that of preceding line markings.

7.3.3 *Continuity Lines for Stop and Give Way Lines*

Continuity lines for stop and give way lines shall be in the form of a single broken line of 100 mm wide with 600 mm line segment and 300 mm gap (TM04) in continuity with the outer lines of a double line installation and in continuity with the line, where only single stop is used.

7.3.4 *Continuity Lines for Right Turn Markings*

Markings to guide right turning traffic which has to cross two or more lanes may be provided in the form of broken white line with 500 mm line segment and 500 mm gap (i.e. LM19/LM20) for both rural and urban intersections and width shall be the same as that of preceding line markings. This pattern will be applicable for continuity line provided between through traffic lane and acceleration lane length including taper length.

7.3.5 *Continuity Lines for Left Turn Markings*

Markings to guide left turning traffic which has to cross two or more lanes like bus bay, truck lay bye, and rest area and service area are in the form of broken white lines with 1000 mm line segment and 1000 mm gap (i.e. LM21/LM22) for both rural and urban intersections and width shall be same as that of preceding line markings. This pattern will be applicable for continuity line provided between through traffic lane and deceleration lane length including taper length.

7.3.6 Single broken lines provided in **Table A.1 and A.2 in Annexure A** shall be applied for various continuity lines.

7.4 Word Messages

The general information to guide, warn or regulate traffic may also be conveyed by inscription of word message on road surface in addition to directional arrows.

7.4.1 The basic characters for word messages shall be Capital letters only. Numerals, apostrophe and the words are formed in the same manner as for any worded sign, leaving a minimum of 0.3 m clear gap at either side of the lane/carriageway and in between the letters. The size of the basic alphabets and numerals is shown in **Annexure C**. Importantly, the letters shall be elongated in the direction of traffic.

7.4.2 Letters of 1.25 m high in the direction of travel should be adopted for speeds up to 50 kmph and 2.5 m high for speeds above that.

7.4.3 The legends should be as brief as possible and shall consist of not more than three words, for any one message. Legends “RIGHT TURN ONLY”, “EXIT ONLY” should be used to supplement the directional arrows and should not be used without them.

7.4.4 All these legends shall be white and except on well-lit roads, the reflectorized paints shall be used where nighttime visibility is restricted.

7.5 Lane Change and Merging/Diverging Markings

7.5.1 The lane change and merging and diverging at multilane highways will be critical. The length of the tapered portion shall always be in conformity with the continuity lane (LM 21/LM 22) whereas a combination of double line comprising broken line and solid lane (LM 28/LM 29) can be provided between auxiliary lane and through lane as illustrated in **Fig. 7.2**.

7.5.2 The length of nose length to be provided shall be the function of approach speed and the taper rate for diagonal or chevron. The taper rate for nose length shall be as given in **Table 7.2** and the required length shall be provided with entry and exit nose catering to the design speed at which vehicle merge or diverge as given in **Fig. 7.2**.

Table 7.2 Taper Rate of Diagonal/Chevron Marking

Speed (kmph)	Désirable Minimum Taper	Absolute Minimum Taper
< 50 kmph	1:35	1:20
50 to 65 kmph	1:40	1:25
66 to 80 kmph	1:45	1:30
> 80 kmph	1:50	1:40

7.5.3 The taper rate given in **Table 7.2** will be applied at ghost island junctions in order to create right turn protected traffic lanes, allowing free flow in major road.

7.5.4 The nose length at diverging and merging situations shall be over and above the acceleration or deceleration length requirement.

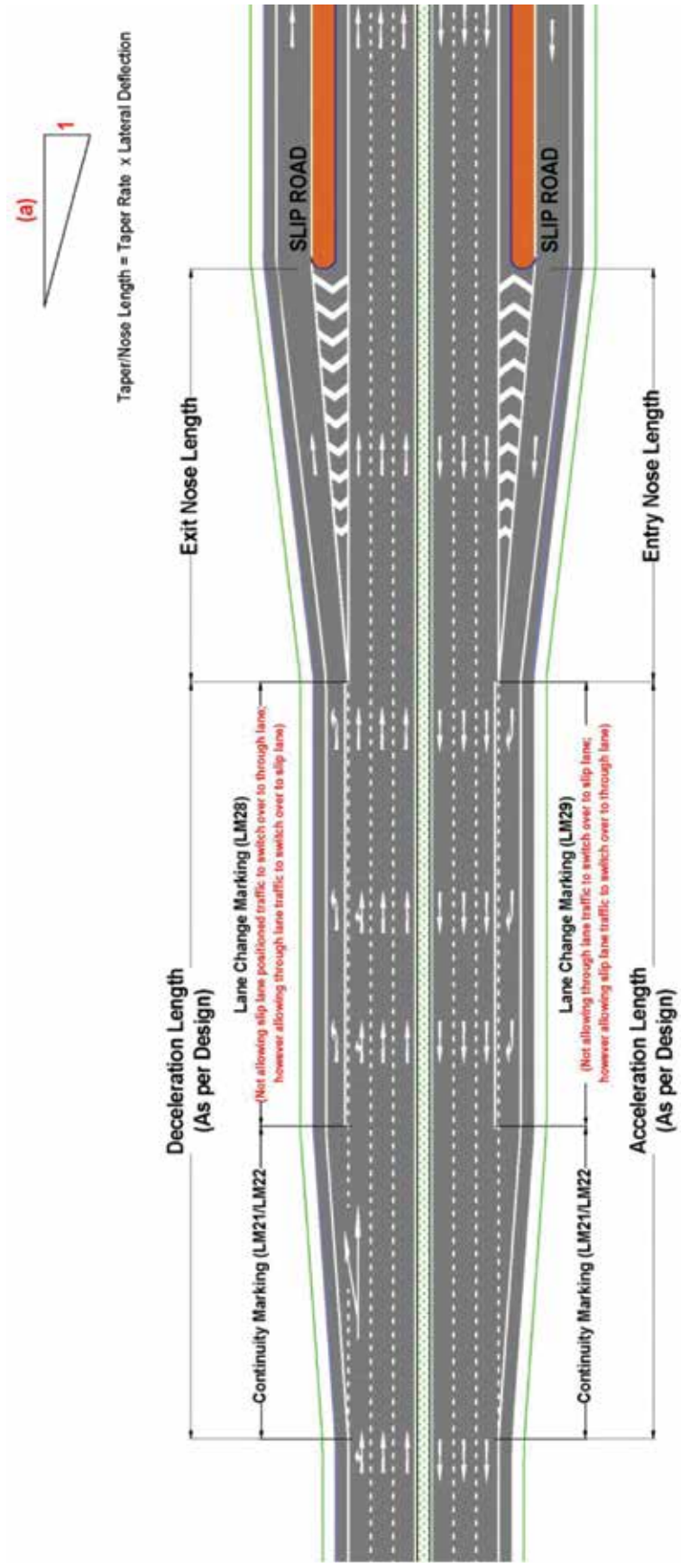


Fig. 7.2 Lane Change Marking and Nose Length in Multilane Highways

7.6 Hatch Markings

7.6.1 Where traffic has to be deflected in an unusual situation, mere edge line will not be effective, in which hatch marking as shown in **Fig. 7.3** should be considered. In the hatch markings also where traffic has to be shifted, taper rate as per **Table 7.2** shall be applied. HM18/HM19 marking shown in **Table A.3** are the hatch markings and shall be applied for markings to create refuge islands.

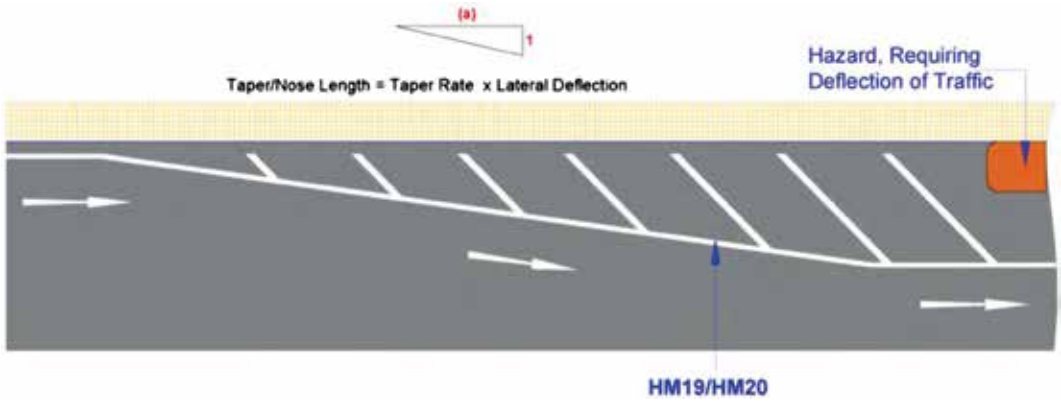


Fig. 7.3 Hatch Marking

7.6.2 For deflecting of one lane to other and also for achieving lane reduction situation, it shall be done with hatch markings.

7.6.3 Ladder hatching should be used where there are two streams of opposite side traffic merge. HM10/HM11/HM12/HM13 marking shown in **Table A.3** is the ladder hatching marking. The spacing of the diagonal in ladder hatching shall be 4 m for speed up to 65 kmph and 6 m for speed exceeding 65 kmph and the width of diagonal shall be 100 mm or 150 mm.

7.7 Raised Profile Edge Lines

7.7.1 Raised profile edge lines are for use as an alternative to the edge markings. It is a continuous line marking with ribs across the line at regular intervals. The advantage of ribs is that the vertical edges of the raised ribs are clearly visible above the water film in wet conditions. The other advantage of raised ribs is that they provide audible warning to drivers when vehicle pass over the ribs and produce audible vibrations as warning. The type and pattern of raised profile lines are shown in **Fig. 7.4**.

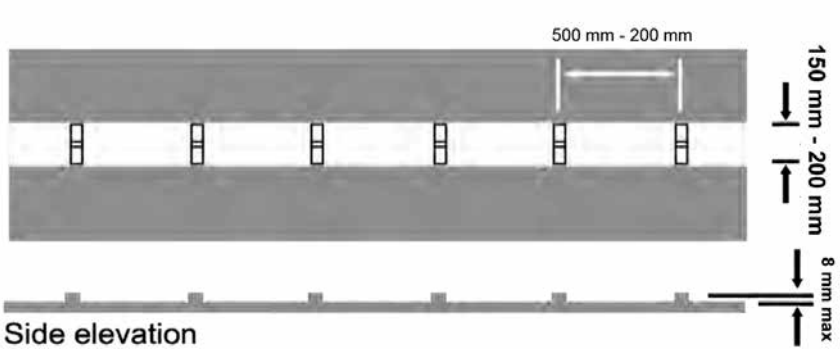


Fig. 7.4 Raised Profile Edge Lines

7.7.2 In general, spacing between two ribs should not exceed 500 mm. However, for expressway the recommended spacing between two ribs is 250 mm. Closely Spaced Ribs helps in maintaining rumble effect; but at the same time, it can become hazardous to the cyclist. The minimum and maximum width of raised profile edge should be 150 mm and 200 mm as shown in HM26/HM27/HM28 in **Table A.3 of Annexure A** and height generally vary from 4 mm to 8 mm, whereas in the case of expressway it can be up to a maximum of 11 mm. Raised profile markings should be discontinued when edge line passes through crossway meant for pedestrian and cyclist.

7.7.3 On the curved roads, having radii less than 1000 m, raised edge line should not be provided as the ribs of the raised edge line markings will destabilize two wheelers. To facilitate drainage, a gap of 100 mm to 150 mm should be provided at an interval of around 36 m; otherwise rain water may get collected on the road surface.

7.8 Lane Reduction / Narrowing Situations and Transitions

7.8.1 The reduction and transition of traffic lanes are frequent and generally carried out in the case of four lane divided carriageway getting reduced to 2-lane bi-directional carriageway condition. In such situations, the drivers should be properly guided to transfer from 4-lane to 2-lane and vice versa. If one or more lanes are to be discontinued, the centre line and the lane lines should be merged in such a way that traffic safely merged on to the reduced number of lanes.

7.8.2 **Fig. 7.5** gives the layout in which 4-lane to 2-lane safe transfer is gained, where the centre line remain the same. The two lane approaches to be reduced to one lane, it shall be curtailed by deflecting them.

7.8.3 **Fig. 7.6** presents the typical layout illustrating the road marking for four-lane divided carriageway to two lane bidirectional carriageway where there is a shift in centre line. Taper length shall be developed for the approach speed as per **Table 7.2**.

7.8.4 **Fig. 7.7** presents the typical layout in which 3-lane is curtailed to 2-lane. The layout shown can also be applied for deflecting one lane if any hazard is present in the third lane. The Taper rate given in **Table 7.2** shall be provided.

7.8.5 There are situations where the carriageway or paved width will have to be reduced like in a narrow bridge. **Fig. 7.8** depicts the typical layout showing how drivers are smoothly guided into such situation. The marking shown in **Fig. 7.8** along with raised profile edges can be applied for tunnel approaches.

7.8.6 Lane changing and transition marking shall be done with corresponding signs and hazards shall be illuminated with appropriate hazard markers.

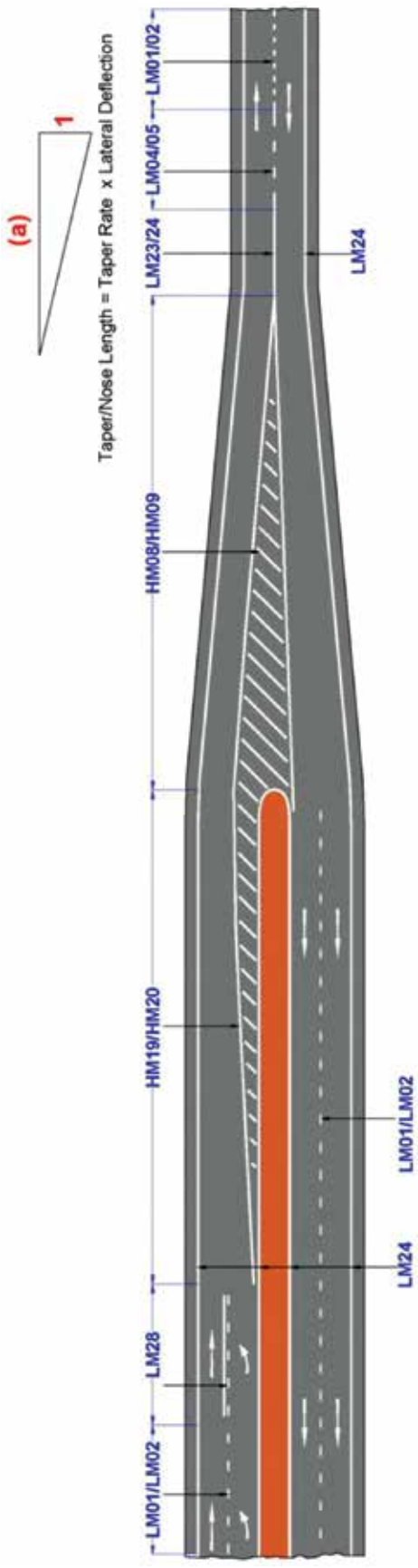


Fig. 7.5 Four Lane to Two Lane Transition (Concentric)

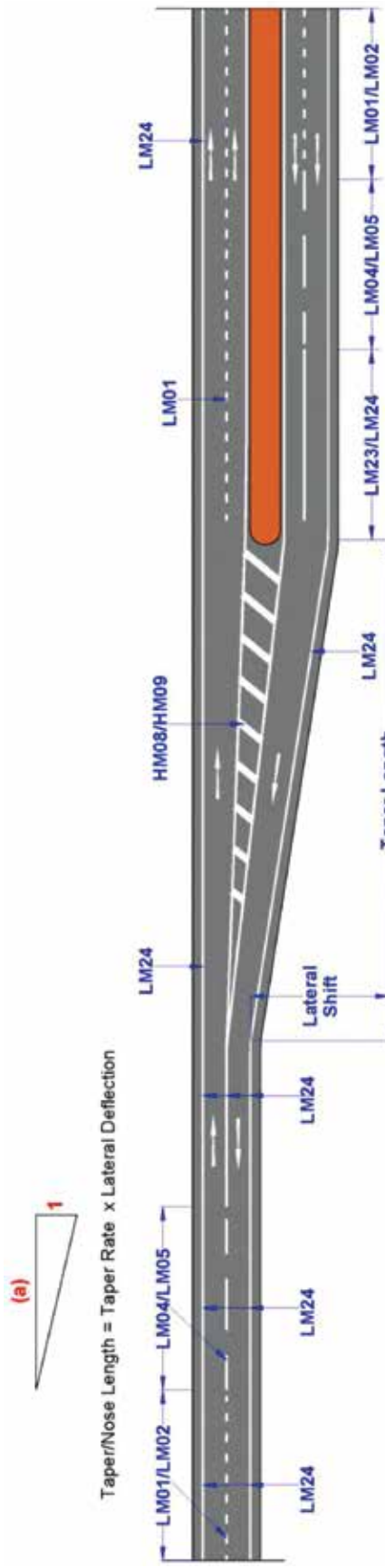


Fig. 7.6 Four Lane to Two Lane Transition (Eccentric)

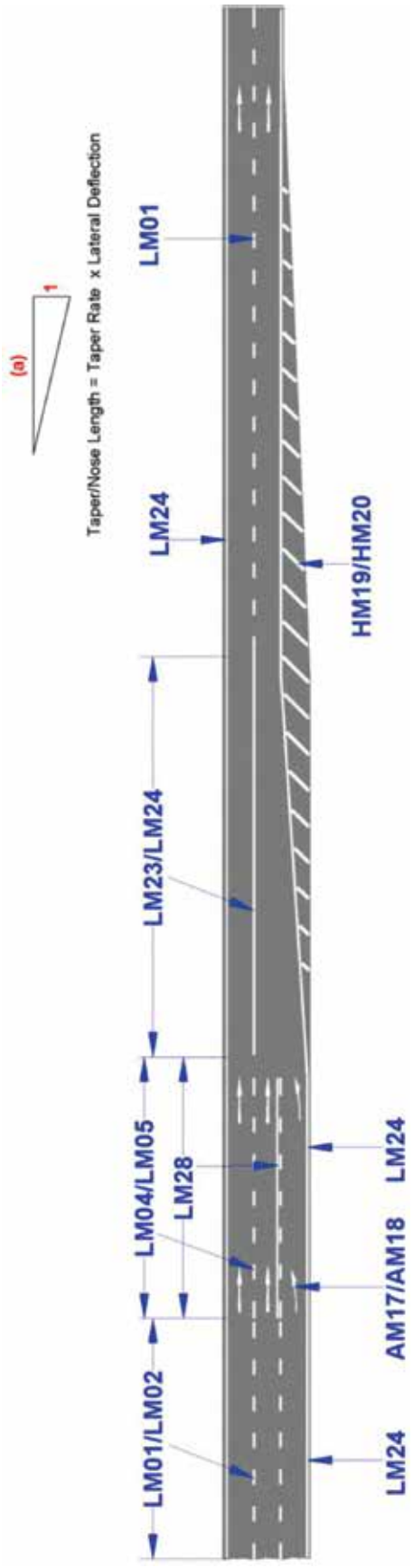


Fig. 7.7 Curtailling of One Lane (For Hazard/Lane Drop)

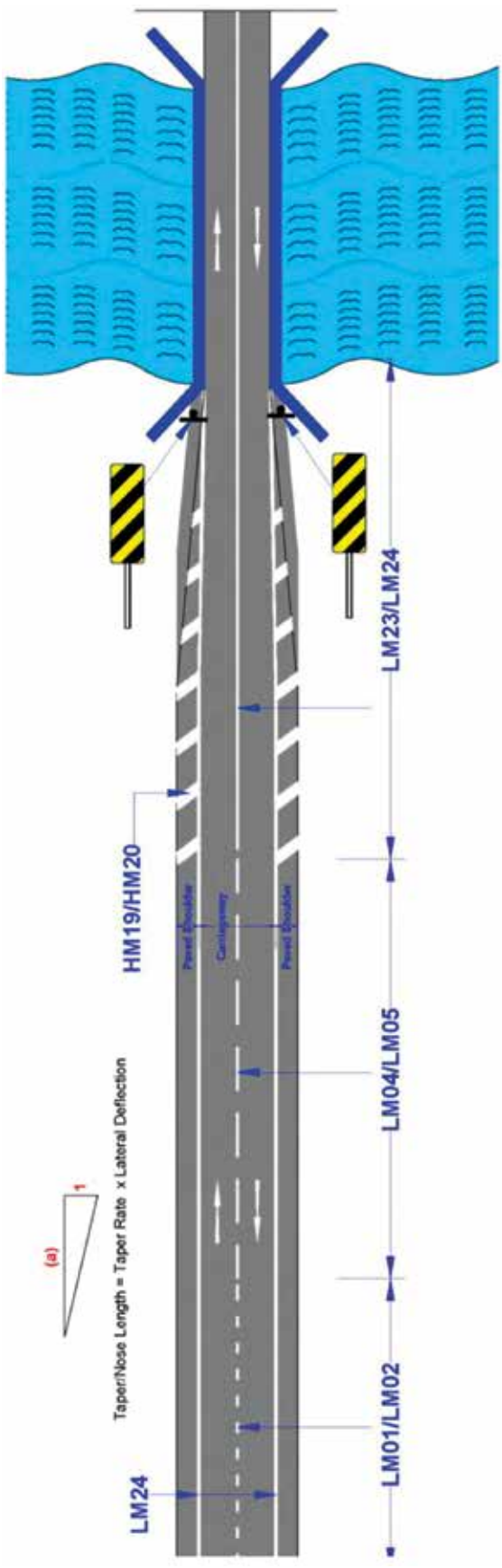


Fig. 7.8 Reduction of Paved Width/Carriageway

SECTION : 8
ARROWS AND WORD MESSAGES

8.1 Directional Arrows

8.1.1 Directional arrows should be used in advance to guide drivers to correct lane when approaching busy intersections whether signal controlled or not. Directional arrows must be elongated in the direction of the traffic flow to have adequate legibility, as arrows are viewed at low angle. The details for directional arrows are given in **Table A.5** of **Annexure A** and in **Table B.1** in **Annexure B**.

8.1.2 For speeds up to 50 kmph, the arrows should be 3.5 m in length and it shall be 5 m for speeds between 51 to 100 kmph, and 9 m for speed greater than 100 kmph including expressway as given in **Table 8.1**.

Table 8.1 Size of Arrows

Speed	Length of Arrows
Up to 50 kmph	3.5 m
51 -100 kmph	5 m
>100 kmph & Expressways	9 m

8.1.3 On two lane approaches to an intersection, the arrangement of arrows indicating the lanes for (a) straight ahead, (b) left turn, and (c) right turn will depend on the relative turning volumes and on the site conditions. In a two lane approach road having heavy right turn movements, the straight ahead and left turn arrow can be provided by combining both of them and the right turn arrow can be provided on the extreme right lane signifying exclusive right turning movements. Similarly, where there is a left filter lane, the same should be marked with left arrow marking alone, in order to exclude non-filtering traffic.

8.1.4 *Mandatory Turn Arrows*

Lane arrows supplemented with the legend "TURN LEFT", "TURN RIGHT" and "AHEAD ONLY" is prescribed. These versions may be used only where they indicate the effect of a statutory prohibition. The markings can also be used to reinforce a green arrow traffic signal or a regulatory turn sign, e.g. entry into a one-way road where all traffic is required to turn in the same direction. Typical example is given in **Fig. 8.1**.

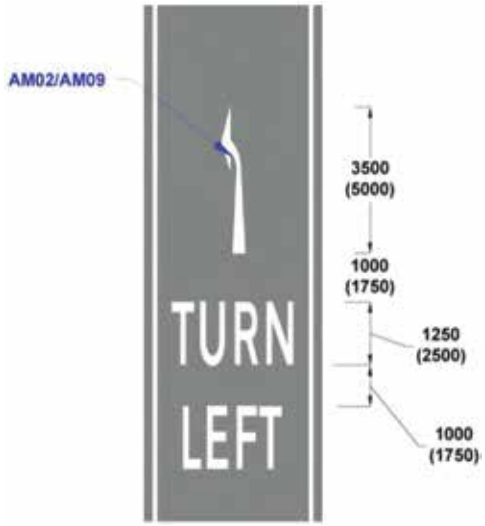


Fig. 8.1 Mandatory Turn Arrow

8.1.5 *Guidance Arrows*

These are marked in the junction area where some guidance to traffic is considered to be helpful. Care should be taken that the meaning is clear to drivers on all approaches. In order to avoid confusion and to ensure compliance, dedicated arrow markings are mandatory in a signal controlled intersection.

8.2 Deflection Arrows

8.2.1 Deflection arrows are used in advance to warn of the approaching restriction and to direct the traffic to the correct lane and also to warn of a hazard or change of direction and to indicate the side on which traffic should pass.

8.2.2 The deflection arrow of 4.5 m length shall be used for speed up to 65 kmph and deflection arrows of 6 m shall be used for speed ranging between 65 kmph to 100 kmph and 9 m for speed more than 100 kmph as given in **Fig. 8.2**. (Refer AM17/AM18/AM19 in **Table A.5** of **Annexure A**).

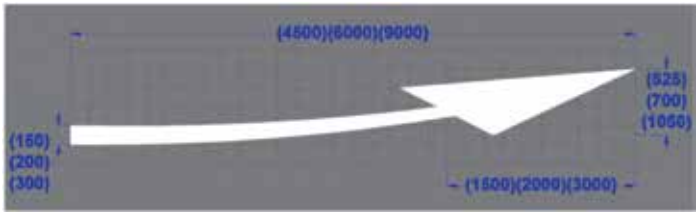


Fig. 8.2 Deflection Arrow

8.2.3 Deflection arrow is also used in cycle or bus lane boundary markings to indicate the side on which other vehicles should pass them.

8.2.4 In the bidirectional carriageways and especially ahead of no overtaking stretch, the deflection arrow shall be used to direct the traffic to streamline to dedicated lane as shown in **Fig 8.3**.

Fig. 8.3 Deflection Arrows Ahead of Restricted Stretch

8.2.5 The arrow may be reversed so that it points to the right in appropriate circumstances.

8.3 Bifurcation Arrows

8.3.1 The bifurcation arrow should be provided at the commencement of deceleration lanes on the approach to junctions to guide vehicles ensuring that the full length of the lane is used to slow down for the junction without impeding the through vehicles on the main carriageway.

8.3.2 Three sizes are prescribed. The longest (32 m) is for use on expressway or high speed all-purpose dual carriageway roads greater than 100 kmph and the medium (16 m) for speed 65 to 100 kmph and the shortest (8 m) elsewhere as given in **Fig. 8.4**. (Refer AM19/AM20/AM21 in **Table A.5 of Annexure A**). It should be noted that the lateral distance between the tips of the arrow heads is 2100 mm for all three sizes of marking. The 'Ahead Arrow' should be laid in the centre of the ahead lane; the turning arrow will then just encroach into the deceleration lane.

8.3.3 The arrow marking may be reversed to suit right turn movements into deceleration lanes in the central reservation of dual carriageways and dedicated right turn lanes on other

roads. The right bifurcation arrow indicating a right turn (or ahead and right) must not be used in a through lane if it is not the lane from which traffic turns right.

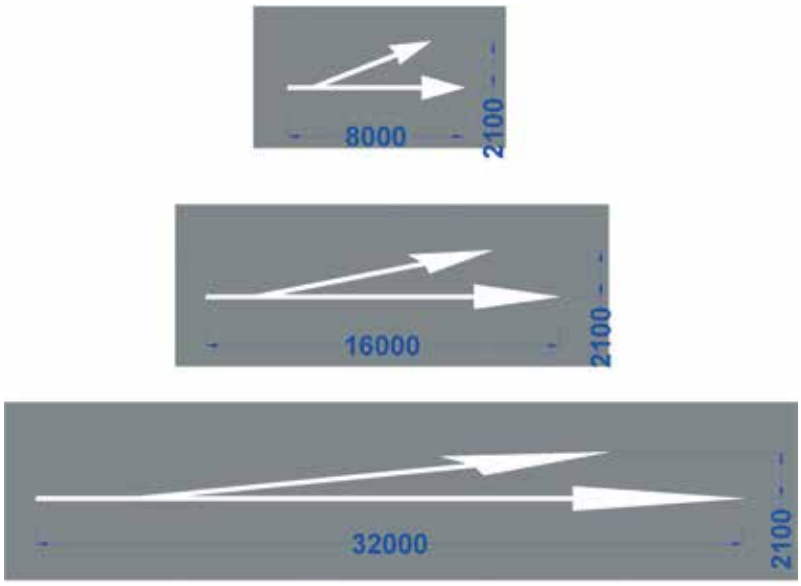


Fig. 8.4 Bifurcation Arrows

8.3.4 **Fig. 8.5** shows the location of the bifurcation arrow in relation to other markings. This may be used as a guide for other sizes of arrows; the aim should be to site the arrow shortly after the commencement of the deceleration lane, at a point where it has developed adequate width.

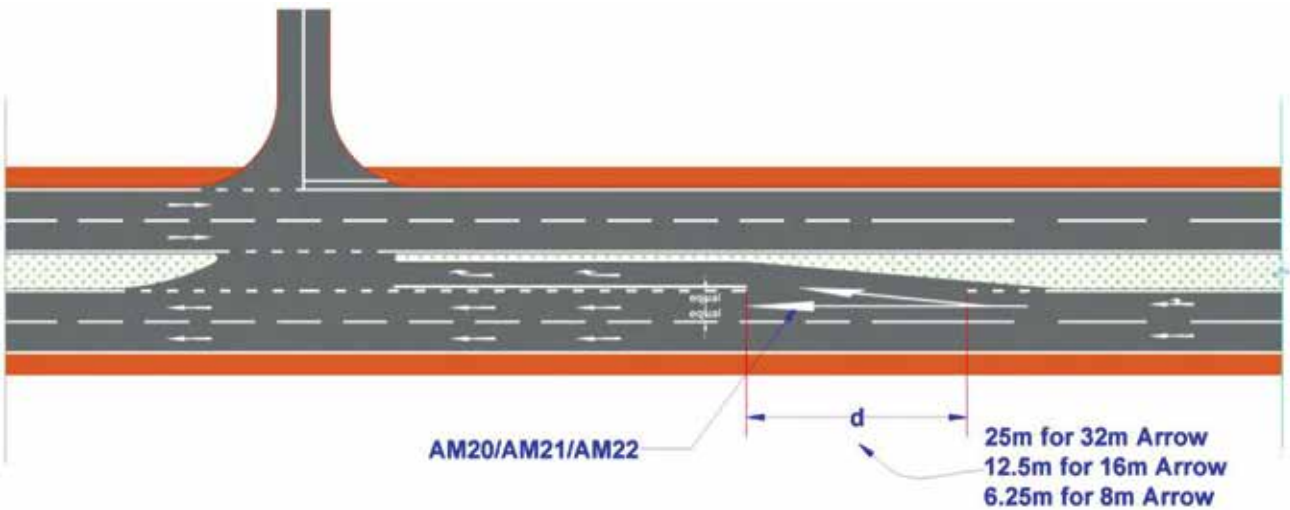


Fig. 8.5 Positioning of Bifurcation Arrow

8.4 Arrows on Side Road Approach

8.4.1 In a side road approach wherein traffic has to turn to other road, normally two to three rows of arrows should be used in sequence on each lane.

8.4.2 The direction arrow nearest to the intersection should be 10 to 15 m from the stop line or the entrance to the junction. The second arrow should be placed 15 to 20 m from first

row of arrow and the third row of arrow at 20 to 30 m before the second arrow as shown in **Fig. 8.6** and is applicable for all minor side road approaches, which should either Stop or Yield to the traffic on the main road. However, the placement of arrows shall be done judiciously in view of the widening of lanes and start of the splitter island.

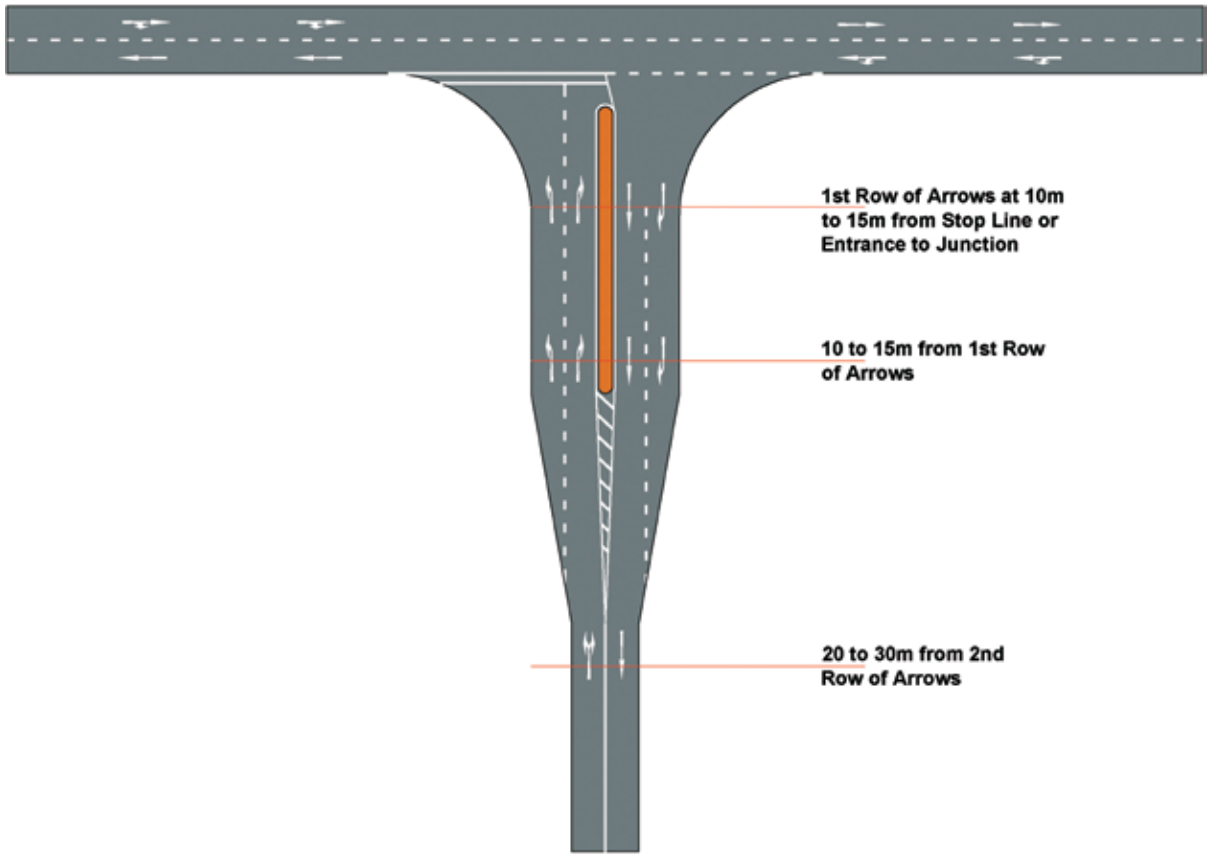


Fig. 8.6 Position of Arrow in Minor Road Approach

8.4.3 Full lane width shall be ensured at location where arrow is shown and shall be placed at the centre of two longitudinal markings.

8.5 Arrows on Main Road Approaches

8.5.1 On approaches to major intersection on a multi-lane highway having more than two lanes involving changing of lanes where traffic have to enter filter lane or auxiliary lane, the position of arrows shall be as given in **Table 8.2** and shown in **Fig. 8.7**.

Table 8.2 Position of Arrow in Main Highway

Approach Speed	SSD	ISD	d 1	d 2	d 3	d 4	d 5
Upton 50 kmph	60	120	15	15	30	60	
51-65 kmph	90	180	15	15	45	90	
66- 80 kmph	120	240	30	30	60	120	
81 to 100 kmph	180	360	30	45	90	180	
>100 kmph & Expressways	240	480	30	60	90	150	150

Fig. 8.7 Position of Arrow in Multi-Lane High Speed Situation

8.5.2 The arrow shall not be used between two Longitudinal Markings (LM) where full lane width for the particular road is available.

8.6 Word Messages

8.6.1 Information to guide, warn or regulate traffic may also be conveyed by inscription of word message on the road surface. Some of these augment kerbside signs, others indicate the areas of the carriageway intended for a particular function (e.g. Bus Stop) or meant to be kept clear (e.g. School).

8.6.2 The size of the basic alphabets and numerals shall conform to the speed range presented in **Table 8.3**. The alphabets and numerals shall be reflectorized. The letters should be elongated in the direction of traffic and details are given in **Table A.6 of Annexure A** and in **Table C.1 to C.3 in Annexure C**. Letters of 1.25 m high in the direction of travel should be adopted for speeds up to 50 kmph and 2.5 m high for speeds up to 100 kmph and 5 m for speed above 100 kmph (including expressways) as shown in **Table 8.3**.

Table 8.3 Size of Letterings

Speed	Length of Letters
Up to 50 kmph	1.25 m
51 -100 kmph	2.5 m
>100 kmph & Expressways	5 m

8.6.3 Word and arrows shall be white in colour, word message should not exceed 3 lines of information and symbol markings should be not more than one lane in width.

8.6.4 Because of the Necessity for Brevity, the following Typical Legends are Recommended which include, STOP, SLOW, BUS, BUS LANE, KEEP CLEAR, SCHOOL, RIGHT TURN ONLY, EXIT ONLY, SPEED-25. The message should be marked in advance, in case visibility is restricted.

8.6.5 Legends RIGHT TURN ONLY, EXIT ONLY should be used to supplement the directional arrows and should not be used without them. The Legends SCHOOL, SLOW and STOP should be used only in addition to the standard signs conforming to IRC : 67-2012.

8.6.6 Lane Destination Markings: Worded lane destination markings reinforce the advance direction sign in conformity. Its letter size depends on speed limit and 1250 mm for speed up to 50 kmph and 2500 mm for speed more than 50 kmph. These markings should be used at distance of equal to longest peak hour queue. It can be helpful to locate arrows in

conjunction with direction signs and only two directions can be shown on one arrow. Typical example is shown in **Fig. 8.8**.

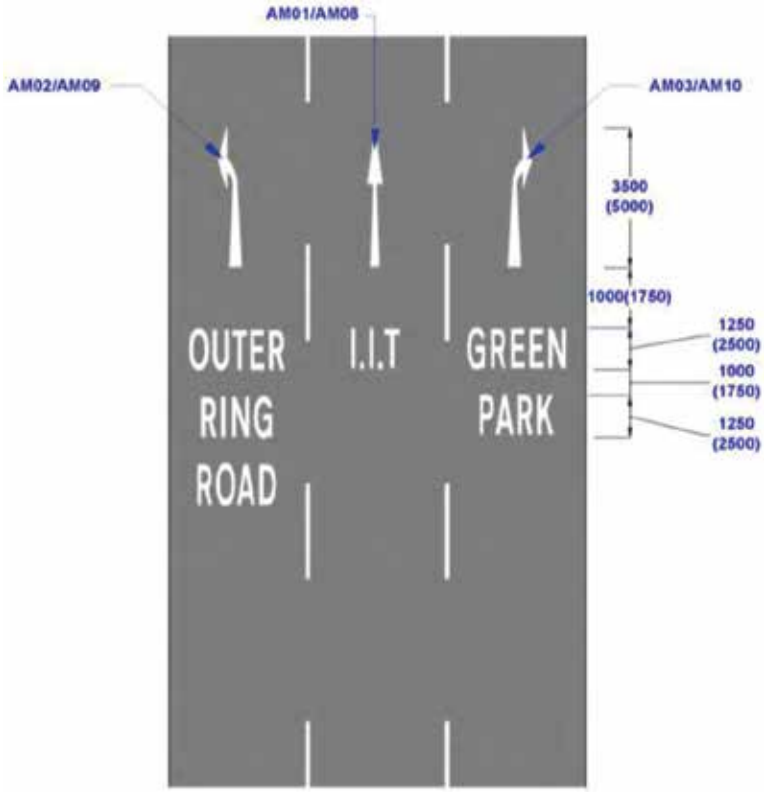


Fig. 8.8 Lane Destination Markings

8.6.7 The word STOP shall not be painted unless every vehicle is required to stop at all times. This word message must be used to supplement a "STOP" sign and Stop Line marking and shall not be used in any other circumstances. The marking should normally be located so that the top of the word is 2 m to 3 m from the nearest part of the double stop line. The word STOP shall be marked on the carriageway before the stop line for the approaching vehicle and at the centre of each lane if it is more than 2 lanes wide so that users of all lanes are able to see the marking at all times. Otherwise, one STOP word is sufficient which shall be marked at the carriageway.

8.6.8 The word message "SLOW" may be used to supplement any warning sign on the approach to hazard or a road intersection including the advance signs giving warning of "STOP" or "GIVE WAY". It should not be used to supplement the roadside "GIVE WAY" sign alone for which the hollow triangular marking has been prescribed.

8.6.9 This word message KEEP CLEAR indicates to drivers that the part of the carriageway at the road intersections which should be left clear as shown in **Fig. 8.9**.

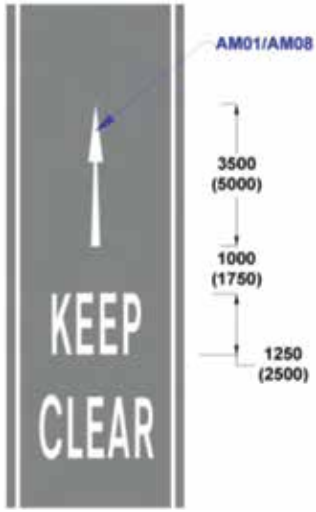


Fig. 8.9 Mandatory Keep Clear

SECTION : 9
MARKINGS FOR AT-GRADE INTERSECTIONS

9.1 General

9.1.1 Carriageway markings within and in the neighbourhood of an intersection would ensure orderly movement of traffic. The type of carriageway marking for a particular intersection depends on speed characteristics of traffic and availability of space. The choice of layout for a particular location depends upon the conditions at site. The markings for the various intersections types illustrated in this section are typical only. The precise layout may be adjusted to suit the design of intersection under consideration.

9.1.2 At-grade intersection, marking involves i) Marking for Traffic Control; ii) Lane Demarcating Markings; iii) Diagonal & Chevron Markings; iv) Directional Arrow Markings and Word messages; v) Hatch Markings/Ghost Island; vi) Prohibitory Markings; vii) Pedestrian crossings.

9.1.3 At the intersections, entry lane width should be between 3 and 3.65 m and at the locations where space is restricted, the entry lane width can be reduced to 2.5 m provided 85th percentile approach speed does not exceed 50 kmph. This reduction in width will help the designer to provide extra lane at the junction. The number of lanes at the entry level and exit side of the junction should match at both sides of the Stop Line.

9.1.4 On a minor road approach, minimum widths to be catered while making marking are given in **Fig 9.1**.

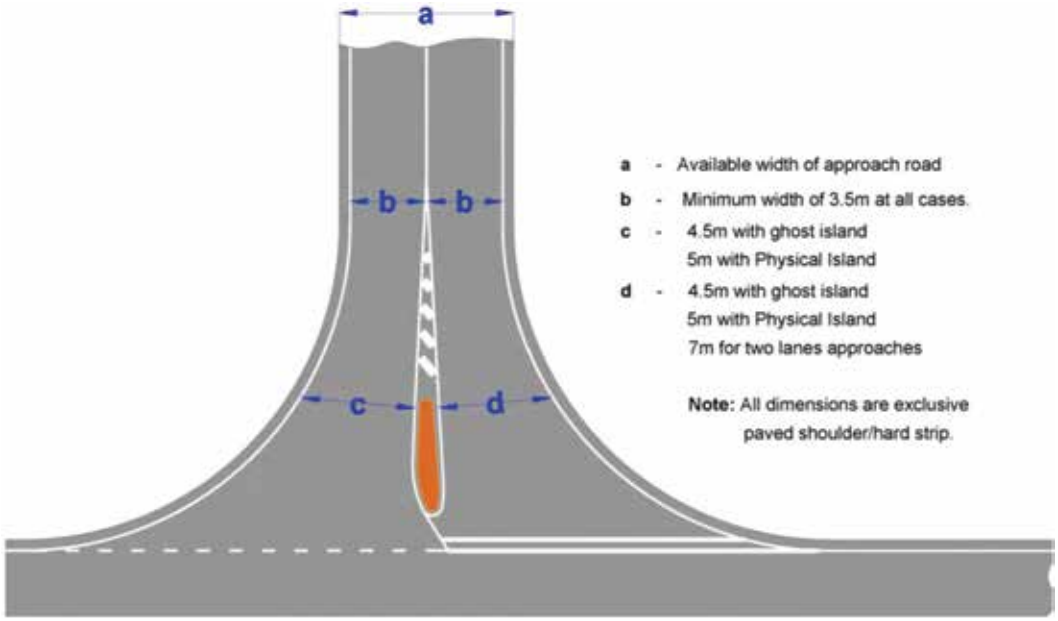


Fig. 9.1 Dimensions for Minor Road Approaches

9.1.5 The lane demarcating markings such as centre line, traffic lane line and edge line are illustrated in **Section 4**. The through lanes should be maintained in its width throughout the carriageway and be separated from the right turn lane with broken markings. The traffic

lane line markings, centre line marking shall be warning broken line for a length equal to Stopping Sight Distance (SSD) on major road approaches.

9.1.6 The traffic control established by Stop and Give way for junctions is given in **Section 6**.

9.1.7 The various continuity line for junctions and diagonal and chevron markings also are given in **Section 7**.

9.1.8 Various directional arrow markings and word messages for junctions are discussed in **Section 8**.

9.1.9 The pedestrian crossing points at junctions should be properly marked for which stop line shall be placed at a minimum distance of 1.5 m in advance of primary signal post/ push button post. The full width of pedestrian crossing should be provided with Refuge Island on the carriageway.

9.1.10 At the junctions where left turn is free or without the control of traffic signal, Give Way markings and signs should be provided so that pedestrian would get priority to cross. If visibility of junction is restricted and if the turning traffic volume is relatively high, whereby pedestrian will not get opportunity to cross, such left turning also shall be put under traffic signal.

9.1.11 *Yellow Box Markings*

Fig. 9.2 is a prohibitory marking to convey that the message that no vehicle shall be stopped/ stationed in the designated box junction area.

Fig. 9.2 Prohibitory Marking at the Intersections

9.1.12 In order to prevent the unauthorised use of the right turn storage lane (which is exclusively meant for right turning traffic) by the through straight traffic, shall be converted to solid line which would serve as barrier line as shown in **Fig. 9.2** and shall be provided at the end of storage lane.

9.1.13 General guidelines to be followed while providing pavement marking at the typical junction layouts are described below:

- Simple Junction
- Skew or Y-junction
- Ghost Island Junction

- Right Turn Protected T-Junction
- Staggered Junction
- Signalised Intersection
- Conventional Roundabouts
- Signal Controlled Roundabouts
- Double Roundabout
- Mini Roundabout

9.2 Simple Junction

9.2.1 The Simple junction is a T or staggered junction without any ghost or physical island both in major and minor side road. Simple junctions are applicable at locations where the side road traffic is very low and there is no evidence of right turning traffic involved in road crashes. The marking for a simple junction is given in **Fig. 9.3**.

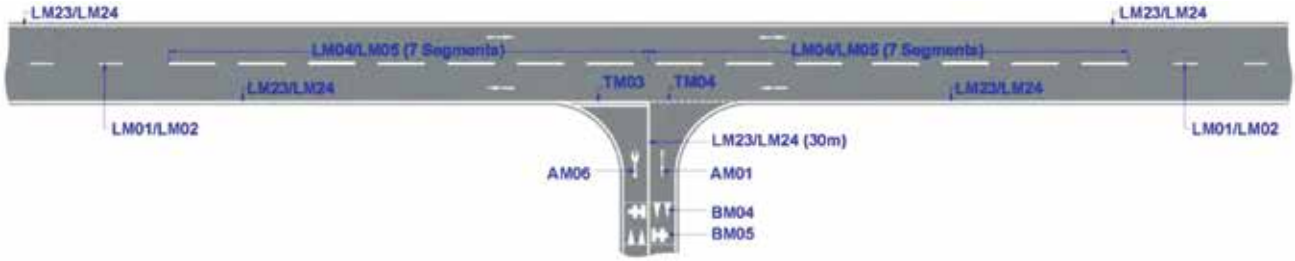


Fig. 9.3 Typical Marking for Simple T-Junction

9.2.2 If the forward visibility is clear enough, the broken centre line can be continued, but would be warning centre line at junction influence area.

9.2.3 If the main road has visibility problems due to horizontal or vertical geometry or any other external factors, centre line shall be provided with no overtaking.

9.2.4 The provision of edge line and width of centre line is also governed as per carriageway width. The Stop line marking along with Stop Sign shall be provided. Around 30 m length barrier line shall be provided for side road, preceded by the warning line.

9.3 Skew or Y-Junction

9.3.1 The skew or Y-Junction is a layout in which a side road approaches the main road at oblique angle.

9.3.2 By virtue of geometry, a triangular island can be catered and thereby side road traffic would be made to align at nearly perpendicular to the main carriageway by which safety can be enhanced substantially. **Fig 9.4** depicts a typical layout.

9.3.3 If the forward visibility is clear enough, the broken centre line can be continued, but would be warning centre line. If the main road has visibility issues due to horizontal or vertical geometry or other external factors, centre line shall be no overtaking. The provision of edge line and width of center line will also be governed by carriageway width.

Fig. 9.4 Typical Marking for Simple for Skew or Y-Junction

9.3.4 The Stop Line Marking along with Stop Sign shall be provided. If the visibility funnel is clear, Give way Marking with Give way Sign shall be given. Around 30 m length barrier line shall be provided for side road, preceded by warning line.

9.3.5 The traffic coming from slip lane shall Give way to traffic in the side road and Give way Marking along with Give way sign shall be provided.

9.4 Ghost Island Junction

9.4.1 It is an at-grade junction in which an area of the carriageway will be made with pavement markings to direct the traffic movement as well as it would give a shelter lane for right turning movement.

9.4.2 Wide paved area generally will provoke drivers to move recklessly and hence hatch markings will cause the drivers to confine within the required space as well to avoid the accidents by hitting raised islands.

9.4.3 If the physical island cannot be installed, wide open area effect can be avoided by providing Ghost Island so as to streamline the traffic movement within core junction area. The minimum area of a physical island shall never be less than 6 sqm, lest it is unlikely to be noticed by traffic, resulting in collision. In such situations, the wide area affect can be minimised through Ghost Island i.e. with pavement markings. The typical hatch marking and ghost island marking is given in **Fig. 9.5**.

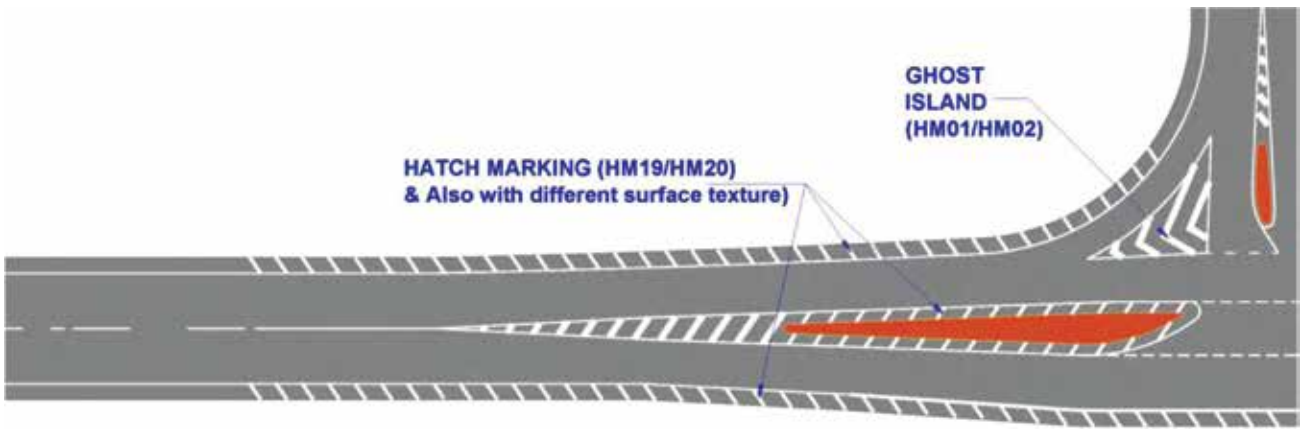


Fig. 9.5 Hatch Marking and Ghost Island

9.4.4 Creating ghost Island in the main carriageway eases the right turning vehicle and also provides some shelter to right turning traffic from through traffic. Ghost Island is not

desirable for single carriageway as the overtaking of vehicle has the chances of conflicting with right turning traffic. However, a storage lane provision with Ghost Island as shown in **Fig. 9.6.** This is a better solution than compelling right turning traffic to wait in the through lane, which can be created by a width of 3 m to 3.5 m at junction influence area.

9.4.5 The width of through lane(s) should not be more than 3.65 m and not less than 3.0 m. The desirable width of turning lane is 3.5 m but at urban junctions it is advantageous to use wider turning lane not exceeding 5 m so that the right turning vehicle can have some shelter. The width of the Ghost Island should be between 2.5 m and 3.5 m and not less than 2.5 m in any case.

9.5 Right Turn Protected T-Junction

9.5.1 It is an at-grade junction in which, an area with the carriageway will be made with Physical Island to create a right turn protected lane for paved markings to direct the traffic movement as well as it would give a shelter lane for right turning movement.

9.5.2 The width of through lane(s) should not be more than 5.5 m unlike with Ghost Island due to raised island and invariably between two raised kerb or island, a minimum of 5.5 m shall be maintained. This minimum width shall be catered in the formation of Physical Island, lest the triangular island shall be with ghost islands.

9.5.3 In the unlikely event of traffic plying through paved shoulder and even can hit the triangular channelizing islands, the islands can be protected by refuge island markings for Physical Island as shown in **Fig. 9.7**.

9.5.4 The filter lane width shall be 3.5 m and no case it is less than 3 m. The width of the raised physical island shall be minimum 1.2 m to act as Refuge Island and also to ensure that signs placed in islands are in intact position without being hit by traffic.

9.5.5 In order to create the right turning lane, necessary tapering shall be done as per the taper rate.

9.5.6 The typical layout for right turn protected T Junction in **Fig. 9.8**. When the carriageway is wide enough and if there is provision for paved shoulder, the shoulder side edge line shall be provided. Similarly the fillet radius is not adequate enough to provide a physical triangular island; the triangular islands can be made of Ghost Island.

9.6 Staggered Junction

9.6.1 The staggered junction is a junction in which major road is continuous and major road can accommodate a shelter lane for right turning traffic and two minor T–junction are eccentrically placed so that there is enough space to provide right turning lane. Wherever there is sufficient space available, it is desirable to convert cross road into staggered junction, which will enhance safety substantially. It has an added advantage upon the cross road on safety performance by preventing easy cross road movements. **Fig. 9.9** gives a typical layout for staggered intersection.

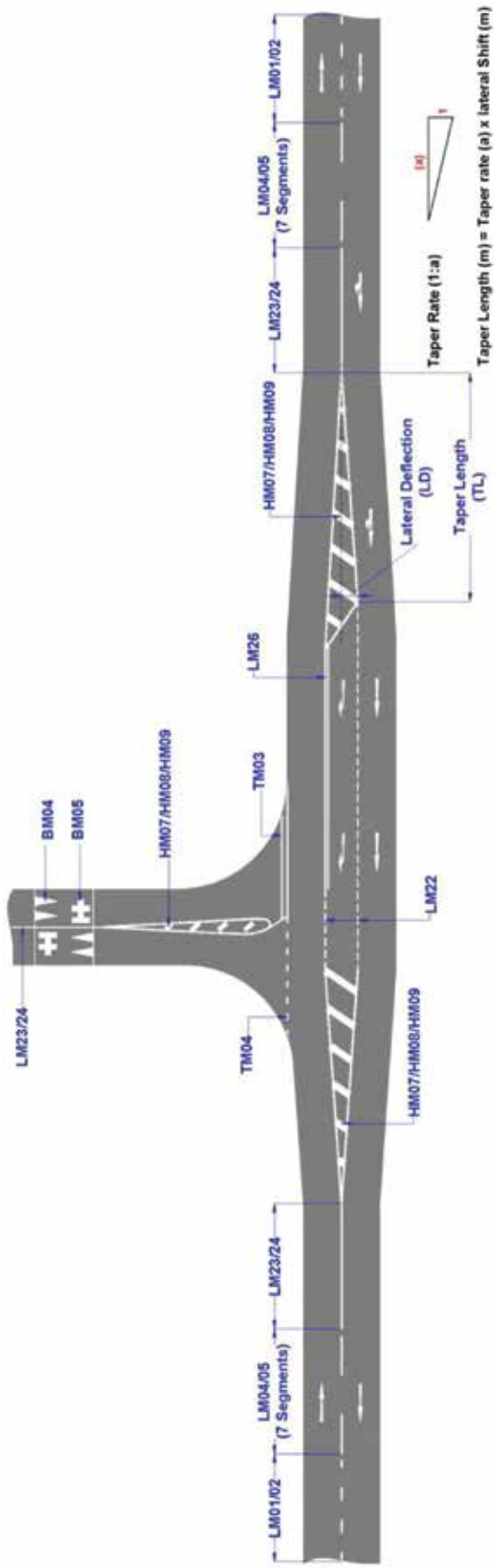


Fig. 9.6 Typical Marking for Junction with Ghost Islands

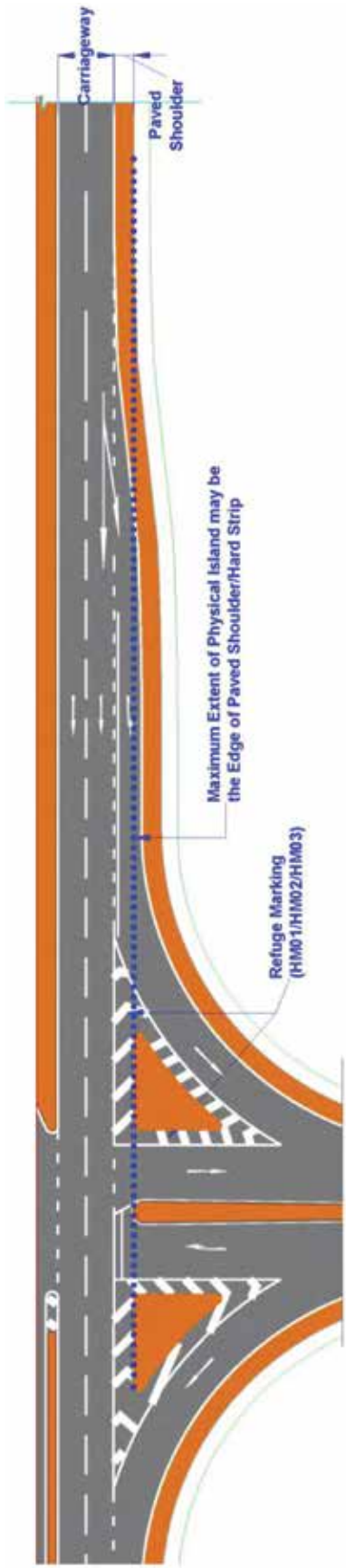


Fig. 9.7 Marking for Refuge for Physical Island

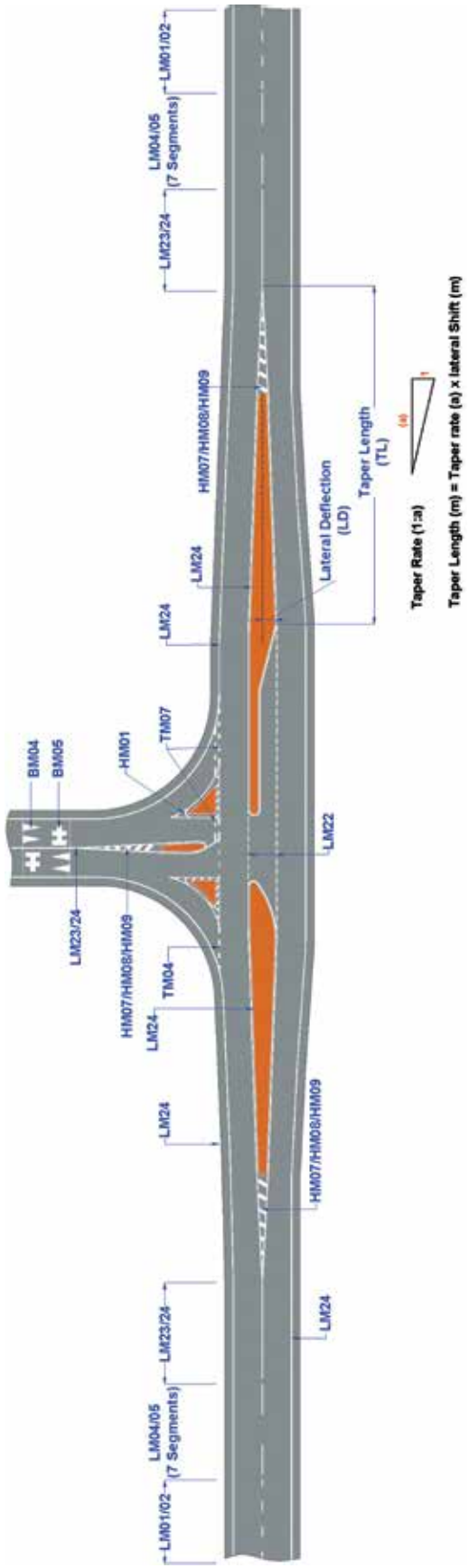


Fig. 9.8 Typical Marking T-Junction with Physical Islands

Fig. 9.9 Layout for Staggered Intersection (With Right Turn Protected Arrangement)

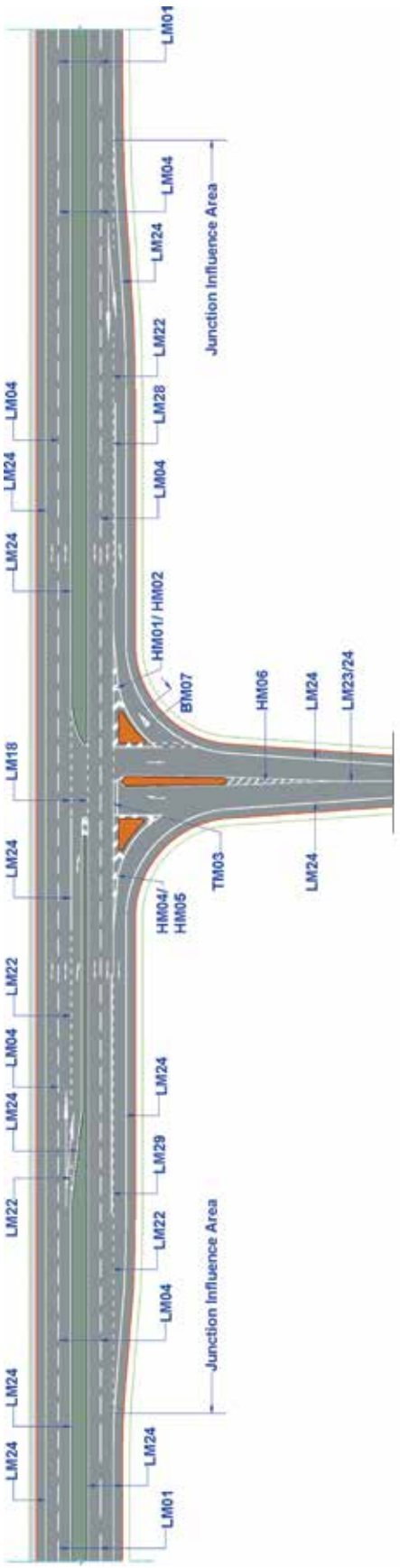


Fig. 9.10 Typical Marking for Junction with a Divided Carriageway

9.7 Dual Carriageway Junctions

9.7.1 The standard layout for right turns on dual carriageway is shown in **Fig. 9.10**. The through lanes should maintain its width throughout the carriageway and be separated from the right turn lane with broken markings.

9.8 Signalised Intersection

9.8.1 At the signal controlled junctions, the Stop Lines should be laid as near as possible to intersection keeping in mind the need of the pedestrians. Care should be taken that driver can have uninterrupted view of at least one signal. Lane lines should also be marked so that maximum available space of the carriageway could be marked. At the place near the intersection and approaches, appropriate arrow should be marked to show the turning lane.

9.8.2 Stop Line should be positioned 1.5 m in advance of nearside primary signal. The markings should be carried out at right angle. The markings should be carried out at right angle to centre line of the carriageway. **Fig. 9.11** shows the basic principles in signal control markings.

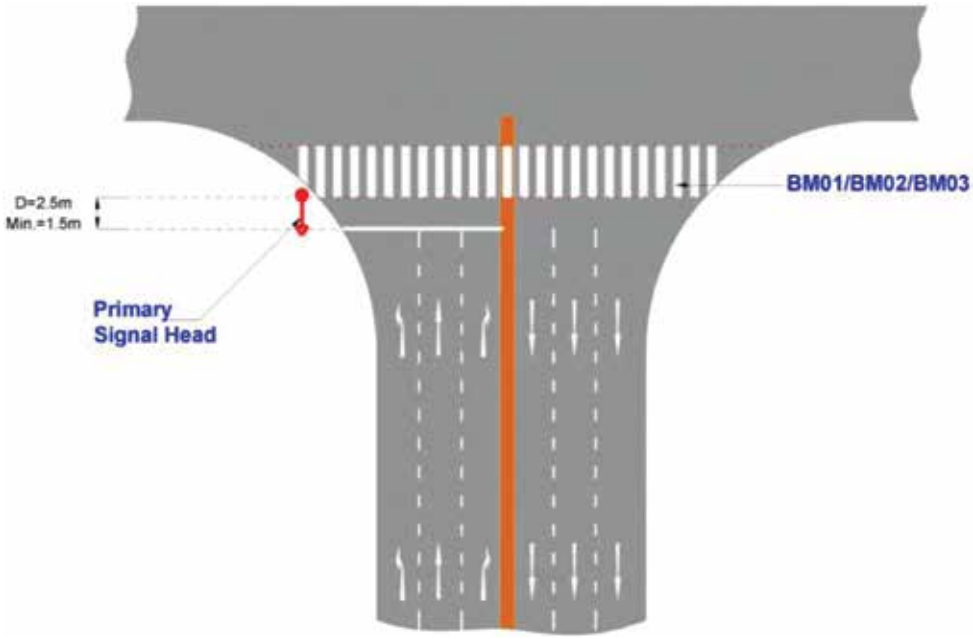


Fig. 9.11 Marking in Signal Controlled Junction

9.8.3 The marking layout for a four armed junction controlled by signal is shown in **Fig. 9.12**. According to signal traffic phase based on traffic turning movements, dedicated arrow markings shall be given. Pedestrian marking shall be provided and shall be user friendly by lowering the height of raised kerb and shall be provided with different surface texture to make it distinct. The width of the zebra crossing shall be based on pedestrian crossing volume and shall be provided with road studs also.

9.8.4 A signalised intersection facilitating free left turn movement is shown in **Fig. 9.13**. If turning movement through free slip road is high, the pedestrian crossing across slip road will also warrant signal control coupled with the provision of Speed Table as per IRC:67 (2012) for facilitating the safe crossing of pedestrians.

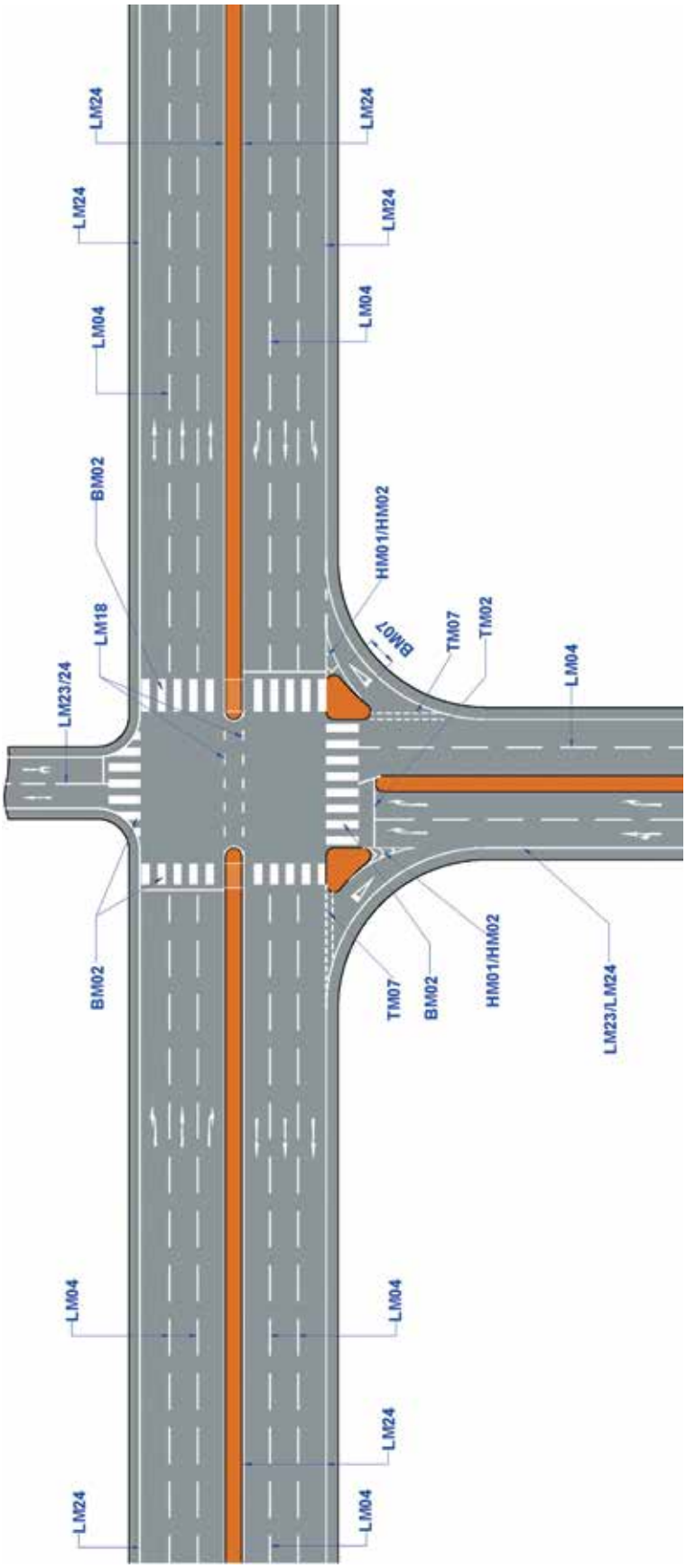


Fig. 9.12 Typical Marking for Signalized Junction (Urban Section)

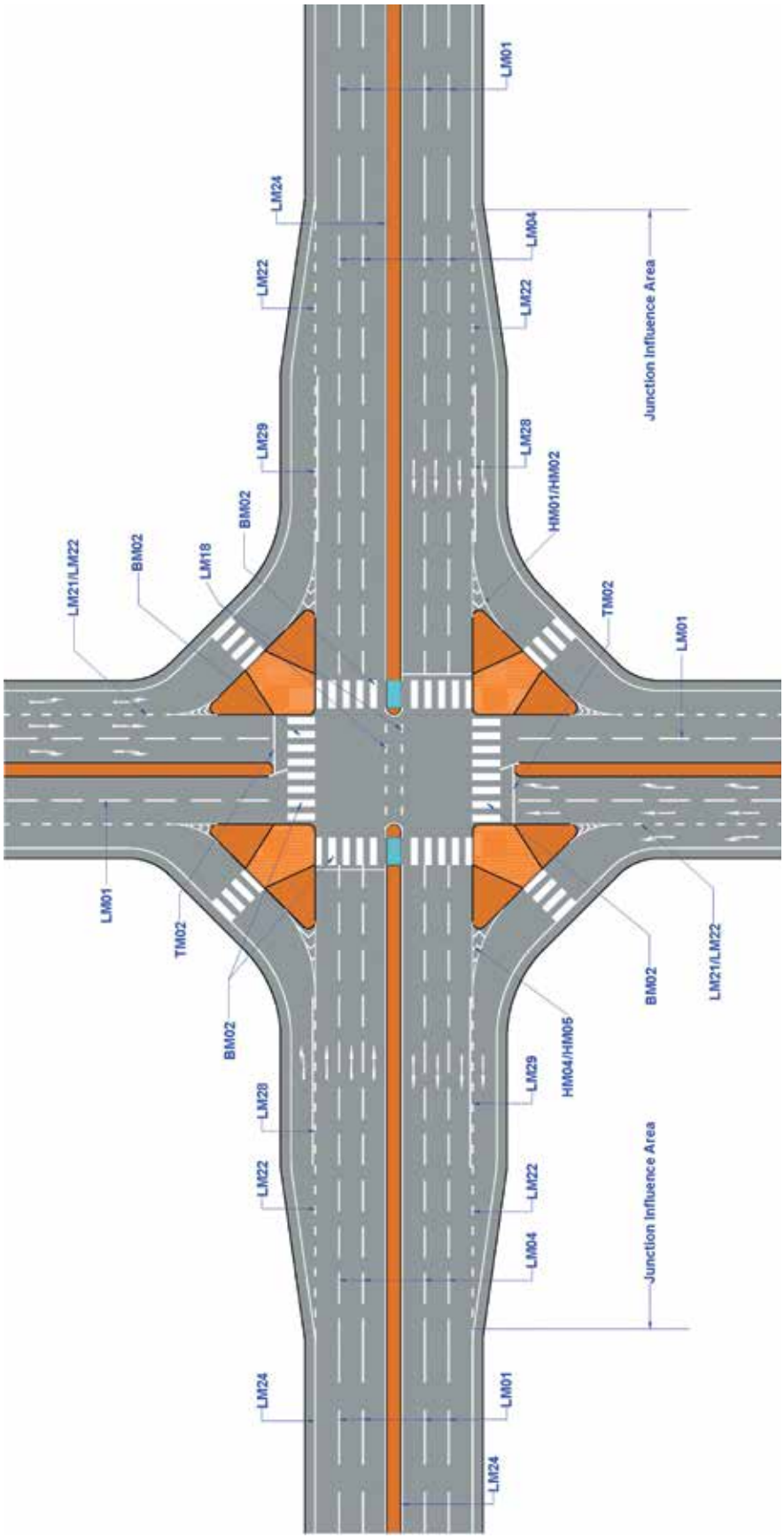


Fig. 9.13 Typical Marking for Signalized Junction (with free left turn)

9.9 Roundabout

9.9.1 The general rule governing the behaviour of traffic at roundabout is that drivers should give way to any traffic on their immediate right. The conventional roundabouts always operate based on the priority from right rule and shall be adhered. The traffic from approach road while entering into circulatory carriageway shall ensure the priority of those vehicles already in the circulatory carriageway as given in **Fig 9.14**.

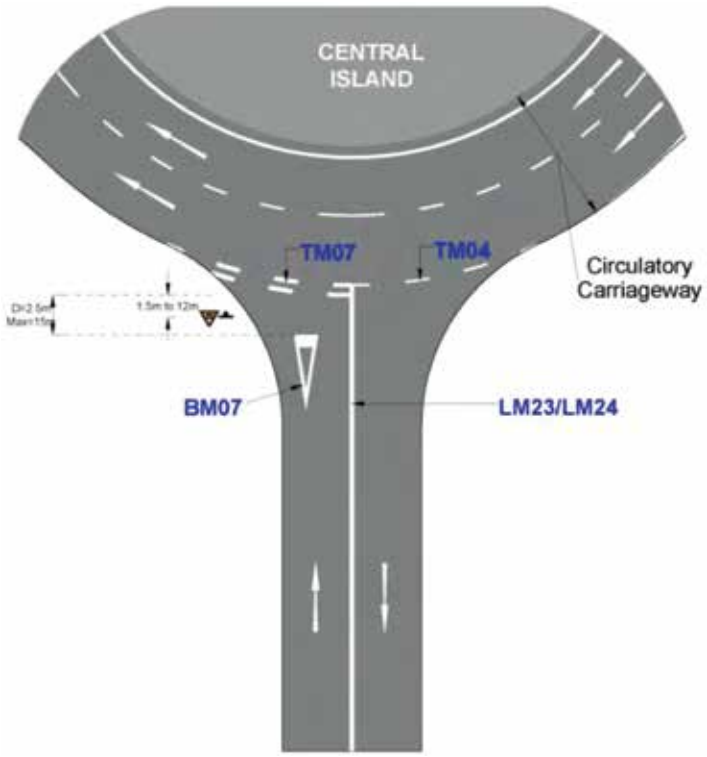


Fig. 9.14 Give Way Marking for Priority in Roundabout Approach

9.9.2 Exit roads at roundabouts should be indicated by signs and directional arrows placed both at the edges of Central Island and the directional islands. Pedestrian and cyclist crossings should be provided with suitable pavement markings.

9.9.3 The marking for conventional roundabout is given in **Fig 9.15** wherein approach roads of more or less same category intersect at the roundabout.

9.9.4 **Fig. 9.16** shows layout of a relatively small roundabout with and without triangular splitter island. The triangular island can be of Physical Island as well as Ghost Island.

9.10 Signal Controlled Roundabouts

9.10.1 Signalled roundabouts have traffic signal on one or more approach arms. Stop line should be laid at right angled to carriageway edge. Lane markings should be provided on the circulatory path of the roundabout lane marking and will improve the road space on the roundabout and guide the driver for its smooth movement. Lane markings will act as a major tool in reducing the incidence of the side swipe of the circulating traffic as well as collision between entering and circulating traffic.

9.10.2 The common configurations of road markings which are used on circulatory

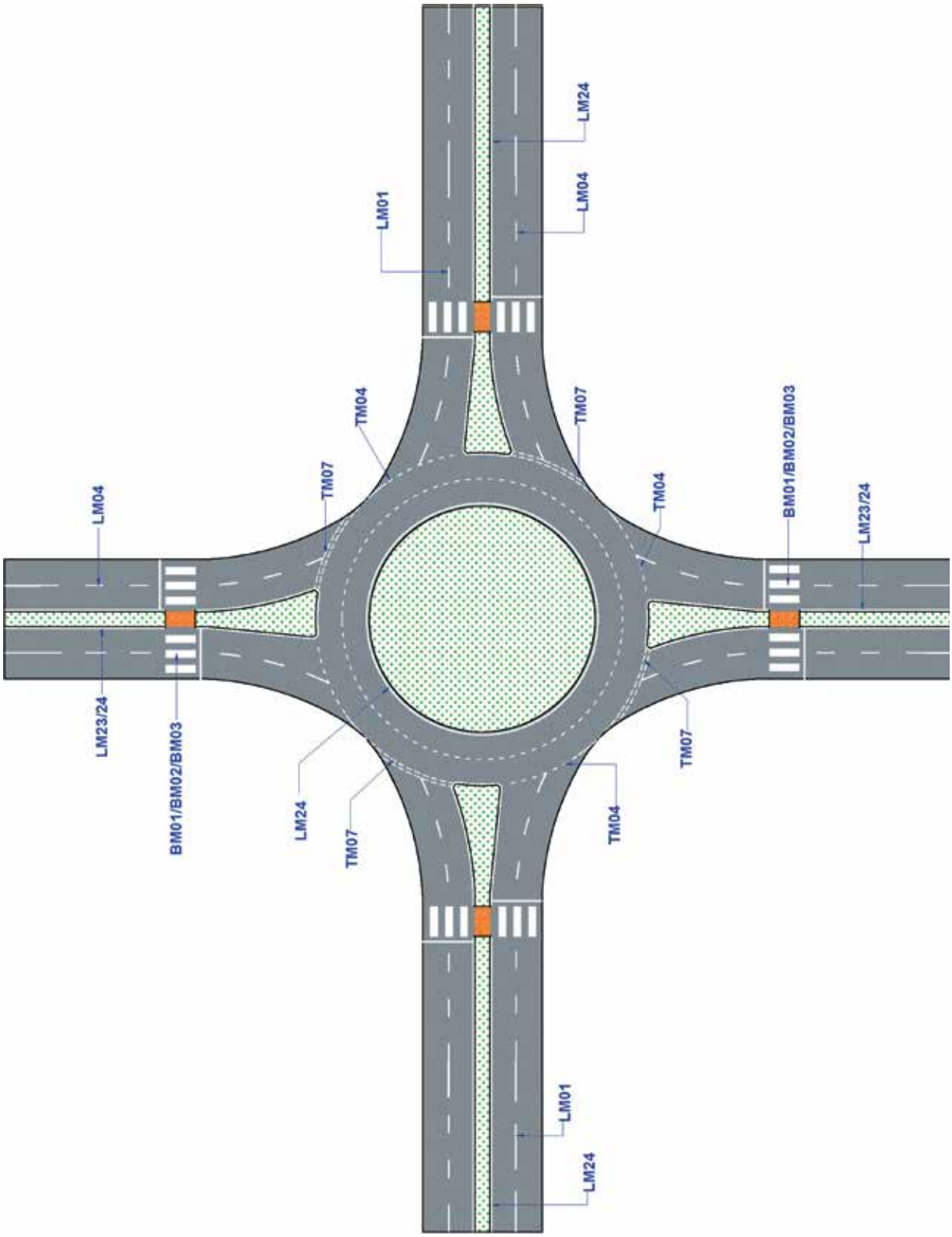


Fig. 9.15 Typical Marking for Roundabout

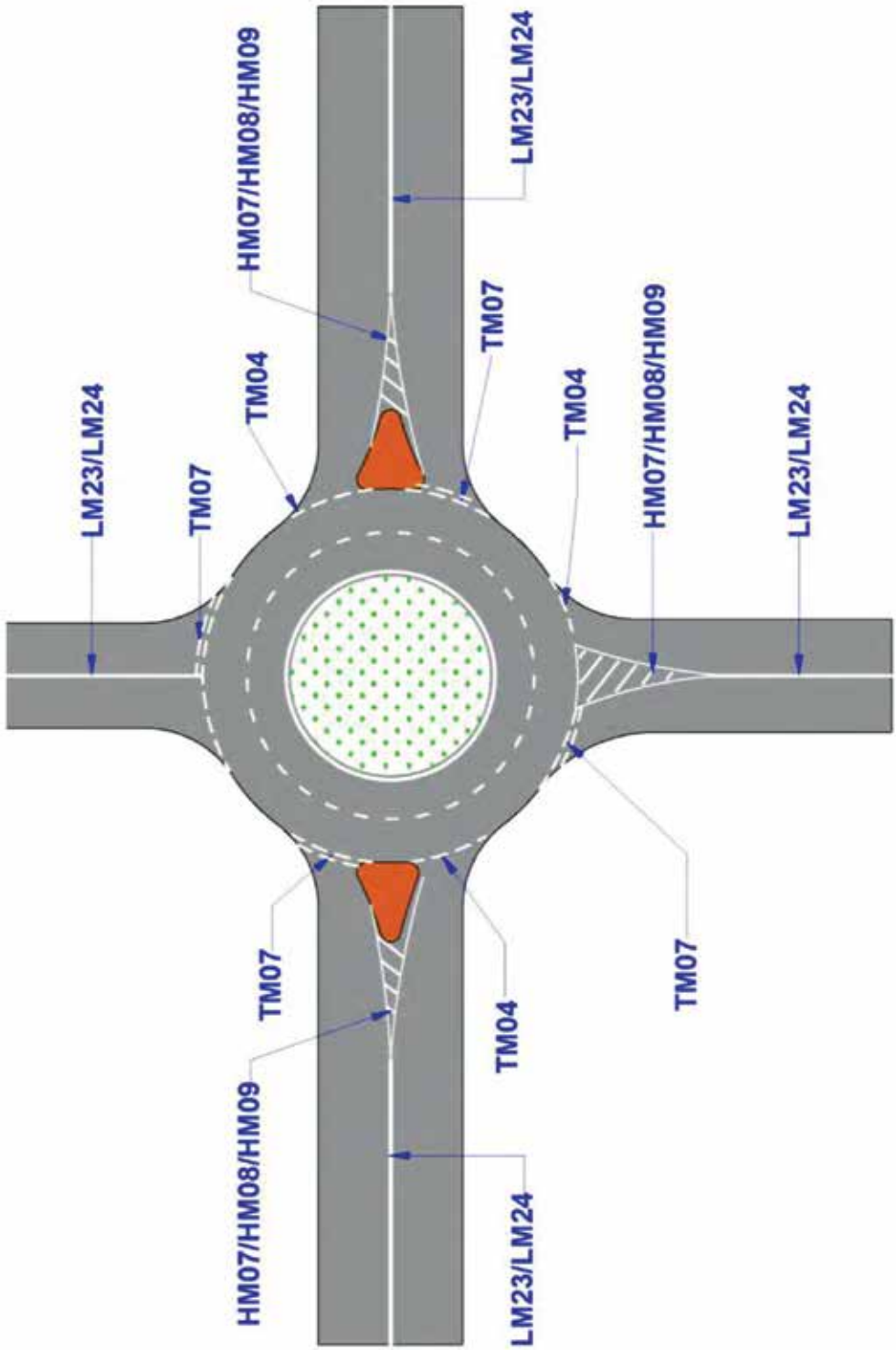


Fig. 9.16 Typical Marking for Roundabout (Approach Roads of Different Category)

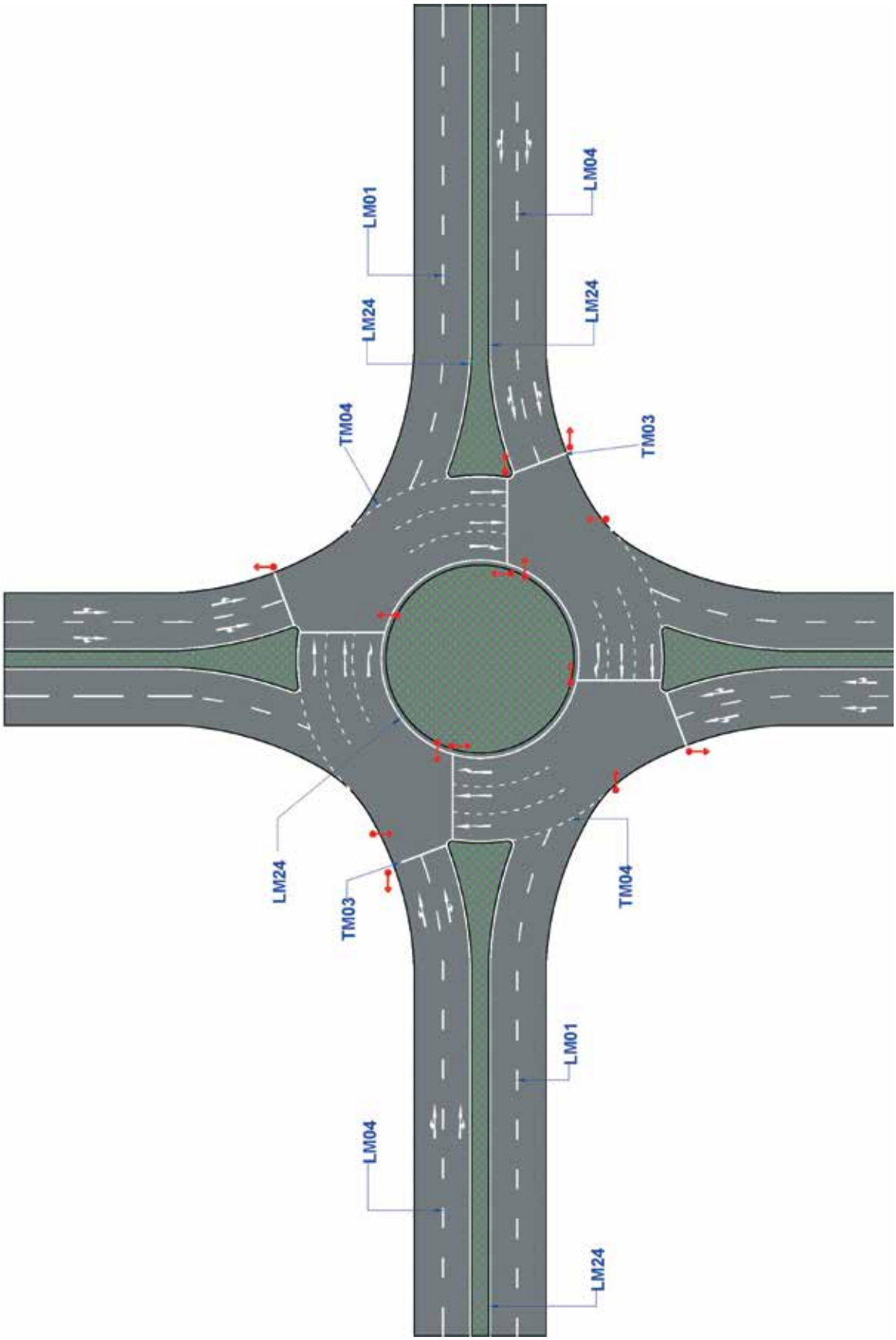


Fig. 9.17 Signal Controlled Roundabout

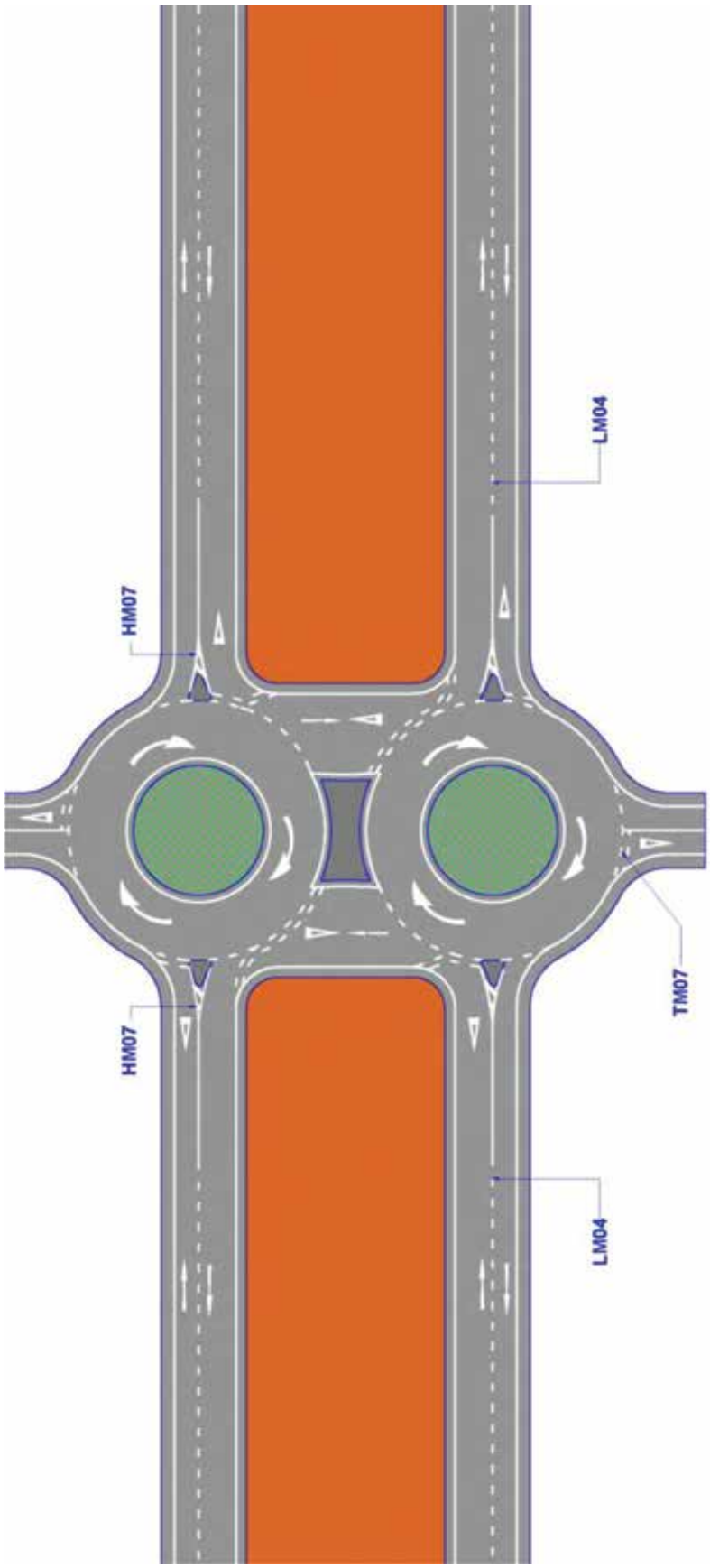


Fig. 9.18 Typical Marking for Double Roundabout

Fig. 9.19 Mini Roundabout (Traffic Control by Giveway)

carriageway are concentric circles, helping the drivers to know the extent of lane width in which he is circulating. Lane arrows and destination arrows are usually repeated on roundabout circulatory carriageways. At the entries of roundabouts, these arrows help the drivers to identify the correct lane for the specific exit on the roundabout. Pedestrians should never be expected to cross the roundabouts and should be provided with safer crossing point outside the rotary.

9.10.3 Yellow box markings at un-signalised roundabout are not allowed but it could be used on signalled controlled roundabouts.

9.10.4 The marking for signal controlled roundabout is given in **Fig. 9.17**.

9.11 Double Roundabout

9.11.1 Double roundabout will be required in situations where in the number of roads are meeting and are not possible to handle them in one big roundabout. In a double roundabout as shown in **Fig. 9.18**, the two roundabouts shall function as standalone roundabouts and by so doing it will enhance safety and capacity.

9.12 Mini Roundabout

9.12.1 Mini roundabouts are effective in improving safety at junctions due to side road delays in urban junctions and could be installed with minimal alterations to kerbs etc. Mini roundabouts have a one-way circulatory carriageway around a slightly raised central disc with or without flared approaches. The layout of mini roundabout is given in **Fig 9.19**. The layout should be designed in such a way that road sign shall be in place as per IRC:67 (2012) to make the driver aware in good time that they are approaching a roundabout.

9.12.2 Mini roundabouts should be used when all approaches are subject to a speed limit of 30 kmph or less. The mini roundabout is not recommended when speed limit on any of the road is above 30 kmph as markings will not be conspicuous at higher speeds and the space on the mini roundabout will not be sufficient for deflection of the vehicle. The choice of size of mini roundabout will depend on the available space. The standard Give Way marking be used at mini roundabouts accompanied by sign of roundabout sited at about 1.5 m advance of Give Way markings. The central islands of mini roundabout should be kept free of all type of furniture as shown in **Picture 9.1**.

Picture 9.1 An Example of Mini Roundabout with Saucer Type Central Island

SECTION : 10
GRADE SEPARATED JUNCTIONS

10.1 General

10.1.1 In the case of traffic approaching the grade separated intersections, there is likelihood that the lane change from the main carriageway to the auxiliary lanes or vice versa generally takes places at high speed and hence has to be dealt carefully. The basic issue to be addressed in this regard is to enable the driver to distinguish clearly between through traffic lanes and the auxiliary lanes. Additional emphasis has to be provided by means of chevron markings in the neutral area.

10.1.2 Merging and diverging can be provided either with lane gain or lane drop or without lane gain or lane drop depending upon the level of traffic bifurcating or merging.

10. 2 Merging/Diverging without Lane Gain or Lane Drop

10.2.1 The traffic merging and diverging occurring in the vicinity of the flyover or Vehicular Under Pass (VUP) are generally carried out without any lane gain or lane drop as given in **Fig. 10. 1**.

10.2.2 The nose length shall be determined based on the speed and actual lateral shift traffic as given in **Section 7**. The position of arrows are given as per **Section 8**. The length of the auxiliary lane and taper shall be as per the design.

10.3 Merging/Diverging with Lane Gains/Lane Drop

10.3.1 If there is substantial quantum of traffic either diverging or merging, the merging or diverging operations are to be facilitated by the provision of a lane gain or lane drop as presented in **Fig. 10.2**.

10.3.2 The nose length shall be determined based on speed and actual lateral shift of traffic as given in **Section 7**. The position of arrows is given in Section 8. The length of auxiliary lane and taper shall be as per the design.

10.3.3 For diverging and merging situations with two lane slip roads, a safer practice of lane gain and lane drop shall be carried out with ghost marking as given in **Fig. 10. 3**.

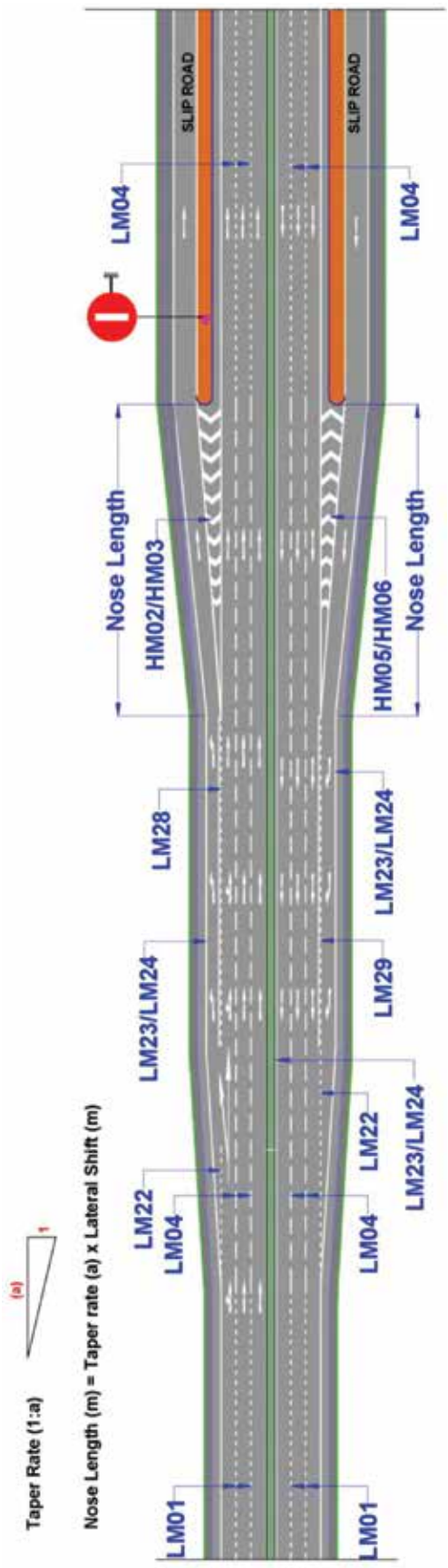


Fig. 10.1 Merging/Diverging (Without Lane Gain/Lane Drop)

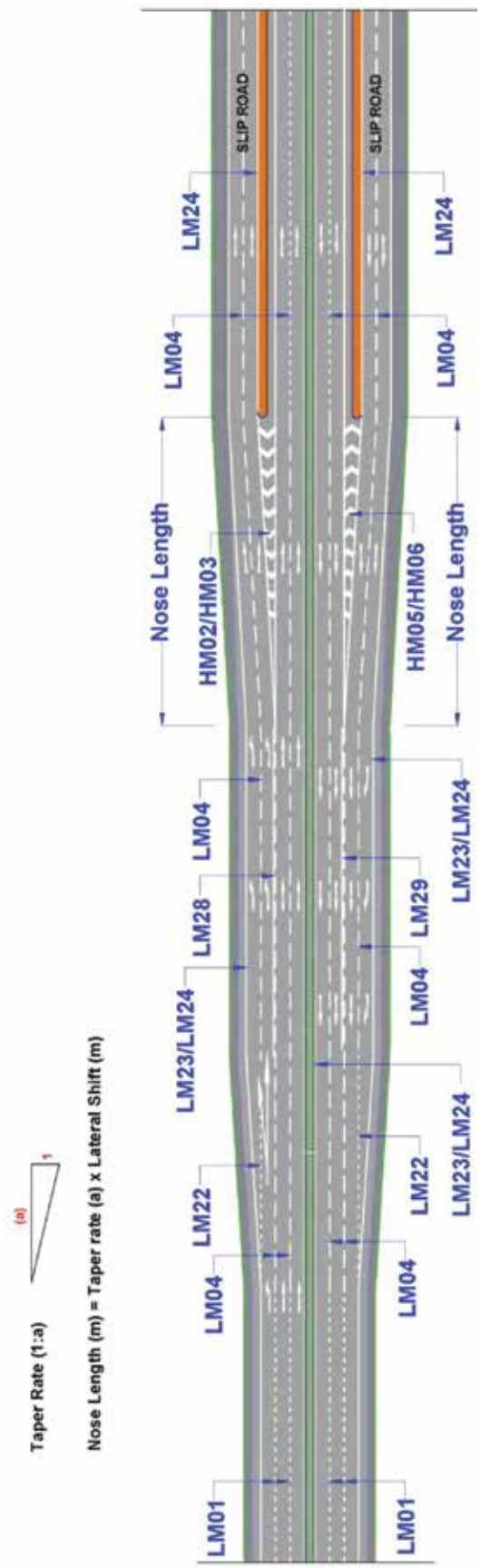


Fig. 10.2 Merging/Diverging (With Lane Gain/Lane Drop)

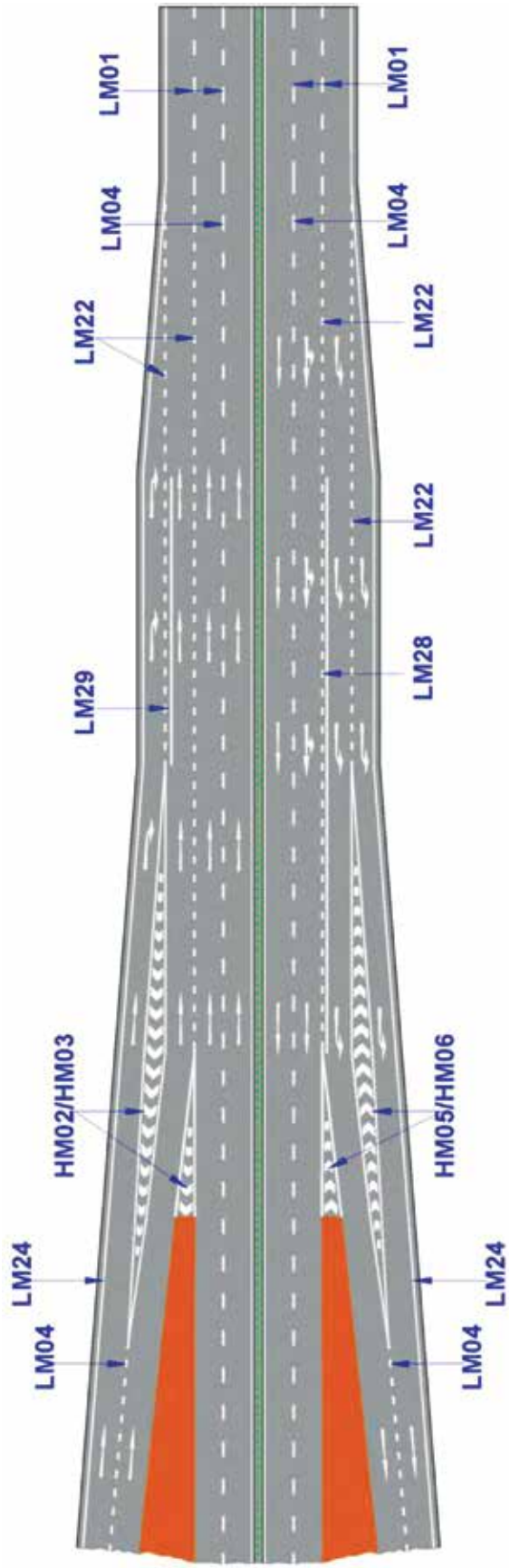


Fig. 10.3 Merging/Diverging with Ghost Island (with Lane Gain/Lane Drop)

SECTION : 11
MARKINGS FOR SPEED REDUCTION MEASURES, PEDESTRIAN CROSSING & CYCLISTS

11.1 Markings on Speed Breakers

11.1.1 The markings on speed breakers are necessary to warn driver about the hazard ahead in advance. For better night time visibility, the marking shall be made with retro-reflective and reinforced with road studs. Speed breaker markings shall be supplemented with warning sign in advance of zebra crossing location and also informatory signs at the location of zebra crossing.

11.1.2 **Fig. 11.1** shows the types of markings to be equipped on the speed breaker, which comprises two rows of checkered markings consisting of alternate black and white bands of 500 mm width on either side of tapering. The Triangular Markings in the case of both Round Top and Flat Top Humps shall be marked. The width of the base of the triangular marking shall be 750 mm and the height from base to its apex shall be a maximum of 1850 mm. The triangular block and chequer block shall be as per the dimension given in **Table A.4 of Annexure A**.

11.1.3 It is desirable to provide raised footpath for at least small length as shown in **Fig. 11.1**. This measure would help in preventing the violating traffic from using the shoulder with their motive to avoid road hump installed in the main carriageway. The road hump of various chord lengths can be developed, facilitating different speed and the geometric details for construction of road humps have been illustrated in **Fig. 11.1**.

11.2 Thermoplastic Bar Marking

11.2.1 Thermoplastic bar marking is a softer treatment to reduce the speed. One set of bar marking (refer TM 08) comprises of 6 bars of 300 mm wide. Each strip of thermoplastic strip shall be of 5 mm high and shall be applied across the full width of the carriageway. Each strip of 300 mm shall be set apart by 600 mm and one set shall comprise of 6 strips. The number of set of bar marking shall be based on approach speed as given in **Table 11.1** and **Fig. 11.2**.

Table 11.1

Approach Speed (kmph)	Bar Marking (Number of TM08)	Distance (d1, d2, d3 & d4) from Hazard
Up to 50 km	1 set	d1 = 50,
51 to 65	2 set	D1 = 50, d2 = 80
66 to 80 kmph	3 set	D1 = 50 m, d2 = 80 m, d3 = 120 m
81 to 100 kmph	4 set	D1 = 50, d2 = 80, d3 = 120, d4 = 180 m

11.3 Pedestrian Crossings

11.3.1 Pedestrian crossing shall be provided at important intersections and is essential where conflict exists between vehicles and pedestrians. The success of the pedestrian crossings depends on where and how they are marked. The site should be so selected

that the pedestrians are subjected to minimum inconvenience and pedestrian would have enough visibility to see the oncoming vehicles and at the same time, the vehicular traffic is not interrupted very often.

11.3.2 At intersections, the pedestrian crossings should invariably be preceded by a Stop Line. At an unsignalised pedestrian crossing, the stop line shall be set back 2 m to 3 m from the start of zebra crossing marking. In a signalised intersection, zebra crossing shall be 1 m ahead of primary signal and Stop Line shall be placed another 1 m ahead of the start of zebra crossing.

11.3.3 If pedestrian crossing length is more than 10.5 m in one go, there shall be Refuge Island in between of at least 1.2 m width to serve as shelter place. The road studs shall also be provided to make the zebra crossing visible to users during night time. All kerbs to be mounted by pedestrian shall never be more than 50 mm and shall be user friendly facilitating wheel chair usage by the disabled at urban locations.

11.3.4 The pedestrians shall have sufficient space on the footpath to wait. The obstruction such as trees, sign posts, lamp posts etc. shall be cleared in the path of pedestrians at either end of the pedestrian crossing.

11.3.5 **Fig. 11.3** depict pedestrian marking done at a typical mid-block section. The width of the pedestrian crossing is governed by the pedestrian volume crossing and by local requirements, but in no case should it be less than the width of footpath subject to minimum of 2.0 m. The width of the crossing generally lies between 2 m to 4 m. (Refer **Table A.4** of **Annexure A** for detailed dimensions). It may be advantageous to install flashing signal 3-5 m in advance to warn drivers about the presence of the crossings in urban locations.

11.3.6 It is desirable to provide raised kerb at least for small length for pedestrian to feel safe while waiting for an opportunity to cross the road as shown in **Fig. 11.3**.

11.3.7 Pedestrian crossing in priority control T-intersection is given in **Fig. 11.4**. The raised median and triangular island shall be depressed so as to make it comfortable for pedestrians and even for wheel chairs.

11.4 Marking for Vulnerable Road Section

11.4.1 The road passing through road section having human activities and pedestrian presence for a distance shall be dealt separately as shown in **Fig. 11.5**.

11.4.2 The centre line and edge line marking for the entire vulnerable section shall be with zig zag hazard marking (HM20/HM21/HM22/HM23) to alter the driver. Both extremities of vulnerable reach shall be provided with speed breaker at locations where it is really required to curtail the speed physically and both extremities shall be provided with bar marking at other locations to serve as soft treatment.

11.5 Bicycle Lane Marking

11.5.1 Bicycle lane marking should be provided when a portion of the carriageway is used by motorized vehicles as well as when it is earmarked for exclusive use of cyclists.

11.5.2 When exclusive lane as a part of carriage way is required for Cyclists, the cycle lane markings should be provided. The markings shall consist of 150 mm (if speed< 65 kmph) wide solid white boundary line, else 200 mm wide solid line (if speed > 65 kmph). The minimum width of the cycle track shall be 1.5 m and shall be 2 m where the cycle traffic is heavy.

11.5.3 The cycle symbol (BM08) as shown in **Table A.4 of Annexure A** shall be marked on cycle lanes. The termination of a prescribed cycle lane should be indicated by an END marking on the carriageway and this must always be used in conjunction with cycle symbol. Cycle lane markings shall be supplemented with cycle lane signs.

11.5.4 The continuity of the white solid line shall be maintained at bus stops and junctions by providing continuity line and the marking should be continuous across driveways. The broken taper line (i.e. 600 mm mark and 300 mm gap) precedes cycle lane and can have inclination up to 30 to 45 degree and shall never be sharper than 1:10 as shown in **Fig. 11.6**.

11.5.5 Advisory cycle lanes markings shall be marked where vehicles look for gap to do so then they can enter the lanes and these are marked with warning lines on either side.

11.6 Railway Level Crossing

11.6.1 Markings at road-rail level crossing shall comprise the following: i) No-overtaking zone marking for roads two lane or more wider roads (Longitudinal); ii) A stop line (Transverse) and iii) Series of bar marking depending on the approach speed; iv) Speed Breaker marking.

11.6.2 The markings shall be placed at all road-rail level crossings having significant vehicle/rail conflict. At unimportant crossings or in urban areas, where other devices are provided with suitable control, these markings may be omitted. Continuous edge line of carriageway at rail crossing shall be marked. The type of centre line marking used generally depends on the width of the carriageway available at rail crossing. Where the width of the carriageway over the rail crossing is less than 5 m, centre line markings will not normally be provided. If carriageway width is between 5 m and 5.5 m, then longitudinal warning lines shall be provided on either side of crossing. And if carriageway width is greater than 5.5 m, then the double white solid lines at the crossing shall be provided. Arrow markings shall be provided at approach arms to reinforce the solid lines at crossings.

11.6.3 *Transverse Marking*

If the traffic signal is installed, then stop line of 300 mm width shall be placed at 1 to 2 m from signal. At open controlled crossing, Give way line shall be provided at more than 2.0 m from near approach rail preceded by give way marking and sign.

11.6.4 **Fig. 11.7** depict the typical provision of marking on approach arms by delineating with a series of bar marking, speed breaker and stop line markings.

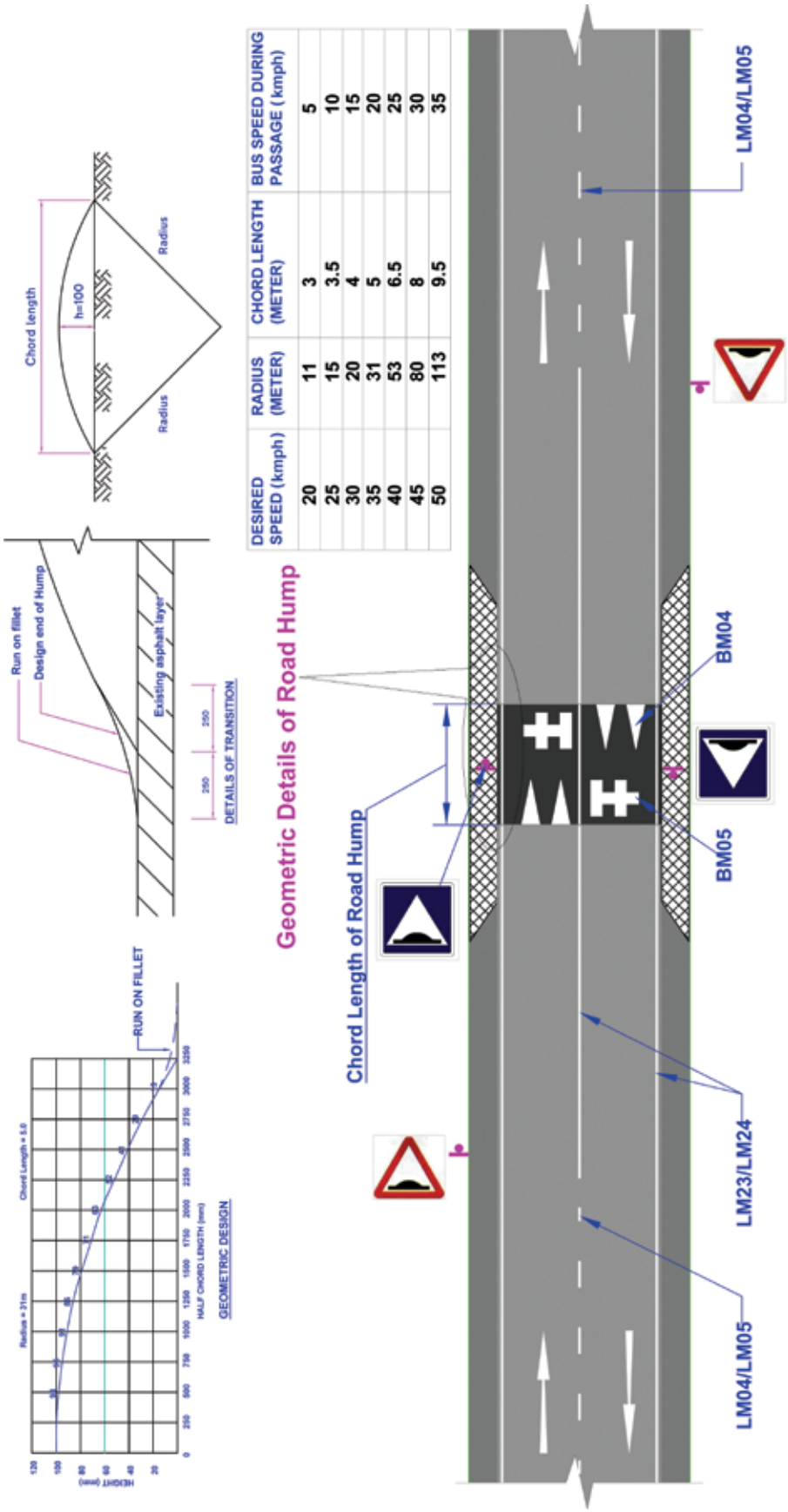
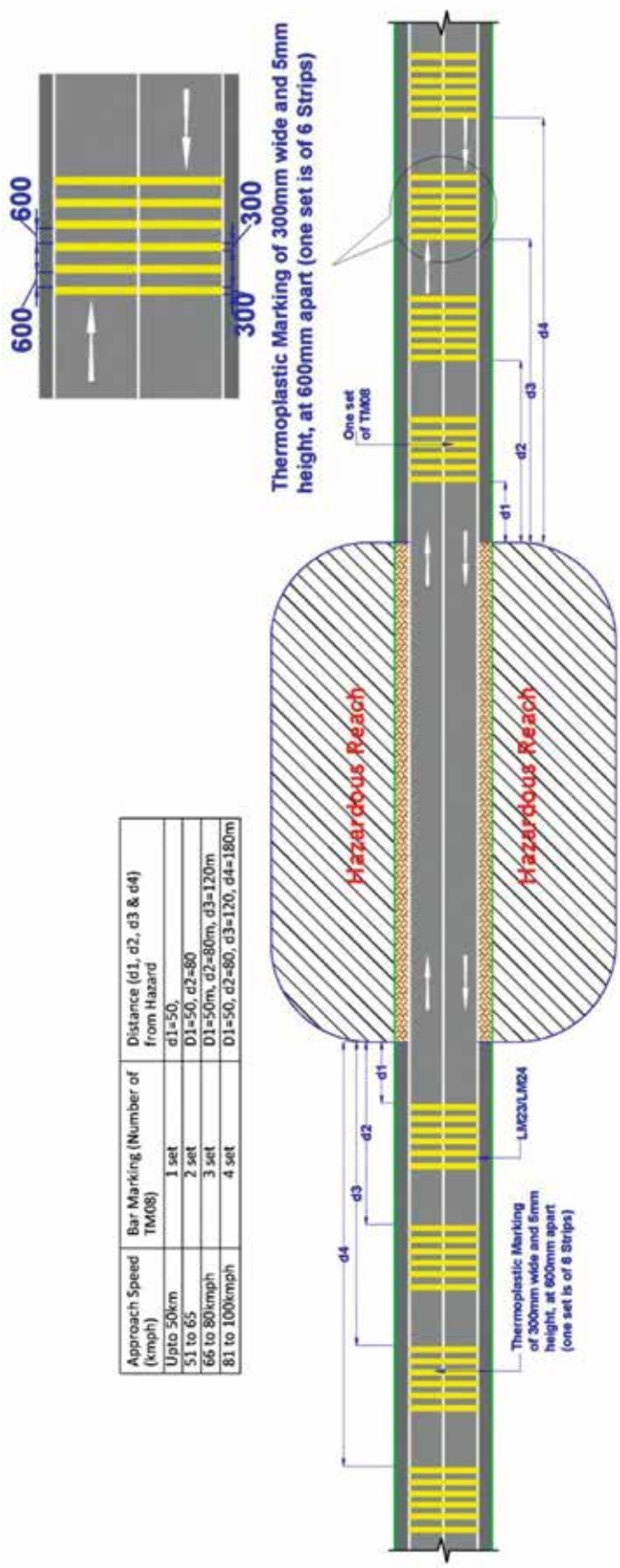


Fig. 11.1 Marking for Road Hump



Approach Speed (kmph)	Bar Marking (Number of TM08)	Distance (d1, d2, d3 & d4) from Hazard
Upto 50km	1 set	d1=50,
51 to 65	2 set	D1=50, d2=80
66 to 80kmph	3 set	D1=50m, d2=80m, d3=120m
81 to 100kmph	4 set	D1=50, d2=80, d3=120, d4=180m

Fig. 11.2 Bar Marking

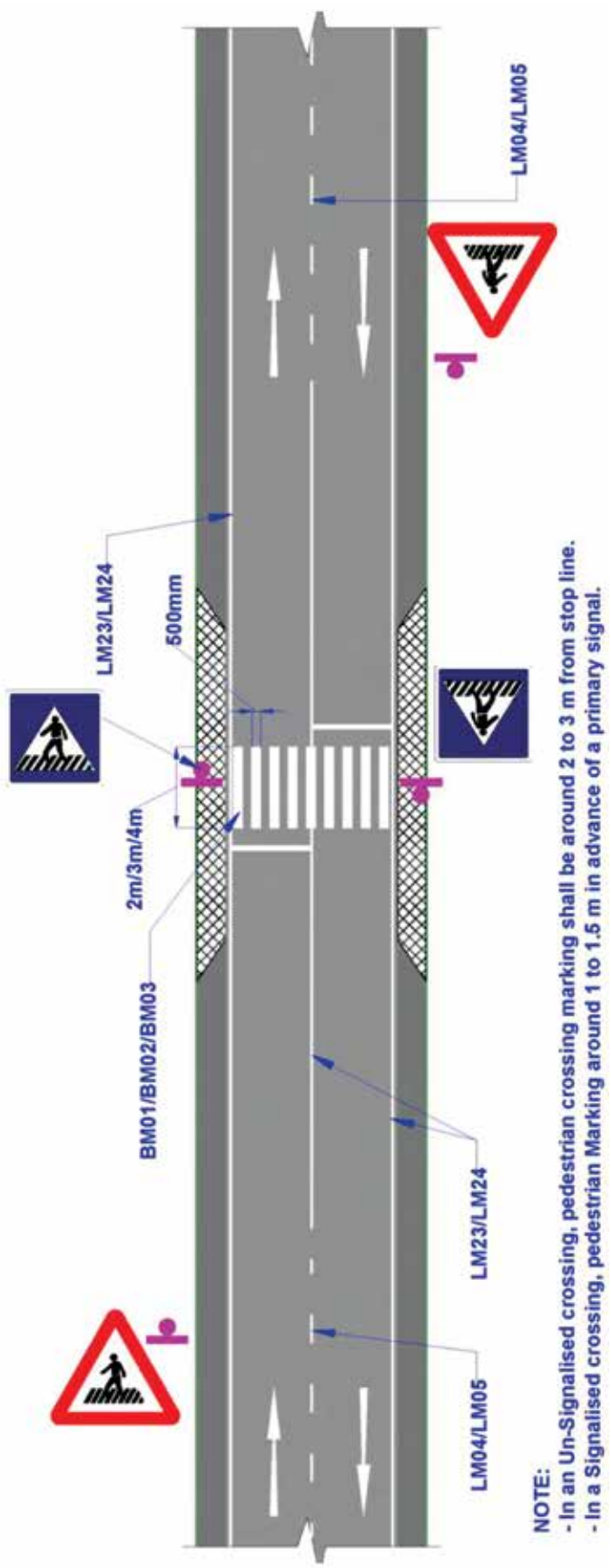


Fig. 11.3 Pedestrian Crossing

Fig. 11.4 Pedestrian Crossing Marking on Priority Junction

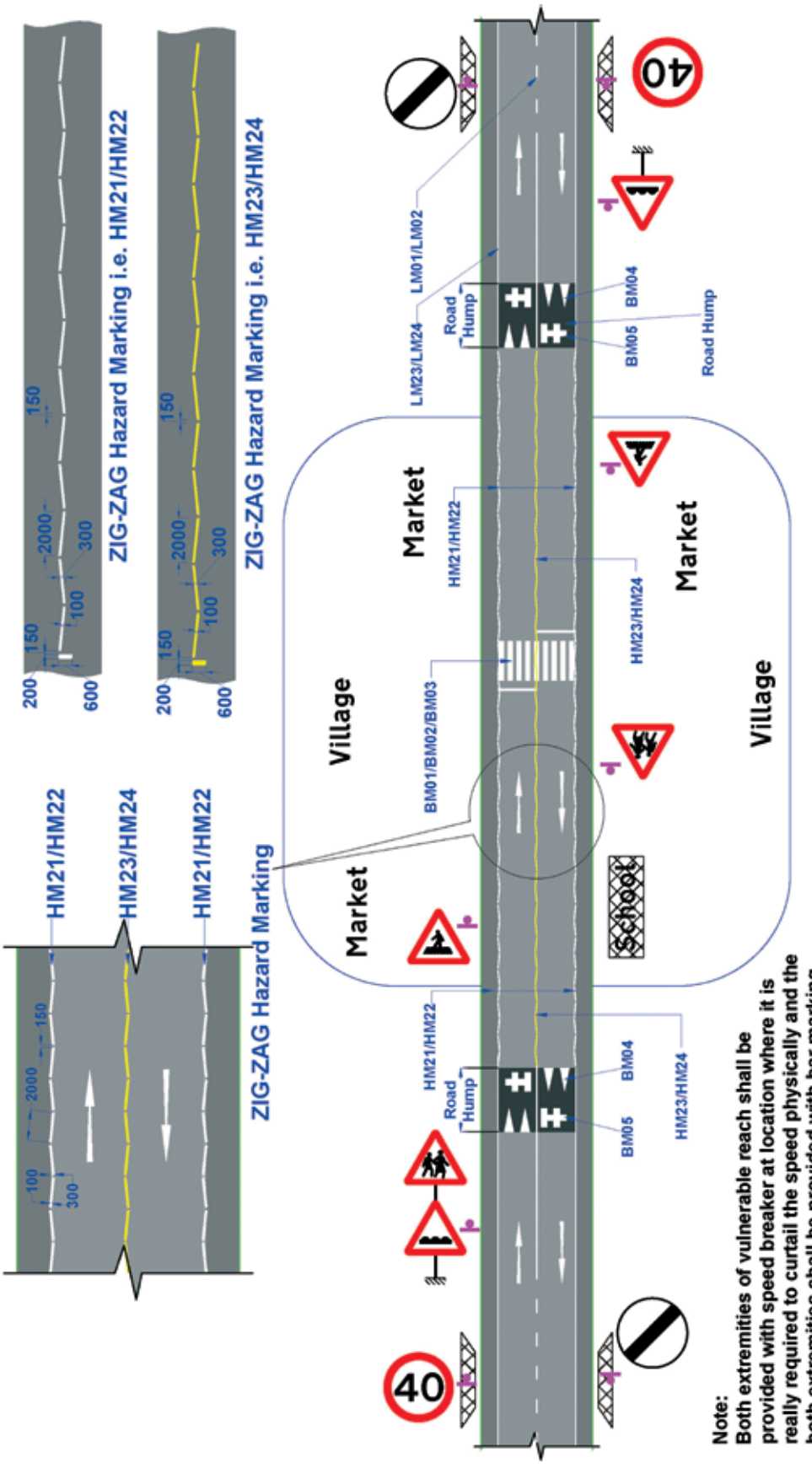


Fig. 11.5 Pedestrian Crossing in Vulnerable Reach (Special Treatment)

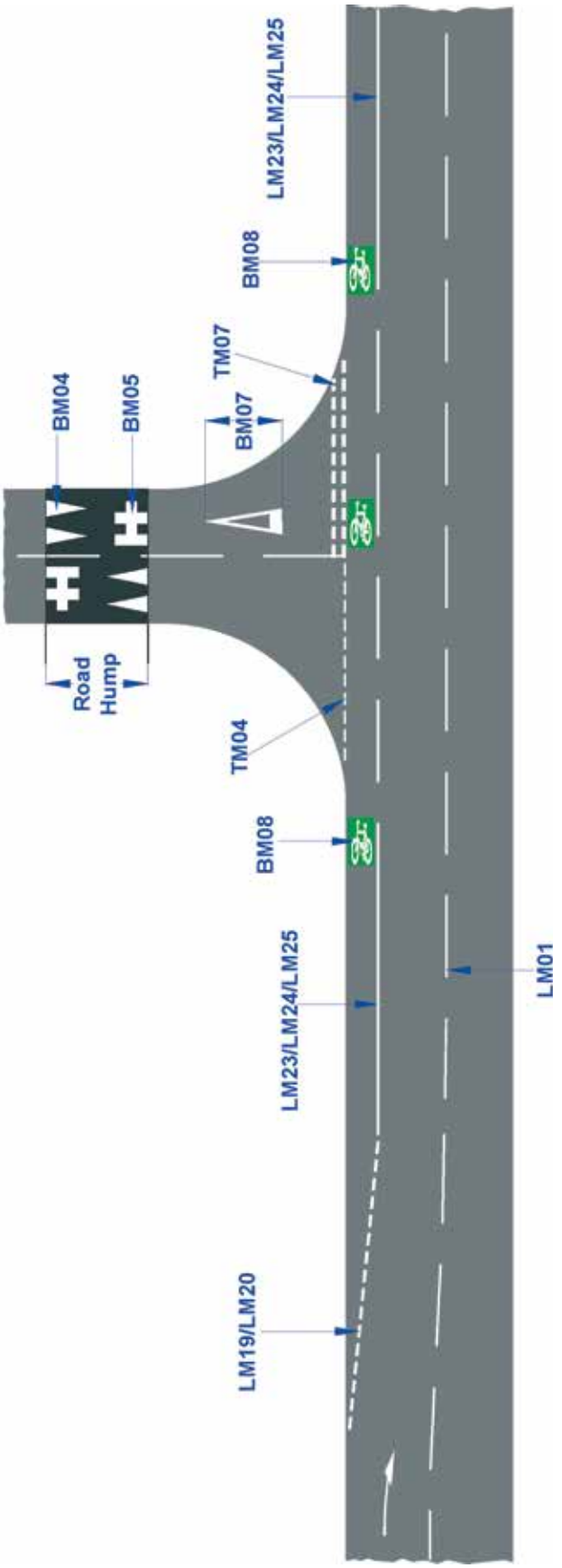


Fig. 11.6 Cycle Track

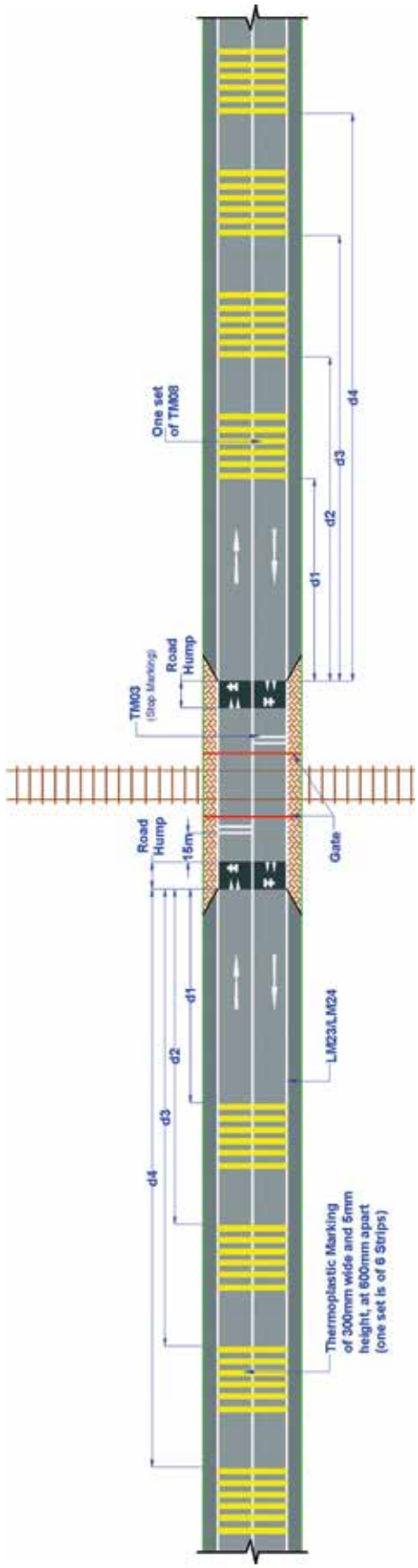


Fig. 11.7 Rail Crossing

SECTION : 12
MARKINGS FOR BUSES, TRUCK LAY-BY AND TOLL PLAZA

12.1 Bus Lane

12.1.1 The lanes reserved for the buses without physical separation shall be provided with white line as bus lane markings as given in **Fig. 12.1**. Generally, a basic width of 3 metres is required for a bus lane. The distance is measured from the edge of the kerb to the centre of the continuous white line. A gap in the white line should be provided adjacent to each side road.

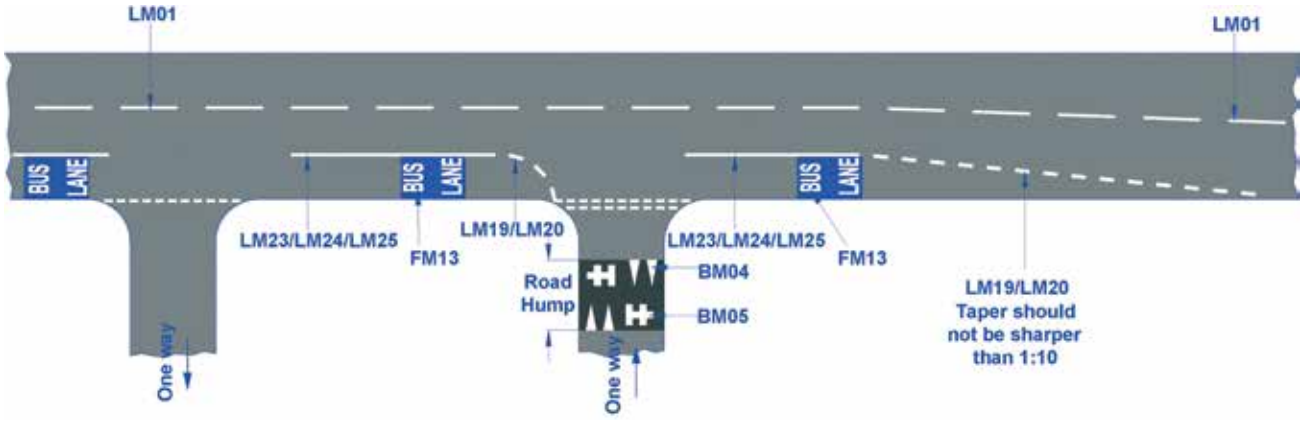


Fig. 12.1 Bus Lane

12.1.2 The legend “BUS LANE” should be marked on the carriageway across the lane at its commencement and repeated after each junction. Where junctions are more than 300 m apart, this legend should be repeated between junctions at approximately 150 m interval.

12.1.3 Where a bus lane commences just beyond an intersection, adequate length be left for the taper to commence at the intersection so that the inclined line does not extend across the intersection mouth. The taper shall never be sharper than 1:10. Similarly to allow traffic to position itself correctly on the carriageway, the continuous bus lane should end in advance of any intersection with major left-turning flow.

12.2 Bus Stop

12.2.1 Pavement markings at the bus stops should be provided with the word “BUS STOP” written prominently on the pavement. The length of the bay for bus stops shall be 15 m at the minimum, as shown in **Fig. 12.2**. It may be increased in stages of 30 m upto a maximum of 45 m. The word message “BUS STOP “shall be repeated in each box of 15 m length. The line marking for bay shall be white in colour and 100 mm wide.

12.2.2 Pedestrian crossings should be marked slightly behind the standing position of buses in order to avoid conflicts. Moreover, the kerbs should be marked with continuous yellow line to indicate no parking. This marking should be used to supplement a roadside bus stop.

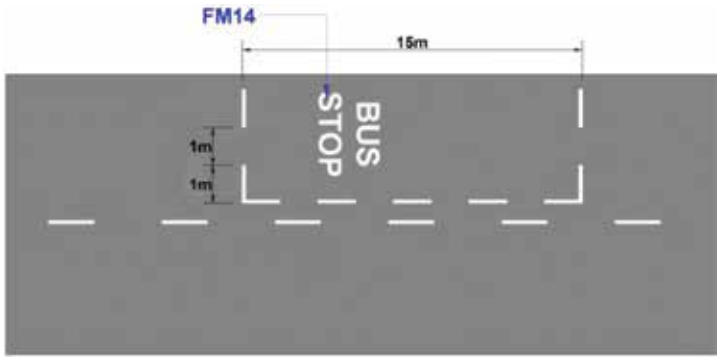


Fig. 12.2 Pick-Up Bus Stop

12.2.3 Bus stop markings shall be supplemented with bus bay signs at the start of transition approach to bus stop. The layout and general marking of kerb loading bus stops in urban areas, and pick up bus stops on rural highways shall be respectively as per IRC:70 "Guidelines on Regulation and Control of Mixed Traffic in Urban Areas" and IRC : 80 "Type Designs for Pick-up Bus Stops on Rural (i.e. Non-urban) Highways".

12.3 Bus Bay Marking

12.3.1 The bus bay marking should be provided with proper chevron marking and can be either with Physical Island or with Ghost Island.

12.3.2 Generally Physical Island shall be aligned in such a way that a vehicle plying on paved shoulder should not collide with physical separating island and shall be set back adequately. **Fig. 12.3** illustrates the marking requirement for bus bay having a separating island both with Physical and Ghost Island. The continuity lane also shall be provided maintaining the continuity line in tandem with the shoulder side edge and shoulder side edge line shall be aligned with proper diagonal /chevron marking ensuring that through lanes are well defined.

12.4 Truck Lay-by Marking

12.4.1 The truck lay marking should be provided with proper chevron marking and with advance informatory signs.

12.4.2 Generally, Physical Island shall be aligned in such a way that a vehicle plying on paved shoulder not hit the separating island ahead and shall be set back adequately with proper diagonal/chevron marking as shown in **Fig. 12.4**. The continuity lane shall be provided maintaining the continuity of the shoulder side edge line clearly defining the through lanes and diverging and merging.

12.5 Toll Plaza Marking

12.5.1 The toll plaza area shall be equipped with proper chevron marking and with proper advance signs.

12.5.2 The edge line on the median and shoulder side shall be continuous. The traffic lane line shall also be continued in such a way that the traffic emerging from the through lane can align uniformly to toll booth as shown in **Fig. 12.5**. Care shall be exercised for the lanes designated for electronic toll collection using appropriate road signs as per IRC:67 (2012) and marking shall be done judiciously.

12.5.3 Toll booth shall be provided with chevron marking and also with continuous line to establish the quantum of queueing on toll booth approach.

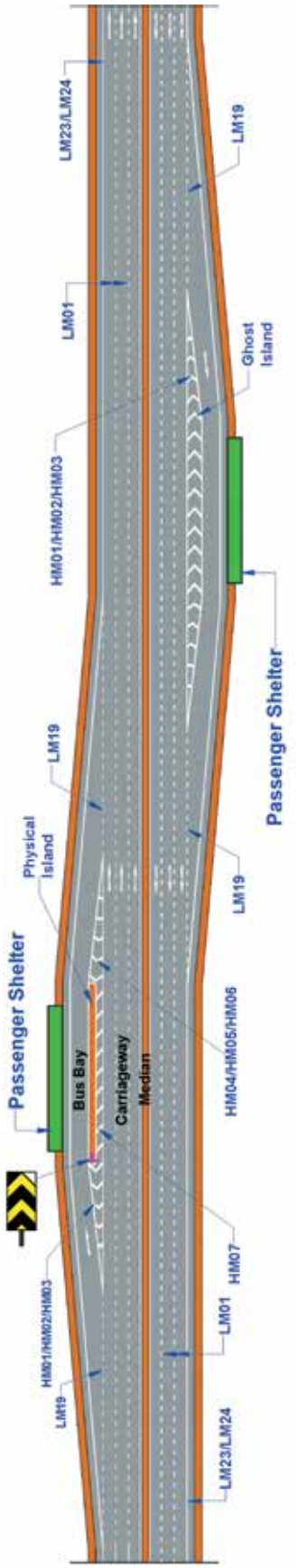


Fig. 12.3 Bus Bay

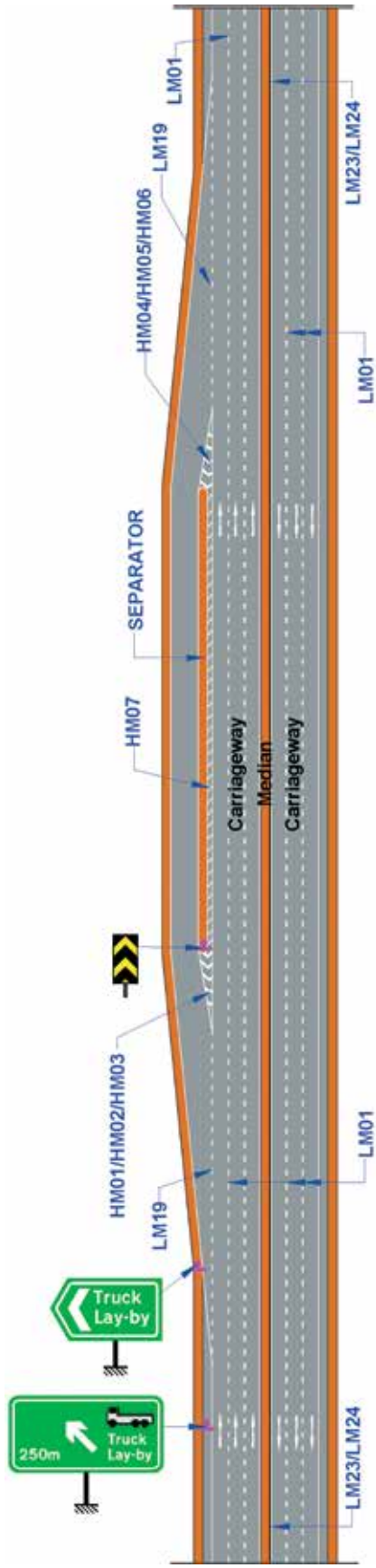


Fig. 12.4 Truck Lay-by

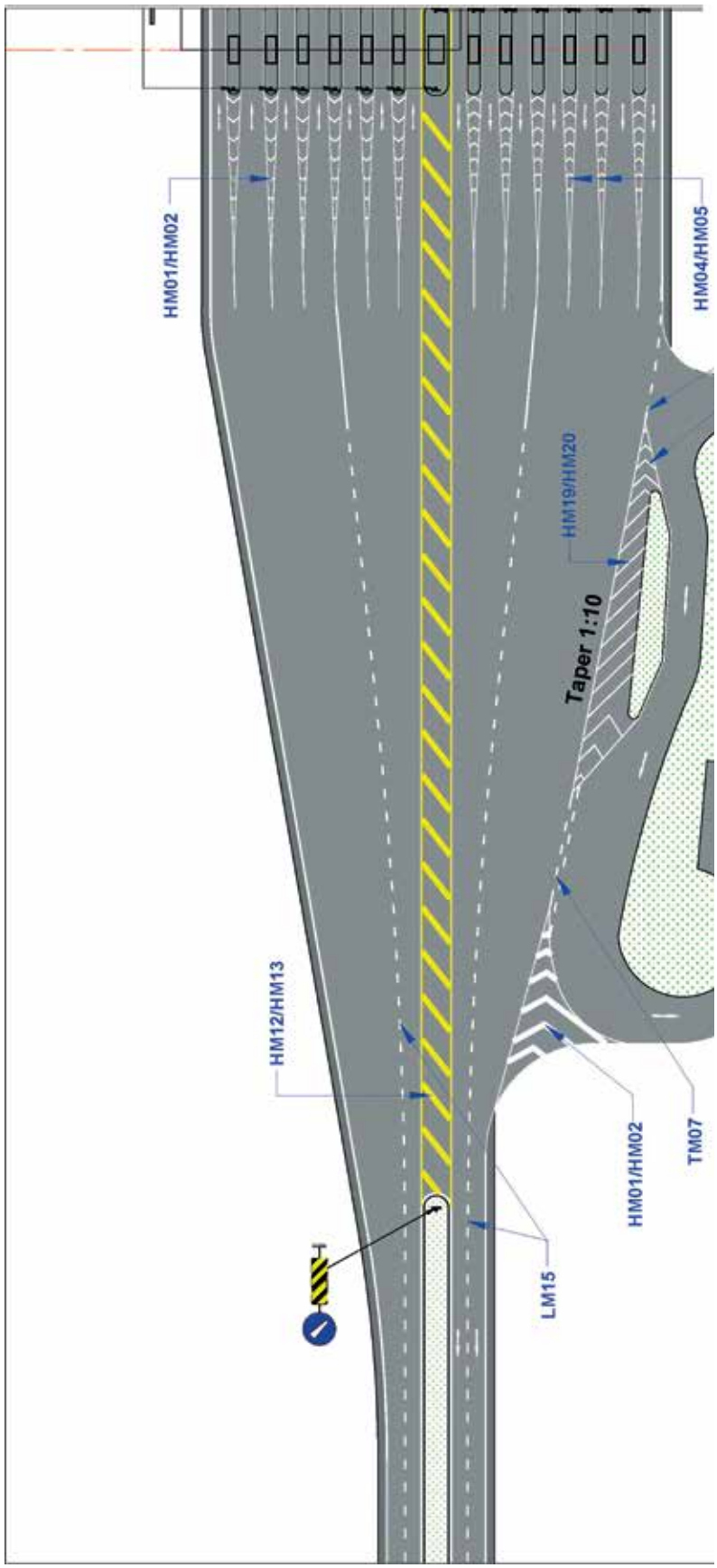


Fig. 12.5 Toll Plaza

SECTION : 13
PARKING AND RESTRICTIONS

13.1 Parking Spaces

13.1.1 The limitation in parking space on urban roads warrants efficient use of the parking spaces. Proper parking markings avoid the tendency of encroachment on fire hydrant zones, bus stops, loading / unloading zones and other such locations where parkings of vehicle will be undesirable. The markings shall be solid white lines of 100 mm wide.

13.1.2 The limits of the designated parking places should also be indicated by informative parking signs mounted on the kerb side in accordance with IRC:67-(2012).

13.1.3 The word “TAXI”, “CARS”, “SCOOTERS”, “AUTO-RICKSHAWS”, etc, may also be written if the parking area is specific for any particular type of vehicles. These words should also be indicated on the supplementary plate. Typical details for off street parking are given in **Fig. 13.1**.

13.1.4 Special Marking (TSR Parking): TSR parking is generally situated on to the left side of the motor vehicle lanes. The lane widths of the carriageways shall not be affected by the TSR parking as separate pockets are to be created and delineated for them using Road Marking. The TSR parking has special marking shall be in blue paint coupled with TSR written on it along with a symbol of an auto rickshaw. Dimensions for this symbol marking box shall be 2000 mm perpendicular to the lane and 3100 mm along the lane. This place is the temporary parking place for the Three wheeler Scooter Rickshaws (TSR). No other vehicle except TSR is allowed to be parked in the TSR designated parking area.

13.1.5 Parking can be on street or off street parking and a typical detail for off street parking is given in **Fig. 13.2**.

13.2 Restrictions

13.2.1 The stretch in which parking is to be restricted has to be delineated with yellow kerb painting coupled with the provision of yellow edge line. Restrictions like Keep Clear marking can be effected on road stretches located in front of school and hospitals by providing zig-zag marking and this may be further supplemented by painting the kerb using yellow colour marking for the length intended to be kept clear of traffic along with proper sign as shown in **Fig. 13.3**.

13.2.2 A stretch of road in which parking is prohibited for certain hours can be distinguished with yellow single solid edge as given in **Fig. 13.4**.

13.2.3 A stretch in which parking or waiting is prohibited at all times has to be distinguished by providing yellow double solid edge as shown in **Fig. 13.5**.

13.2.4 In order to make the ‘No-Parking’ or ‘No-Waiting’ for stricter compliance, lest the lane would be blocked leading to a chaotic situation shall be delineated with zig-zag marking as shown in **Fig. 13.6**.

13.2.5 In order to signify that the loading or unloading of goods is allowed during certain hours of the day, loading and unloading prohibition can be imposed by the provision of road marking as given in **Fig. 13.4 and 13.5**. This shall be supplemented with the erection of appropriate sign boards with typical messages displaying day and time restrictions like “No Loading - Mon-Sat 8.30 am to 6.30 pm” or “No Loading”, etc. as the case may be.

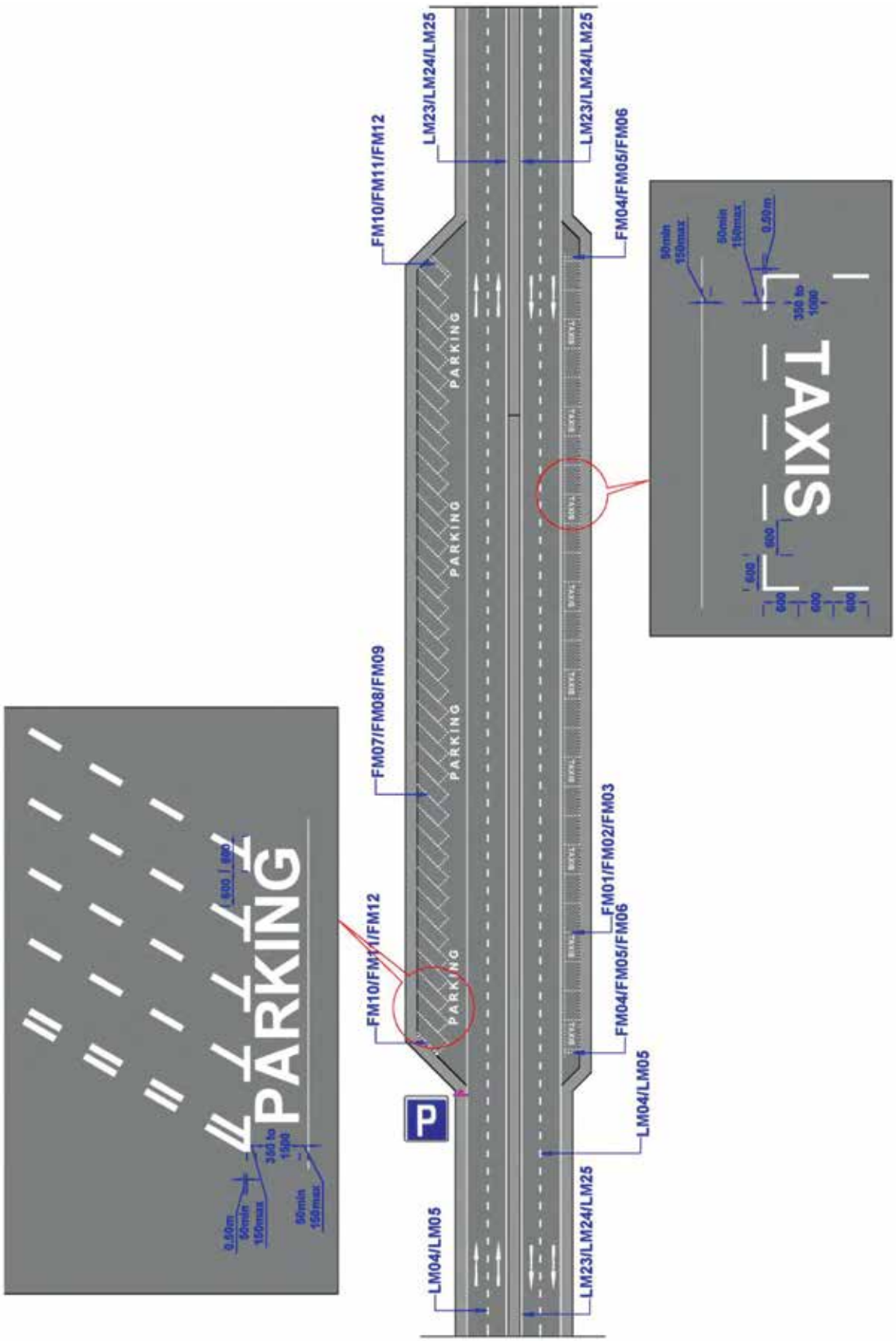


Fig. 13.1 On-Street Parking

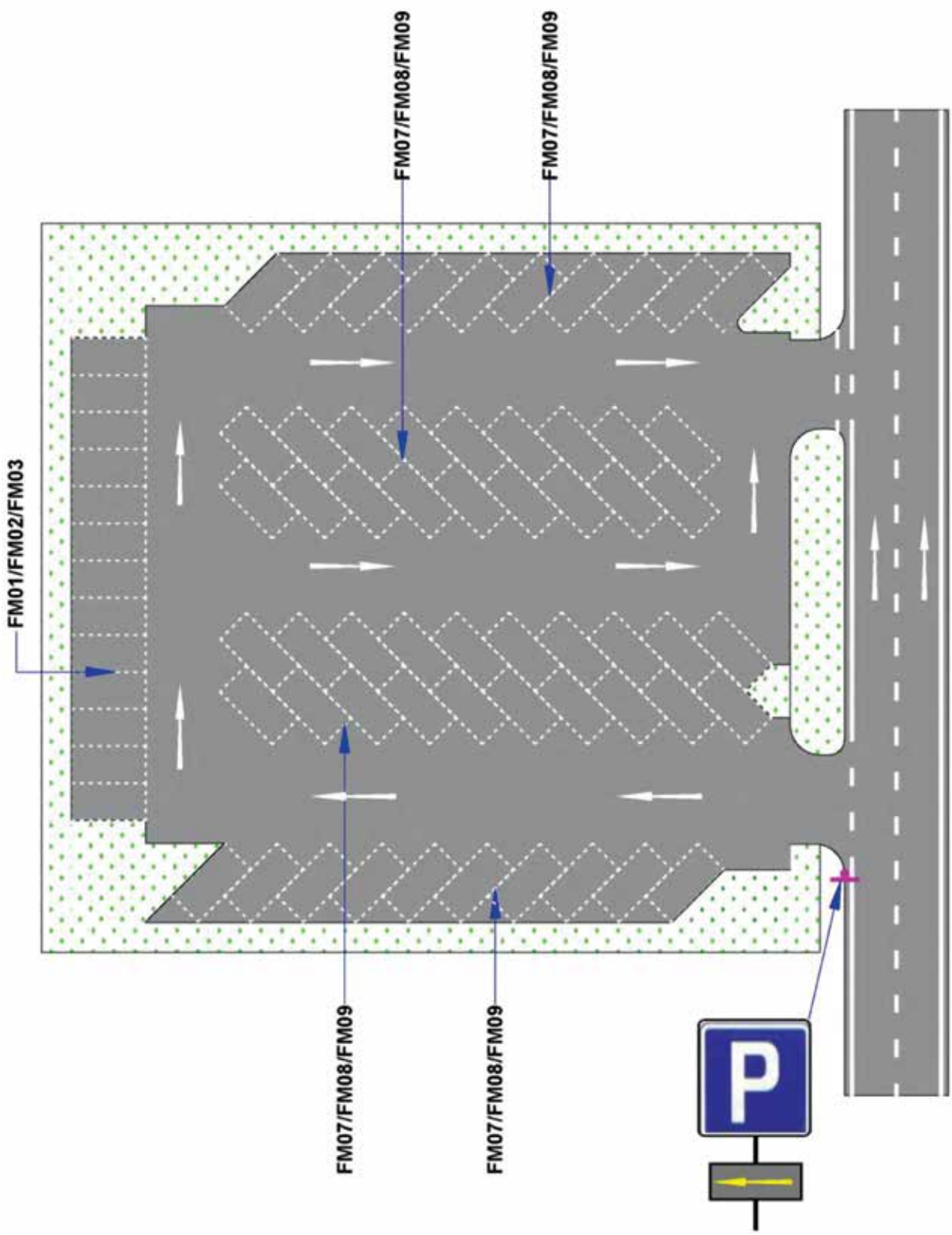


Fig. 13.2 Off-Street Parking

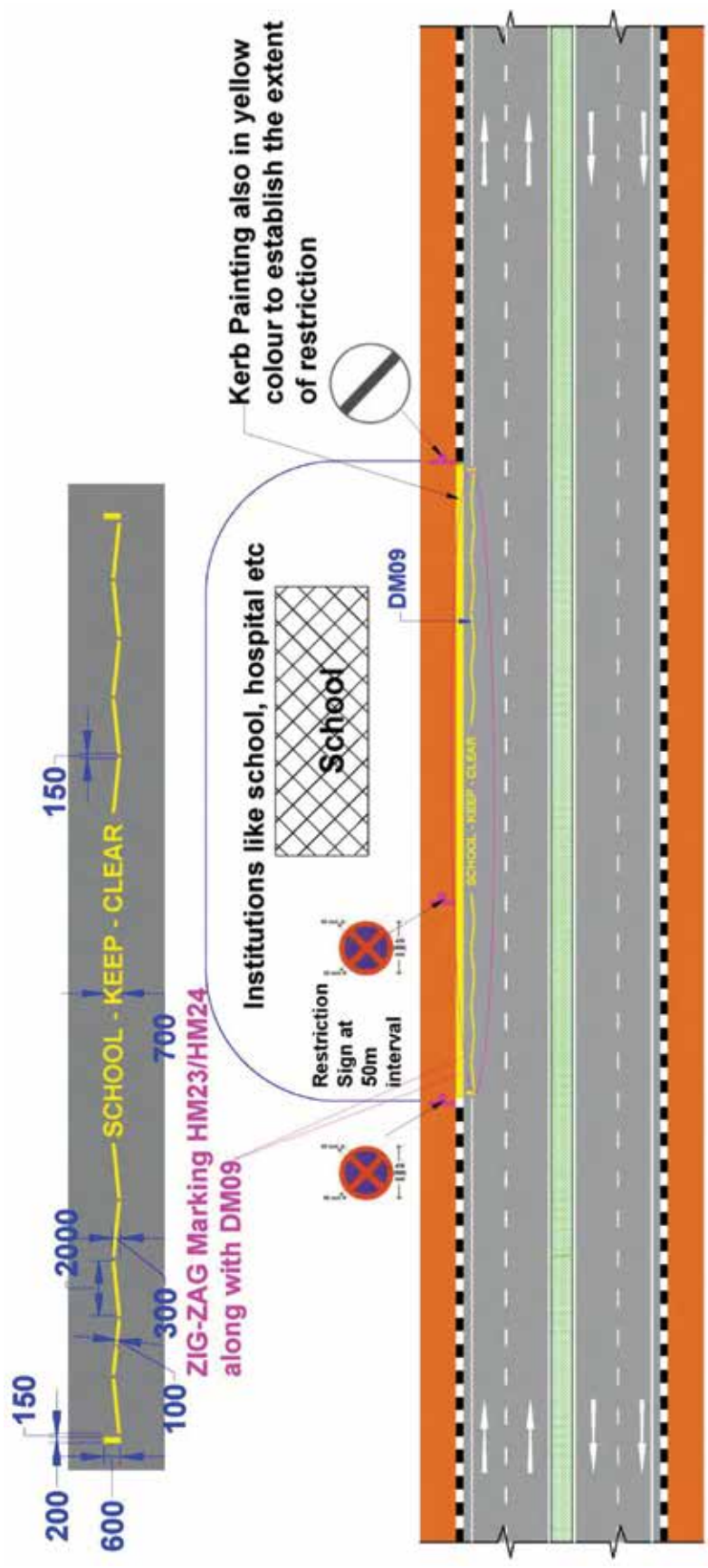


Fig. 13.3 Keep Clear Markings

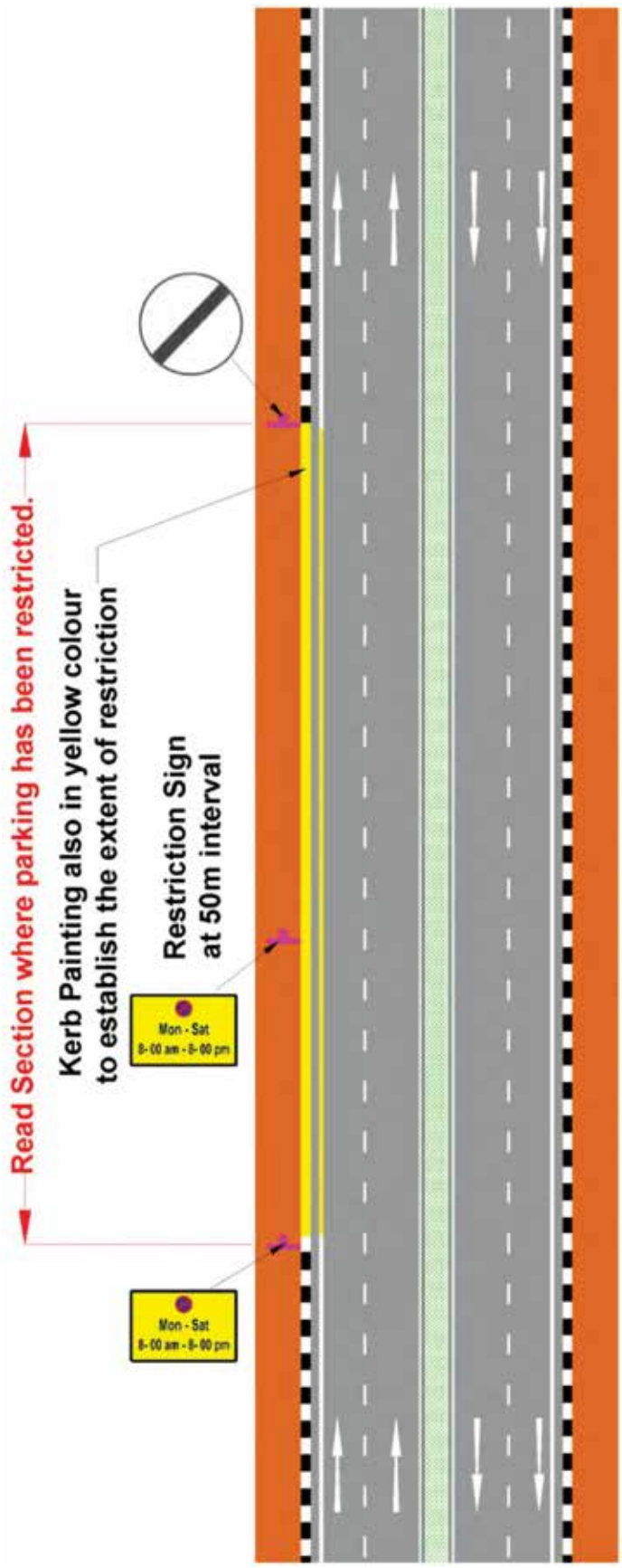


Fig. 13.4 No-Parking for Certain Hours

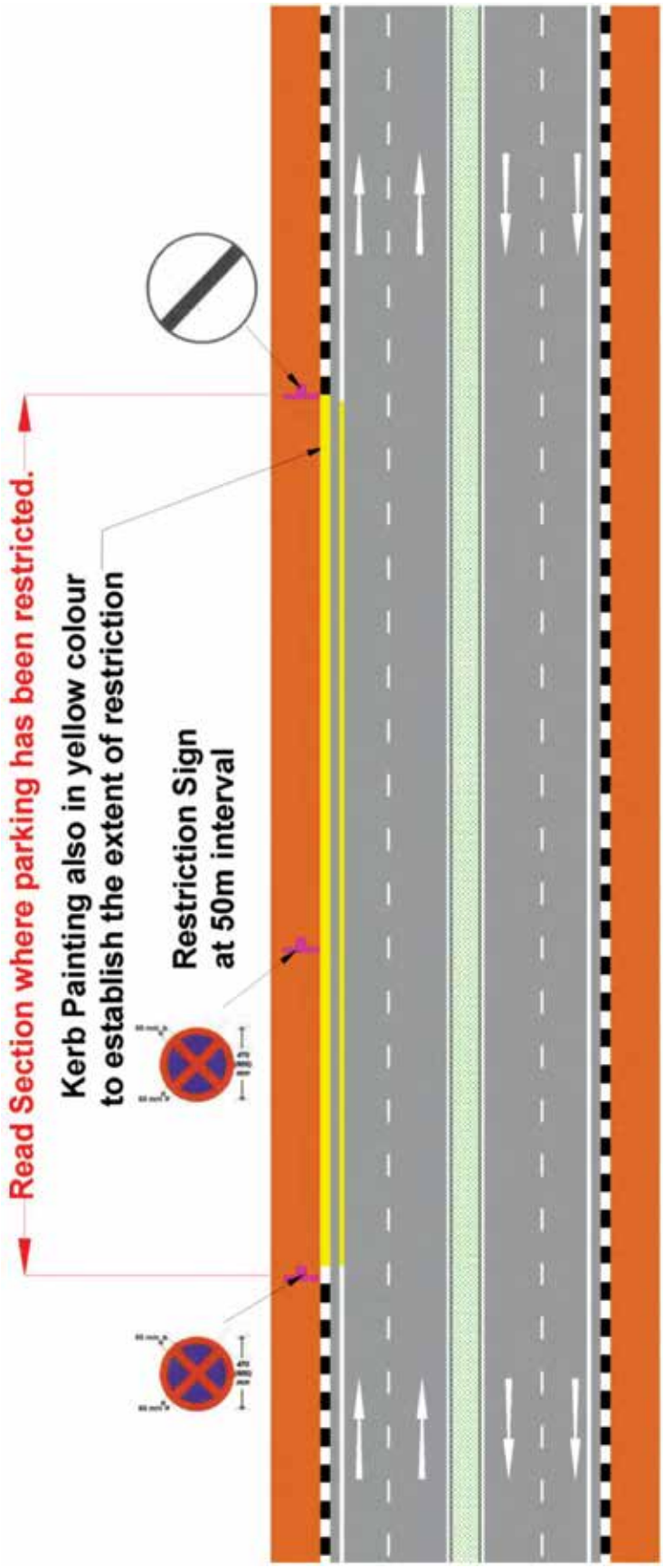


Fig. 13.5 No-Parking

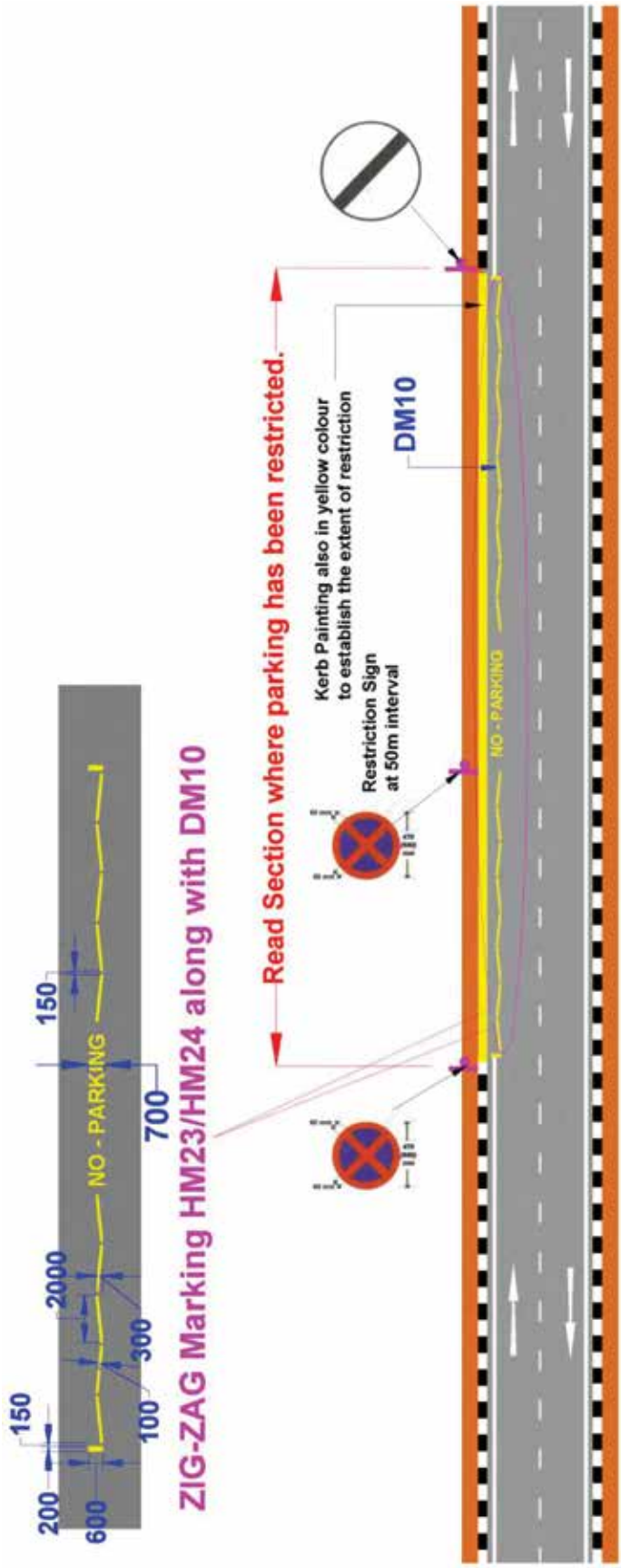


Fig. 13.6 No-Parking for Stricter Compliance

SECTION : 14
OBJECT PAINTINGS

14.1 Object Markings

14.1.1 Basically objects within / adjacent to the carriageway are physical obstructions which constitute a serious hazard to the traffic flow and shall be adequately marked. The objective of delineating such objects is to make those objects more visible during the night time for facilitating safe driving and thereby taking the measures towards the prevention/ avoidance of collision of vehicles with the objects.

14.1.2 Physical obstructions present on the road can be classified under two categories namely,

i) Objects within carriageway and ii) Objects adjacent / near to carriageway based on the location of such objects on the roadway.

14.1.3 Typical obstructions within carriageway are monuments, raised channelizing islands, central island and central median, underpass structures such as piers, abutments and their restricted vertical clearance.

14.1.4 Typical obstructions adjacent/near to the carriageway are continuous raised kerbs at the edge of carriageway, culvert head walls, subway abutments and piers, electrical poles, sign posts, signal supports, trees, guard rails and stones.

14.2 Markings for Objects within the Carriageway

14.2.1 On the face of obstructions (underpass pier, abutment, restricted vertical clearance) located within the carriageway shall be marked by not less than six alternate black and yellow stripes sloping downward at an angle of 45 degrees towards traffic. The diagonal stripes shall be uniform and its width shall not be less than 300 mm as shown in **Fig. 14.1**.

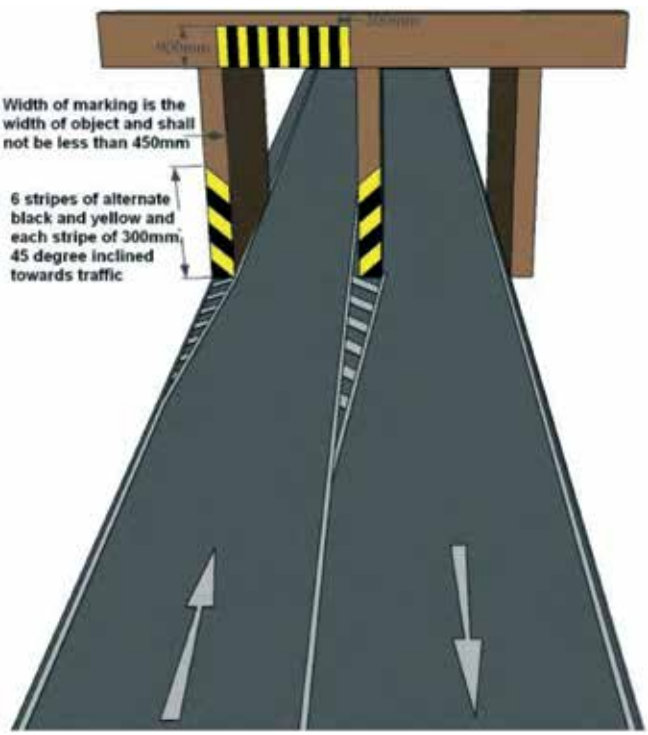


Fig. 14.1

14.2.2 On structures with restricted vertical clearance, the markings of vertical black and yellow stripes having width of at least 300 mm shall be marked. If the obstructing object does not easily lend itself to markings, the markings may be placed on an independent surface mounted immediately in front of the object. Total width of the road marking to be provided in such circumstances shall be at least equal to the width of obstruction protruding into roadway including paved shoulder and shall not be less than 450 mm.

14.2.3 In addition to the Object markings, warning lines on pavement shall be marked prior to approaching the obstruction and diagonal marking preceded by object markings as shown in **Fig. 14.1**.

14.2.4 Kerbs of raised channelizing islands, central island and central median shall be marked with alternate vertical black and white strips of 500 mm width to improve the visibility.

14.3 Markings for Objects adjacent to Carriageway

14.3.1 The objects of subway piers, abutments and culvert head walls that are not in the roadway including paved shoulder shall be marked with at least six alternate black and white stripes sloping down at an angle of 45 degrees towards the traffic as in **Fig. 14.2**.

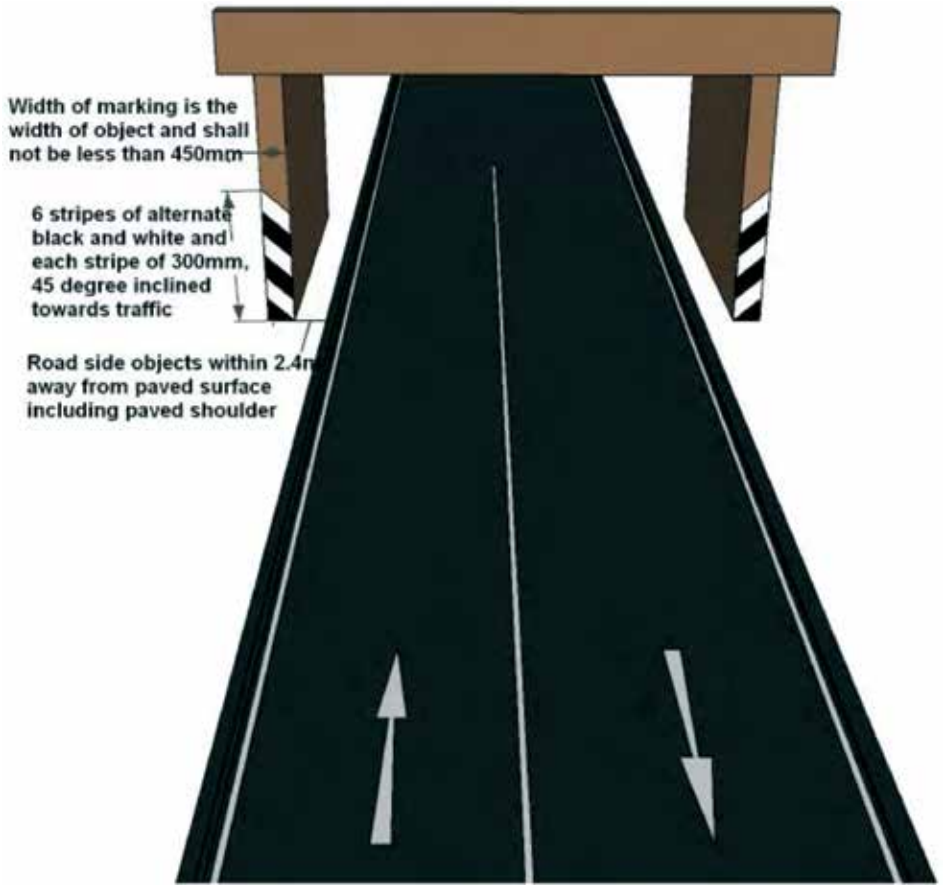


Fig. 14.2

14.3.2 The objects of electrical poles close to the carriageway shall be marked with alternate horizontal black and white stripes up to a height of 1.25 m above the road level. The stripes shall be uniform and not less than 100 mm wide.

14.3.3 The object of guard rails, guard stones or drums and trees that are not likely to be hit unless a vehicle runs off the carriageway shall be painted solid white. In the case of trees, the marking shall be up to a height of 1.25 m above the road level with 300 m band with black paint in the middle of 1.25 m height to enhance the visibility.

14.3.4 All objects located within 2.4 m from shoulder/kerb shall be painted. In addition to the object markings, object markers shall be placed in front of the objects to enhance the visibility. The height of object marker shall be at least 1.2 m above the nearest traffic lane.

14.3.5 Kerbs of all islands located in the line of traffic flow shall be painted with vertical black and white stripes of 500 mm wide as illustrated in **Fig. 14.3**.

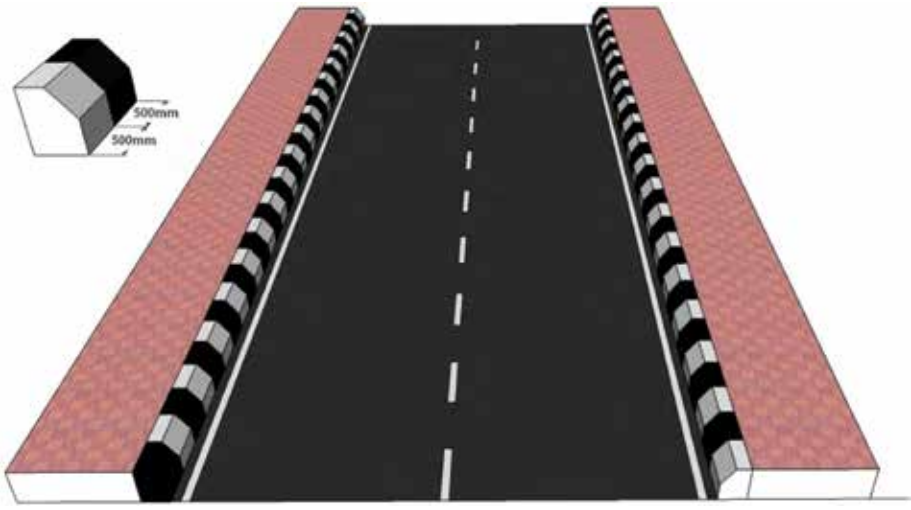


Fig. 14.3

14.3.6 The concrete barrier or bridges and flyover shall also be painted with vertical black and white stripes of 500 mm wide as illustrated in **Fig. 14.3**.

14.3.7 The section where some restriction like 'No-Parking' or 'No Stopping 'measures, is in vogue, the kerb shall be painted with yellow colour as illustrated in **Fig. 14.4**.

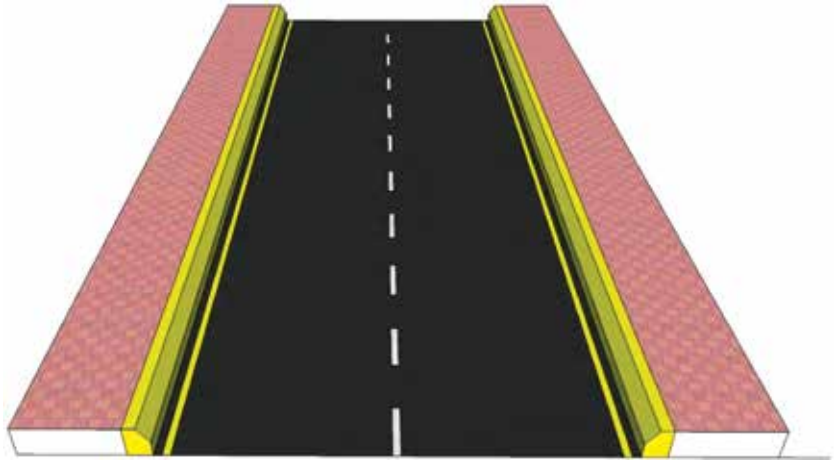


Fig. 14.4 Section of Where Restriction Applies

SECTION : 15
PERFORMANCE ASSESSMENT AND MONITORING

15.1 General

In this section, the level of performance required to govern the quality of the road marking is discussed. It also describes the assessment mechanism for various performance characteristics. The performance of the white road markings is based on daytime visibility, nighttime visibility, wet reflectivity and wear durability.

15.2 Wear Durability

Assessment of the degree of wear is measured as a percentage of the area remaining intact of the high performance pavement marking. Pavement marking systems demonstrate different wear profiles (**Figs. 15.1 and 15.2**). Some pavement marking systems wear out faster corresponding with the traffic operation while others tend to exhibit the phenomenon of staying intact for a longer time with the pavement surface depending up on its wearing resistance. As wear may be more apparent on left-hand edge lines or side road entries, the overall performance of the marking system needs to be taken into account.

Fig. 15.1 Above 95% of Area Intact

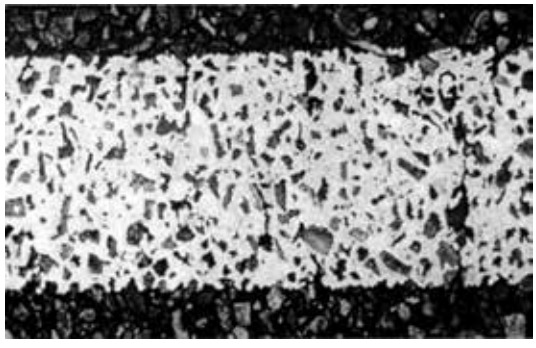


Fig. 15.2 Below 70% of Area Intact

15.3 Daytime Visibility

Reflection in day light or under road lighting is measured based on the luminance coefficient exhibited under the diffuse illumination i.e. Q_f measured in accordance with EN 1436 and expressed in milli candela per square meter per lux (mcd/m²/lux). Q_d corresponds to how drivers can view the marking from distance (30 m) see **Fig. 15.3**. depicts the typical day time visibility of a properly laid road marking. Day time luminance is to be measured using the method described in **Annexure D**.

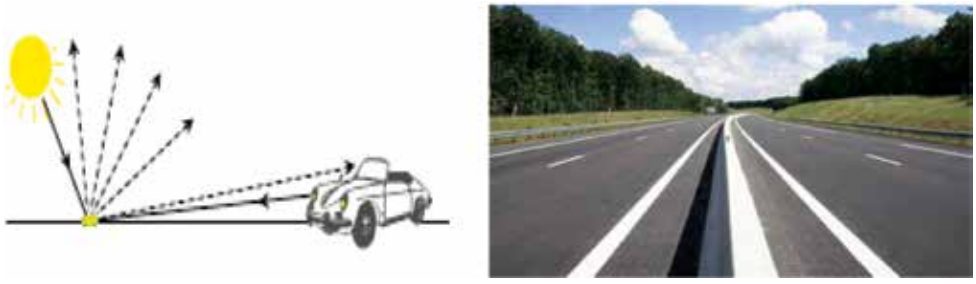


Fig. 15.3 Day Visibility of Road Marking

15.4 Nighttime Visibility

15.4.1 *Dry Retro-Reflection*

Retro-reflectivity (night time line visibility) is a result from vehicle headlamps being retro-reflected back to the source (the driver) at a very narrow observation angle see **Fig. 15.4**. This ultimately facilitates in the proper visibility of the pavement markings during night time to the driver. The measurement of the retro-reflected light is the coefficient of retro-reflected luminance and is expressed as mcd/m^2/lux.

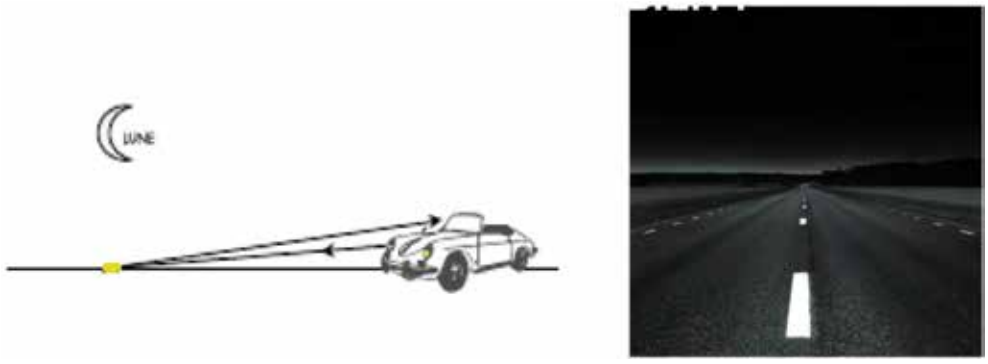


Fig. 15.4 Night Visibility of Road Marking

Nighttime pavement marking visibility is a function of both line pattern dimensions and retro-reflectivity, can be appreciated in **Fig. 15.4** sharing both daytime and nighttime visibility. The brighter and wider the marking is, the longer is the road preview time, or end-of-line detection distance. This is an important safety consideration to be kept in mind for all types of roads. Dry retro-reflectivity is to be measured using the method described in **Annexure E**.

Another important parameter is the quality and the quantity of Titanium Dioxide used in the paint. This chemical is the white pigment used to render brightness to the pavement marking.

Fig. 15.4a Daytime and Nighttime Visibility

15.4.2 *Wet retro-reflection*

A film of water coating the glass beads in wet condition reduces retro-reflective performance of the pavement markings. Wet retro-reflectivity is to be measured using the method described in **Annexure E**.

Pavement markings may change the micro texture and the macro texture of the pavement surface. For cyclists and motorcyclists in particular, this may have a destabilizing effect. It is to be noted that the improved skid resistance is generally brought about by the inclusion of surface applied angular particles to the marking. The angular particles may create shadowing of the retro-reflective elements (glass beads) and as a consequence, the measure of retro-reflectivity (night time visibility of the markings) may be reduced. Picture of a Skid Resistance Testing Tool is given in **Fig. 15.5**.

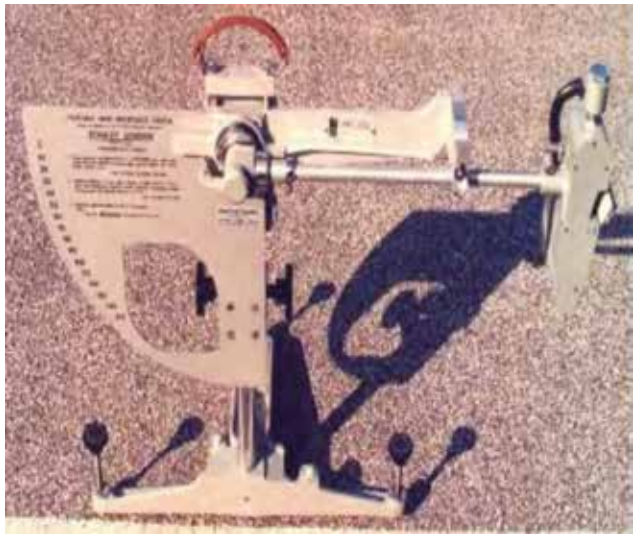


Fig. 15.5 Skid Resistance Testing Tool

15.5 Performance Criteria

The performance criteria given here under are meant to be used on white colour pavement markings only.

15.5.1 *Daytime Visibility*

The luminance coefficient under diffuse illumination Q_d for road marking on

- ✓ Cement Road (Q_d), shall be minimum of 130 mcd/m^2/lux during the expected life service time
- ✓ Asphalt road (Q_d), shall be minimum of 100 mcd/m^2/lux during the expected life service time

Testing method shall be according to **Annexure D**.

15.5.2 *Nighttime Visibility*

(i) Dry retro-reflection

Dry retro-reflectivity shall be compliant with **Table 15.1** and measured in accordance with the method described in **Annexure E**.

Table 15.1 Initial and Minimum Performance for Dry Retro Reflectivity during Nighttime

S. No.	Design Speed	(RL) Retro-Reflectivity (mcd/m²/lx)	
		Initial (7 Days)	Minimum Threshold Level (TL) and Warranty Period Required up to 2 Years
1	Up to 65	200	80
2	65 - 100	250	120
3	above 100	350	150

(ii) Wet Retro-reflection

Wet retro-reflectivity shall be compliant with **Table 15.2** and measured in accordance with the method described in **Annexure E** irrespective of the design speed. In wet condition design speed does not have bearing on road marking.

Table 15.2 Initial and Minimum Performance for Night Visibility under Wet Conditions

S. No	(Rw) Retro - Reflectivity (mcd/m²/lx)	
	Initial (7 Days)	Minimum Threshold Level
1	100	50

15.6 Skid Resistance

Skid resistance parameter shall be considered under urban /city traffic condition encompassing the locations like zebra crossing, pedestrian crossings, bus bay, bus stop, cycle track, intersection delineation etc., as given in **Table 15.3** Skid resistance is to be measured using the method described in **Annexure G**.

Table 15.3 Initial and Minimum Performance for Skid Resistance

	Skid Resistance (BPN)	
Type of Road	Initial (7 Days)	Minimum Threshold Level
Urban/City	55	45

SECTION : 16
WARRANTY AND TESTING METHODS

16.1 Warranty

Road markings are laid on the pavement either temporary or for long term purposes. The life of the road markings is limited to the duration of the working zone. In the case of long term purpose road markings, it is appropriate to consider the reasons of safety to have a functional life that lasts for at least two years. The road authority must demand for a warranty period for the pavement marking. During the warranty period, all the performance parameters must remain higher than the minimum threshold level. Performance parameters should be checked every year on a random section of the network conforming to the procedure presented in **Section 15**.

16.2 Testing Methods - Inspection

16.2.1 *General*

Road Markings shall be inspected using the methods and frequency defined in this section. The purpose of inspection is to identify when the deterioration of road markings would occur resulting in the delivery of safety benefits. In this regard, it is essential to determine the appropriate timing for maintenance intervention.

16.2.2 *Characteristics requiring Maintenance Inspection of Pavement Marking*

Road marking shall be preferably subjected to routine inspection desirably once in six months for all the characteristics in accordance with the inspection methods set out in the flow diagrams in **Annexure F**.

- Retro-reflectivity Dry and Wet (R_L and R_w)
- Wear (W)
- Luminance coefficient (Q_d)
- Skid resistance (SRT)

The location of the road markings will determine which of these characteristics require inspection and the methods of inspection to be employed.

16.2.3 *Methods of Inspection and Frequency*

The road corridor/network should be surveyed on a routine annual basis. For all longitudinal road markings on National Highways and Expressways : An annual survey of retro reflectivity exhibited by the pavement marking laid on the ground may be carried out by using the High Speed Monitor (HSM) instrumentation system or any other appropriate instrumentation system. This assessment would help to understand whether the pavement marking conforms to the criteria shown in the Flow **Diagram A of Annexure F**. The results may be averaged for every 100 m interval. The areas of the network that cannot be surveyed by HSMs (e.g. STOP lines, Give Way lines, Exit arrows etc.) shall be inspected annually by the alternative inspection methods set out in **Flow Diagram B in Annexure F**. These inspections shall include at least an assessment of retro reflectivity by the use of handheld Retro-Reflectometer. Measurements shall be carried out as set out in **Annexure E** and assessed against the criteria set out in **Annexure F, vide Flow Diagram B**.

16.3 An Assessment of Wear

A visual assessment shall be carried out on 50 percent of the road markings at each location or for every 20 m on a 5 m length of an area for continuous road markings. An average of the results shall be taken and assessed against the criteria set out in **Annexure F**, vide **Flow Diagram B**.

16.4 An Assessment of the Luminance Co-efficient

16.4.1 Measurements shall be carried out on 50 percent of the road markings at each location or every 20 m for continuous road markings. An average of the results shall be taken and assessed against the criteria set out in **Annexure F,** vide **Flow Diagram B**.

16.4.2 Skid resistance measurements shall be carried out annually on a quarter of the critical areas of the network detailed in **Annexure G,** vide **Flow diagram C**. Measurements should be taken on the most trafficked areas of the road markings at each location and an average of the results shall be taken.

16.4.3 Road markings framed by longitudinal road markings such as hatched road markings or ghost islands shall need to be inspected as these will deteriorate at a slower rate than the surrounding markings. Road makings of this type shall be maintained along with the replacement of any surrounding deteriorated continuous road markings.

16.5 Road Marking Evaluation Process

This technique shall be used to assess for newly installed markings as well as for in-service markings. This technique can be used to assess all types of pavement markings. All measurements are to be made in the direction of travel. On the centre line of undivided highways, measurements should be made in both directions unless otherwise specified.

16.5.1 *Longitudinal Pavement Marking Line*

For Pavement Marking Lines (3 km or less): Measurements shall be made on any randomly located evaluation section on the pavement marking line. The sample size shall be set at least 20 numbers and the average of the 20 measurements is to determine the retro-reflectivity of the marking as given in **Fig. 16.1**.

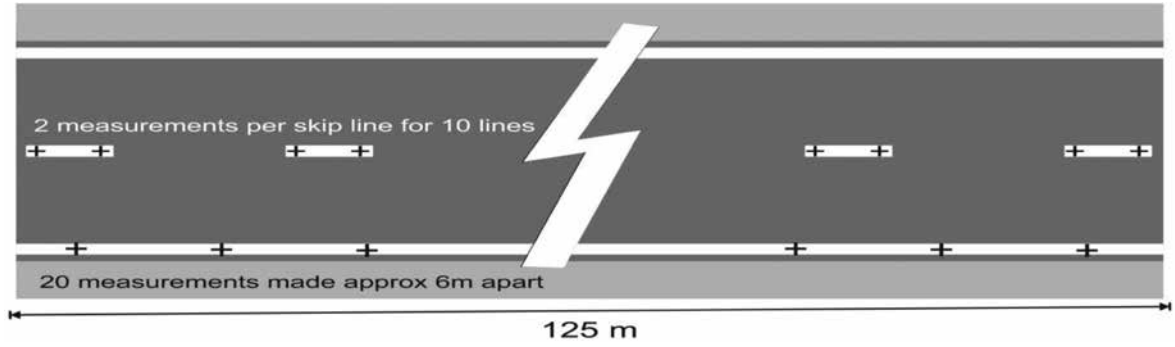


Fig. 16.1 Typical Evaluation of Pavement Marking for Distance Less than 3 km

For Pavement Marking Lines (3 to 16 km): Measurements shall be made on at least three randomly selected evaluation sections wherein the pavement marking line is in place. The evaluation sections shall not overlap. Measurements within each evaluation section shall be

made with a sample size of 20 and the average retro-reflectivity for each evaluation section shall be calculated. The grand average is determined using the average retro reflectivity from each evaluation section.

For Pavement Marking Lines (more than 16 km): For assessing pavement marking lines wherein the length if more than than 16 km, it is essential to select more than three evaluation sections as given in **Fig. 16.2** and the average retroreflectivity for each evaluation section shall be calculated. The grand average is determined using the average retro-reflectivity from each evaluation section.

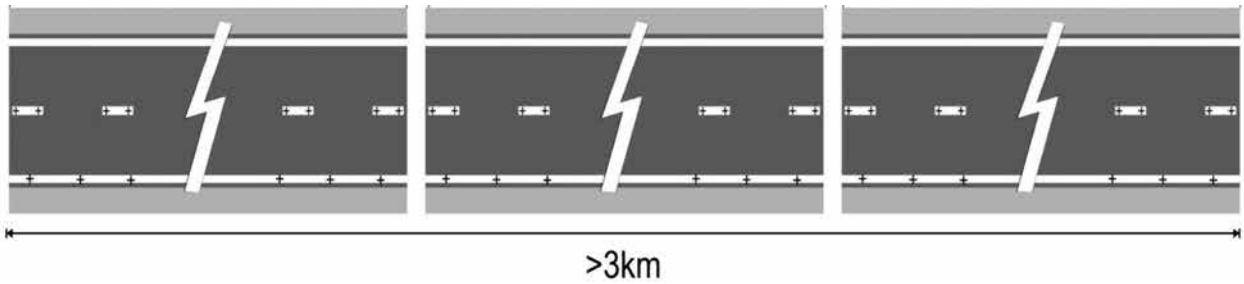


Fig. 16.2 Typical Evaluation of Pavement Marking for Distance More than 3 km

16.5.2 *Legends, Symbols, Pedestrian Crossing, and other Non-Longitudinal Markings*

Legends: Each letter is considered as an evaluation section; three measurements shall be made in each letter in the direction of travel. The average value shall be calculated for each letter and the average value of each measurement section can be used to compute the grand average. The grand average shall be used to determine compliance with the appropriate specification.

Symbols or Transverse Lines: Each symbol or transverse line is considered a separate evaluation section. Six measurements shall be made on symbols or transverse lines that are 2.4 m tall or wide. Three measurements on symbols or transverse lines smaller than 2.4 m shall be made. The average value shall be calculated for each symbol or transverse marking and the average value of each measurement section can be used to compute the grand average. The grand average shall be used to determine compliance with the appropriate specification.

Pedestrian Crossings: Three random stripes shall be selected as an evaluation section; six measurements shall be made in each of the selected stripes. The average value of each stripe shall be calculated and the average value of each measurement section can be used to compute the grand average. The grand average shall be used to determine compliance with the appropriate specification.

16.6 Category of Defect and Maintenance

As a result of the inspections referred above, any defects may be noticed and these shall be categorized under the two categories given below:

Category 1:

Defects that require prompt attention because they represent an immediate or imminent

hazard, there is a breach of statutory duty (e.g. A Badly Worn-out STOP or GIVE WAY line, double white lines) or a slippery road marking.

Category 1 defects shall be corrected or made safe at the time of inspection if reasonably practical or within no more than 24 hours of notification. If it is not possible to repair the defects within 24 hours, then the appropriate prescribed sign (e.g. “NO ROAD MARKINGS FOR X KM”) shall be displayed until long term repairs are carried out. These repairs shall be completed within 7 days of the notification of the defect.

Category 2:

Defects that require rectification within six months of the inspection

16.7 Records

An inspection report in a format agreed by the road authority shall be maintained for all inspections.

All measurements collected and defects identified during inspection shall be reported and recorded, including details of any action taken or required.

An annual report including a summary of inspections, routine maintenance operations and changes in the network shall be supplied to the road authority at the end of the financial year.

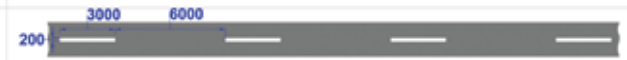
16.8 Inventory

An accurate computerised inventory shall be maintained and made available to the road authority on request. The stock inventory shall be maintained through back-up facilities with agreed security procedures.

ANNEXURE : A

(Refer Section 3 Under Para 3.1)

TABLE : A.1 : LONGITUDINAL MARKINGS (LM)

Marking Abbreviation	Type	Length of Line Segment (mm)	Length of Gap (mm)	Width (mm)	Colour	Pattern
LM01	Broken	3000	6000	100	White	
LM02	Broken	3000	6000	150	White	
LM03	Broken	3000	6000	200	White	
LM04	Broken	6000	3000	100	White	
LM05	Broken	6000	3000	150	White	
LM06	Broken	6000	3000	200	White	
LM07	Broken	1500	3000	100	White	
LM08	Broken	1500	3000	150	White	
LM09	Broken	3000	1500	100	White	
LM10	Broken	3000	1500	150	White	
LM11	Broken	3000	3000	100	White	
LM12	Broken	3000	3000	150	White	
LM13	Broken	3000	3000	200	White	
LM14	Broken	1500	1500	100	White	
LM15	Broken	1500	1500	150	White	
LM16	Broken	1500	1500	200	White	
LM17	Broken	600	300	100	White	

[Continued]

ANNEXURE : A

(Refer Section 3 Under Para 3.1)

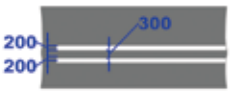
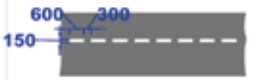
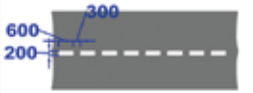
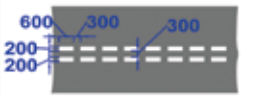
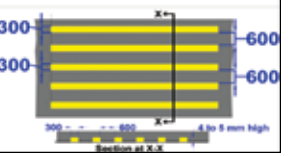
TABLE : A.1 : LONGITUDINAL MARKINGS (LM)

Marking Abbreviation	Type	Length of Line Segment (mm)	Length of Gap (mm)	Width (mm)	Colour	Pattern
LM18	Broken	600	300	150	White	
LM19	Broken	500	500	100	White	
LM20	Broken	500	500	150	White	
LM21	Broken	1000	1000	100	White	
LM22	Broken	1000	1000	150	White	
LM23	Continuous	NA	NA	100	White	
LM24	Continuous	NA	NA	150	White	
LM25	Continuous	NA	NA	200	White	
LM26	Continuous (Two Lines)	Two Solid Lines separated by 100/150/200 mm		Each Solid Line of 100mm	White	
LM27	Continuous (Two Lines)	Two Solid Lines separated by "x"mm apart, "x" > 200mm		Each Solid Line of 100mm	White	
LM28	Continuous & Broken	Continuous & Broken separated by 100mm		Each Line of 100mm	White	
LM29	Continuous & Broken	Continuous & Broken separated by 100mm		Each Line of 100mm	White	
LM30	Continuous (Two Lines)	Two Solid Lines separated by "x"mm apart, "x" > 100mm		Each Solid Line of 150mm	White	
LM31	Broken	15000	3000	200	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.2)

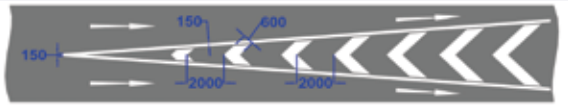
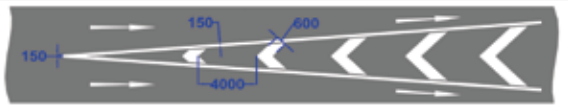
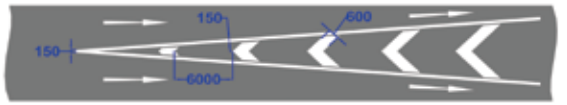
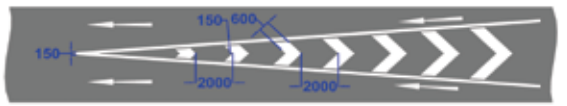
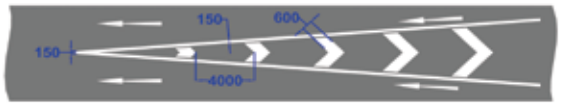
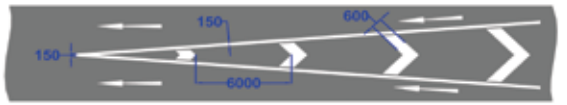
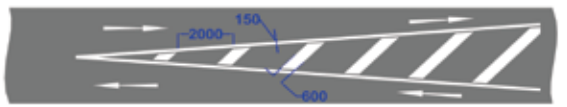
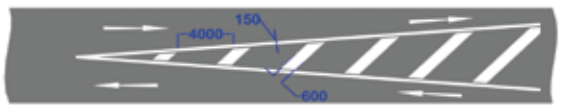
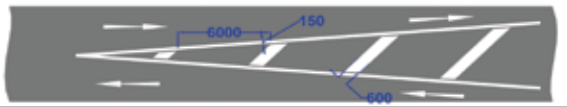
TABLE : A.2 : TRANSVERSE MARKINGS (TM)

Marking Abbreviation	Type	Length of Line Segment (mm)	Length of Gap (mm)	Width (mm)	Colour	Pattern
TM01	Continuous	One Solid Line		200	White	
TM02	Continuous	One Solid Line		300	White	
TM03	Continuous (Two Lines separated by 300mm apart)	Two Solid Line		Each Solid Line of 200mm	White	
TM04	Broken	600	300	100	White	
TM05	Broken	600	300	150	White	
TM06	Broken	600	300	200	White	
TM07	Broken (Two Lines separated by 300mm apart)	600	300	Each Broken Line of 200mm	White	
TM08	Bar Marking (One Set)	Across Full Carriageway	6 Strips of 300mm wide, 5mm high @ 600mm apart		Yellow	

ANNEXURE : A

(Refer Section 3 Under Para 3.3)

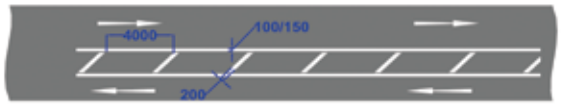
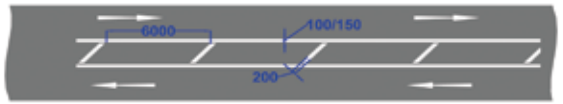
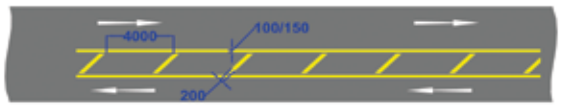
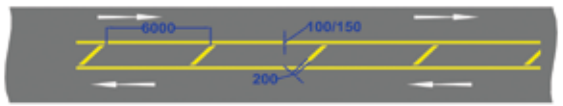
TABLE : A.3 : HAZARD MARKINGS (HM)

Marking Abbreviation	Type	Width(mm)		Space (mm)	Colour	Pattern
		Longitudinal	Diagonal / Chevron			
HM01	Chevron (Diverging)	150	600	2000	White	
HM02	Chevron (Diverging)	150	600	4000	White	
HM03	Chevron (Diverging)	150	600	6000	White	
HM04	Chevron (Converging)	150	600	2000	White	
HM05	Chevron (Converging)	150	600	4000	White	
HM06	Chevron (Converging)	150	600	6000	White	
HM07	Diagonal	150	600	2000	White	
HM08	Diagonal	150	600	4000	White	
HM09	Diagonal	150	600	6000	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.3)

TABLE: A.3 : HAZARD MARKINGS (HM)

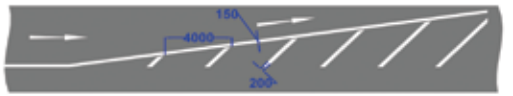
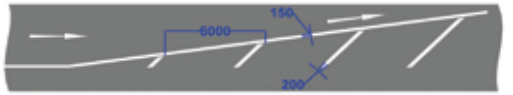
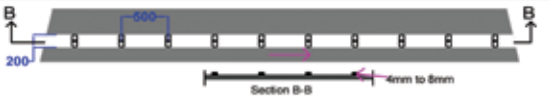
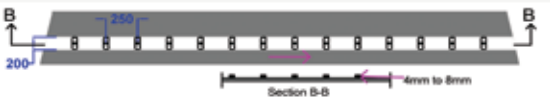
Marking Abbreviation	Type	Width(mm)		Space (mm)	Colour	Pattern
		Longitudinal	Diagonal / Chevron			
HM10	Ladder Hatching	100/150	200	4000	White	
HM11	Ladder Hatching	100/150	200	6000	White	
HM12	Ladder Hatching	100/150	200	4000	Yellow	
HM13	Ladder Hatching	100/150	200	6000	Yellow	
HM14	Continuous	One Solid Line of 100mm		NA	Yellow	
HM15	Continuous	One Solid Line of 150mm		NA	Yellow	
HM16	Continuous (Two Lines)	Each Solid Line of 100mm separated by 100 / 150 / 200 mm		NA	Yellow	
HM17	Continuous (Two Lines)	Each Solid Line of 150mm separated by "x"mm, "x" > 100mm		NA	Yellow	
HM18	Continuous (Two Lines)	Each Solid Line of 200mm separated by "x"mm, "x" > 100mm		NA	Yellow	

[Continued]

ANNEXURE : A

(Refer Section 3 Under Para 3.3)

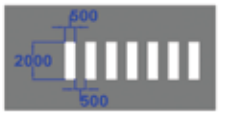
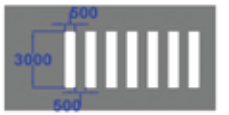
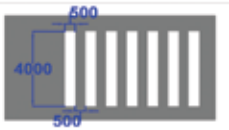
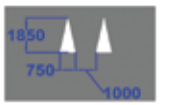
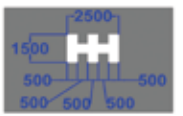
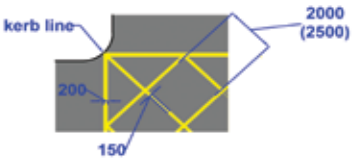
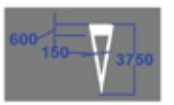
TABLE : A.3 : HAZARD MARKINGS (HM)

Marking Abbreviation	Type	Width(mm)		Space (mm)	Colour	Pattern
		Longitudinal	Diagonal / Chevron			
HM19	Deflecting	150	200	4000	White	
HM20	Deflecting	150	200	6000	White	
HM21	ZIG-ZAG (Hazard)	100	NA	NA	White	
HM22	ZIG-ZAG (Hazard)	150	NA	NA	White	
HM23	ZIG-ZAG (Hazard)	100	NA	NA	Yellow	
HM24	ZIG-ZAG (Hazard)	150	NA	NA	Yellow	
HM25	Bar Marking	NA	300	As per Design	Yellow/ White	
HM26	Raised Profile Marking	NA	150	500	White	
HM27	Raised Profile Marking	NA	200	500	White	
HM28	Raised Profile Marking	NA	200	250	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.4)

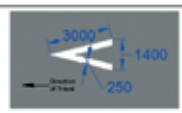
TABLE : A.4 : BLOCK MARKINGS (BM)

Marking Abbreviation	Type	Dimension (mm)		Gap in Between (mm)	Colour	Pattern
		Length	Breadth			
BM01	Rectangular Block	2000	500	500	White	
BM02	Rectangular Block	3000	500	500	White	
BM03	Rectangular Block	4000	500	500	White	
BM04	Triangular Block	750	1850	1000	White	
BM05	Chequer Block	500	500	500	White	
BM06	Box Marking	2000	2000	NA	Yellow	
BM07	Giveway Symbol	3750	1200	NA	White	
BM08	Cycle Symbol	As Shown		NA	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.5)

TABLE : A.5 ARROW MARKINGS (AM)

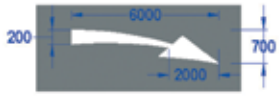
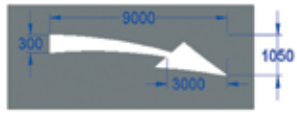
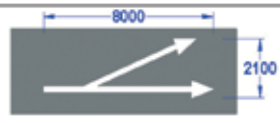
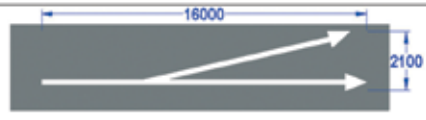
Marking Abbreviation	Type	Length (mm)	Width (mm)	Colour	Pattern
AM01	Straight Arrow	3500	500	White	
AM02	Left Arrow	3500	750	White	
AM03	Right Arrow	3500	750	White	
AM04	Straight & Left Arrow	3500	850	White	
AM05	Straight & Right Arrow	3500	850	White	
AM06	Right & Left Arrow	3500	750	White	
AM07	Straight, Right & Left Arrow	3500	850	White	
AM08	Straight Arrow	5000/9000	500	White	
AM09	Left Arrow	5000/9000	750	White	
AM10	Right Arrow	5000/9000	750	White	
AM11	Straight & Left Arrow	5000/9000	850	White	
AM12	Straight & Right Arrow	5000/9000	850	White	
AM13	Forward Arrow	3000	1400	White	

[Continued]

ANNEXURE : A

(Refer Section 3 Under Para 3.5)

TABLE: A.5 : ARROW MARKINGS (AM)

Marking Abbreviation	Type	Length (mm)	Width (mm)	Colour	Pattern
AM14	Arrow for Cycle Track	NA	1000	White	
AM15	Arrow for Cycle Track	NA	1000	White	
AM16	Arrow for Cycle Track	NA	1000	White	
AM17	Deflection Arrow	4500	1500	White	
AM18	Deflection Arrow	6000	1500	White	
AM19	Deflection Arrow	9000	3000	White	
AM20	Bifurcation Arrow	8000	2100	White	
AM21	Bifurcation Arrow	16000	2100	White	
AM22	Bifurcation Arrow	32000	2100	White	
AM23	Roundabout Rotation Arrow	3025	NA	White	
AM24	Roundabout Rotation Arrow	4450	NA	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.6)

TABLE : A.6 DIRECTIONAL MARKINGS (DM)

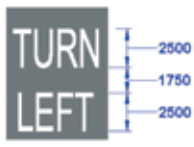
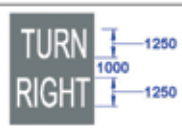
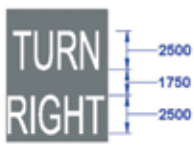
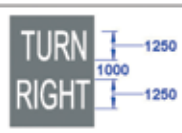
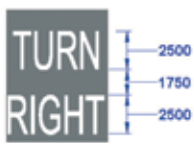
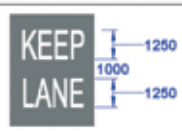
Marking Abbreviation	Type	Width (mm)	Height (mm)	Colour	Pattern
DM01	Direction Information "STOP"	2050	1250	White	
DM02	Direction Information "STOP"	2050	2500	White	
DM03	Direction Information "SLOW"	2050	1250	White	
DM04	Direction Information "SLOW"	2050	2500	White	
DM05	Work Message "SPEED LIMIT"	1500	1250	White	
DM06	Work Message "SPEED LIMIT"	1500	2500	White	
DM07	Direction Information "KEEP CLEAR"	2550	1250	White	
DM08	Direction Information "KEEP CLEAR"	2550	2500	White	
DM09	Direction Information "SCHOOL KEEP CLEAR"	NA	700	Yellow	
DM10	Direction Information "No PARKING"	NA	700	Yellow	
DM11	Direction Information "NO ENTRY"	NA	1250	White	
DM12	Direction Information "NO ENTRY"	NA	2500	White	

[Continued]

ANNEXURE : A

(Refer Section 3 Under Para 3.6)

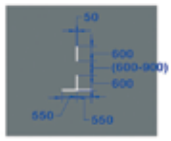
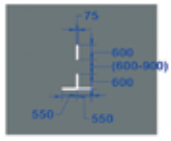
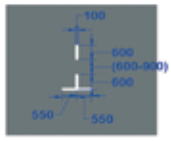
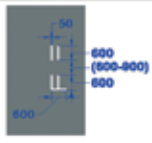
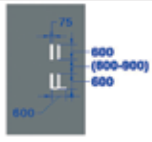
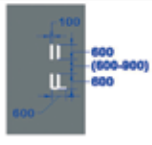
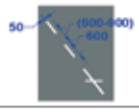
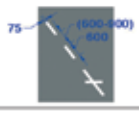
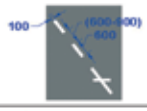
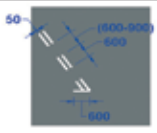
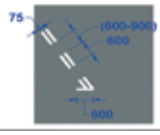
TABLE : A.6 : DIRECTIONAL MARKINGS (DM)

Marking Abbreviation	Type	Width (mm)	Height (mm)	Colour	Pattern
DM13	Direction Information "NO ENTRY"	NA	1250	White	
DM14	Direction Information "NO ENTRY"	NA	2500	White	
DM15	Direction Information "TURN LEFT"	NA	1250	White	
DM16	Direction Information "TURN LEFT"	NA	2500	White	
DM17	Direction Information "TURN RIGHT"	NA	1250	White	
DM18	Direction Information "TURN RIGHT"	NA	2500	White	
DM19	Direction Information "TURN RIGHT"	NA	1250	White	
DM20	Direction Information "TURN RIGHT"	NA	2500	White	
DM21	Direction Information "KEEP LANE"	NA	1250	White	
DM22	Direction Information "KEEP LANE"	NA	2500	White	

ANNEXURE : A

(Refer Section 3 Under Para 3.7)

TABLE : A.7 : FACILITY MARKINGS (FM)

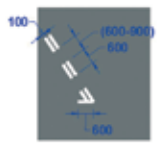
Marking Abbreviation	Type	Length of Mark (mm)	Width (mm)	Colour	Pattern
FM01	Parking (Mid Block)	As Shown	50	White	
FM02	Parking (Mid Block)	As Shown	75	White	
FM03	Parking (Mid Block)	As Shown	100	White	
FM04	Parking (Last Block)	As Shown	50	White	
FM05	Parking (Last Block)	As Shown	75	White	
FM06	Parking (Last Block)	As Shown	100	White	
FM07	Parking (Mid Block)	As Shown	50	White	
FM08	Parking (Mid Block)	As Shown	75	White	
FM09	Parking (Mid Block)	As Shown	100	White	
FM10	Parking (Last Block)	As Shown	50	White	
FM11	Parking (Last Block)	As Shown	75	White	

[Continued]

ANNEXURE : A

(Refer Section 3 Under Para 3.7)

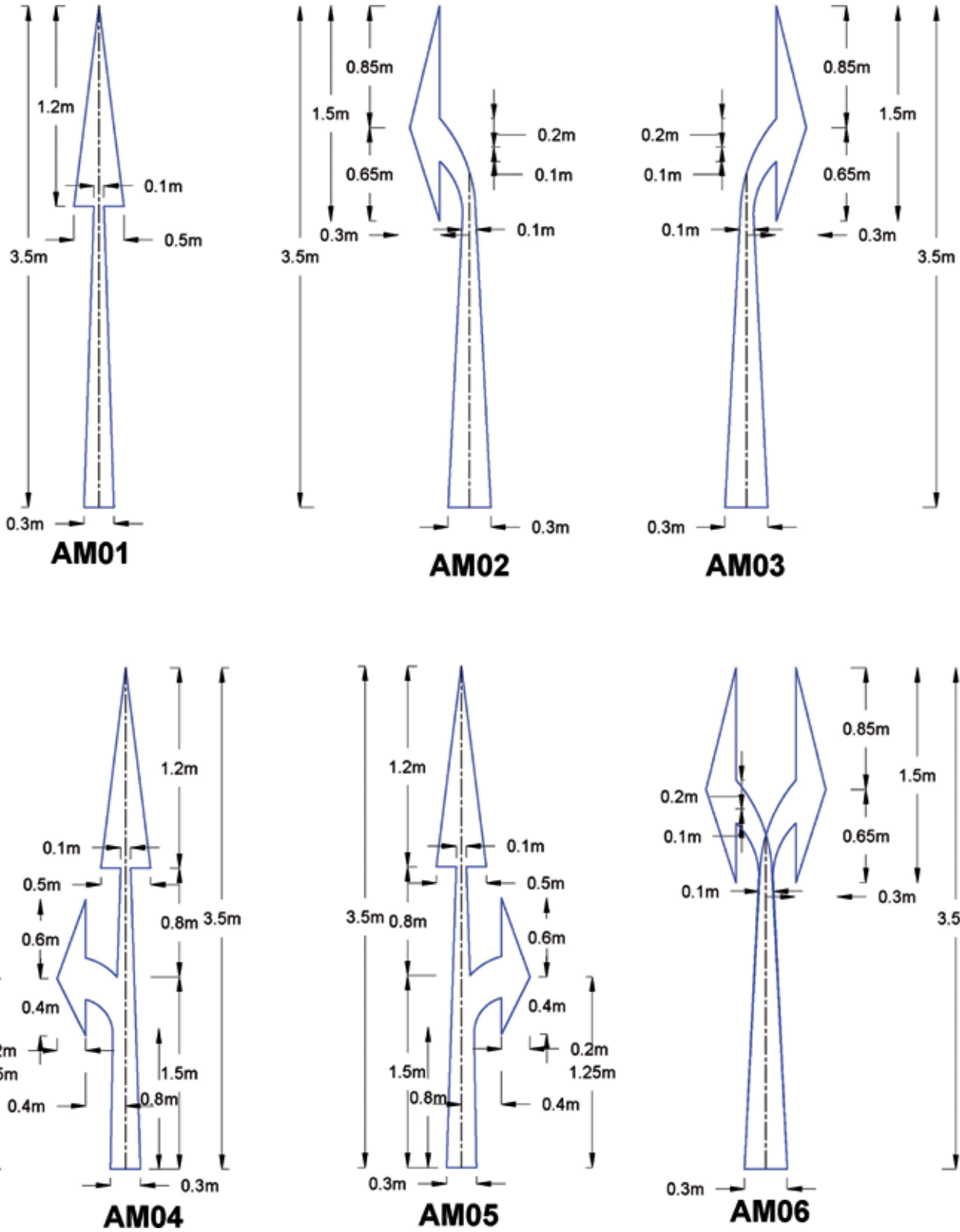
TABLE : A.7 : FACILITY MARKINGS (FM)

Marking Abbreviation	Type	Length of Mark (mm)	Width (mm)	Colour	Pattern
FM12	Parking (Last Block)	As Shown	100	White	
FM13	Word Message "BUS LANE"	NA	1250	White	
FM14	Word Message "BUS STOP"	NA	1250	White	
FM15	Word Message "TRAM & BUS ONLY"	NA	1250	White	
FM16	Word Message "TAXIS"	NA	350	White	
FM17	Word Message "TAXIS"	NA	700	White	
FM18	Word Message "DISABLED"	NA	700	White	
FM19	Word Message "SLOW" for Cycle track	NA	700	White	
FM20	Word Message "SLOW" for Cycle track	NA	1050	White	

ANNEXURE : B

(Refer Section 8 Under Para 8.1.1)

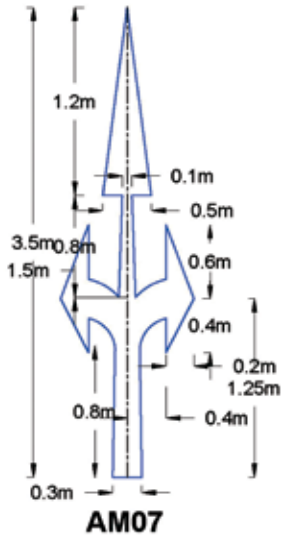
TABLE : B.1 : DETAILS OF ARROW MARKINGS



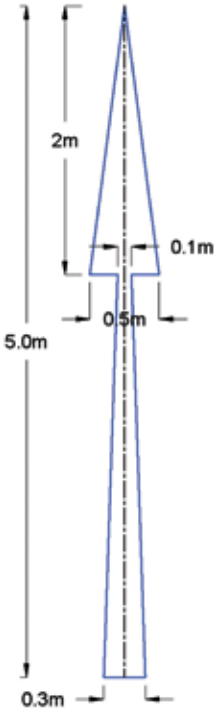
ANNEXURE : B

(Refer Section 8 Under Para 8.1.1)

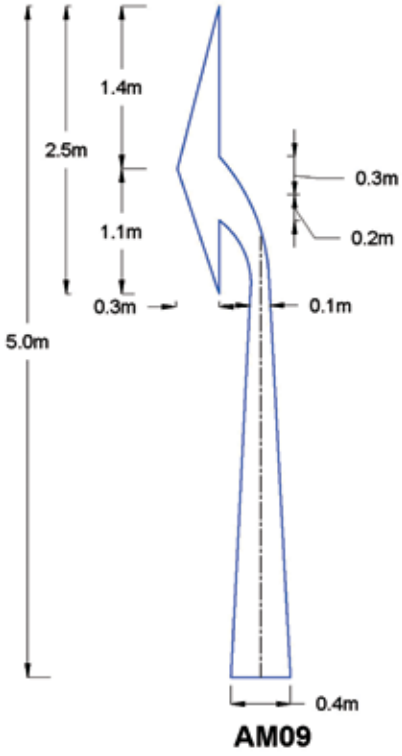
TABLE : B.1 : (CONTD.)



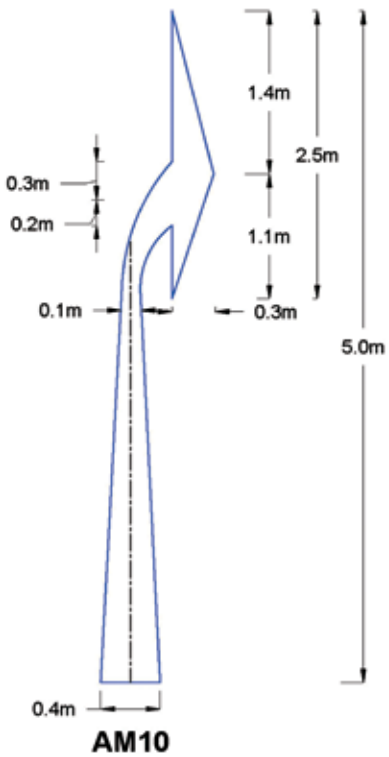
AM07



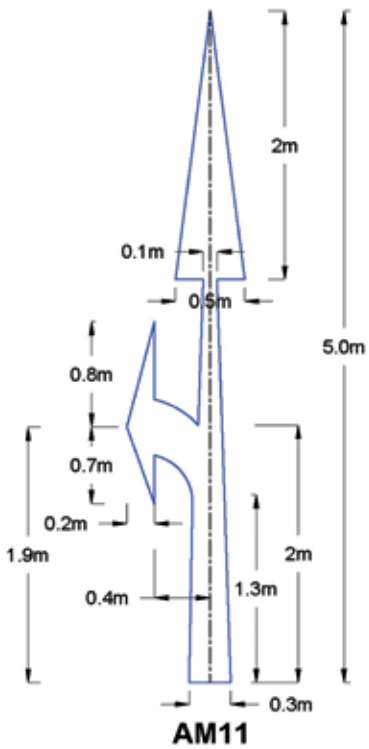
AM08



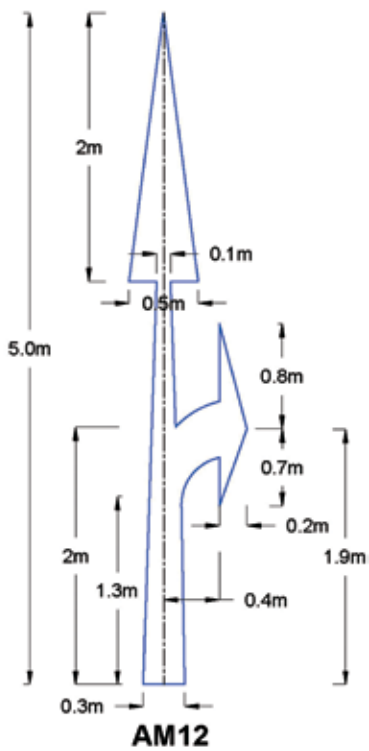
AM09



AM10



AM11

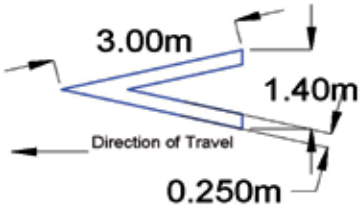


AM12

ANNEXURE : B

(Refer Section 8 Under Para 8.1.1)

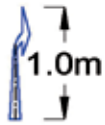
TABLE B.1: (CONTD.)



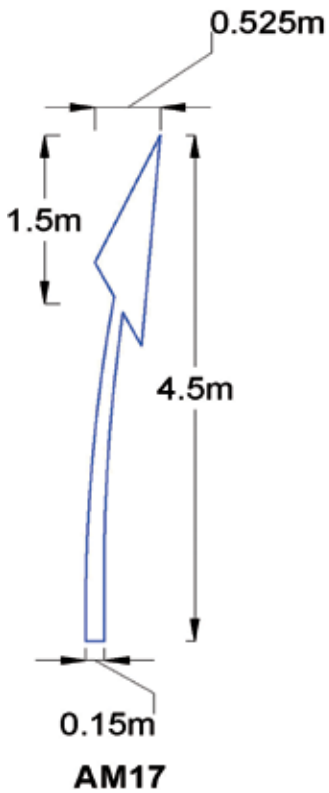
AM13

AM14

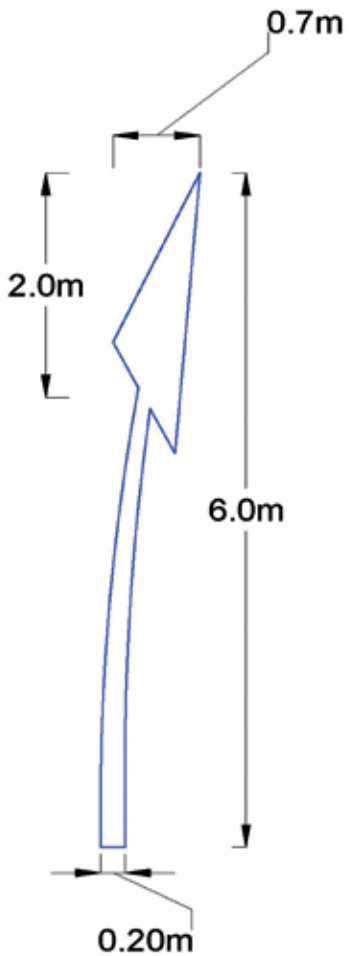
AM15



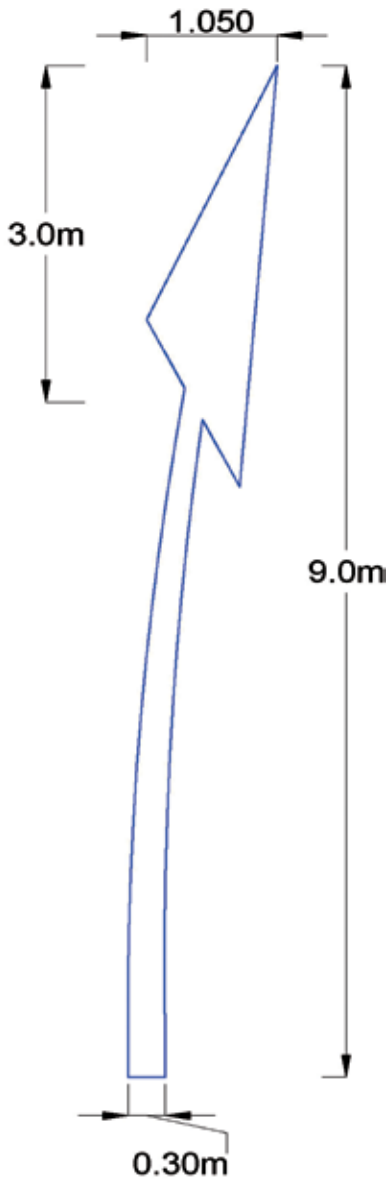
AM16



AM17



AM18

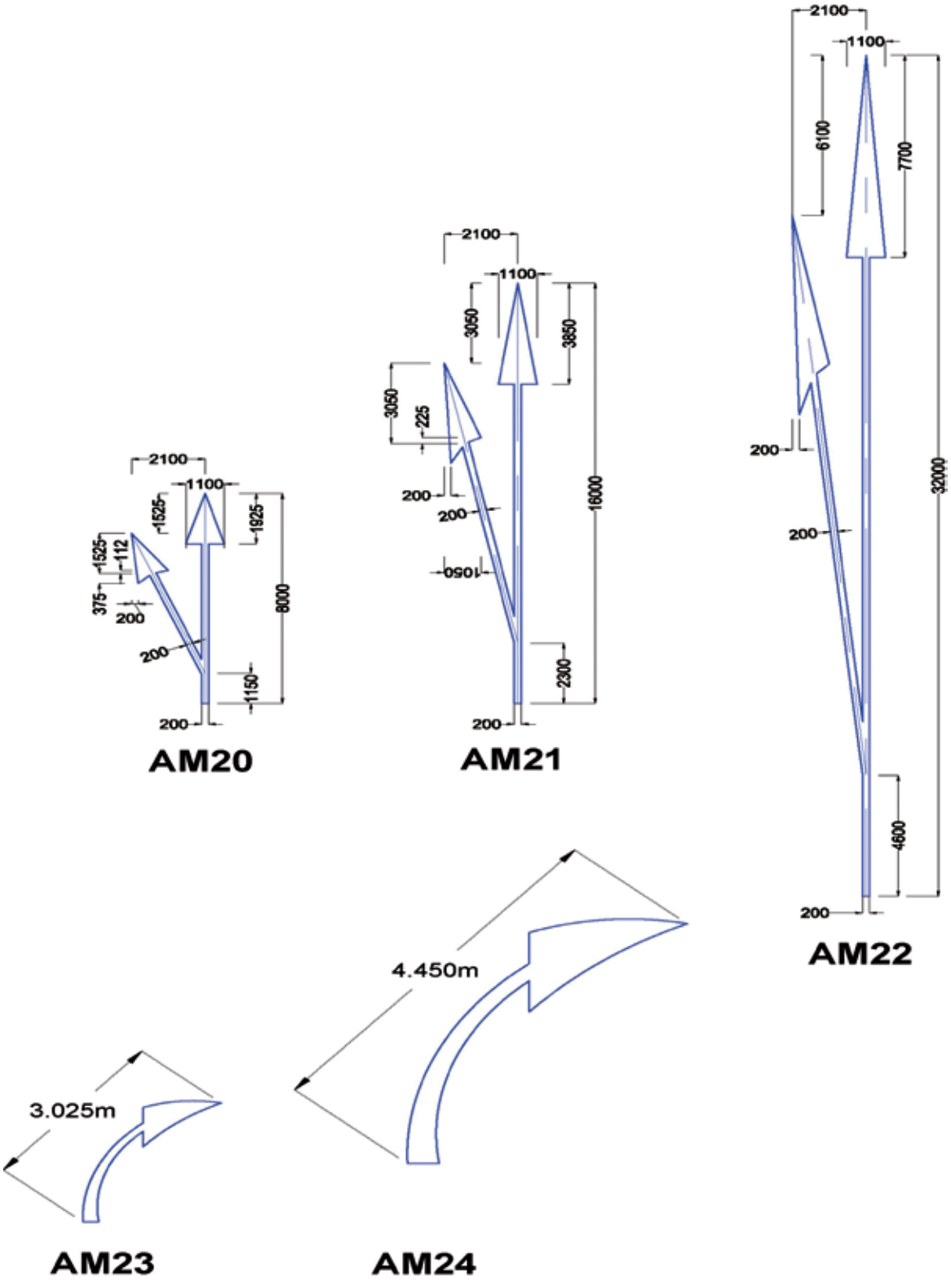


AM19

ANNEXURE : B

(Refer Section 8 Under Para 8.1.1)

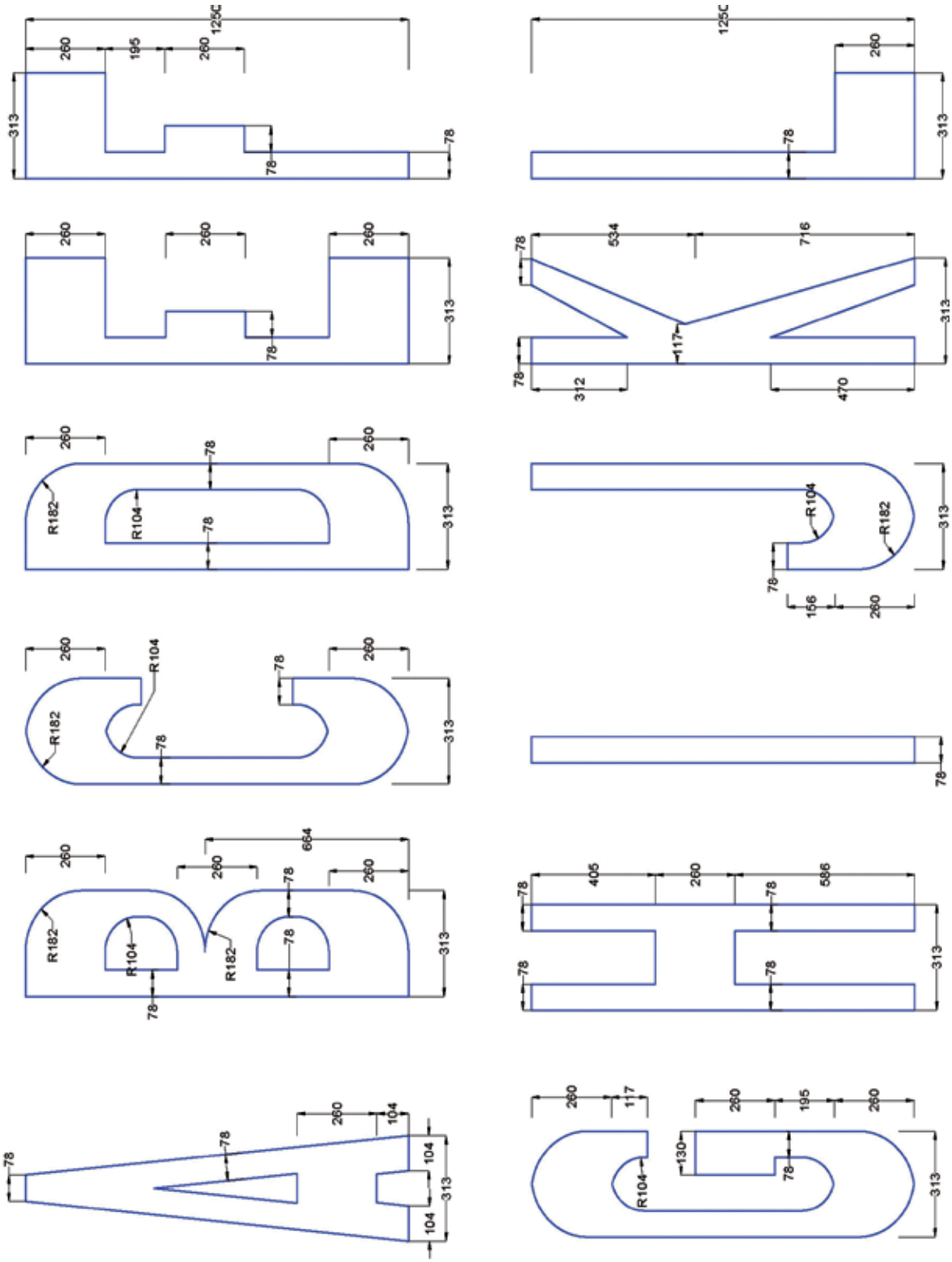
TABLE : B.1 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

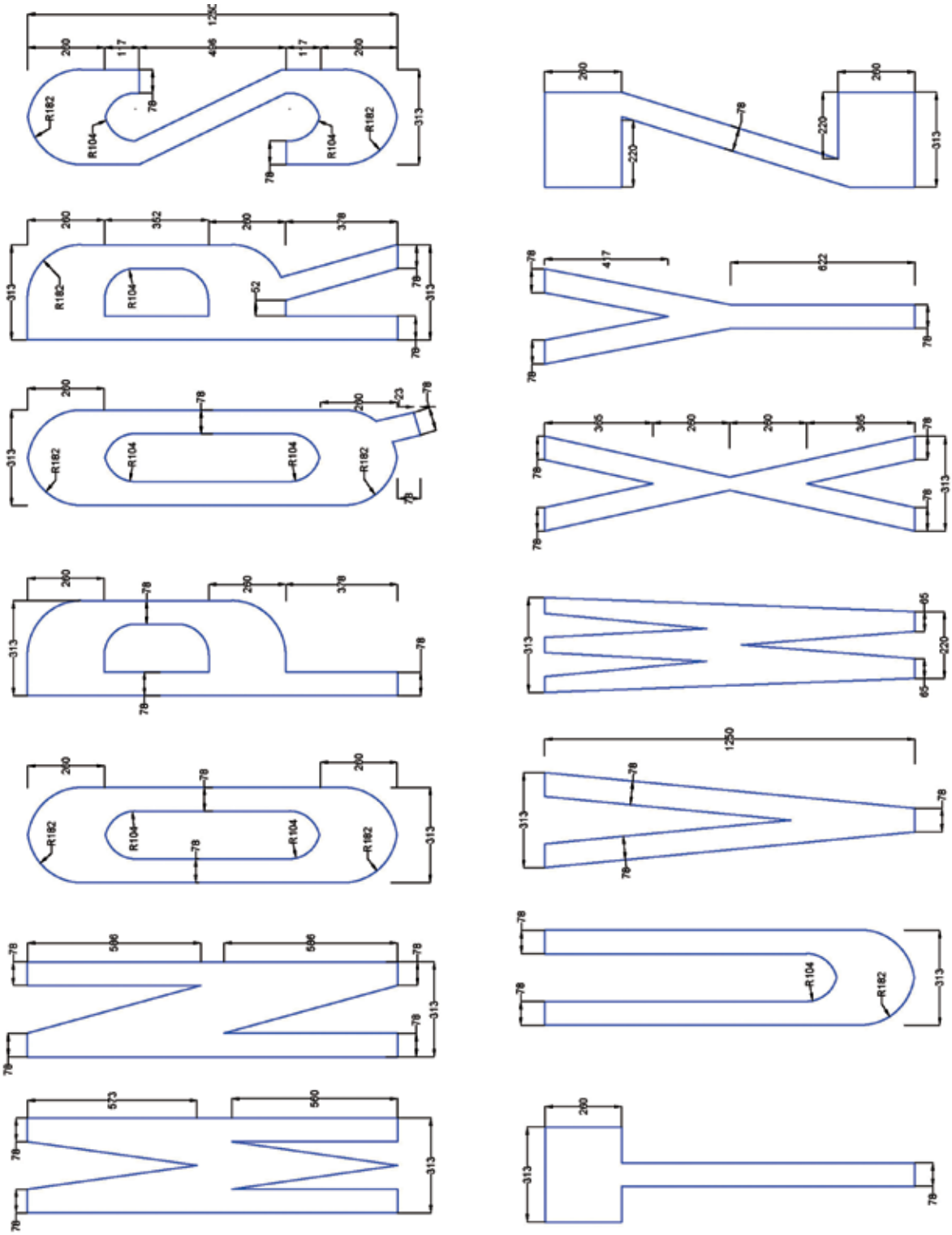
TABLE : C.1 : DETAILS OF LETTERS & NUMERALS (SPEED UPTO 50 KMPH)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

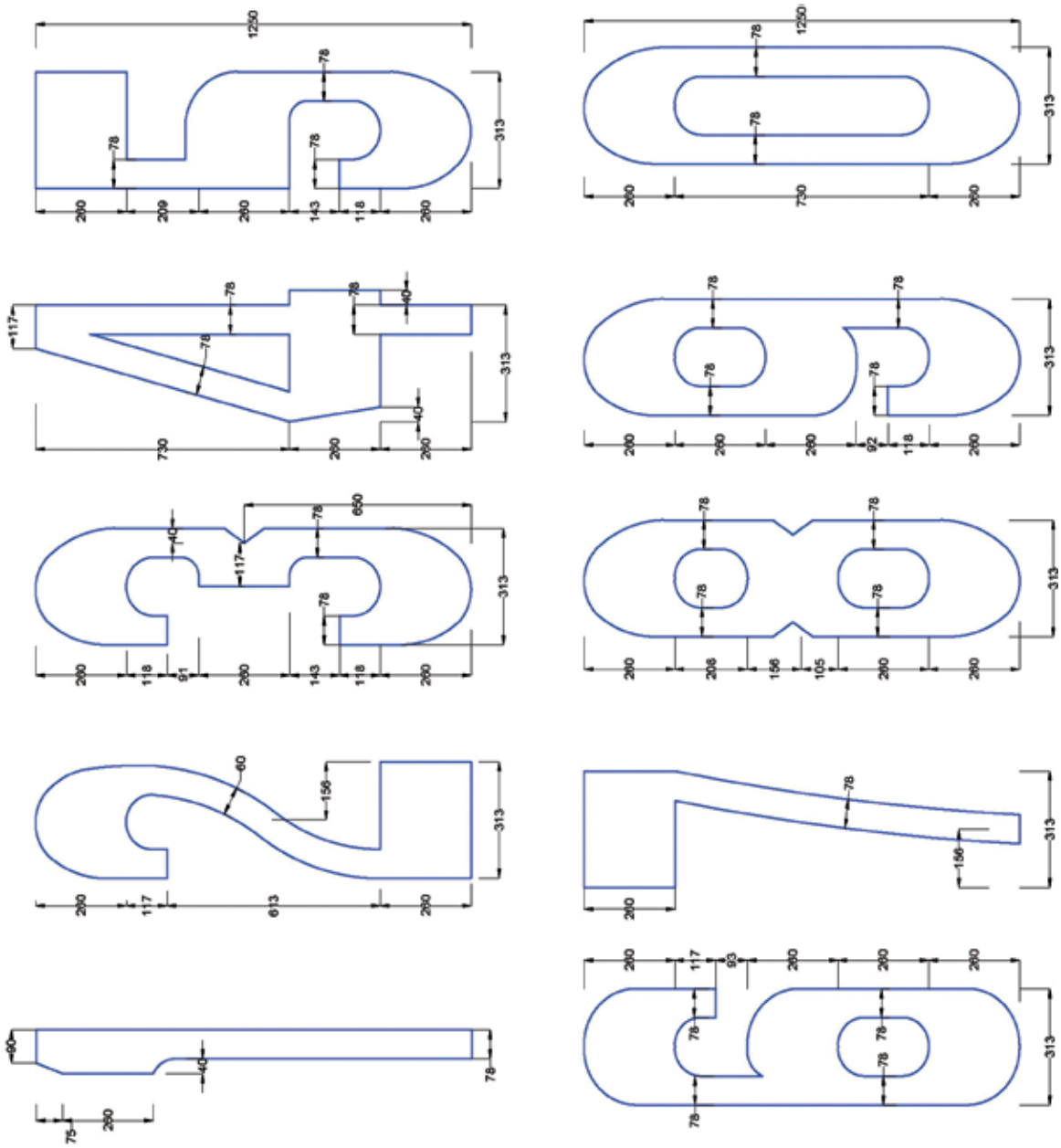
TABLE : C.1 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

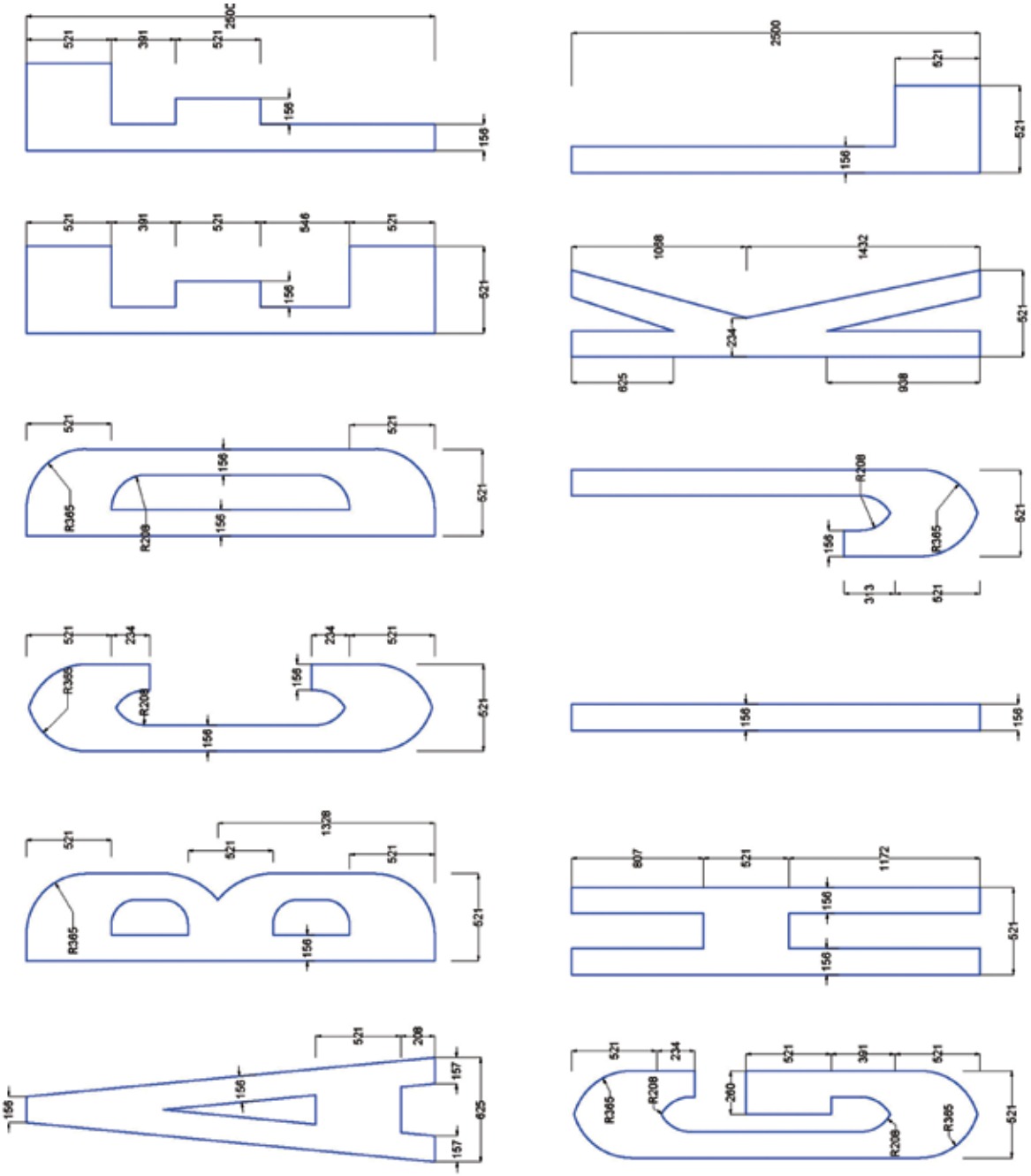
TABLE : C.1 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

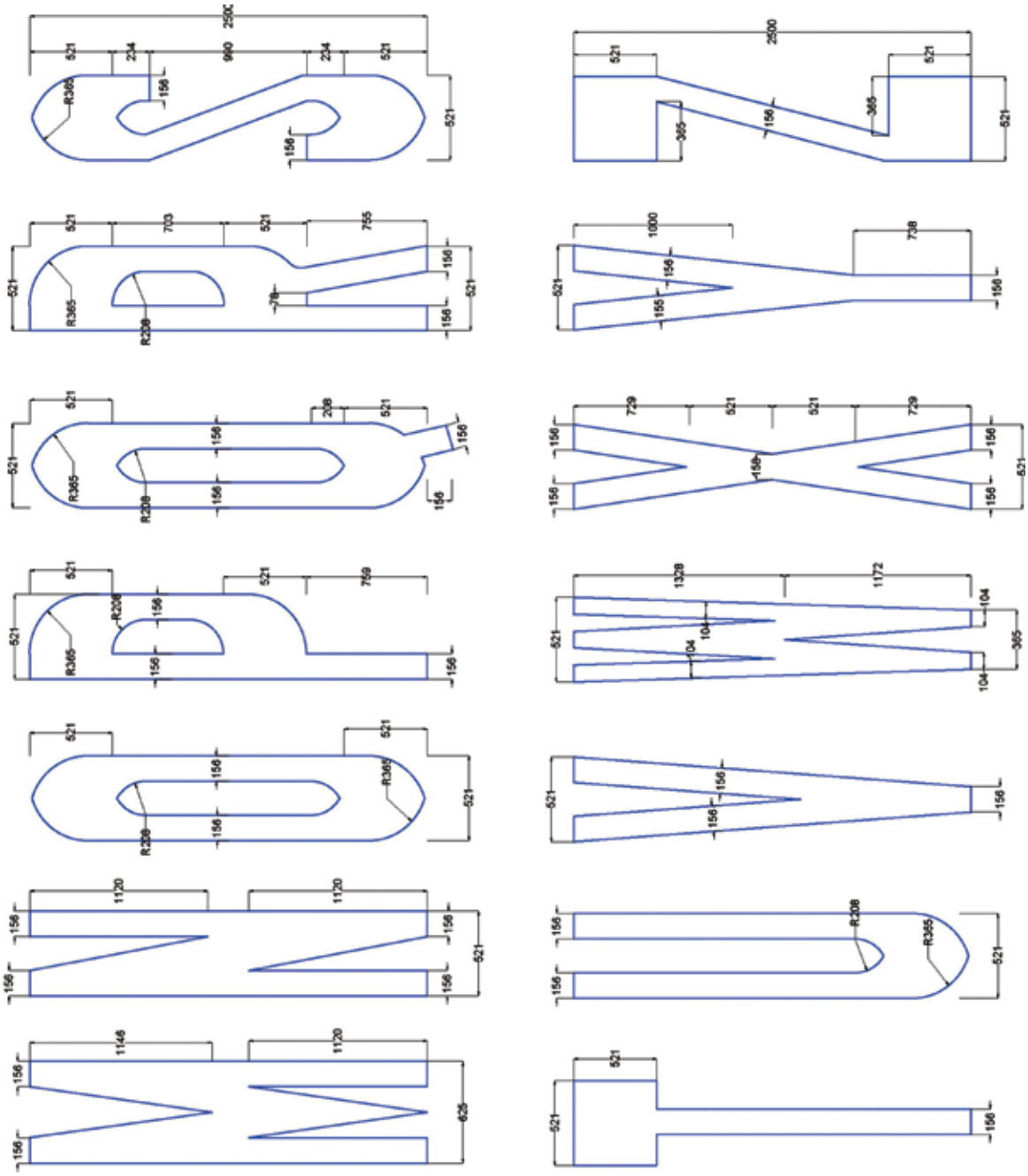
TABLE : C.2 : DETAILS OF LETTERS & NUMERALS (SPEED > 51 - 100 KMPH)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

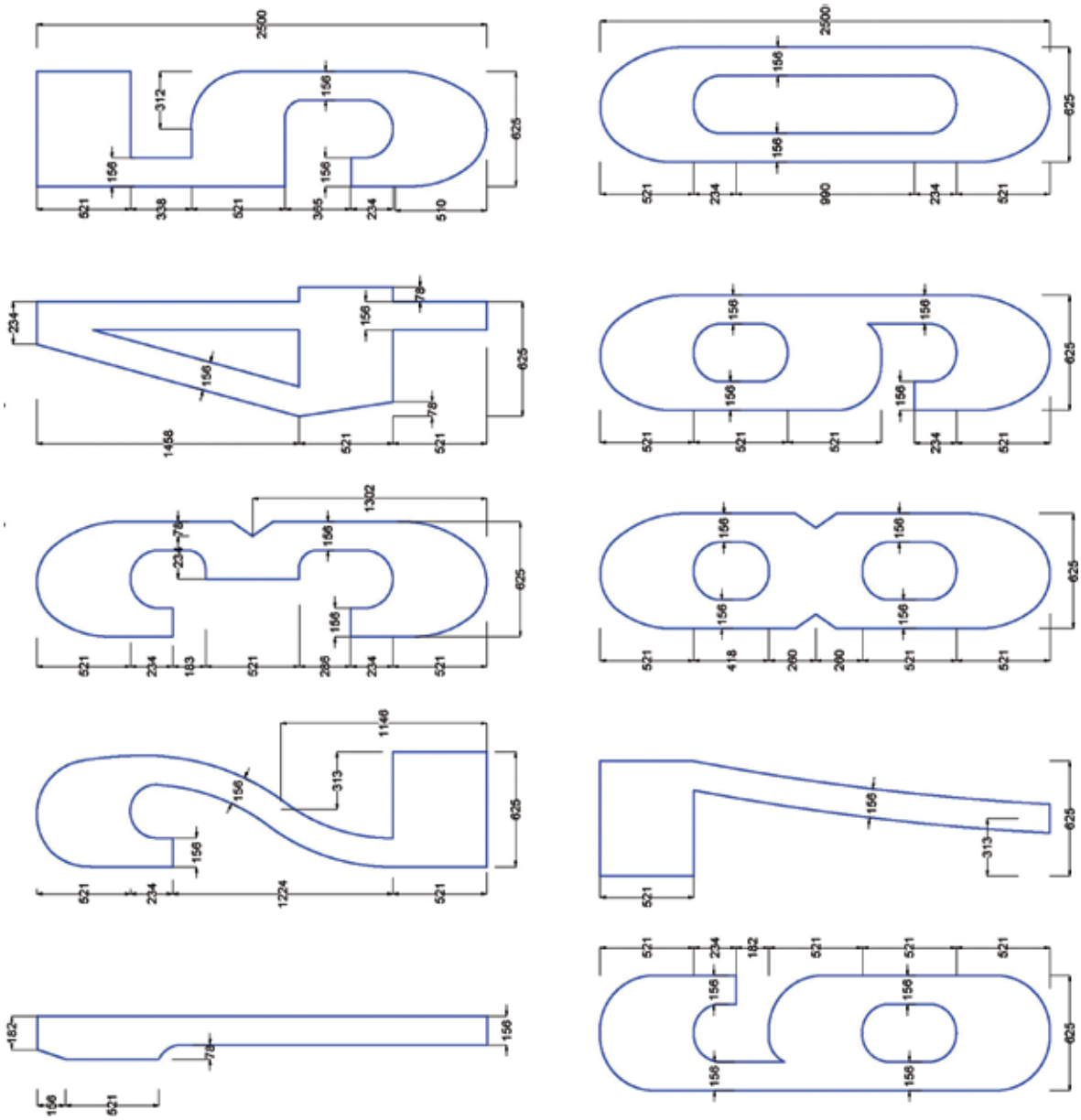
TABLE : C.2 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

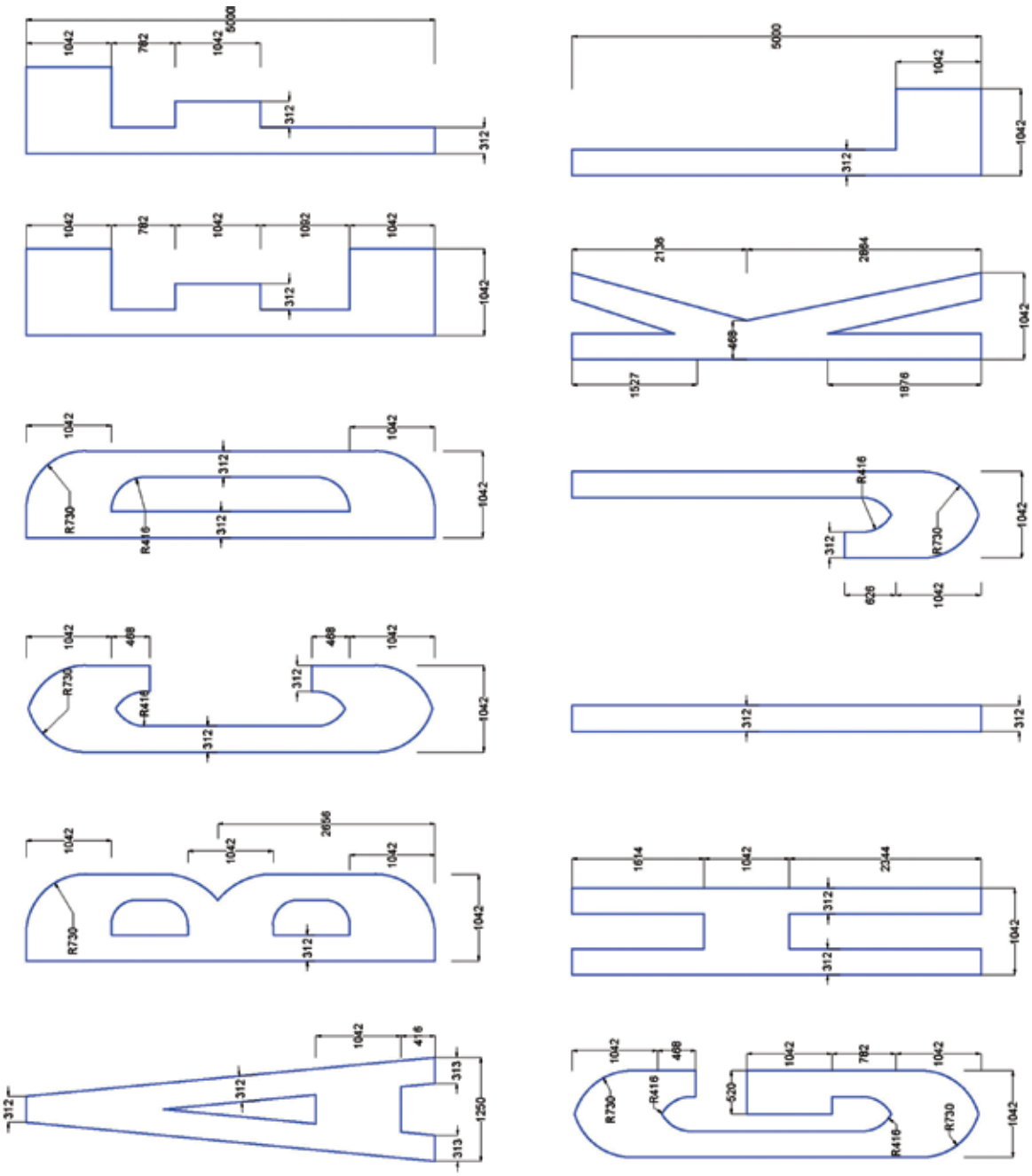
TABLE : C.2 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

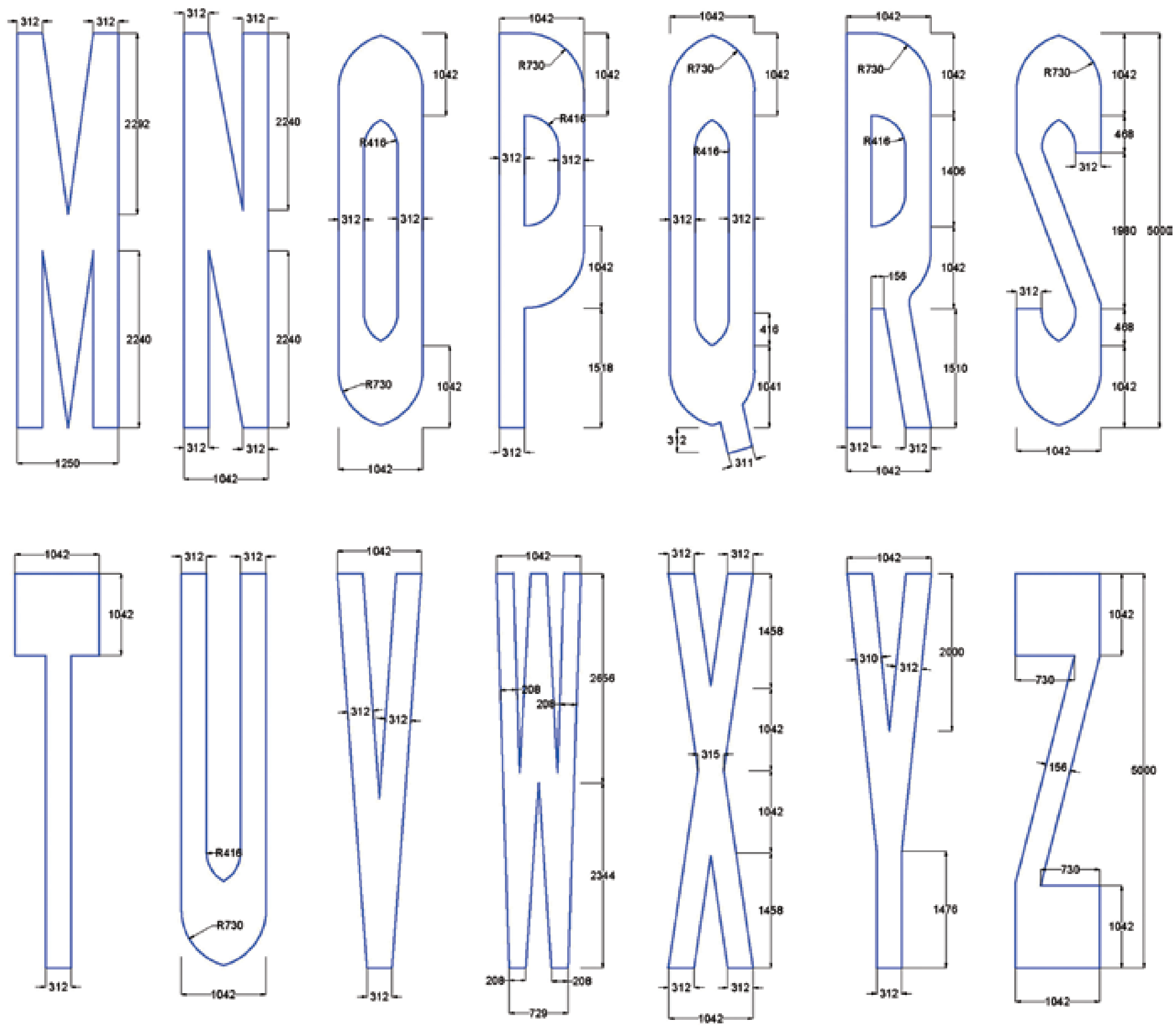
TABLE : C.3 : DETAILS OF LETTERS & NUMERALS (SPEED > 100 KMPH)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

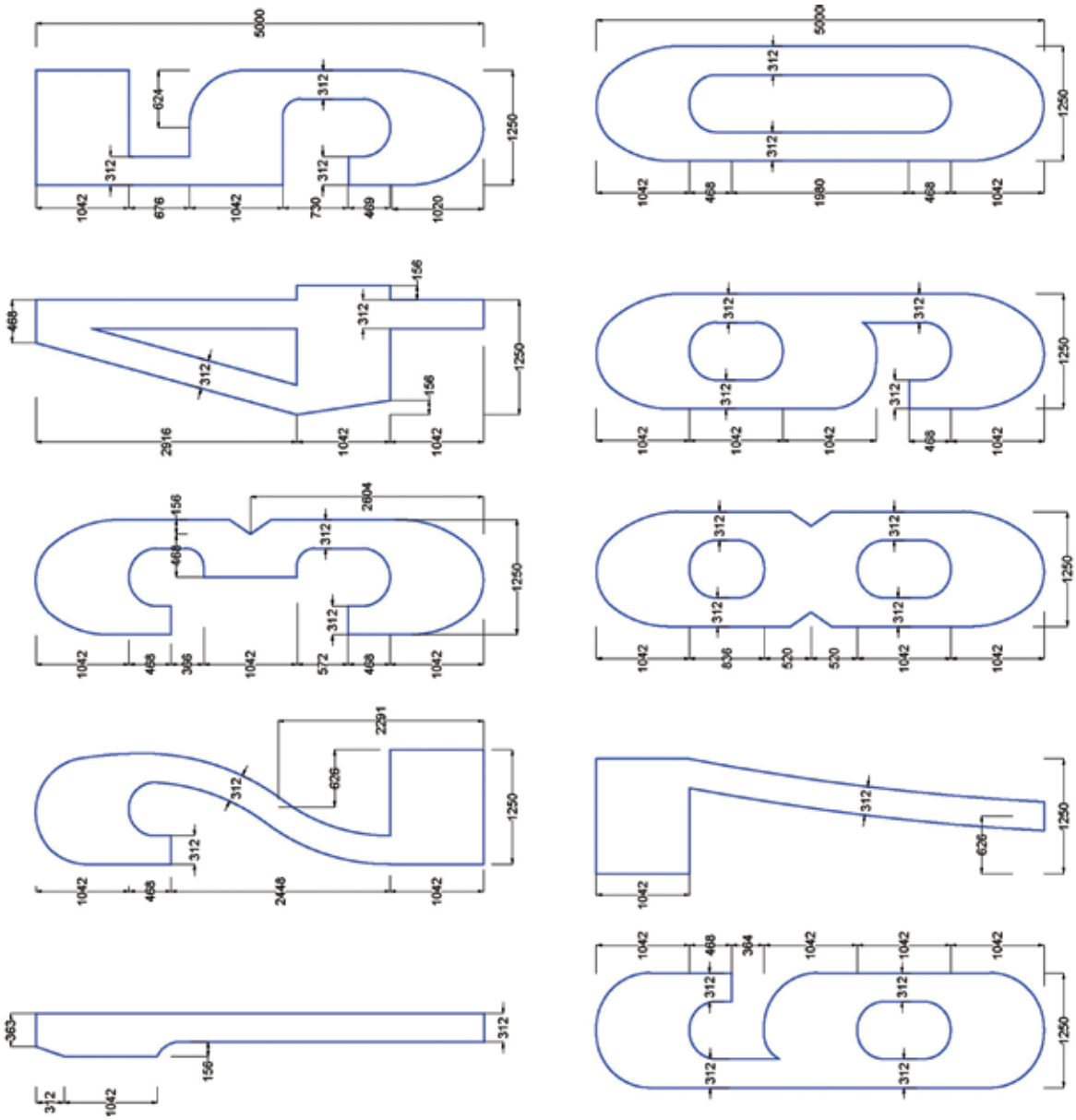
TABLE : C.3 : (CONTD.)



ANNEXURE : C

(Refer Section 7 Under Para 7.4.1)

TABLE : C.3 : (CONTD.)



ANNEXURE : D

(Refer Section 15 Under Para 15.3)

MEASUREMENT METHOD FOR THE LUMINANCE COEFFICIENT

Introduction

Equipment for the measurement of the luminance coefficient under diffuse illumination Q_d of a field of a road marking includes an illumination system, a photometer and means to define a horizontal reference plane with a reference centre. Laboratory measurements are used to establish Q_d values for samples, which are to be used to test or calibrate in situ equipment. The reference plane and the reference centre are defined by means of a sample holder and an alignment procedure. The diffuse illumination can be provided in a photometric sphere. A light source is mounted in the sphere in such a way, that direct illumination falls only on the lower half of the sphere. By reflection and inter-reflection, the upper half of the sphere has a close approximation to a uniform luminance. The reference plane is the horizontal plane through the centre of the sphere and the reference centre is the centre of the sphere. In some cases, samples can be as short as 200 mm. Samples used to test or calibrate portable instruments need to be at least 40 cm long, while samples used to test or calibrate vehicle mounted equipment need to be longer. For some structured road markings, fairly long samples are required. A practical width of samples is often 200 mm. A sample should be backed by a substrate to assist handling and should show a non-deformed surface of the road marking. The sample can either be laid directly onto the substrate, or it can be taken from a road and adhered to the substrate.

Portable instruments are intended for the measurement of Q_d values of road markings on the road, but may be used to measure Q_d values of road marking materials on sample panels before placing them on the road. A portable instrument integrates the photometer and the illumination system. For a fixed-aim instrument, the reference plane and the reference centre is defined by feet of the instrument. For an aiming instrument, the reference plane and the reference centre is defined by an aiming procedure.

When measuring a structured road marking with a portable instrument, it is necessary to establish if the instrument in question is able to measure the structured road marking with the actual height of structures and gaps between these. The Q_d value is established as the average of a number of readings taken with shifts of the instrument in steps along the marking, covering one or more spacing of structures.

Vehicle mounted instruments are used to measure Q_d values of road markings while moving at traffic speed, and can be used for longer stretches of road than portable instruments and in cases where the use of portable instruments requires extensive precautions, in particular on expressways. Vehicle mounted instruments should in principle comply with the same requirements as for portable instruments, and should be able to cope with the movements of the vehicle and with changing conditions of daylight. However, the operation at speed may cause additional difficulties of the measurement, which may lead to compromises with requirements or cause additional variation of measured values.

Note : At present, vehicle mounted equipment available in the market uses daylight illumination, which under an overcast sky with a reasonable free view to the horizon, approximates diffuse illumination. Due to variations in daylight, luminance and luminance should be measured simultaneously. Suitable daylight illumination does not occur very often. Portable and vehicle mounted instruments are to be calibrated, maintained and used according to instructions rendered by the instrument supplier.

Spectral Match

The photometer shall have a spectral response according to the V(λ) distribution and the illumination shall have a spectral emission according to standard illuminant D65 as defined in ISO 10526. However, it is permissible to use illumination with other spectral distributions, if the spectral response of the photometer is modified to provide a correct overall spectral response of illumination and measurement.

Note : Only in the case of fluorescence it is necessary that the spectral emission of the light source itself is correct.

Portable instruments shall have an overall spectral response that ensures correct measurement of at least white and yellow road markings. The overall spectral response can be tested by means of a white (spectrally neutral) reflection standard, or a white road marking sample, and a set of long pass absorption filters providing colours of light yellow and dark yellow.

The ratio of the Q_d values obtained with a yellow filter inserted in front of the photometer, and without the filter, shall be within ± 5 percent of the luminous transmittance of such a filter in standard illuminant D65 illumination. The filter shall be inserted at a location, where it does not affect the illumination of the white reflection standard or road marking sample. Filters of other colours may be added to test the ability of an instrument to measure road markings of such colours.

Standard Measuring Condition of Measuring Equipment

The photometer measures a field of the reference plane, which is located about the reference centre. The illumination system illuminates a field of the reference plane, also located about the reference centre.

The fields are arranged according to method A, if the illuminated field contains the measured field, and according to method B if the measured field contains the illuminated field. The measured area, defined as the area of the smaller of the two fields, shall be minimum 50 cm².

The observation direction is the central direction of all rays from the measured area to the photometer leading to detection. The observation angle, symbol ‹, is the angle between the observation direction and the reference plane. In the standard measuring condition, the observation angle ‹ shall be 2.29° ± 0.05° and the total angular spread of the measuring directions shall not exceed 0.33°.

Note : **1** The standard measuring condition is intended to simulate a visual distance of 30 m for the driver of a passenger car with an eye height of 1.2 m above the road with diffuse illumination from daylight or under road lighting.

2 For some instruments, measuring directions can be tested by putting steady light through the optical system of the photometer, and observing the transmitted beam. Putting light through the optical system needs to be done in consultation with the supplier of the instrument and according to his instructions.

Diffuse illumination is obtained with an illumination system that provides a surface of constant luminance, which may be an opening into an illuminated photometric sphere, or other device.

When using a photometric sphere, the illumination shall cover all of the interior sphere surface above the opening with such a degree of uniformity that the ratio of the smallest to the largest luminance of the interior sphere surface is minimum 0.8, when measured in directions through the centre of the opening with a circular measuring field of a diameter 0.1 times the diameter of the sphere.

When the height of the remaining part of the sphere, after introducing the opening, is minimum 0.8 times the diameter of the sphere, no further measures to secure uniformity of luminance are required.

When less of the sphere surface remains than stated above, or when the sphere is approximated by other shapes, the ratio of the smallest to the largest luminance of interior surfaces shall be minimum 0.8, when measured in different directions and locations through the opening. The test shall be carried out with the opening empty, and shall be repeated with the opening covered by a reflecting surface of white, matt finish with suitable holes to allow for the measurements.

The surface of constant luminance shall be close to the road marking surface in order to provide adequate sensitivity to surface reflection. This may be tested by measurement of road markings with a low degree of surface texture. Typical bias values shall be reported by the manufacturer.

Practical Applications of Measuring Equipment

The equipment shall have sufficient sensitivity and range to accommodate Q_d values expected in use, typically 1 to the maximum of approximately 318 mcd/m²/lux(1000/π) . The linearity over this range of Q_d values shall be adequate for the purpose. The sensitivity, range and linearity of portable instruments may be tested by means of suitable samples. The equipment shall be able to cope with the conditions expected in use such as stray light entering from the surroundings. Portable instruments are used in conditions of full daylight and shall be constructed so that readings are not affected by ambient light in these conditions. Some instruments may need to inform the operators by warnings or error messages if necessary.

Offset by stray light in daylight conditions may be tested by measurement in full daylight, where readings obtained without additional cover of an instrument are compared to readings obtained with additional cover by a black cloth or other obstructions about the instrument.

Portable instruments may be tilted and shifted in height relative to the road marking surface because of texture and curve of road markings on the road, particles on the surface and structure of structured road markings. For fixed-aim instruments, the sensitivity to tilts and

shifts shall be tested by shifting the height position H of the instrument parallel to a road marking sample and simultaneously moving the sample horizontally so that the measured area stays in the same location on the sample surface. The movement of the sample is by H/sin 2.29° = 25.H for Method A ; the sample is not to be moved for Method B. Using a non-glossy surface, the measured Q_d value shall not change by more than ±10 percent, when the height position is shifted from '0 mm' to -1 mm, 1 mm and 2 mm.

Aiming instruments shall meet the same requirements, but verification has to be according to the construction of the instruments. Other height positions may be included to demonstrate the ability of an instrument to measure road markings with extreme texture, in particular structured road markings.

Note : When an instrument is able to perform at a height position H, it is able to measure structured road markings when the structure height is at most H or the gaps between structures is at most 25.H.

Calibration of the Measuring Equipment

For laboratory measurement on road marking panels placed in a photometric sphere, direct calibration is obtained by mounting the photometer at the reference centre with an orientation towards the upper part of the sphere, and calibrating the photometer reading to be 1000/π approximately 318 mcd/m²/lx(1000/π). The photometer can then be used to measure the Qd values of the road marking panels directly in mcd/m-2/lux-1. Direct calibration is suitable, when the luminance of the upper part of the sphere is perfectly constant. Else, indirect calibration by means of a standard sample with a known Q_d value, measured with direct calibration or with another traceable calibration technique may be preferable. The 'sample' may be a curved mirror or another optical system that gives a view to the upper part of the sphere.

A portable instrument shall be calibrated by means of a traceable standard sample with a known Q_d value. Independent calibration of the standard sample shall be possible. A transfer standard may be used for routine tests of the calibration in order to avoid frequent handling of the standard in road conditions.

Uncertainty of Measurement

Note : **1** The concept of 'uncertainty of measurement' is the overall concept that involves both, trueness (or bias) and precision (repeatability or reproducibility).

Some level of trueness can be assured indirectly by use of measuring equipment, when also limiting the use to the range of applicability of the particular equipment. Precision can be determined by conventional means according to the definitions.

2 Ideally, trueness could be established by means of road marking panels with accepted reference values measured in laboratory conditions. However, laboratory measurements are not presently sufficiently developed.

Accordingly, uncertainty of measurement can be addressed in the following steps:

- calibration;
- ability to cope with practical conditions including applicability for structured pavement markings,;

- compliance with the standard measuring condition;
- spectral match including applicability in terms of colours of road markings;
- precision (repeatability and reproducibility)

Suppliers/producers of measuring equipment shall account for each of these steps in such a way that the range of applicability and the uncertainty of measurement within this range can be addressed:

- the uncertainty of calibration shall be accounted for with reference or traceability to a calibration standard with an accepted reference value
- an instruction shall be available regarding use of equipment in practical conditions, in particular for use on structured road markings
- these and other steps shall be accounted for on the basis of independent test reports to the widest possible extent.

ANNEXURE : E

(Refer Section 15 Under Para 15.4.1)

MEASUREMENT METHOD FOR THE COEFFICIENT OF RETRO REFLECTION

Introduction

Equipment for the measurement of the coefficient of retro reflected luminance RL of a field of a road marking includes an illumination system, a photometer and means to define a horizontal reference plane with a reference centre. Laboratory measurements are used to establish RL values for samples, which are to be used to test or calibrate in situ equipment. The reference plane and the reference centre are defined by means of a sample holder and an alignment procedure. In some cases, samples can be as short as 20 cm. Samples used to test or calibrate portable instruments need to be at least 40 cm long, while samples used to test or calibrate vehicle mounted equipment need to be longer. For some structured road markings, fairly long samples are required. A practical width of samples is often 20 cm. A sample should be backed by a substrate to assist handling and should show a non-deformed surface of the road marking. The sample can either be laid directly onto the substrate, or it can be taken from a road and adhered to the substrate.

Portable instruments are intended for the measurement of RL values of road markings on the road, but may be used to measure RL values of road marking materials on sample panels before placing them on the road. A portable instrument integrates the photometer and the illumination system. For a fixed-aim instrument, the reference plane and the reference centre is defined by feet of the instrument. For an aiming instrument, the reference plane and the reference centre is defined by an aiming procedure. When measuring a structured road marking with a portable instrument, it is necessary to establish if the instrument in question is able to measure the structured road marking with the actual height of structures and gaps between these. The RL value is established as the average of a number of readings taken with shifts of the instrument in steps along the marking, in total covering one or more spacing of structures.

Vehicle mounted instruments are used to measure RL values of road markings while moving at traffic speed, and can be used for longer stretches of road than portable instruments and in cases where the use of portable instruments requires extensive precautions, in particular on motorways. Vehicle mounted instruments should in principle comply with the same requirements as for portable instruments, and should be able to cope with the movements of the vehicle and with changing conditions of daylight. However, the operation at speed may cause additional difficulties of the measurement, which may lead to compromises with requirements or cause additional variation of measured values. Portable and vehicle mounted instruments are to be calibrated, maintained and used according to instructions by the instrument supplier.

Spectral Match of Measuring Equipment

The photometer shall have a spectral response according to the V (λ) distribution and the illumination shall have a spectral emission according to standard illumination 'A' as defined in

ISO 10526. However, it is permissible to use illumination 'A' with other spectral distributions, if the spectral response of the photometer is modified to provide a correct overall spectral response of illumination and measurement.

Note : Only in the case of fluorescence it is necessary that the spectral emission of the light source itself is correct, but it is unlikely that fluorescence will occur to a significant degree in conditions of RL measurement.

Portable instruments shall have an overall spectral response that ensures correct measurement of at least white and yellow road markings. The overall spectral response can be tested by means of a white (spectrally neutral) reflection standard, or a white road marking sample, and a set of long pass absorption filters providing colours of light yellow and dark yellow. The ratio of the RL values obtained with a yellow filter inserted in front of the white reflection standard and without the filter shall be within ± 5 percent of the luminous transmittance of an air space pair of two such filters in standard illuminant 'A' illumination. The filter shall be inserted with a small tilt to avoid signal by surface reflection, and at some distance from the standard to avoid surface reflection back to the standard. Filters of other colours may be added to test the ability of an instrument to measure the road markings of such colours. For vehicle mounted instruments, it is also permissible for the light source to be a visible laser, if calibration is carried out for the colour of the road markings to be measured.

Standards for Measuring Condition of Measuring Equipment

The photometer measures a field of the reference plane, which is located about the reference centre. The illumination system illuminates a field of the reference plane, also located about the reference centre. The fields are arranged according to Method A, if the illuminated field contains the measured field whereas according to Method B if the measured field contains the illuminated field. The measured area, defined as the area of the smaller of the two fields, shall be minimum 50 cm².

The observation direction is the central direction of all rays from the measured area to the photometer leading to detection. The observation angle, ε symbol is the angle between the observation direction and the reference plane. The illumination direction is the central direction of all rays from the illumination system to the measured area. The illumination angle is the angle between the illumination direction and the reference plane. In the standard measuring condition, the observation angle ‹ shall be 2.29°± 0.05, the illumination angle shall be 1.24°± 0.05 and the angle between the two vertical planes containing respectively the observation and the illumination direction shall be 0°±0.05. The total angular spread of the measuring directions shall not exceed 0.33°. The total angular spread of the illumination directions shall not exceed 0.33° in the plane parallel to the reference plane and 0.17° in the plane perpendicular to the reference plane.

Note 1: The standard measuring condition is intended to simulate a visual distance of 30 m for the driver of a passenger car with an eye height of 1.2 m and a headlamp mounting height of 0.65 m above the road.

Note 2: For some instruments, compliance with the standard measuring condition can be tested by putting steady light through the optical systems of the photometer and the illumination system,

and observing the transmitted beams. Putting light through the optical systems needs to be done in consultation with the supplier of the instrument and according to his instructions.

Practical Applications of Measuring Equipment

The measuring equipment shall have sufficient sensitivity and range to accommodate RL values expected in use, typically 1 mcd/m^2/lx to 2000 mcd/m^2/lux. The linearity over the range of RL values expected in use shall be adequate for the purpose.

The sensitivity, range and linearity of portable instruments may be tested by means of suitable samples. Portable instruments are used in conditions of full daylight and shall be constructed so that readings are not affected by ambient light in these conditions. Some instruments may need to inform the operators by warnings or error messages, if necessary.

Offset by stray light in daylight conditions may be tested by measurement in full daylight, where readings obtained without additional cover of an instrument are compared to readings obtained with additional cover by a black cloth or other obstructions about the instrument. Portable instruments are used to measure wet road marking surfaces, whose RL values might be small, while surface reflections are strong. Portable instruments shall be constructed, or compensated, so that surface reflections are not provoking offset of the readings. Sensitivity to surface reflections may be tested by measurement of a black acrylic plate with a smooth, clean surface, whose RL value is naught. Portable instruments may be tilted and shifted in height relative to the road marking surface because of texture and curve of road markings on the road, particles on the surface and structure of structured road markings. For fixed-aim instruments, the sensitivity to tilts and shifts shall be tested by shifting the height position H of the instrument parallel to a road marking sample and simultaneously moving the sample horizontally so that the measured area stays in the same location on the sample surface. The movement of the sample is by H/sin2.29°= 25.H for Method A and by H/sin1.24°= 46.H for method B. The measured RL value shall not change by more than ±10 percent, when the height position is shifted from 0 mm to -1 mm, 1 mm and 2 mm.

Other height positions may be included to demonstrate the ability of an instrument to measure road markings with extreme texture, in particular structured road markings.

Note : When an instrument is able to perform at a height position H, it is able to measure structured road markings when the structure height is at most H or the gaps between structures is at most 25.H. Aiming instruments shall meet the same requirements, but verification has to be according to the construction of the instruments.

Calibration of Measuring Equipment

For laboratory equipment, direct calibration is obtained by mounting the photometer at the reference centre, with an orientation towards the illumination system, and measuring the reading illumination. This reading is several decades larger than typical readings during measurement, and accordingly the linearity of the photometer shall be verified over the full range. Indirect calibration by means of a standard sample with a known RL value, measured with direct calibration or with another traceable calibration technique, may be preferable. A sample in the form of a tilted white ceramic surface is particularly suitable. A portable

instrument shall be calibrated by means of a traceable standard sample with a known RL value. Independent calibration of the standard sample shall be possible. A transfer standard may be used for routine tests of the calibration in order to avoid frequent handling of the standard in road conditions.

Note A : Standard with a tilted surface to be used for Method B needs to be assigned the value of sin 1.24°/sin 2.29° = 0.542 times the measured RL value. For vehicle mounted instruments, it is permissible to use calibrated portable instruments for field calibration provided that the portable instrument in use is calibrated with a traceable standard.

Condition of Wetness

The test condition shall be created using clean water poured from a bucket from a height of about 0.3 m above the surface. The water is poured evenly along the test surface so that a crest of water momentarily floods the measuring field and its surrounding area. The coefficient of retro-reflected luminance RL in condition of wetness shall be measured under the test condition after the water has been poured. The amount of water to be poured at one location is at least 3 litres. The test condition can also be created (60 ± 5) after stopping the artificial rain.

Note

1 The test condition is not applicable for newly applied road markings, when the surface is hydrophobic so that water forms puddles on the surface. The hydrophobic surface property normally disappears a few weeks after a road marking is applied.

2 In hot, sunny weather the road surface may be so hot that the road surface dries out very quickly. It helps to pour water on the road surface more than once to cool it down.

If portable equipment is cool after transport, dew will form on its optics when placing it on a hot, wet road surface. The portable equipment should be allowed to warm up and the road surface should be cooled down.

Uncertainty of Measurement

Note

1 The concept of 'uncertainty of measurement' is the overall concept that involves both trueness (and bias) and precision (repeatability or reproducibility). Some level of trueness can be assured indirectly by use of measuring equipment. Precision can be determined by conventional means according to the definitions.

2 Ideally, trueness could be established by means of road marking panels with accepted reference values measured in laboratory conditions. However, laboratory measurements are not presently sufficiently developed.

Accordingly, uncertainty of measurement can be addressed in the following steps:

- calibration;
- ability to cope with practical conditions including applicability for structured pavement markings;
- compliance with the standard measuring condition;
- spectral match including applicability in terms of colours of road markings;
- precision (repeatability and reproducibility).

Suppliers/producers of measuring equipment shall account for each of these steps in such a way that the range of applicability and the uncertainty of measurement within this range can be addressed:

- the uncertainty of calibration shall be accounted for with reference or traceability to a calibration standard with an accepted reference value;
- an instruction shall be available regarding use of equipment in practical conditions, in particular for use on structured road markings;
- these and other steps shall be accounted for on the basis of independent test reports to the widest possible extent.

Conditions of wetness cause additional uncertainty. According to tests carried out by CEN/TC 226 WG2, the repeatability (95 %) of the condition of wetness is approximately 5 mcd/m^2/lx for wet road markings with RL values up to 60 mcd/m-2/lx-1.

Procedure for the In-Situ Testing of Retroreflection using Handheld Devices

General

This procedure is recommended for the use of handheld equipment as described in the procedure BS EN 1436. Avoid moving the instrument whenever there are large temperature changes. If necessary, ensure that the instrument is effectively shielded from direct sunlight. For longitudinal lines, position the equipment so that its light source shines in the same direction as a vehicle's headlights would. Measurements on other road markings (such as symbols, letters etc.) should be taken, wherever appropriate, in the general direction from approaching vehicles. All markings to be measured should be free from dirt and completely dry. A suitable brush should be used to remove loose dirt and/or loose glass beads prior to testing. Safety must be given prime consideration during this type of operation. Constant attention must be given to the safety of the operator and of other road users.

Selection of the Test Area

Choose an area of marking which appears representative of the total area to be assessed.

Number of Readings

For continuous lines, take 15 readings over a 5 metre section minimum. If the marking is a centre line, take 15 readings with the equipment facing in each direction. For intermittent lines, take 5 readings per mark for 3 consecutive marks. Note readings should not be taken at the very beginning or end of the line. For markings wider than 150 mm, take readings down the central axis of the line but including some "off-centre" also. Take care to ensure that any such "off-centre" measurements are still made within the confines of the marking. For other markings, such as symbols, letters, transverse marking lines, reading should be taken at 5 approximately equidistant points on the surface of the marking. If a particular reading appears inconsistent another reading, that reading should be taken.

Recording and Interpretation of Results

A survey report for each location should be produced. Information to be included in the report should be as follows:

- Operator's name
- Equipment type and geometry
- Test procedure
- General location
- Length of site
- Location of measurement point
- Date and time of test
- Ambient temperature
- Type and dimensions of markings
- Condition of marking
- Pre-treatment of marking (washed, brushed etc.)
- Weather conditions at time of testing
- Road surface type

Calculate an average of all the readings for a particular area. Readings for individual marks should be "sub-totalled" before being combined.

Optional Measurement of Retroreflectivity in Condition of Wetness

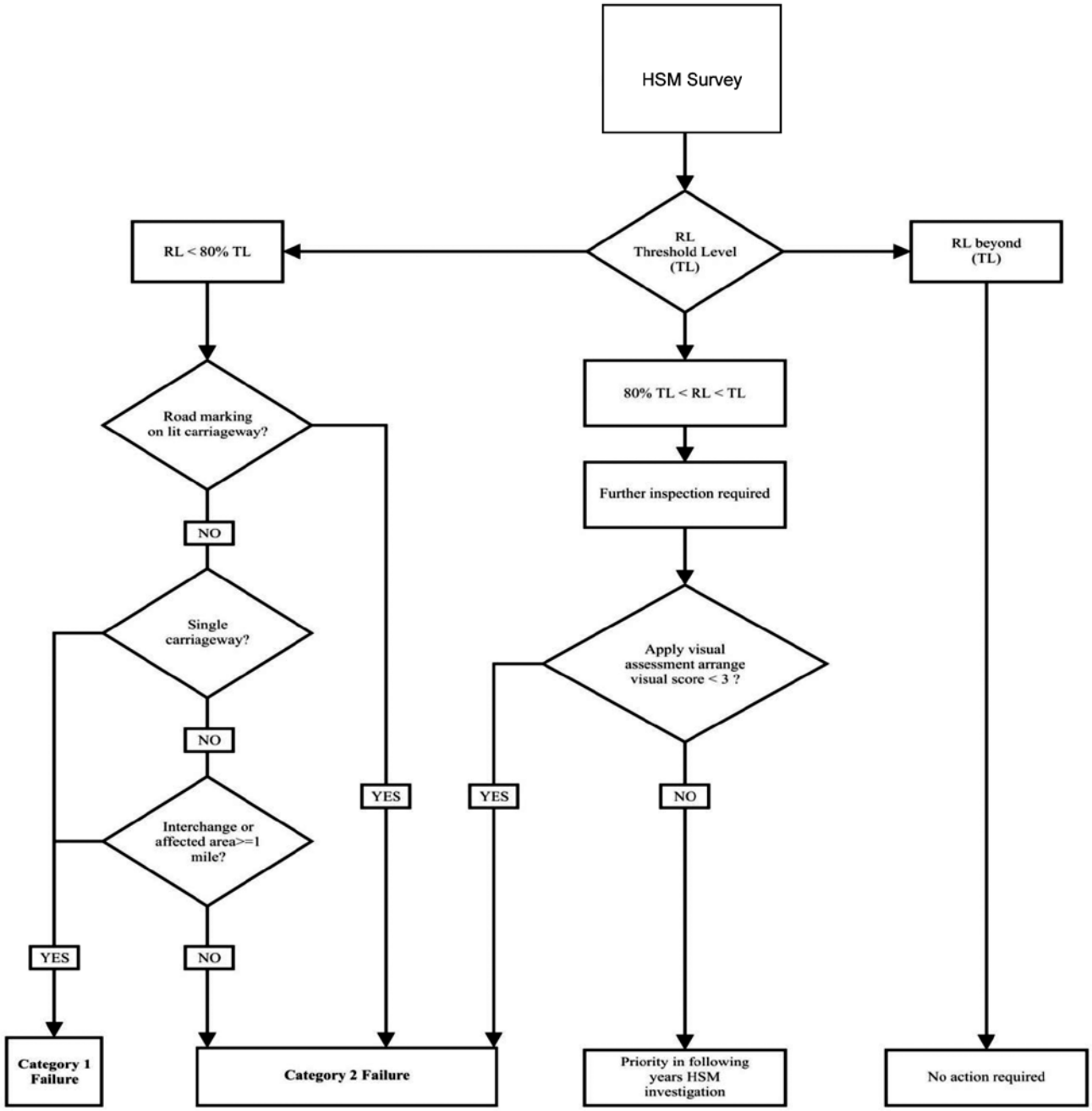
In addition to the measurement method for the retro reflectivity, RL, of dry markings, EN 1436 also includes inspection methods for "condition of wetness". The inspection method for "condition of wetness" is as follows:

The test condition is created using clean water poured from a bucket with an approximate capacity of 10 litres and from a height of approximately 0.5 m above the surface so that the measuring field and its surrounding area is momentarily flooded by a crest of water. The retro reflectivity shall be measured under the test condition one minute after the water has been poured.

ANNEXURE : F

(Refer Section 16 Under Para 16.2.2)

FLOW DIAGRAM FOR INSPECTION METHOD



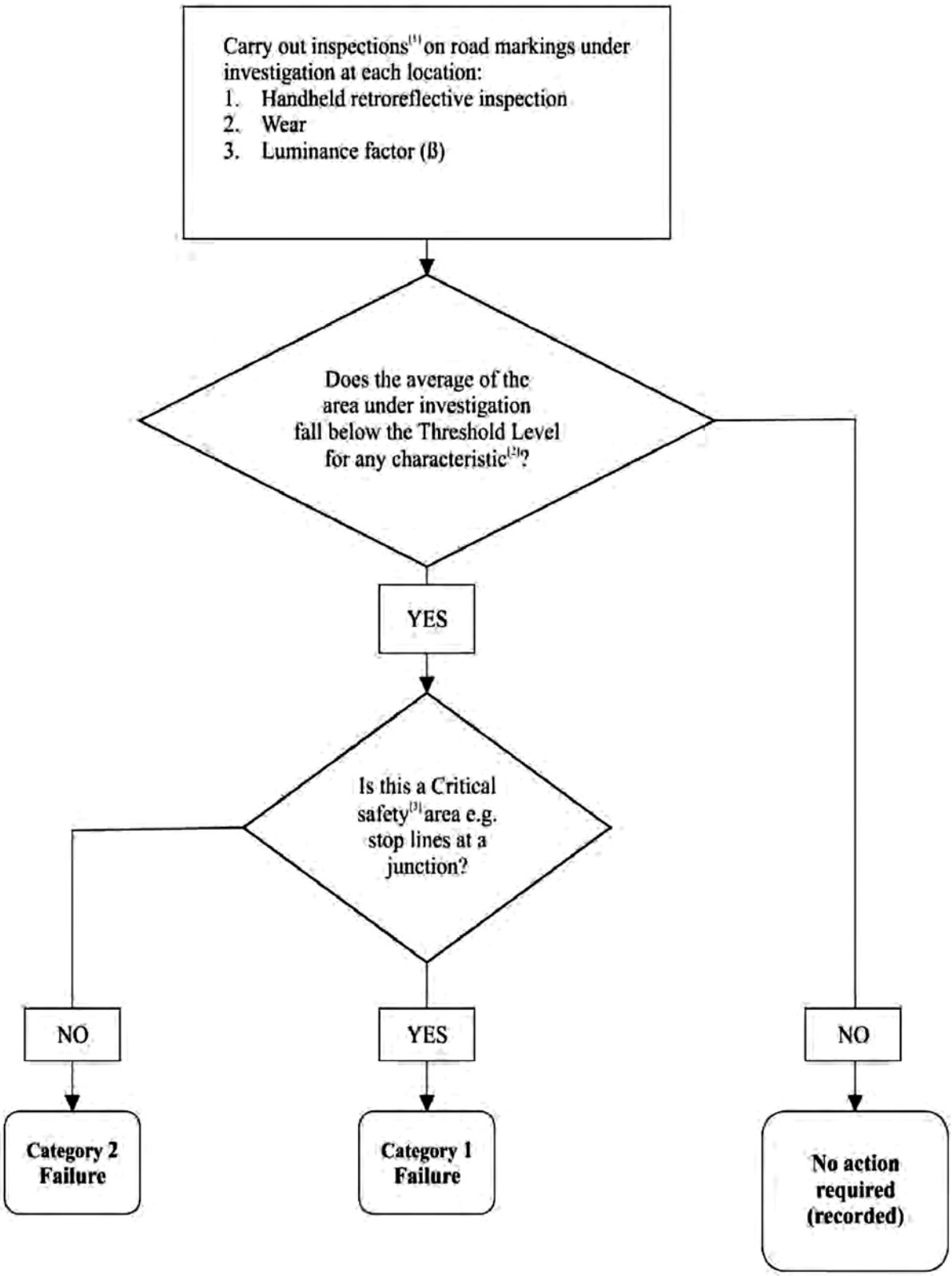
Flow Diagram A : Assessment of Longitudinal Road Markings

HSM – High Speed Monitor , RL – Dry Retro-reflectivity ,TL- Threshold level

Note

1 HSM results should be aggregated and reported over 100 m lengths.

2 The visual assessment system is detailed in **Appendix E** and should be applied to each road marking and aggregated over 100 m length.



Flow **Diagram B**: Assessment on areas not Accessible for Assessment by HSM

(For e.g.: Slide Road Junction, Exit Arrows etc.)

Note 1 Measurements of retro reflectivity shall be carried out as set out in **Appendix G**. Measurements for wear shall be carried out on 50 % of the road markings at each location or every 20 m for continuous road markings. Optionally, where “Wet Night” markings have been laid, markings may be assessed by the inspection method stated in **Appendix G**.

Note 2

Characteristic	Threshold Level	Method
Retro-reflectivity (RL)	80 mcd/m^2/ lux for design speed up to 60 kmph 120 mcd/m^2/ lux for design speed bet 65 -100 kmph 150 mcd/m^2/ lux for design speed above 100 kmph < 35 mcd/m^2/lux for optional “ wet night” assessment	
		BS EN 1436 & Appendix G
Wear	< 70 % of marking remaining	Visual assessment
Q_d	< 100 mcd/m^2/lux for asphalt road	
	< 130 mcd/m^2/lux for yellow cement road	BS EN 1436

Note 3 Critical areas of the network refer to those areas of the network that may pose a risk to the road user if badly worn.

ANNEXURE : G

(Refer Section 15 Under Para 15.6)

MEASURING METHOD FOR SKID RESISTANCE

Principle of the Test

The test equipment consists of a swinging pendulum fitted with a rubber slider at its free end. The energy loss caused by the friction of the slider over a specified length of the road surface is measured and the result is expressed as Skid Resistance Tester (SRT) units.

Note : The Skid Resistance Tester simulates the performance of a vehicle with patterned tyres braking with blocked wheels at 50 km/h on a wet road.

Description of the Skid Resistance Tester

The skid resistance tester consists of a base with three levelling screws, a vertical column with a 508 mm pendulum of 1.5 kg mass, with a spring loaded rubber slider mounted on the end, giving a constant force of 22.2 N on the test surface. On the column, control knobs permit the vertical movement of the suspension axis. The operator is provided with means for holding and releasing the pendulum arm so that it falls freely from a horizontal position. A 300 mm long pointer indicates the position of the pendulum throughout its forward swing and indicates the measured value on a circular scale. Two friction rings are used to bring the result to the zero of this scale for a completely free swing of the pendulum arm.

Maintenance of the Rubber Slider

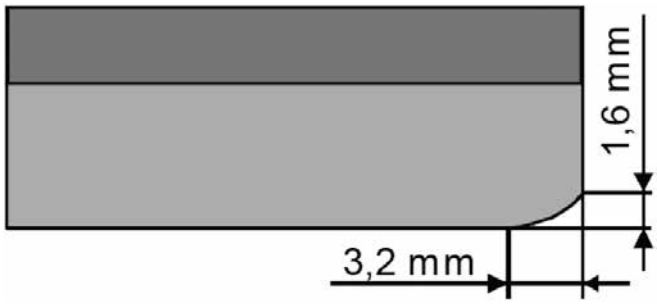
The rubber slider is of dimensions 76.2 mm, 25.4 mm and 6.3 mm and shall be made from rubber with the properties given in **Table A-G:1**.

Table A-G:1 Properties of the Rubber Slider

Temperature ºC	Resilience % Lupkea	Hardness IRDH[b]
0	43 to 49	55 ± 5
10	58 to 65	
20	66 to 73	
30	71 to 77	
40	74 to 79	

[a] Lupke rebound test in accordance with ISO 4622
[b] International Rubber Hardness Degree in accordance with ISO 48

The slider can only be used for one year after the date mentioned on its side face. One slider edge can be used for at least 100 settings (500 swings). The wear of the edge should not exceed 3.2 mm horizontal and 1.6 mm vertical as shown in Figure. All new sliders should be roughened by swinging 5 times on a dry surface and 25 times on a wet surface (after adjusting the sliding length to 125 mm to 127 mm).



Maximum Wear of the Rubbber Slider

Adjustment of the Sliding Length

Prior to measurement, the sliding length shall be adjusted as follows:

Ensure that the base of the apparatus is level, with the central column in front of the centre of the area under test. Raise the head so that the pendulum arm swings free of the surface and check the zero setting in this position. If necessary adjust the setting using the friction rings so that the pointer reading is zero. Check the sliding length (to be between 125 mm and 127 mm) by gently lowering the pendulum arm until it touches the surface on one side. Place the spacer so that the outer mark on the side corresponds with the contact line between the rubber and the surface. Raise the slider off the surface by means of the lifting handle, move it without friction to the other side and then gently lower onto the surface again. The contact line should be between the two marks on that side of the spacer. Adjust by raising or lowering the head. When the required height is obtained, lock the head and place the pendulum in its release position.

Measuring the SRT Value

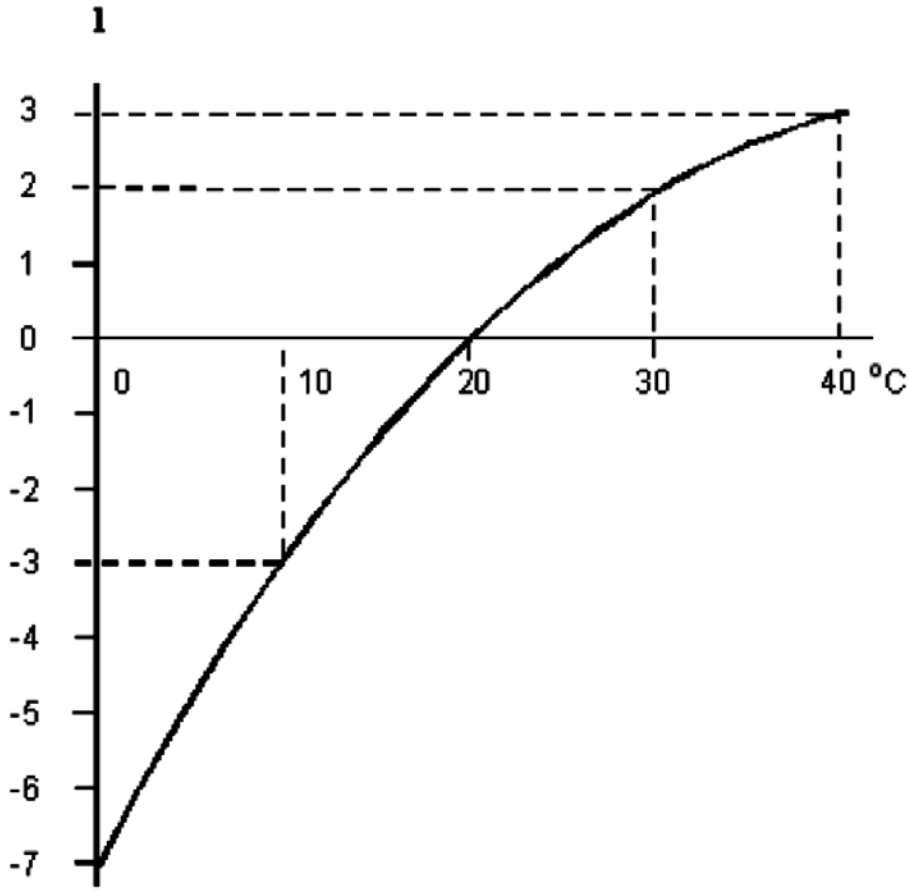
The SRT value shall be measured as follows:

The surface under test shall be cleaned with a smooth wet brush. Place the pendulum arm in its release position and the pointer in line with it. Wet the surface by applying 100 ml ± 20 ml of water on the contact area, release the arm immediately after applying the water and, after the maximum has been reached, catch the pendulum on its return swing with the left hand to avoid damage by striking the road surface. Read the position of the pointer. Replace the arm and the pointer in the release position. Repeat the same measurement five times. If the values obtained do not differ by more than 3 units, record the mean of the five readings as the SRT value. Otherwise, repeat the test until three successive readings are constant. Record the temperature of the water lying on the road just after the measurement.

Correction for the Temperature

The effect of temperature on rubber resilience exerts a perceptible influence in all skidding resistance measurements; it shows itself as a fall in skidding resistance as the temperature rises. In addition, the magnitude of the variation of skidding resistance with temperature varies considerably from road to road, because of the changes in road surface texture. As a

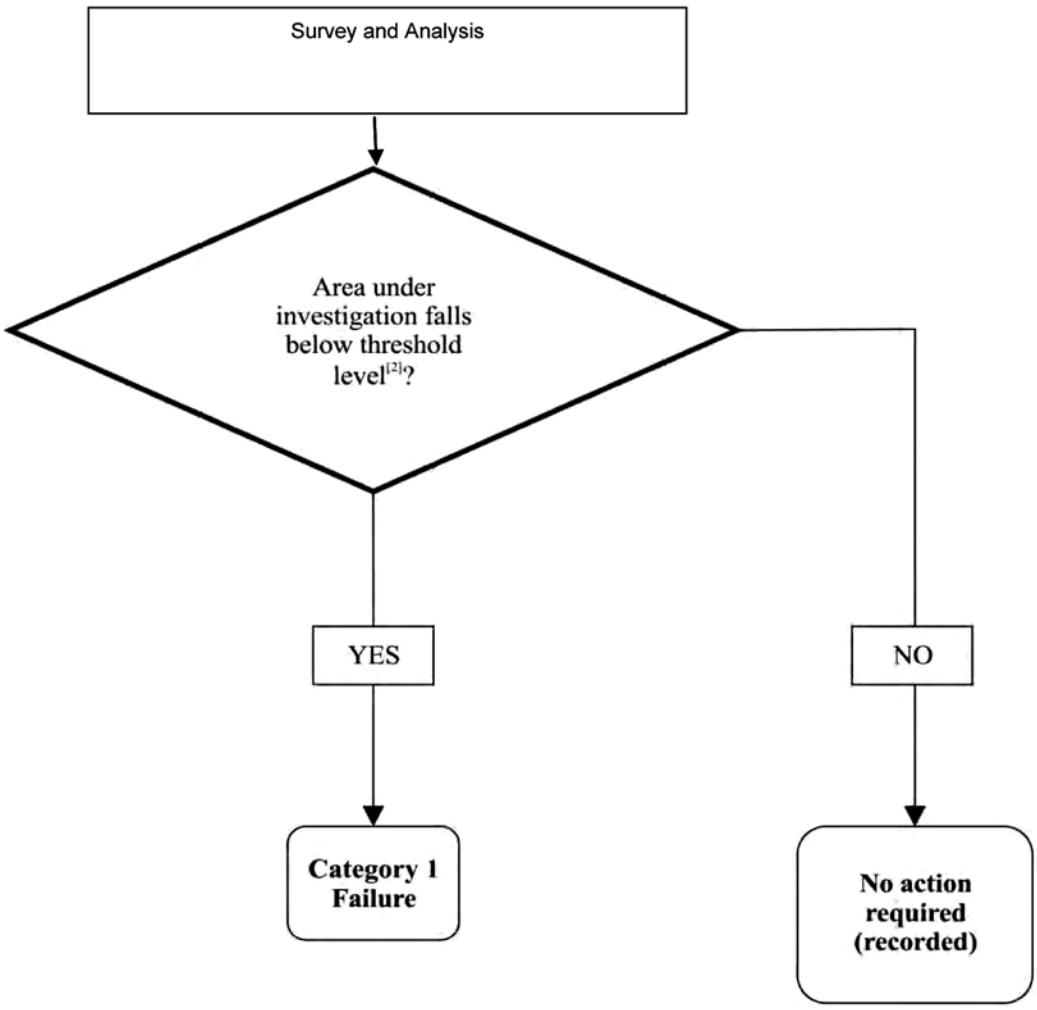
rough guide however, an average temperature correction evaluated for a range of surfaces is given in figure D2; thus it is apparent that a correction for the effect of the temperature only becomes important for tests made below 10ºC, and then its main use is to give a more accurate assessment of the skidding resistance which the road is likely to offer to the tyres of vehicles, since they are likely to be running at temperatures rather higher than that of the slider rubber on the portable tester.



Temperature Corrections for Skid Resistance Values to Allow for Changes in Resilience of the Slider Rubber

To assist in the interpretation of the results, the temperature of the water lying on the road immediately after test should be recorded. It should be stressed that the change in state of polish of road surfaces throughout the year is a much bigger factor determining changes in skid resistance than is the change in temperature; the latter accounts for about one-quarter of the total seasonal change in skid resistance, which is primarily due to real and reversible changes in the road surface. In order to have an idea of the influence of all variable parameters such as temperature, slider wear etc., both before and after a series of measurements, the skid measurement should be conducted with the same slider on one or more standard samples, the value of which has previously been determined in the laboratory at 20ºC.

Note : The trueness of a measurement cannot be established as the characteristic is defined by the Skid Resistance Tester itself and not by physical laws.



Flow Diagram C: Skid Resistance on Critical Areas

Note 1 : Critical areas of the network refer to those areas of the network that pose a risk to the road user through skidding or potential accidents:

i) GIVE WAY lines and/or STOP lines

ii) Large areas of paint, e.g. exit arrows to slips on the main line

iii) Transverse yellow bars

Area	Threshold Level (BPN - British Pendulum Number)	Method
Normal	< 45 BPN	
Large surface areas, e.g. letters, numbers or arrows	< 55 BPN	BS EN 1436
Transverse yellow bar markings	< 55 BPN	

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the code/guidelines/manual, etc. from the date specified therein)