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ACRONYMS AND DISAMBIGUATION

AADT	:	Annual Average Daily Traffic
ADB	:	Asian Development Bank
ASTM	:	American Society for Testing and Materials
BS	:	British Standard
CBD	:	Chief business district
DoLIDAR	:	Department of Local Infrastructure Development and Agricultural Roads
DoTM	:	Department of Transport Management
DoR	:	Department of Roads
FBC	:	Full Bright Consultancy
FHWA	:	US Federal Highway Administration
GIS	:	Geographical information system
GoN	:	Government of Nepal
IDA	:	International Development Association
IRI	:	International Roughness Index
JICA	:	Japan International Cooperation Agency
KEI	:	Katahira & Engineers International
km	:	kilometer
kph	:	kilometer per hour
LRN	:	Local Road Network
MLIT	:	Ministry of Land, Infrastructure, Transportation and Tourism (Japan)
MoCS	:	Ministry of Commerce and Supplies (Nepal)
MoPIT	:	Ministry of Physical Infrastructure and Transport (Nepal)
MVTMA	:	Motor Vehicle and Transport Management Act
MVTMR	:	Motor Vehicle and Transport Management Rule
NIRTTP	:	Nepal India Regional Trade and Transport Project
NRs.	:	Nepalese Rupees
ODA	:	Official Development Assistance
PCU	:	passenger car unit
PMS	:	Pavement Management System
RRPM	:	Raised Road Pavement Markers (road studs)
SRN	:	Strategic Road Network
STEP	:	Sub-regional Transport Enhancement Project (ADB assisted)
ToR	:	Terms of Reference
UK	:	United Kingdom
UN	:	United Nations
USA	:	United States of America
VOC	:	Vehicle Operating Cost
vph	:	vehicle per hour
WB	:	World Bank
WHO	:	World Health Organization

EXECUTIVE SUMMARY

Road traffic signs are the main means of delineating traffic regulation; guiding, warning and informing about impending dangers and situations. In order to consistently guide and convey the message to the road users, traffic signs have to be standardised and consistent with internationally recognised signs. With the passage of time, it therefore becomes necessary to update the existing sign standard to accommodate new traffic control devices and also maintain consistency with the internationally standardized signs (UN Convention on Road Signs and Signal- Vienna Convention and 2010 UN Consolidated Resolution on Road Sign and Signal).

The objective of this study was therefore to review and update the existing standard on road traffic signs and update it.

The methodology that was adopted for this study was a review of the existing sign standard (Traffic Sign Manual 1997 published by the Department of Roads, signs incorporated in the Motor Vehicle and Transport Management Regulation 1997), review the past practices that was in place for signage in Nepal and identification of new standardised signs that are necessary for inclusion in the updated traffic sign manual. Interaction with the stakeholders (Department of Transport Management, Department of Roads) were also conducted to gather information on any parallel study regarding traffic signage.

Chapter 2 summarise the purpose of standard road traffic signs, the type of signs that exists (regulatory signs; warning, signs; informatory signs; supplementary plates and road-markings) and discuss the basic principles for behind the development of a comprehensive list of signs that is consistent with accepted international norms (1968 UN World Convention on Road Signs and Signal- Vienna Convention and 2010 UN Consolidated Resolution on Road Sign and Signal). It is important that signage are visible, understandable and road users know what they mean and are motivated to behave correctly.

Chapter 3 discusses on the design, layout and positioning of different signs on the road.

Chapter 4 describes the size, installation, visibility requirement for regulatory signs; discuss on speed management and recommend new speed-limit to introduce in Nepal; describes traffic calming measures and lastly lists a new schedule of regulatory signs to be included in Nepal.

Chapter 5 describes warning signs dealing with their size, installation, placement and visibility requirement that must be maintained. Finally, a new schedule of warning signs to be included in Nepal is recommended.

Chapter 6 describes informatory signs that includes the signs that belong to the direction signs and other informatory signs. The font size, colour codes that should be adopted for direction signs is presented. Within the direction sign category, new font style Preeti is recommended for the Nepali texts and UK Transport Medium and UK Transport Heavy is recommended for the English texts. A more comprehensive text size that are conducive for the design speed applicable for the road where the informatory sign is installed is also recommended. Finally a new schedule of informatory signs is included in this chapter.

Chapter 7 describes supplementary plates and traffic signals including the text size, font style for the message to adopt. A new font style, Preeti and UK Transport Heavy have been recommended for the Nepali and English text to use in the supplementary plates. Finally a new schedule of supplementary plates is recommended for Nepal. This chapter also discusses about traffic signals dealing with their installation, basic means of control; pedestrian signal (pelican) including their basic phasing arrangement and installation. Finally the existing schedule of signals been recommended to be maintained.

Chapter 8 discusses on signage at construction work zone covering with the planning that is required, the basic signs necessary at such zones and presents two generic signage arrangement at work-zones.

Chapter 9 describes road-marking starting their purpose and ending with a new recommended schedule of road-marking.

Chapter 10 pertains to specification for manufacturing signs; standard of construction for signs including colour coding; reflectorization of signs; brief outline of the material specification for traffic signals; specification for the frame supports and fittings for signs and material specification for road-marking and road-studs.

Chapter 11 describes the specification for installation of sign-posts, application of road-markings and installation of road-studs.

Chapter 12 covers maintenance of signs and their monitoring. It describes about the maintenance schedule to maintain, storage of signs and brief discussion on maintenance of road-studs.

A review of the existing standard of signs were conducted and an updated schedule of signs compatible with the international standard were presented. The review found that all of the existing signs included in the Traffic Sign Manual 1997 published by Department of Roads are still necessary and have been included in the new schedule of signs along with new signs that has been added. It is recommended that these updated signs are incorporated in the amendment of the Motor Vehicle Transport Regulation 1997. Similarly, it is recommended that the Department of Transport Management regularly review and updated these sign standards in the future as well.

मुख्य-संक्षेप

सडकमा सडक प्रयोगकर्ताहरुलाई अगाडी देखिने र हुन सक्ने खतराजन्य अवस्थाहरुको बारे सचेत गराउन, सुचना दिन, सडक (ट्राफिक) नियमलाई लागु गराउन, सडकमा सवारीहरुको आगमनलाई निर्देशित राख्न सडक (ट्राफिक) संकेतहरुको महत्वपूर्ण भूमिका हुन्छ । सडक प्रयोगकर्ताहरुलाई सही तवरले, समान रुपले निर्देशित राख्न र साथसाथै अन्तराष्ट्रिय स्तर अनुरुपमा स्थापित मापदण्ड संग पनि समानजस्यता हुने ट्राफिक संकेतहरु लागु गर्न पनि आवश्यक हुन्छ । यस कारण हाल प्रचलित संकेतहरुलाई प्रयोगमा आउने र देखिएको ट्राफिक नियन्त्रण उपकरणहरुसंग पनि मिल्दोजुल्दो र विश्वव्यापी रुपमा प्रचलित संकेतहरुसंग मिल्दो बनाउन आवश्यक हुन्छ ।

यस अध्ययनको उद्देश्य हाल प्रचलनमा आएको संकेतहरुको विश्लेषण गरी अध्यावधिक गर्ने रहेको छ ।

यस अध्ययनको अध्ययन विधीमा हाल प्रचलित ट्राफिक संकेतहरु (सन् १९९७ मा सडक विभागद्वारा प्रकाशित ट्राफिक संकेत निर्देशिका अथवा मान्यूल, सवारी तथा यातायात व्यवस्था नियमावली २०५४) को पुनर्वालोकन, विगतमा यस सम्बन्धमा अपनाइएका विधीहरुको पुर्नवालोकन गरिएको थियो । साथै अबको अध्यावधिक ट्राफिक संकेत निर्देशिका तयार गर्दा समावेश गर्न पर्ने अन्तराष्टिय मापदण्ड अनुरुपका थप नयाँ ट्राफिक संकेतहरु पहिचान गरिएको थियो । अध्ययनको क्रममा सम्बन्धित सरोकारवालाहरु (यातायात व्यवस्था विभाग, सडक विभाग)संग पनि छलफल गरिएको थियो ।

यस अध्ययनको अध्याय २ मा सडक ट्राफिक संकेतहरुको उपयोगिता, आवश्यकता, प्रकार बारे वर्णन (प्रतिबन्धात्मक संकेत चिन्ह, चेतनामूलक संकेत चिन्ह, सूचनामूलक संकेत चिन्ह, अन्य संकेत र सडक रेखांकन चिन्हहरु) र विश्वव्यापी रुपमा प्रचलित मापदण्ड अनुरुपको ट्राफिक संकेतहरुको विस्तृत सूची तयार गर्ने बारे बर्णन गरिएको छ । सडकमा प्रयोग हुने ट्राफिक संकेतहरु स्पष्ट देखिने, सजिलै बुझ्किने र संकेतहरुले निर्देश गरेको सुचना अनुरुप सडक प्रयोगकर्ताहरुलाई प्रेरित गर्ने खालको हुनु आवश्यक छ ।

अध्याय ३ मा विभिन्न ट्राफिक संकेतहरुको डिजाईन, बनाउट, आकार तथा संकेत राखिने स्थानहरुको बारेमा उल्लेख गरिएको छ ।

अध्याय ४ मा प्रतिबन्धात्मक संकेत चिन्हहरुको साइज र तिनलाई राख्दा टाढांबाट देख्न गरी कायम गर्न पर्ने न्यनतम दूरी (visibility requirement) बारेमा उल्लेख गरिएको छ । साथै नेपालका सडकहरुमा प्रयोगमा ल्याउन सकिने नयाँ गति सिमाहरुको वारेमा पनि उल्लेख गरिएको छ । यसै अध्ययनमा सडकमा गुड्ने सवारीहरुको गतीलाई स्वतस्फुर्त रुपमा नियन्त्रण गर्न सकिने संरचनाहरु ९तचबाष्अ अबष्लन ऊभबकगचभक० बारेमा र अन्तमा प्रतिबन्धात्मक ट्राफिक संकेतहरुको नयाँ अद्यावधिक सूची समावेश गरिएको छ ।

अध्याय ५ मा चेतनानामूलक ट्राफिक संकेतहरुको साइज, तिनलाई राख्दा टाढांबाट देख्न गरी कायम गर्न पर्ने न्यनतम दूरी बारेमा उल्लेख गरिएको छ । साथै चेतनामूलक ट्राफिक संकेतहरुको नयाँ अद्यावधिक सूची पनि यस अध्यायमा समावेश गरिएको छ ।

अध्याय ६ मा सूचनामूलक ट्राफिक संकेतहरु जसमा दिशाका संकेत र अन्य सूचनामुलक संकेतहरु पर्दछ त्यस बारेमा वर्णन गरिएको छ । यी संकेतहरुमा प्रयोग गरिन पर्ने अक्षरका साइज, लिपी (fonts) र रङ्गका बारेमा पनि जानकारी दिइएको छ । यी संकेत चिन्हको परिवार अन्तर्गत पर्ने दिशाका संकेतहरुमा लेखिने नेपाली

अक्षरलाई विगतको लिपी अलवा ँप्रिती' लिपीलाई र अंग्रेजी अक्षरको लागी UK Transport Medium र UK Transport ज्भबखथ लिपी उपयोग गर्न सिफारिश गरिएको छ । सूचनामूलक ट्राफिक संकेतहरुहरुलाई जडान गरिने सडकको डिजाइन गतीज्ञ का आधारमा त्यस्ता संकेतहरुमा राखिने अक्षरहरु निश्चित साइज बारे पनि यस अध्यायमा नौलौ प्रस्तुत गरिएको छ । अन्तमा प्रयोगमा ल्याउन सूचनामूलक ट्राफिक संकेतहरुको नयाँ अद्यावधिक सूची पनि समावेश गरिएको छ ।

अध्याय ७ मा अतिरिक्त संकेत प्लेटहरु ९क्गाउउभिभलतबचथ एवितभक० र ट्राफिक बत्तीहरुको बारेमा उल्लेख गरिएको छ । अतिरिक्त संकेत प्लेटहरुमा प्रयोग गरिने नेपाली अक्षरको लागी `प्रिती' लिपी र अंग्रेजी अक्षरको लागी UK Transport Heavy लिपी प्रस्ताव गरिएको छ । साथै अतिरिक्त संकेत प्लेटकरुको नयाँ अद्यावधिक सूची पनि सिफारिश गरिएको छ । अध्यायमा ट्राफिक बत्तीहरुको जडान बारे, पैदलयात्रीहरुलाई सडकको बिचमा राखिने पैदलमूलक ट्राफिक बत्तीहरु (Pelican or Pedestrian Mid-Block Signal) साधारणतया हुने फेजिङ्ग (Phasing) व्यवस्था, जडान र व्यवस्था को बारेमा वर्णन गरिएको छ । अन्तमा अतिरिक्त संकेत प्लेटहरुको नयाँ अत्यावधिक सूची प्रस्ताव गरिएको छ ।

अध्याय ८ मा सडकहरुको निर्माण स्थानहरुमा रेखाङ्कन व्यवस्थापन (Construction Work-Zone Signage) , तिनको योजना, आदी, बारे वर्णन गरिएको छ । साथै यस्ता निर्माणस्थलको लागी साधारतया प्रयोग गरिन सकिन् दूइटा उदाहरणमा समावेश गरिएको छ ।

अध्याय ९ मा सडक सतहमा लेखिने रेखाङ्कन संकेत बारेमा उल्लेख गरिएको छ र यस्ता रेखाङ्कन संकेतको लागी नयाँ प्रयोग गर्न सकिने नयाँ अत्यावधिक सूची प्रस्तावित गरिएको छ ।

अध्याय १० मा सडक संकेतहरु बनाउदा उपयोग गर्नु पर्ने स्पेसिफिकेसन, मापदण्ड, रङ्ग, तिनलाई टल्काउन ९चभाभिअतयचष्शबतष्यल०, आदि, को बारेमा विस्तृत रुपमा उल्लेख गरिएको छ । साथै संकेतहरु निर्माणमा प्रयोग हुने सामग्रीहरुको मापदण्डको बारेमा पनि उल्लेख गरिएको छ ।

अध्याय ११ मा अन्य ट्राफिक संकेत तथा सडक सतहमा लेखिने रेखाङ्कन को स्पेसिफिकेसन समावेश गरिएको छ ।

अध्याय १२ मा ट्राफिक संकेतहरुको संभार तथा व्यवस्थापनका बारेमा उल्लेख गरिएको छ । यसमा मर्मत संभारको सन्दर्भमा पालना गर्न पर्ने कार्यतालिका, संकेत चिन्हहरुको भण्डारण एवं विशेष प्रकारका टल्किने रेखाङ्कन अथवा रोड स्टड ९चयबम कतगम० को मर्मत बारे पनि बर्णन गरिएको छ ।

यस अध्ययन प्रतिवेदनमा हाल प्रचलित ट्राफिक संकेतहरुको अध्ययन गरी यस्ता संकेतहरुलाई विश्वव्यापी स्तरसंग मिल्ने गरी अध्यावधिक गरी पेश गरिएको छ । पुनवालोकनको सिलसिलामा सडक विभागबाट प्रकाशित ट्राफिक संकेत म्यानुअल १९९७ मा उल्लेख भएका सबै सडक संकेतहरुलाई यथावत रुपमा समावेश गरी

[१] सडक डिजाइन गर्दा निर्देशित सडकको लागी कायम भएको मापदण्ड अनुरुप सडकको स्वरुप र स्तर अनुरुप कुनै डिजाइन गती (design speed) लाई आधार मानी तयार गरिएको हुन्छ । डिजाइन गतीले सडकको ज्यामिती, स्तरलाई निर्धारण गर्दछ ।

नयाँ संकेतहरु पनि समावेश गरिएको छ । सवारी तथा यातायात व्यवस्था नियमावली २०५४ को सशोधन पनि भैरहेको हुँदा यी सम्पूर्ण अत्यावधिक ट्राफिक संकेत चिन्हहरुलाई उपरोक्त संशोधित नियमावलीमा समावेश गर्न प्रस्ताव गरिएको छ । साथै यातायात व्यवस्था विभागले समयानुकुल रुपमा ट्राफिक संकेतहरुलाई नियमित रुपमा अध्यावधिक गर्दै लैजान पनि प्रस्ताव गरिएको छ ।

CHAPTER 1 INTRODUCTION

1.1 RATIONALE OF STANDARD ROAD TRAFFIC SIGN

Road traffic signs are the main means of delineating traffic regulations; guiding, warning road users of impending situations, restrictions or information on the road. The term 'traffic sign therefore includes not only signs but also road markings, delineators, road studs, traffic light signals and other traffic control devices.

In order to consistently guide road users to behave or to convey the message correctly, it is very important to develop road traffic sign standards (sign standard referred here includes road marking as well). With the passage of time, it also becomes necessary to update these standards to designate new traffic control devices and to make them consistent with the internationally standardized signs and road markings. In this context, the signs should be consistent with the UN mandated conventions (1968 UN Convention on Road Signs and Signal- Vienna Convention and 2010 UN Consolidated Resolution on Road Sign and Signal).

1.2 CONTENT OF THIS DOCUMENT

A substantial portion of the details provided in the DoR Traffic Sign Manual 1997 (TSM 1997) has been reproduced in this document. Moreover, additional signs have been included based on assessment and feedback from experts and stakeholders.

1.3 LEGAL BASIS AND CHANGES REQUIRED

As per Motor Vehicle and Transport Management Act 2049 (1993) or MVTMA 1993, the Department of Transport Management (DoTM) is mandated to install necessary traffic signs of symbols, colour, size and model conforming to international practice. Road users legally need to drive or abide by the traffic signs.

This updated Traffic Signs Manual will be incorporated as part of the amended Motor Vehicle and Transport Management Regulation to provide a legal basis for enforcement. It has also provided a code of practice for DoTM, designers, manufacturers and contractors to ensure a consistent approach to signage throughout Nepal for better understanding and recognition of signs.

1.4 DOTM'S PRACTICES FOR STANDARD ROAD TRAFFIC SIGN

1.4.1 Past Practices

A schedule of standard road traffic signs are included in the Motor Vehicle and Transport Management Regulation 2055 (1997) or MVTMR 1997. This schedule includes regulatory, warning and informatory signs that apply on the roads but does not include road marking.

While Motor Vehicle and Transport Management Act 2049 (1993) has solely authorized DoTM to install traffic signs, it has not installed any signs in the road network of Nepal on its own to date but has recently fabricated signs to traffic police for installation upon the later demand. Amongst the road agencies, only DoR has substantially installed and maintained traffic signs and road marking along the strategic roads using the power delegated from DoTM allowed in MVMTA 1993. Installation of signs in the local road network under DoLIDAR is virtually non-existent.

Signage and road marking is inadequate and provisioned on ad-hoc basis (e.g. number of signs per km) even in the strategic roads and this inadequacy can only be identified if a road safety audit is conducted on the road concerned. These delineation measures which are of utmost important and first line of defense against road hazards or critical points along the road network receive low priority.

1.4.2 Current Status

Currently, the status quo regarding road traffic signs and road marking has not changed but DoTM has recently provided signs to traffic police for installation upon the later's demand. Within the main roads in Kathmandu Valley and strategic roads, delineation have received more attention and there are numerous NGOs, private organizations, business houses that sponsor installation of signs in Kathmandu through advertisement schemes. However, uniformity in the signs, their placement or education for road users on sign is lacking.

CHAPTER 2 PURPOSES OF STANDARD ROAD TRAFFIC SIGNS

2.1 TYPES OF SIGNS

As discussed previously, the road traffic signs serve one of the three purposes.

i. Regulatory: To regulate road users to mandatorily follow certain rules or restrictions (no parking, no stopping and parking, speed limit, no entry, no overtaking, no left-turns, etc.).

ii. Warning: To warn road users of impending situations (presence of intersections, sharp bends, bridges, crossings, pedestrian movements, steep vertical drops, etc.)

iii. Informatory: To inform of destination and facilities (zebra-crossing, directions, bus-stops, taxi-stand, bus laybys, etc.)

iv. Supplementary: To indicate what the restriction or warning applies to and are attached to either in the primary regulatory or warning sign but never on their own.

v. Road-marking: Are marking painted over the pavement to regulate, warn and inform road users and clarify, complement the message in the sign-posts.

2.2 PERSPECTIVE USERS

As the responsible agency for installing and maintaining traffic signs, this document will be useful literature for DoTM to follow. Road agencies such as DoR, DoLIDAR municipalities, VDCs, DoLIDAR will also find this document a useful resource in planning, designing and installing traffic signs and road-markings throughout the country. Traffic police will find this document useful in interpreting the rules that apply according to the signs installed or marked. Correlation of the signs with vehicle or road-user involved in a road crash can lead to useful clues regarding the cause in context to crash analysis and countermeasure determination.

2.3 BASIC PRINCIPLE FOR SIGNS, DEVELOPMENT OF COMPREHENSIVE LIST

2.3.1 Developing a Comprehensive List of Signs

Clear and efficient signing is essential in the road network for proper traffic movement and regulation. A poorly signed road or a road with poor sign maintenance will have adversely affect traffic safety and rules compliance along the road. Road users depend on signs for information and guidance and road authorities depend on signing for the efficient working of their road network in terms of enforcement of traffic regulations, traffic control and to assist in traffic safety.

Signs must convey their message clearly, quickly and lucidly to the road users in an unambiguous manner. Therefore, using standard signs assists in their quick recognition owing to consistency in the shape, colour and lettering for each type of signs for specific purpose. For maximum benefits, there should be uniformity of signs as well as uniformity in their use, siting and illumination.

Signs should only be used where they can usefully guide, control traffic and promote road safety. A balance must be achieved between too many and too few signs. For example, the incorrect or unnecessary use of a sign frequently annoys drivers and prompt him/her to lose respect for the sign. This type of attitude from the road users will in time render the sign ineffective in situations where it is really needed. For the same reason, one should avoid installing signs which impose a restriction that will be very unpopular and difficult to enforce. Drivers will stop taking signs seriously when they see others ignoring them without being caught. Signs are only effective if they satisfy the following criteria.

- They are visible and legible
- They are understandable
- The road users know what they mean and
- The road users are motivated to behave correctly

Items 1) depend on the correct siting and maintenance of signs; item 2) requires the design of the signs and symbols to be as self-explanatory as possible; items 3) and 4) depend on effective education and enforcement, which, is outside the scope of this Manual. Other basic requirements for road traffic signs are as follows.

- *Have a well-designed message:* Message in the sign should be displayed in a simple way to be easily understandable. A picture or symbol which is more effective than words, easily understood by the users who are illiterate should be adopted as far as possible. Worded signs should only be used when there is no alternative.
- *Is noticeable*: Signs must have sufficient impact to be noticed by drivers which should be taken into account in its design. Signs should be sited where the background will not distract the eye from the sign.
- *Is appropriately sized and sited:* The size and siting of the sign is also relevant and there are several sizes recommended for most of the signs. Identifying the right size is based on the speed of the traffic at the site. This means that the symbols and lettering need to be large enough to enable drivers to read it at the required distance.
- *Is easy to read:* The symbols and legends on signs must be easy to read and is taken into account in the design of the symbols, lettering, lettering spacing, colours, etc.

- *Are clearly visible at night:* It is not sufficient to rely on illumination by vehicle headlights and it is strongly preferred that signs are reflective either wholly or in part.

- *Be durably constructed and installed:* Traffic signs should be constructed and installed so as to last for many years without any attention apart from occasional cleaning.

2.4 DEVELOPING A COMPREHENSIVE LIST OF SIGNS

The existing schedule of signs in MVTMR 1997 does not include many signs that is deemed necessary nor does it include new signs that designate emerging urban environment (e.g. pedestrianized zones, shared zones, transit malls, cycle lanes, etc.) or traffic control devices (traffic calming devices such as road humps, chicanes, built-outs, gateways, rumble strips, gantry sign-board, etc.). Many of the signs included in the Traffic Sign Manual 1997 published by DoR are not listed in MVTMR 1997 but been installed in various locations in Nepal. Therefore, this manual has reviewed the various signs that are in use globally and included new ones deemed relevant to Nepalese conditions currently and into the near future.

2.5 COMPATIBILITY WITH INTERNATIONALLY STANDARDIZED SIGNS

All the signs included in this manual conform to the 1968 UN World Convention on Road Signs and Signal (the Vienna Convention) including most part of the 2010 UN Consolidated Resolution on Road Signs and Signal. For practicality, where there are more than two versions of the same sign, the one adopted in India is adopted with some exception. The Indian standards for signs also conform to the Vienna Convention.

CHAPTER 3 DESIGN AND USE OF STANDARD SIGNS

3.1 CHOOSING THE APPROPRIATE SIZE FOR SIGNS

To simplify the design of the regulatory and warning signs in this manual, the size of the signs is specified corresponding to the traffic and road environment on which they are erected. If additional impact is necessary, it may be necessary in certain circumstances to use a larger size of the sign than the road warrants. For example, a larger sized sign will be required at the end of a road section where vehicle speeds have not been reduced by either the road surface condition or where investigation shows that drivers have been ignoring a sign leading to crashes. The size of the informatory signs and supplementary plates depends on the height of the Nepali and English lettering used on the sign and the words involved.

3.2 POSITIONING OF SIGNS AND SITING

3.2.1 General Aspect of Positioning the Signs

When positioning signs, the following three aspects are to be considered.

- its siting in relation to the intersection, hazard, etc., that it refers to;
- its position in relation to the edge of the carriageway;
- the height of the sign plate and its angle to the road.

Any special requirements for a specific sign is given in the relevant traffic sign diagram. The recommended position for a sign in this manual should be used as a guide only since the precise positioning can only be confirmed at the site itself owing to site constraints, especially in urban area.

While positioning the sign-posts, one must always check that (i) the signs are clearly visible; (ii) there is no confusion which road the sign refer to; (iii) the signs do not obstruct the view of drivers and (iv) there is adequate lateral clearance to the signs to avoid being struck by vehicles. If necessary, the siting or mounting can be altered to overcome the problem.

3.2.2 Clearance, Placement of Two Signs on Same Post, Angle of Placement

One must ensure that all the part of the signs have a lateral clearance of at least 600 mm from the outer edge of the shoulder, carriageway (see Figure 3.1) or traffic island to prevent vehicles hitting the signs and avoid placing the signs at places where vehicles stop or park on the shoulder.

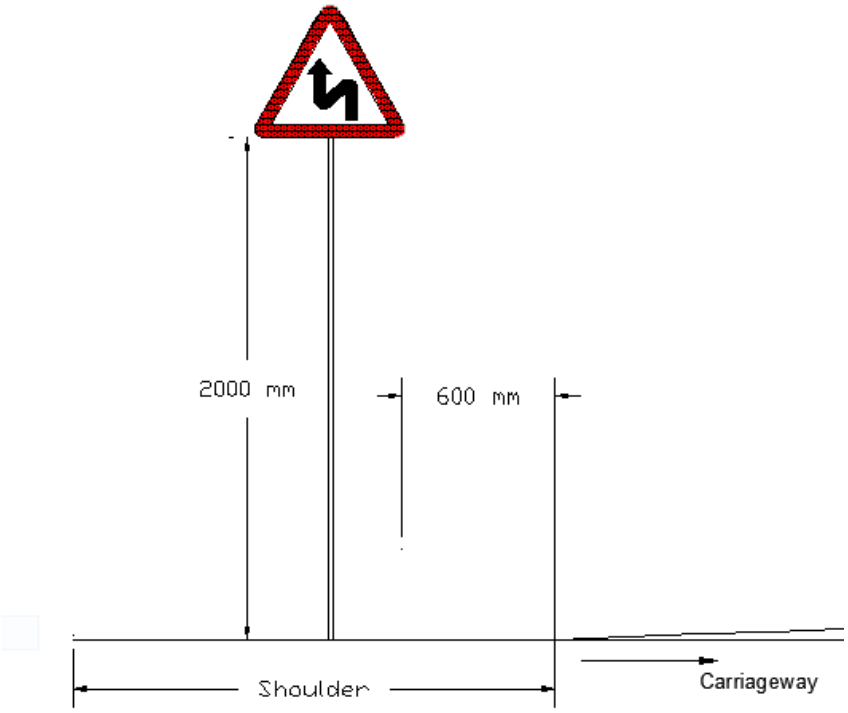


Figure 3.1 Minimum Lateral Clearance for Signs

Similarly, there should be a vertical clearance of 2 m between the lower edge of the sign-post to the carriageway level or footpath (in case of urban areas) to discourage vandalism and tendency to paste posters defacing the sign plate. However, temporary signs can be mounted on a frame keeping the sign at least 300 mm from the ground.

When placing two warning signs on the same post, one should place the sign that relates to the nearest hazard at the top. The sign plates should normally be aligned accordingly to face the driver. On unlit roads the plate should be slightly angled away from the road to avoid mirror reflection when illuminated by vehicle headlights as shown in Figure 3.2.

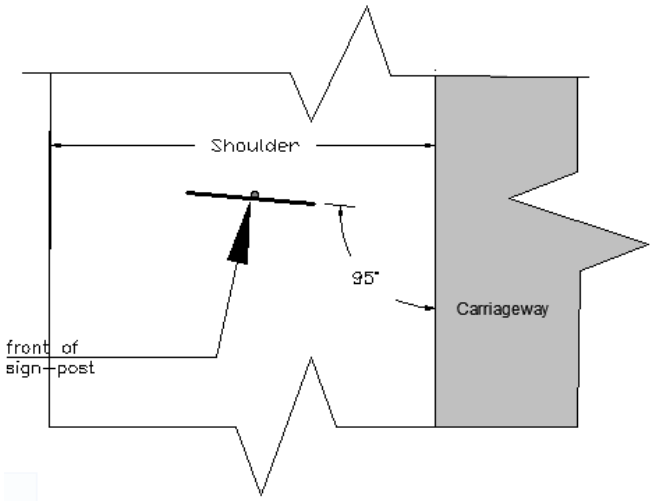


Figure 3.2 Top View of the Sign Plate Showing Placement

3.2.3 Siting the Signs

The message in the sign has to be conveyed to the driver at the right time, neither too late for the driver to take action, nor too soon that he has forgotten it by the time he has to act on it.

Signs should generally be sited on the left-hand side of the road as left-hand driving rules are applicable in Nepal. But it may be better to put the sign on the right-hand side of the road or both sides in certain cases to improve visibility or emphasize the restriction that applies (e.g. sharp bends, no entry, etc.).

Regulatory signs are normally sited at or near the point where the instruction applies. Each sign is designed to be read from a certain distance (visibility distance), which is determined by the road designation. The sign must be sited where there is visibility to see it from this distance. The minimum visibility distances are specified in the respective section of the manual on each sign group.

Most warning signs and some direction signs are sited in advance of the hazard or intersection that they relate in order to allow drivers enough time to take appropriate maneuvers (e.g. slow down) or evasive action. This advance distance depends on the road designation as it also relates to the speed limit that is applicable for specific hierarchy of road. This advance distance (stopping sight distance) is indicated in the section pertaining to each sign group. If owing to site constraint, signs have to be sited at a distance closer or further from their standard position, a supplementary plate is used to indicate the actual distance to the intersection or hazard. However, it is safer to increase rather than shorten the distance between a sign and the intersection or hazard concerned.

CHAPTER 4 REGULATORY ROAD TRAFFIC SIGNS

4.1 PURPOSE AND USE

Most regulatory signs mainly enforce traffic regulation or control traffic and are either mandatory or prohibitory. The prohibitory types impose restrictions such as speed-limit, load-limit, no turning, no parking, etc., and most are circular with red border. The mandatory types instruct drivers to follow certain rules before proceeding (e.g. Stop, Give Way, etc.). Most other mandatory signs such as the Keep Left sign are circular with a white symbol and border on a blue background.

Regulatory signs must only be used where it is essential to control traffic based on safety or efficiency consideration. Drivers will take more notice of them if they can see why they are needed. Advance warning signs for regulatory requirements are sometimes required but these signs themselves do not qualify as regulatory signs.

4.2 SIZES AND INSTALLATION

The size of the regulatory signs depend on the designation of the road on which they were erected and will generally be as shown in Table 4.1.

Table 4.1 Size of Regulatory Signs

Road Designation/Specific Regulatory Signs	Diameter of the Sign (mm)
National highways, feeder roads, other rural roads	600
For additional impact on national highways, feeder roads and other rural roads	750
Town and urban roads	600
Town and urban roads where space is limited	450
Signs attached to traffic signal columns	300
Stop signs, Go signs and Give Way signs	750 (600 mm in urban areas)

4.3 PLACEMENT, VISIBILITY REQUIRED

Regulatory signs are normally sited at or near the point where the instruction applies and should be aligned in such a way that there is no confusion about which road they refer to. Drivers must be able to see the sign in advance from at least 75 m and 60 m on the national highways and other roads, respectively, so that they have time to read the message and act on it. Regulatory signs are placed at the left-hand side of the road but a second sign on the right-hand side may be used where extra impact is needed.

4.4 SPEED MANAGEMENT AND SPEED LIMIT SIGNS

4.4.1 Speed Management

Speed management is an important element to improve road safety as speed significantly influences the severity of road crashes (i.e. fatalities, serious injuries). For example, crash risk doubles when the speed increases by 5 kph and 10 kph above the safe speed in the urban and rural roads, respectively. On the other hand, the reduction in the severity of crash from speed reduction is significant. Table 4.2 illustrates the impact of speed control on the crash severity and damages based on research conducted in the United States.

Table 4.2 Impact of Speed on Crash Severity

Change in:	Change in Mean Speed					
	Speed Reduction			Speed Increase		
	-10%	-5%	-1%	+1%	+5%	+10%
Fatalities	-38%	-21%	-4%	+5%	+25%	+54%
Serious injuries	-27%	-14%	-3%	+3%	+16%	+33%
Other injuries	-15%	-7%	-1%	+2%	+8%	+15%
Property damage crashes	-10%	-5%	-1%	+1%	+5%	+10%

Source: Traffic Safety; L. Evans; Science Serving Society, Bloomfield Hills, Michigan, USA; 2004

Traditionally, speed limit over a road was based on adoption of the 85th percentile speed (i.e. the speed at or below which 85% of the drivers travel when they have full freedom to choose their speed i.e. free-flow conditions). However, over the years with considerable research and emphasis to safe speed, many countries no longer use the 85th percentile speed as the key factor to determine the speed limit. Therefore, the state-of-the-art practice recommends establishing or refining the speed limit on a road based on (i) crash history; (ii) current operating performance and (iii) road and roadside geometry.

Amongst the above factors, the crash- history is the most important parameter which influences the choice of speed limit. In this context, the crash-rate (number of crashes per 100 million VKT2) is usually referred, but this parameter is difficult to ascertain in Nepal as statistics on the VKT is not usually available. The road and roadside geometry such as the road alignment (straight, curved, steep, terrain), cross-section (divided/undivided carriageway, exclusive right-

[2] VKT= vehicle km travel

turn lanes, number of lanes, lane width, presence of cycle or bus lanes, shoulder type, etc.) all influence the choice of the speed-limit. Similarly, operating environment such as land use (residential precinct, commercial districts, shared zone, etc.) and traffic pattern (volume, composition, presence of significant pedestrians, cycle traffic, etc.) also guide the choice of speed limit to adopt. Lastly, when an unpaved rural road is concerned, a lower speed limit than the corresponding default speed limit is decided considering the three factors previously discussed above.

While it is difficult for DoTM to comprehensively pursue a detailed assessment of the parameters discussed above when fixing speed-limit in Nepalese roads, it is important that the department recognizes the significance of these principles and gradually use it in a simplified manner to fix speed limit for various roads. DoTM can continuously refine the speed-limits over time as it gains more experience and insights.

It is important for the speed limits to be reasonable and enforceable and therefore departures from the national speed limit should only be imposed if the situation definitely renders it unsafe for vehicles to adopt the higher speed-limit. On the other hand, speed-limit sign is unnecessary at locations such as sharp bends, tight hair-pins, section of restricted visibility, etc., and in such circumstances, the use of proper warning signs instead will be more effective. Within the current practice, the lowest speed-limits recommended for various types of roads and condition are illustrated below but these need to be refined adopting new concepts as discussed previously.

Table 4.3 Speed-Limits Currently Recommended in Nepal

Type of Road/ Environment	**Lowest Recommended Speed-limit**
Urban roads with substantial pedestrian traffic	25 kph
Any road crossing a bailey bridge[3]	25 kph
	Recommended Speed Limit
Highest standard expressways[4]	Not defined
Multi-lane roads in strategic road network	Not defined
Double-lane roads in strategic road network	Not defined
High quality urban arterial with negligible	60 kph

[3] A bailey bridge is a steel truss bridge that can be quickly assembled and installed at river crossing for temporary relief. These bridges are put in operation for the dry seasons and dismantled before the onset of monsoon.

[4] Expressways are high standard, access-controlled road with divided carriageway and are classified as Class I strategic roads.

pedestrians.	
Double-lane/ wide road with negligible pedestrian traffic (urban/rural terai road)	50 kph
Across any double-lane/ wide road (urban/rural terai road) crossing a bridge without footpaths	50 kph
Urban roads with moderate pedestrian traffic	40 kph
Urban road with narrow through lane	40 kph

4.4.2 Traffic Calming Measures

Traffic calming measures are constructions laid over a road to automatically force vehicles to reduce speed or self-enforce speed control. The concept through which these devices are able to force vehicle to automatically reduce speed while the latter traverse through these devices is through creation of lateral protrusion or vertically raising of the carriageway surface in one form. In another form, speed control is achieved by alerting errant vehicles as they run-over the undulated road surface provided at the edges (shoulder rumble-strip), centre-line (central rumble strips) or making the speed reduction zone prominent (e.g. gateway) . Figure 4.1 illustrates the various types of traffic calming devices that are provided.

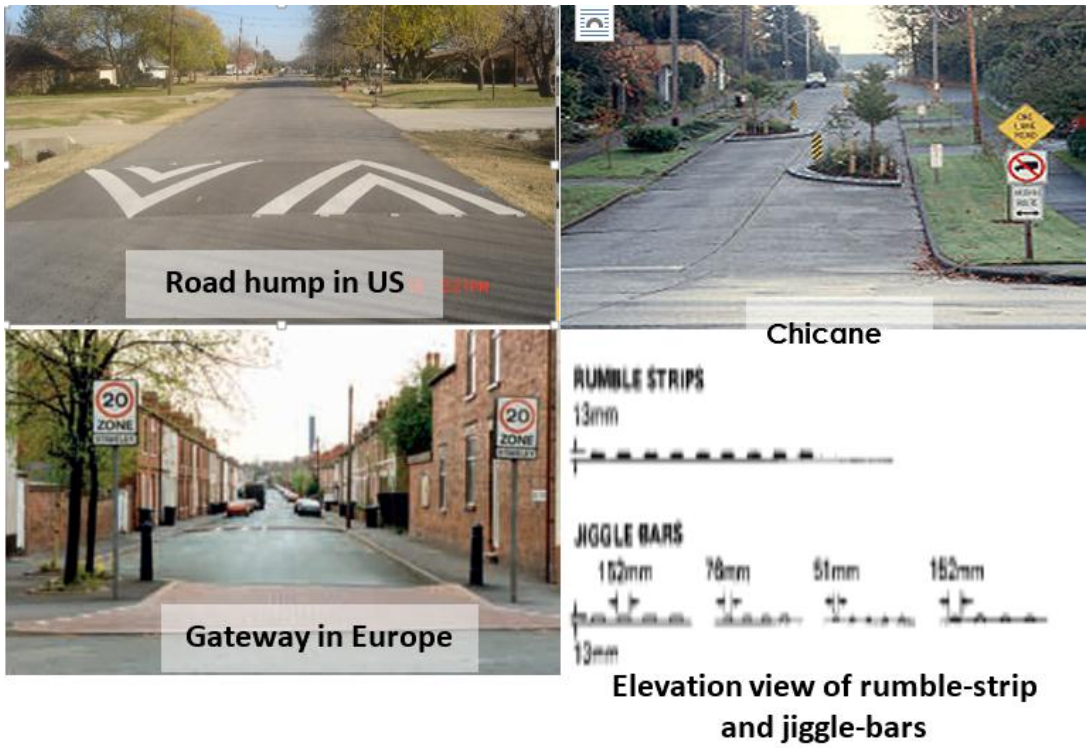


Figure 4.1 Example of Traffic Calming Measures

There are various types of traffic calming devices of which the most common are as follows.

- Road humps

- Rumble devices
- Chicanes
- Built-outs
- Gateways
- Mini-roundabouts

A brief description of each of these devices is given below.

(1) Roads Hump

A road hump is a raised paving constructed in the form of a parabola as shown in Figure 4.3 . Owing to this device, vehicles need to slow down when traversing through it.

Figure 4.2 Example of a Road Hump in UK

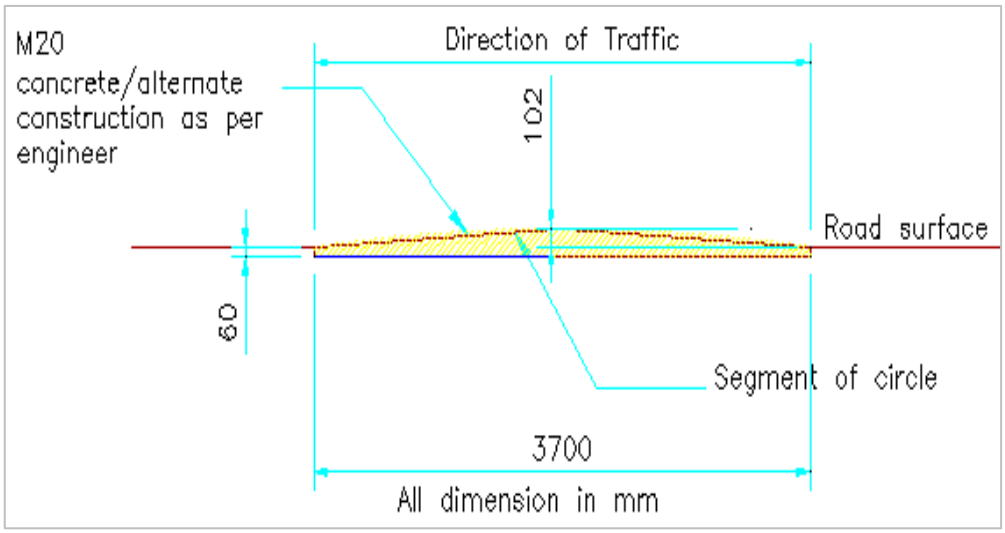


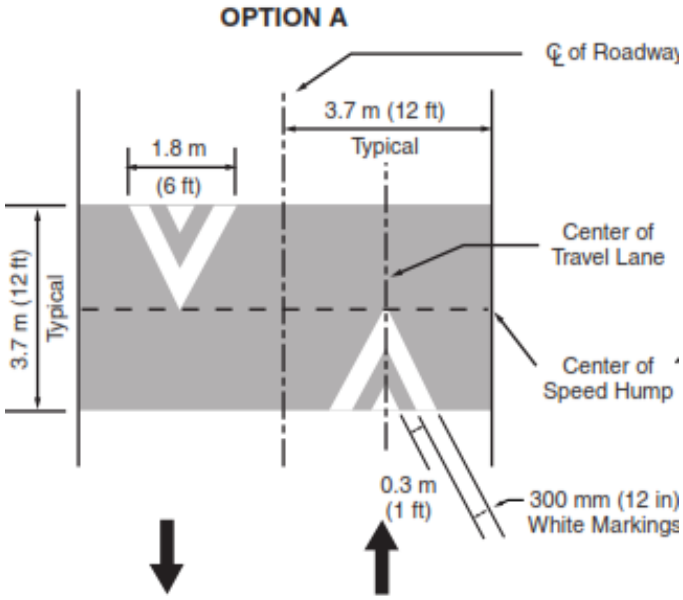
Figure 4.3 Appropriate Cross-section of A Road Hump

As shown in Figure 4.3, the hump is constructed of concrete or other constructions with the parabolic hump having a maximum height of 102 mm at the crown and a 60 mm bedding for

maximum depth. The road hump should span between 3.5 to 4 m (Figure 4.3 adopts a 3.7 m span) to the maximum height indicated in order to effectively induce vehicles to reduce speed. The existing road-humps constructed in various locations in Nepal do not generally conform to the above standard but it is expected that these structures will gradually be modified based on this guide.

Road humps should also be adequately delineated with road marking and warning signs in order to be conspicuous to the drivers. There are various pattern of road marking adopted for road humps ranging from the saw-tooth, shaded saw-tooth to checkered pattern but the single saw-tooth as indicated in Source: (1) MUTCD Part 3: Markings; US FHWA; 2003; (ii) Indiana Mart www.indianamart.com

Figure 4.4 is recommended for use in Nepal (note that the saw tooth shown here is based on right-hand driving in US and should be aligned to correspond to left-hand driving in Nepal.)



Source: (1) MUTCD Part 3: Markings; US FHWA; 2003; (ii) Indiana Mart www.indianamart.com

Figure 4.4 Shaded Saw-tooth Marking Used Over a Road Hump in US

Road humps constructed in Nepal should be marked and signed as illustrated in Figure 4.5 for a two lane road and it is highly recommended to reflectorize the road-marking and signs for added impact and visibility at night.

Road humps should not be constructed along national highways, expressways and main carriageway of arterials[5]. But a series of road humps along local streets, service lanes of arterials,

[5] The cross section of an arterial with divided carriageway comprise of service lanes on both side of the main carriageway. The main carriageway is reserved for through traffic while local traffic that need to access side

residential areas, shared zones, can effectively control speed in these areas with the applicable warning signs together with supplementary plates denoting the distance up to which humps are present should be installed in advance to two ends (see Figure 4.6). Description of warning signs and supplementary plates is given at the latter section of this manual.

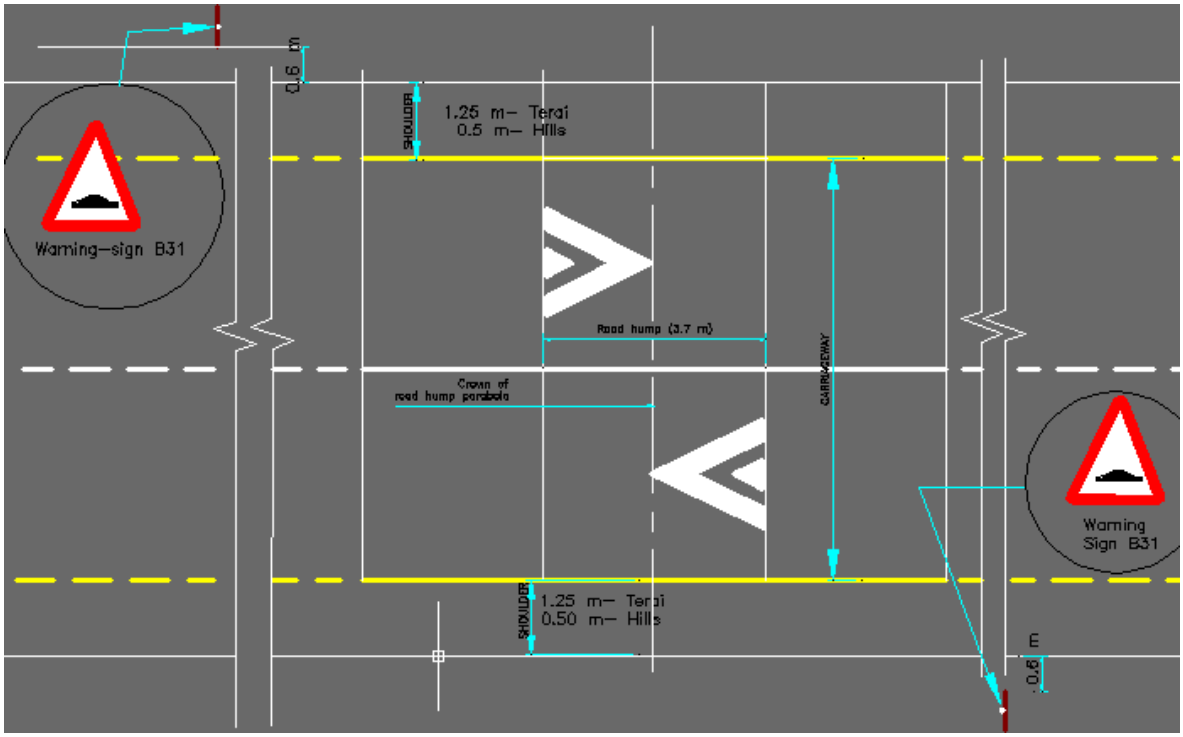


Figure 4.5 Recommended Signage including Road Marking at Road Humps

approaches need to confine to the service lanes and number of access opening to the main carriageway is limited to improve traffic mobility.

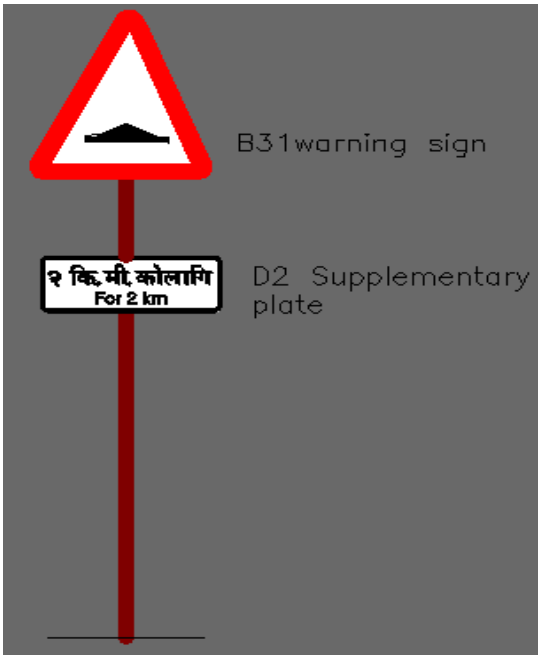


Figure 4.6 Signage at Both Ends of a Road Section with Series of Humps

(2) Rumble Devices

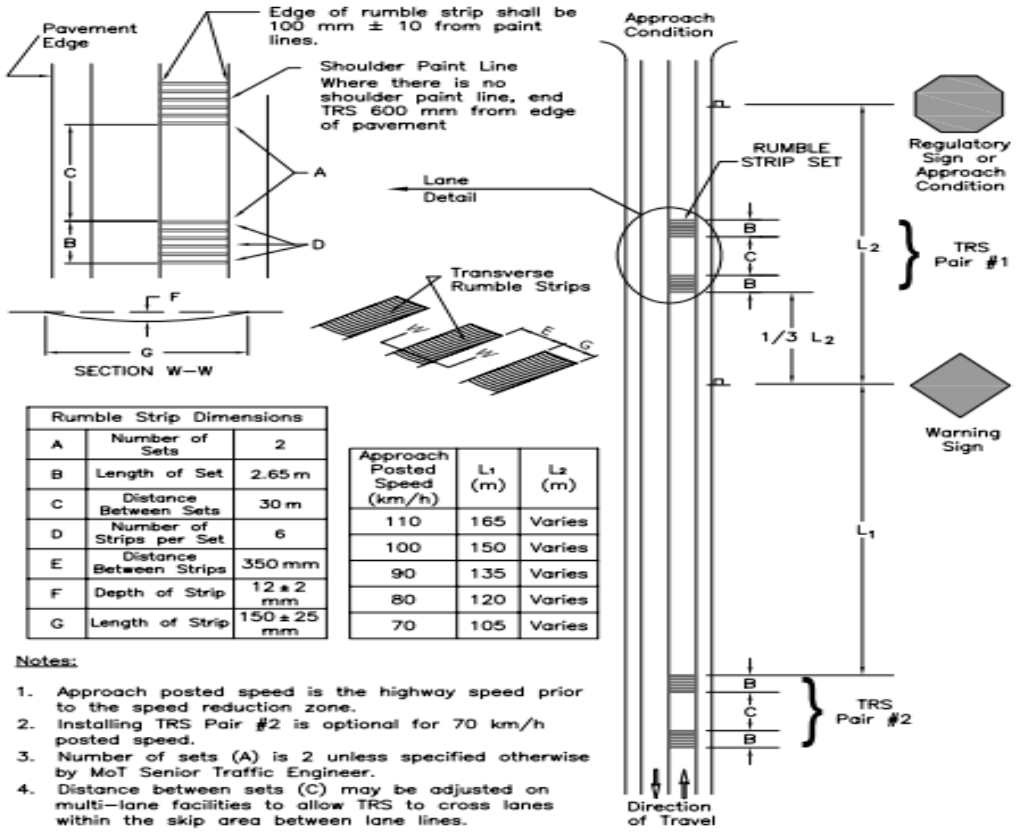
A1.1.1.1. These devices comprise a series of narrow strips of humps of low height (maximum of 15 mm) provided over the road alerting driver to reduce speed or to take evasive action to prevent errant vehicles to cross over the centre-line or run-over the edge-line when noise or vibration is generated as it travel over these devices. The latter form of these devices constructed along the centre or edge –line rather function as safety devices to prompt drivers to confine to one's lane or avoid straying too close to the edge rather than speed control. Alternatively their construction can also involve milling or grinding depression rather than hump. Rumble devices can also be constructed to reduce speed and they can be of the following types.

- Transverse rumble bars or strips
- Jiggle bars
- Rumble areas

a. Transverse Rumble Bars or Strips

These comprise of a set of narrow bands of thermoplastic humps of defined span constructed in pairs with certain interval as shown in Source: Technical Circular T-01/09; British Columbia, Canada; 2009

Figure 4.7. The height of each individual humps should not exceed 15 mm while no vertical face should exceed 6 mm in height) from the road surface. The individual bars spanning 150 mm±25 mm each, are constructed by applying thermoplastic marking or alternatively grooves corresponding to same depth (150 mm±25 mm) is constructed.



Rumble Strip Dimensions		
A	Number of Sets	2
B	Length of Set	2.65 m
C	Distance Between Sets	30 m
D	Number of Strips per Set	6
E	Distance Between Strips	350 mm
F	Depth of Strip	12 ± 2 mm
G	Length of Strip	150 ± 25 mm

Approach Posted Speed (km/h)	L_1 (m)	L_2 (m)
110	165	Varies
100	150	Varies
90	135	Varies
80	120	Varies
70	105	Varies

Source: Technical Circular T-01/09; British Columbia, Canada; 2009

Figure 4.7 Layout for Transverse Rumble Strip in Canada

Transverse rumble strips can also be constructed across the shoulder alone to discourage errant drivers travelling along the shoulder.

Transverse rumble strips are not recommended when cycles are permitted unless there is a minimum of 1.2 m clear path or shoulder is available in consideration of cyclists' safety. Transverse rumble strips should preferably be delineated with road marking such as "STOP AHEAD" or "SIGNAL AHEAD" since the purpose of the rumble strips may not be clear. Over the years, many road authorities no longer use traverse rumble strips for traffic calming but as safety measure to alert of impending conditions ahead. The milled construction method for transverse rumble strips can only be adopted when the asphalt is at least 50 mm thick.

One should carefully evaluate the adoption of transverse rumble strips near residences or other sensitive noise receptors. Transverse rumble strips should not be installed across the carriageway near sharp horizontal or vertical curves while the transverse ones over the shoulder should not be installed if cycle traffic is present. Milled transverse rumble strips should not be applied over cracked pavement nor on bridge decks.

b. Jiggle-bars

In jiggle bar constructions, sets of closely spaced humps of low height (13 mm) spanning certain length are provided at certain interval as illustrated in Figure 4.8 but the span of each individual bars in each set gradually increase to effect a more effective audible and vibratory sound than rumble strips.

Figure 4.8 Elevation View of Jiggle Bars

c. Rumble areas

Rumble area is a continuous strip of carriageway constructed of coarsely textures aggregates which produces rumble (height limited to 6- 7 mm) when traffic travel over it with the noise increasing with speed (see Figure 4.9).

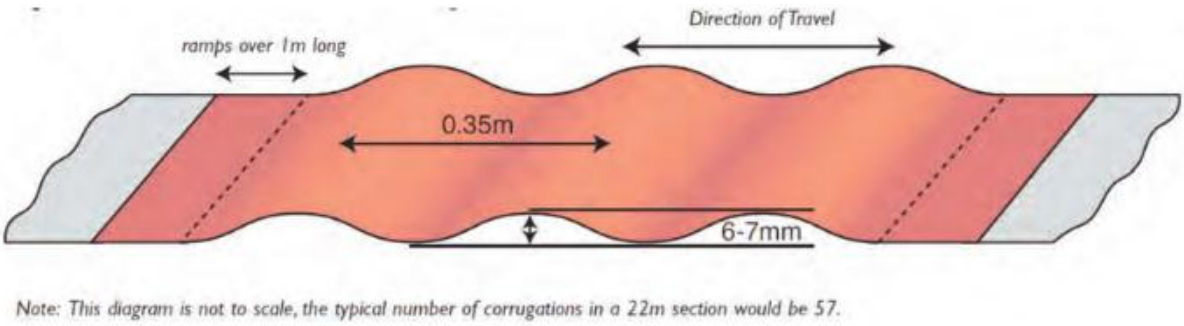


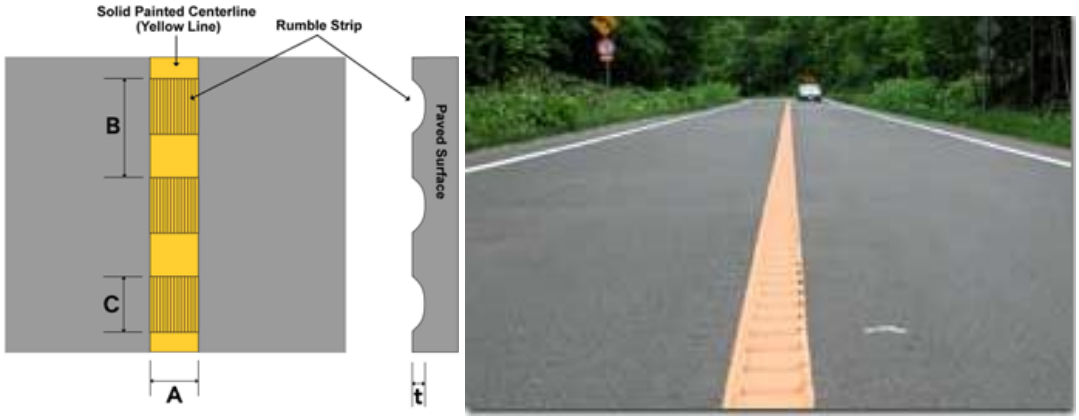
Figure 4.9 Rumble Areas

Source: US Department of Transport; 2005.

d. Central-line Rumble Strips

These are narrow rumble strips that are laid over the centre-line as shown in to alert driver if they are violating the prohibition to cross over the solid centre-line where it is placed. Source: Civil Engineering Research Institute for Cold Region, Japan; 2006

Figure 4.10 shows the construction of a centre-line rumble strip adopted in Japan.



Source: Civil Engineering Research Institute for Cold Region, Japan; 2006

Figure 4.10 Centre-line Rumble Strips over a Solid Yellow Centre-line

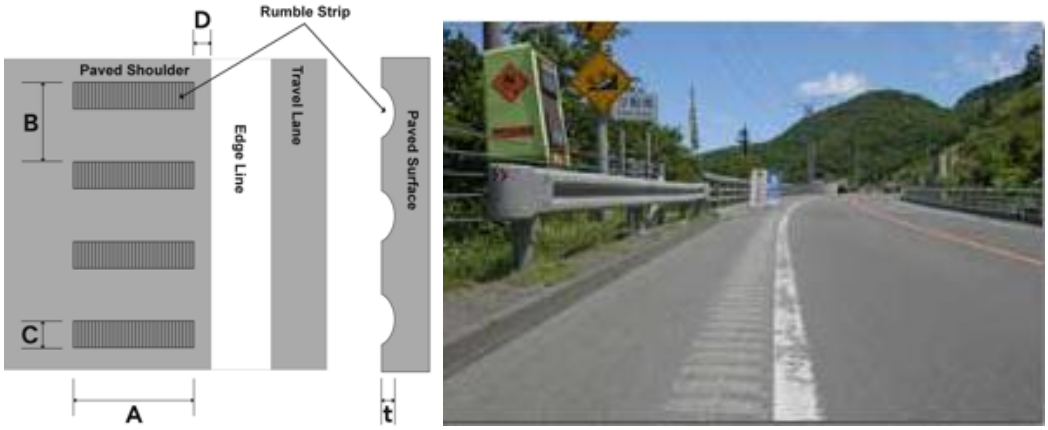
As illustrated in Source: Civil Engineering Research Institute for Cold Region, Japan; 2006

Figure 4.10, each of the individual strips 170 mm wide (dimension C) are spaced at 300 mm interval (dimension B). The strips are 350 mm thick (dimension A) and are laid in between the vertical projection is limited to 12 mm (dimension t). These types of rumble strips at the centre-line have not been applied in Nepal to date and technical know-how about its construction including specialized equipment is currently not available in Nepal. Nevertheless, in future, these measures can be applied or piloted in areas where there is a high cases of head-on crashes following required training and equipment procurement.

e. Shoulder Rumble Strips

Source: Civil Engineering Research Institute for Cold Region, Japan; 2006

Figure 4.11 illustrates shoulder rumble strips applied in Japan to alert drivers against straying too close towards the edge or to reduce run-off-the-road crashes.



Source: Civil Engineering Research Institute for Cold Region, Japan; 2006

Figure 4.11 Shoulder Rumble Strip Construction

The series of strips 350 mm wide (dimension A), spanning 80 mm (dimension C) are constructed at an interval of 230 mm (dimension B) keeping the depth of rumble at 9 mm (dimension t). Based on research, these types of strips are recommended where shoulder at least 1.2 m wide is available in consideration to cyclists' safety. These rumble strips immediately before structures such as narrow bridges and tunnel mouths is regarded as effective as deviations from lanes at those structures can be extremely dangerous. These type of rumble strips have not been adopted to date in Nepal but with time, it is worthwhile to pilot application of these measures at locations where there are substantial run-off-the road crash after training and equipment procurement.

(3) Chicanes

Chicanes is a pair of lateral projections that are constructed inside the carriageway to narrow the road. The pair of projections is staggered as shown in Figure 4.12 to force drivers to weave through such structures and automatically force to reduce speed.

Figure 4.12 Illustration of Chicanes

As illustrated above, the projections can range from extension of the kerbs to simple island construction with vegetation. Single chicanes are also sometimes adopted and research in UK has demonstrated that car speed is forced to reduce to as much as 36 kph. However, it is important to note that chicanes designed to reduce speeds of commercial vehicles up to 36 kph should have road hump or speed table in order to reduce speed of cars as well (otherwise cars will not be affected regarding speeding). Double chicanes can reduce speeds up to 24 kph.

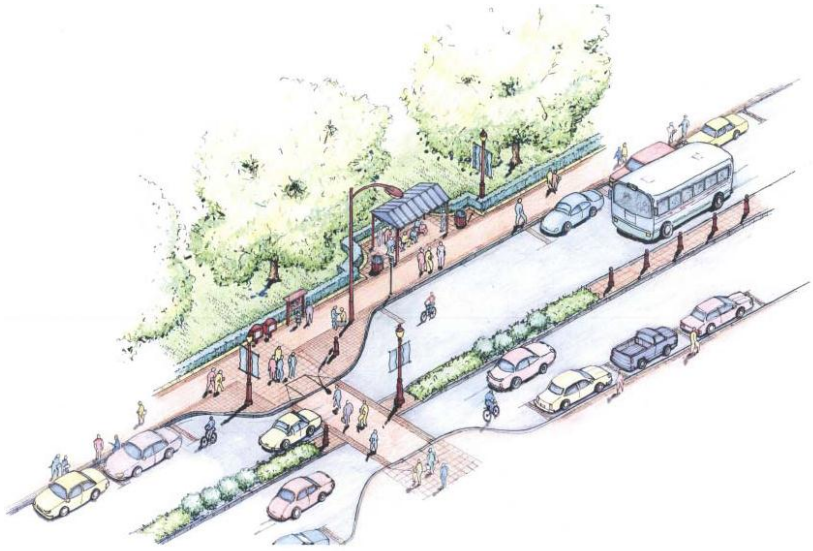
(4) Built-outs

Built-outs are lateral projection constructed inside the carriageway from both sides to narrow the carriageway. These are more appropriate for speed reduction in towns or major settlements. These constructions can also be effectively designed to provide indented bus laybys or on-street

parking and superimpose with pedestrian crossing at the built-out as shown in Source: Institute of Transportation Engineers, US.

Figure 4.13.

Build outs should be visible during daylight as well as night-time therefore requiring street lighting. To improve its prominence, bollards appropriately signed and approach marking from the kerb to the outer edge of the build out is necessary.



Source: Institute of Transportation Engineers, US.

Figure 4.13 Example of Built-out Superimposed with Convenient Pedestrian Crossing

(5) Gateways

Gateways are signage and prominent delineation (colour paving, pavement road marking, etc.) that are provided at the interface between a general zone and a traffic calmed area or residence where speed need to be controlled (see Source: Traffic Calming on Trunk Roads; TA87/04; UK Department of Main Roads & Bridge.

Figure 4.14)

Source: Traffic Calming on Trunk Roads; TA87/04; UK Department of Main Roads & Bridge.

Figure 4.14 Examples of Gateway

The visual impact of gateways is the most important factor that influences effectiveness of speed control. Therefore, the visual impact is enhanced with prominent markings to reduce width at the edge or centre of carriageway or creating ghost islands (i.e. virtual island delineated by means of marking alone). Research in UK have demonstrated that speed reduced at gateways by 5 to 21 kph (average 8 kph) while the mean and the 85th percentile speed reduced by 8 to 11 kph on an average.

(6) Mini-roundabouts

Mini-roundabouts can be used within built-up areas where the speed is not more than 48 kph and can also substantially reduce crashes. But like all checks regarding appropriateness for adopting a roundabout, all the flows from approach should be reasonably the same.

Figure 4.15 Mini-roundabout

Mini-roundabout having a flushed or domed island at the centre can allow large vehicle to overrun the central area while turning if necessary. The maximum height of the domed central area is 125 mm and the vertical face at the island kerb should not exceed 6 mm.

4.5 SCHEDULE OF REGULATORY SIGNS

The updated list of regulatory sign-post including additional one that were missing in the existing schedule in MVTMR 1997 and new signs to be included is given below. For uniformity, all regulatory sign posts will have the reference starting with the letter "A" for consistency with that given in the DoR Traffic Sign Manual 1997 (TSM 1997). The reference to the existing sign-posts listed the TSM 1997 is also maintained and the new sign-posts continue after them. A description of each of regulatory sign-post is given in Annex 1 of this manual.

Table 4.4 Updated Schedule of Regulatory Sign-Posts

Regulatory Sign-post Code	Description
A1	Stop and Give Way

Regulatory Sign-post Code	Description
A2	Give Way
A3	No Entry
A4	No Motor Vehicles
A5	No Trucks
A6	No Handcarts
A7	No Bullock Carts
A8	No Pedestrians
A9	No Vehicles Over Length Shown
A10	No Vehicles Over Height Shown
A11	No Vehicles Over Width Shown
A12	No Vehicles Over Maximum Gross Weight Shown
A13	Axle Weight Limit
A14	No Parking
A15	No Stopping
A16	No Overtaking
A17	No Passing Without Stopping
A18	No Right Turn
A19	No Left Turn
A20	No u turns
A21	No use of horn
A22	Maximum speed
A23	End of speed restriction
A24	Temporary stop sign
A25	Temporary go sign
A26	Restriction ends
A27	Ahead only

Regulatory Sign-post Code	Description
A28	Turn left
A29	Keep left
A30	Turn left ahead
A31	Small roundabout
A32	Pass either side
A33	One way traffic
A34	No vehicle carrying explosive
A35	No bus
A36	Shared route for cycles and pedestrians only
A37	Separate route for cycles and pedestrians
A38	Route for cycles only
A39	No cycles
A40	Routes for buses and cycles only
A41	No overtaking zone
A42	Give way to oncoming traffic
A43	Speed-zone
A44	Pedestrian Zone
A45	End Pedestrian Zone
A46	End Speed Zone

CHAPTER 5 WARNING ROAD TRAFFIC SIGNS

5.1 PURPOSE AND USE

Warning signs alert all road users of hazards including potential ones or situation, features that lie ahead on the road. As such they indicate a need for road users to be extra cautious and may require a reduction in speed, certain maneuver for traffic safety. This section advises when to use such sign while a description of each warning sign is given in Annex 2.

While adequate warning signs greatly facilitates road safety, they should be used sparingly and only where needed to be most effective. Over signage or their placement to warn of conditions which are already obvious to the users or are so minor not requiring any extra care will lose their effectiveness with the users disregarding these signs in such locations over time. The need to be extra cautious in judiciously deciding installation of warning sign is particularly true in urban roads. For example, intersections in a built up or commercial district in a town are obvious and speed are already low thus not requiring warning signs for intersection presence.

5.2 SHAPES, SIZES AND INSTALLATION

Most warning signs are triangular shaped with equal side (equilateral triangle) with a red border depicting a symbol in black signifying the hazard ahead on a white background (Figure 5.1 for examples). For more clarity, additional information is provided in supplementary plates installed beneath the main warning sign.

Figure 5.1 Examples of Warning Signs in Use in Nepal

It takes time for a driver to act on the message given by a sign and slow his vehicle down to a safe speed. Therefore signs must be sited sufficiently in advance to the hazard that lies ahead to allow for this. Drivers must be able to see the sign from at least 60 m away (75 m on national highways) so that they have time to read the message sufficiently in advance before taking appropriate action or proceeding appropriately.

There should also be clear visibility from required distance to the sign. For this reason, sign should be placed where the visibility is not obstructed by either the road alignment (e.g. sharp curves, tight hairpins, high grades, etc.) or natural features (e.g. vegetation, utility poles, structures, etc.). Thus, while warning signs are missing at the left-hand side of the road, the road geometry or vegetation may require the warning signs to be installed on the right hand side (e.g. on a sharp bend), they should be placed on both the sides to accord that visibility or to add impact. However, in all such cases, care should be taken to confirm that there is no confusion as to which drivers the sign is directed to i.e. the sign-board should aligned appropriately to ensure this.

The size of the signs must also be large enough to be readable clearly by drivers travelling at the average speeds of the traffic. The sizes applicable and distances at which the signs should be adopted are prescribed in Table 5.1. A larger size warning sign than prescribed standard size may be necessary for additional impact if it is observed that the sign have not been effectively complied. In such cases, a larger size version of the sign is adopted as prescribed in Table 5.1.

Table 5.1 Size and Placement of Warning Signs

Type of Road/ Environment	Recommended Size of the Sign (mm)		Distance of Signs from the Hazard
	Height	Length of triangular shaped sign (all sides equal)	
National highways – normal cases	750	866	180
National highways –for additional impact	900	1039	180
Feeder roads	750	866	100
Urban roads	600	693	50
Urban roads – for additional impact	750	866	50

Note: Sizes and distance is based on DoR TSM 1997.

If it is not possible to install the sign at the prescribed distance, the distance to the hazard should be indicated on the supplementary plate D1. Where warning sign must be placed away from the standard distance prescribed, there is the choice to either place it nearer or farther from the

prescribed distance. However, it is preferable and safer to place such warning sign further instead of nearer from safety consideration.

5.3 SCHEDULE OF WARNING SIGNS

Based on the review of the existing warning signs and identification of the missing as well as new requirement, an updated list of warning sign-posts is shown in Table 5.2. This list includes the existing signs listed in DoR TSM 1997 and new signs that are deemed necessary to denote emerging hazards, events or environment along the roads in Nepal in the foreseeable future. However, the list of warning signs should be reassessed at specific time in the future similar to other signs and continually updated. All the warning signs are coded with the prefix Box for consistency with the existing reference listed in TSM 1997 and the code number for the new signs continues from the existing reference number.

Table 5.2 Schedule of Warning Signs-Posts

Warning Sign-Post Code	Description
B1	Crossroads
B2	Major Road Ahead
B3	Side Road Right
B4	Staggered Junction
B5	T Junction
B6	Y Junction
B7	Traffic Merges From Left
B8	Traffic Merges From Right
B9	Roundabout
B10	Bend to the Right
B11	Hairpin Bend to Right
B12	Double Bend First Left
B13	Sharp Bend to the Left
B14	Road Narrows on Both Sides
B15	Road Narrows on the Right
B16	Dual Carriageway Ends
B17	Traffic Signals
B18	Steep Hill Downwards
B19	Steep Hill Upwards
B20	Height Limit Ahead
B21	Two Way Traffic Straight Ahead
B22	Two Way Traffic Crosses One Way Road
B23	Pedestrian Crossing
B24	Pedestrians in Road Ahead
B25	Children

Warning Sign-Post Code	Description
B26	Cattle
B27	Wild Animals
B28	River Bank
B29	Uneven Road
B30	Slippery Road
B31	Road Hump
B32	Low Flying Aircraft
B33	Falling Rocks
B34	Dangerous Dip
B35	Narrow Bridge
B36	Other Danger
B37	Checkpoint
B38	Road Works
B39	Loose Chippings
B40	Railway Level Crossing without Gate or Barrier
B41	Railway Level Crossing with Gate or Barrier
B42	Temporary Diversion Ahead
B43	Dangerous Obstruction (Verges)
B44	Dangerous Obstruction (Central Reservation)
B45	T Junction
B46	Sharp Bend
B47	Direction of Temporary Diversion to the Right
B48	Delineator Posts
B49	Tunnel
B50	Series of curves

The details of each of these warning signs are given in Annex 2 of this manual. The permissible sizes for each sign are indicated in the sign diagram and the sizes shown in brackets are only adopted for additional impact as discussed in Table 5.1.

CHAPTER 6 INFORMATORY ROAD TRAFFIC SIGNS

6.1 PURPOSE AND USE

Informatory signs are mainly of two categories; (i) direction signs and (ii) other information signs. Separate description of each of these two categories of informatory signs is given below.

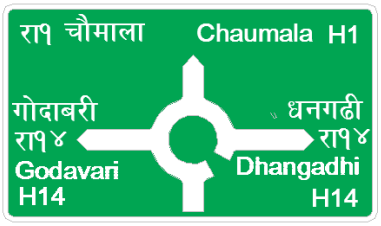
6.1.1 Direction Signs

This category of informatory sign comprise the larger group of the informatory signs informing drivers about the direction to various destination from the point where these signs are installed in order to help them in their trips. In this respect, these signs help to (i) reduce delays and frustration for the road users; (ii) keep the traffic movement smooth, safe through the intersections and (iii) promote commerce and tourism. The most important direction signs belong to one of following groups:

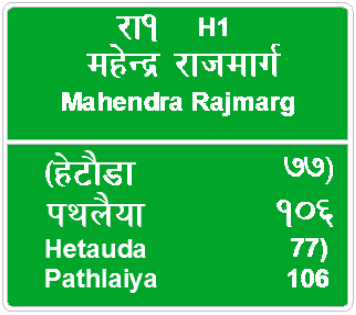
(1) Advance direction signs, which, informs a driver about his/her route ahead in advance to an intersection.

(2) Direction signs, which give route information at an intersection.

(3) Route confirmatory signs, which confirms and often give additional information about the route ahead beyond an intersection.



Advanced direction sign, C22



Route confirmation sign, C23

Temporary diversion sign, C26

Direction sign in urban areas, C28

Figure 6.1 Direction Signs Example Used in Nepal

Source: Traffic Sign Manual, 1997; GoN DoR

6.1.2 Other Informatory Signs

Other informatory signs (i) give advance information of restrictions or prohibition that lie ahead or the end of a restriction or prohibition; (ii) give other information such as the name of a town, village, etc. and (iii) inform about facilities ahead (e.g. on/ off- street parking, lay-bys, picnic areas, telephones etc.).

Figure 6.2 Other Informatory Signs in Use in Nepal

Source: Traffic Sign Manual, 1997; GoN DoR

6.2 FONT TYPE, SIZE, COLOUR TO ADOPT

All the informatory signs will be rectangular shaped with the place identification sign being rectangular shaped with its longer side horizontal with an arrow-head on one side (see Figure 6.1). All the informatory signs to be installed in Nepal will have the colour codes as shown in Table 6.1.

Table 6.1 Colours of Direction Signs

Type of Informatory Sign	Road Type where Sign Installed	Road Type to which Sign Refers	Background Colour	Text/Graphic Colour
Advance direction, direction signs	National highway	National highway	dark green	white
		Feeder, rural road	dark green	white
		Urban roads	white	black
	Feeder road	National highway	dark green	white
		Feeder, rural road	dark green	white
		Urban roads	white	black
	Other roads	National highway	dark green	white
		Feeder, rural road	dark green	white
		Urban roads	white	black

Route confirmation sign at intersections	National Highway	Any roads	dark green	white
	Urban road	Any roads	white	black
Direction sign at intersection	National highway	National highway	dark green	white
	Urban road	Urban road	white	black
Temporary diversion sign at intersection	Any road	Any road	yellow	black
Other informatory signs	Any road	Any road	blue	Text –White mostly Graphics = black or white

If all the destinations of a direction sign installed on a national highway refer to local destinations, the text should be in black on a white background. All the informatory signs should include both the Nepali and English text with the former above its corresponding English text. Table 6.2 shows the font style, color to adopt for the Nepali and English texts to use in informatory signs.

Table 6.2 Font Syle, Colour to Adopt for Informatory Signs

Description	**Description**	
Nepali Text		
Style	Milan TTF/ Preeti	
Colour	White text when on a green, blue, brown or black background	Black Text when on a white or yellow background
English Text		
White letters on a green, blue, brown or black background	UK Transport Medium	
Black text on a white or yellow background	UK Transport Heavy	
Text Case	Sentence	

The text size should be chosen with due regard to the design speed, functional classification and location of the road in order to ensure that the message is legible but not too large to be obtrusive. Milan TTF has been adopted for Nepali font type in informatory signs and supplementary plates since 1997. However, this font is no longer used in desktop publishing nor details, literature regarding its recent revision is available. In its place, numerous fonts for Nepali Devanagari

scripts such as Preeti, Kanchan, Kantipur, Fontasy Himali, etc., have emerged with Preeti being the most widely used font of printing. A comparison of various Nepali fonts shows that the x-height[6] of the various Nepali scripts were more or less equal and only text thickness varied. Past research showed that the x-height of the Milan Text adopted for informatory signs needed to be 25% larger than the corresponding height of the UK Transport font used for English text in order to be legible from the same distance. Similarly, it is observed the x-height of the Preeti font need to be 17% larger than the corresponding height of the upper case letter of UK Transport Medium or Heavy font used for the English texts in the informatory signs. Therefore, the x-height of the Nepali text letter is shown in both Milan TTF and Preeti for convenience. Table 6.3 the size of the text to adopt for use in informatory signs in Nepal.

Table 6.3 Height of Text (mm) to Adopt for Informatory Signs

Type of Sign/ Design Speed of the Road	English Text Height (mm)		Nepali Text Height (mm)		Minimum Clear Visibility to the Sign Required (m)
	Lower Case	Upper Case	Milan TTF	Preeti	
Advanced Direction Signs					
Road with design speed ≤ 30 kph	75 (60)	105 (84)	131 (105)	123 (98)	50 (35)
Road with design speed 31- 50 kph	100 (75)	140 (105)	175 (131)	164 (123)	75 (45)
Road with design speed 51- 65 kph	125 (100)	175 (140)	219 (175)	205 (164)	100 (80)
Road with design speed 66 - 80 kph	150 (125)	210 (175)	263 (219)	246 (205)	135
Road with design speed 81- 100 kph	200 (150)	280 (210)	350 (263)	328 (246)	165
Road with design speed 101- 110 kph	250 (200)	350(280)	438 (350)	410 (328)	225
Road with design speed 111- 120 kph	300 (250)	420 (350)	525 (438)	491 (410)	260
Direction Signs, Route confirmation sign, Place Identification Signs					
Road with design speed ≤ 30 kph	60 (50)	84 (70)	105 (88)	98 (82)	35 (30)
Road with design speed 31- 50 kph	75 (60)	105 (84)	131 (105)	123 (98)	45 (35)

[6] x-height = distance between the top and bottom of a letter (ignoring the vowel superscript and subscript in Nepali Devanagari script).

Type of Sign/ Design Speed of the Road	English Text Height (mm)		Nepali Text Height (mm)		Minimum Clear Visibility to the Sign Required
	Lower Case	Upper Case			
Road with design speed 51 - 65 kph	100 (75)	140 (105)	175 (131)	164 (123)	60 (45)
Road with design speed 66- 80 kph	125 (100)	175 (140)	219 (175)	205 (164)	75 (60)
Road with design speed 81- 100 kph	150 (125)	210 (175)	263 (219)	246 (205)	105 (75)
Road with design speed 101- 110 kph	200 (150)	280 (210)	350 (263)	328 (246)	135 (105)
Road with design speed 111- 120 kph	300 (250)	420 (350)	525 (438)	491 (410)	180 (150)
Overhead signs (gantry mounted)					
Road with design speed ≤ 80 kph	200 (175)	280 (245)	350 (306)	328 (287)	150
Road with design speed 81- 100 kph	250 (200)	350 (280)	438 (350)	410 (328)	200
Road with design speed 101- 110 kph	275 (250)	385 (350)	481 (438)	450 (410)	240
Road with design speed 111- 120 kph	300 (275)	420 (385)	525 (481)	491 (450)	260
Bridge Name Plate					
Name of the bridge	107	150	190	176	
Other texts	-	-	65	60	
Other informatory signs in urban areas, not lying along a national highway	71	100	125	115	

Note: The text size inside bracket (where shown) applies to sites where there are space/site constraints.

The direction signs at important and strategic locations can be reflectorized for visibility during the night time. However, for economy, only the white text and symbol can be reflectorized leaving the background non-reflective.

6.3 SCHEDULE OF INFORMATORY SIGNS

Based on the review, an updated list of informatory signs is given in Table 6.4 and Table 6.5 including those signs already included in TSM 1997. The code for all the signs start with the prefix "C" for consistency with existing reference used in TSM 1997 and the new signs added start after those existing in TSM 1997.

Table 6.4 Schedule of Other Informatory Sign-posts

Other Informatory Sign-Posts Code	Description
C1	No Through Road
C2	Pedestrian Crossing
C3	Parking Place
C4	Overtaking Section
C5	Filling Station
C6	Breakdown Service
C7	Telephone
C8	Overnight Accommodation
C9	First-Aid Post
C10	Hospital
C11	Refreshments
C12	Restaurant
C13	Picnic Site
C14	Recommended Route for Pedestrians and Cyclists
C15	Recommended Route for Pedestrians
C16	Recommended Route for Cyclists
C17	Bus Stop
C18	Taxi Park
C19	One Way Street
C20	Place Identification Sign
C21	Exit from Built-Up Area
C30	Exclusive lane for local buses, cycle and taxi only

Table 6.5 Schedule of Direction Sign-Posts

Direction Sign-Posts Code	Description
C22	On Approaches to Junctions
C23	Route Confirmation Sign - after Junctions
C24	On Approaches to Junction - Alternative Style
C25	At the Junction
C26	Temporary Diversion Sign
C27	At the Junction
C28	On Approaches to Junctions
C29	Bridge name plate

The detail of each of these informatory sign-posts is given in Annex 3 of this manual. The various destinations in direction signs should denote the roads using the reference adopted by DoR, DoLIDAR, municipalities, etc., where such reference is available. A list of highway reference and destination to denote strategic roads is given in Annex 4 and 5. However, this list is not exhaustive and should be expanded to include all probable destinations.

CHAPTER 7 SUPPLEMENTARY PLATES AND TRAFFIC SIGNALS

7.1 SUPPLEMENTARY PLATES

7.1.1 General

Supplementary plates denote additional information or clarify the message given in the primary signs and are mostly installed in combination with regulatory or warning signs but never used on their own. These plates are mounted 75 mm below the primary sign.

7.1.2 Sign Size, Shape and Text

Supplementary plates are rectangular shaped with text in black over a white background as shown in Figure 7.1. Supplementary plates that comprise of texted message only should include the Nepali text inserted above its corresponding English text.

Figure 7.1 Example of Supplementary Plates in Use in Nepal

Source: Traffic Sign Manual, 1997; GoN DoR

In terms of the font style, the Nepali text can either adopt Milan TTF and Preeti fonts while the English text should adopt the UK Transport Heavy. The text size to adopt for both the Nepali and English text should be as shown in Table 7.1.

Table 7.1 Size of the Text to Adopt for Supplementary Plates

S/N	Length of the Message	English Upper Text Height (mm) (UK Transport Heavy)	Nepali Text Height (mm)	
			Milan TTF	Preeti
1.	Short message	60	75	70
2.	Long message	100	125	117

7.1.3 Schedule of Supplementary Plates

Table 7.2 lists the supplementary plates recommended for use in various roads in Nepal based on review of the existing signs as well as new ones. All the supplementary plates will be coded starting with the prefix "D" in consistency with the existing reference in TSM 1997 and new plates are numbered following the existing plates reference. Description of each of these supplementary plates is given in Annex 6 of this manual.

Table 7.2 Schedule of Supplementary Plates

Supplementary Plates Code	Description
D1	Distance to Hazard
D2	Distance over which Hazard Extends
D3	School
D4	Except Buses
D5	Flooding
D6	Single Track Road
D7	Stop
D8	Give Way
D9	Single Track Bridge
D10	Road Closed
D11	Accident
D12	Ice
D13	One Way
D14	Dual Carriageway
D15	Except for Access
D16	Time Period
D17	Car
D18	Truck
D19	Bus
D20	Motorbike
D21	Tempo
D22	Cycle
D23	Rickshaw
D24	Arrow to the Right
D25	End
D26	End of restriction
D27	Speed cameras
D28	Only
D29	Adverse camber

7.2 TRAFFIC SIGNALS

7.2.1 General

Traffic signals are usually installed at an intersection for the following purposes.

- to provide traffic control at an intersection with traffic capacity or road safety problem;
- to control conflicting movements with high traffic flows;
- to facilitate access to and from local areas in a major/minor road system
- to integrate with an area-wide traffic management system

A benefit after signalization is that traffic flows along a major road breaks into platoons (i.e. a queue of vehicles travelling closely at certain interval) which assist pedestrians to cross the major street as well as allow vehicles in the minor road to cross or enter the major road.

Factors influencing the provision of traffic signals are as follows.

- Traffic flows
- Traffic conflicts
- Road crashes
- Pedestrian requirements
- Access to major roads
- Cost of installation

In general, there are requirements that assess whether a particular intersection is suitable for signalization i.e. warrants requirement to satisfy. However, a detailed guide to signals and phasing design is outside the scope of this manual, the subsequent sections will generally advice on traffic

signals in the aspect relating to placement, fixing the signal heads and the signs associated with signals.

Traffic signals comprise of two categories; (i) signal to control vehicles and (ii) signs to control and facilitate pedestrian crossing movements or pelican signals.

7.2.2 Installation

The signal head should have a vertical clearance of approximately 2.3 m above the carriageway surface. The signal should be close to the kerb or edge of the carriageway but have adequate lateral clearance to prevent the signal head being struck by vehicles. The signal lenses should have hoods to shield them away from being seen by un-related drivers on other approaches. The traffic signals ahead warning sign B17 may be needed on the approaches to the junction.

Traffic signals are installed on the nearside of each approach and become the primary signals. In addition, additional signals are also installed beyond the intersection (secondary signals) to improve visibility and facilitate traffic control through the signal control. These secondary signal therefore indicate to vehicles close to the stop line, the same information that is displayed in the primary signal. In certain circumstances it may be undesirable or impractical to position the secondary signal beyond the intersection on a specific approach. On these occasions the secondary may be on the entry side of the junction, preferably on the offside and beyond the stop line.

Each approach has a transverse stop line (Type F1) associated with the primary signal indicating the place at which vehicular traffic must stop. The F1 stop line is marked on the carriageway 1.3 meters in advance of the signal. The signal and stop line may be set back to accommodate a pedestrian crossing, or to make turning movements easier for long vehicles.

Each road which meets at the junction is described as an arm of that junction and each arm is considered as having one or more approaches depending on the intended direction of travel of the traffic stream on leaving the signalled area.

7.2.3 Basic Means of Control

The primary purpose of a traffic signal at an intersection is to reduce conflict between traffic streams. Conflict at an intersection results increased delay and crashes.

Traffic control is in the basic signal configuration is achieved with the indication of red, amber and green signals (see Figure 7.2) and depending on the traffic movement, the signal may also include exclusive green, amber and red arrow light signals to assign the right-of-way to individual movement at an approach (e.g. left, through or right movement).

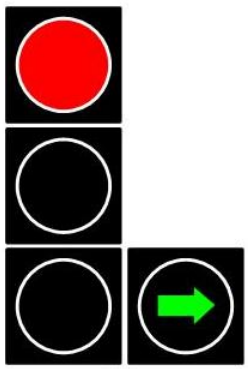
	
Signal with basic three signal-heads	**Signal showing exclusive right turn heads**

Figure 7.2 Example of Signal Heads

Each traffic stream must have clear vision of the primary signal on its approach and the additional displays which are associated with it. The signaling sequence will be red, green, amber and red and the interpretation of each signal indication is as follows.

- Red light: Indicates that traffic is prohibited from proceeding beyond the stop line.
- Green light: Indicates that vehicular traffic may proceed beyond the stop line and may turn in any direction, subject to the normal priority rules being observed and provided that the turn is not prohibited by a supplementary light signal (red arrow) or a regulatory traffic sign.
- Amber light - Conveys same prohibition as red signal except for those vehicles which are too close to the stop line to be able to stop line should proceed. This phase is usually displayed for three seconds.

On signals where additional signal head are installed, their arrangement and its signal indication will be as follows.

- Left turning signal-head are fitted left from the three basic signal head (see Figure 7.3). These turning head may display when the main signal-head is red to indicate that vehicles may turn left only. Left-turning signals are not usually necessary and critical in left-hand driving prevalent in Nepal but may be warranted when through traffic from the side approach at an intersection is substantially heavy or it is necessary to enforce left-turning vehicles[7]

[7] In the basic signal phase design, left-turning traffic move along with the through traffic at an approach when the signal head is green and simultaneously the corresponding pedestrian signals at the side approach turn green. As per

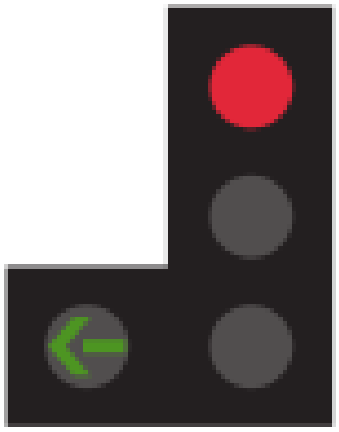


Figure 7.3 Left-turning Signal-head Arrangement and Display

- Right-turning signal-head ae fitted to the right of the three basic signal head, its indication signaling a movement to the right.

When turning signal-head are provided, drivers expect that they have an exclusive right of way and therefore it is strongly recommended that when signal arrows are installed, there is no conflict the with the traffic already using the intersection.

The left-turning signal-head may be installed to display amber to indicate left-turns even when the signal for the through movement indicate red signal. This amber left arrow indicates that it is permissible to go left provided that vehicles give way to traffic using the intersection but it is not advisable to use this type of signal arrow in conjunction with a pedestrian crossing.

An additional red signal-head may be on the right of the three signal-heads indicating that right-turns are prohibited when the arrow light is lit.

Wherever green or amber narrow signals are provided, these arrows will flash for 3 seconds before they turned off while the red arrow signal do not flash before turning off.

7.2.4 Signals to control pedestrian movements

(1) General

Pedestrian signals should only be used together with vehicle traffic signals. Signal-controlled pedestrian signals or pelican signal at mid-block crossings is necessary when traffic speed is high or the pedestrian crossing volume is very heavy.

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rule, pedestrians along the cross-street have priority over the left-turning traffic but this rule is not abided or difficult to enforce in Nepal. Therefore, left-turning signal is necessary to allow pedestrians at the side approach to safely cross.

Figure 7.4 Example of Mid-block Pelican Crossing in US

Source: Dan Burden, Walkable Communities Inc. , US

Pelican signal-head are also usually installed at signalized intersection and in the default phasing arrangement indicate green signal when the signal indication at the side approach turns green. The pedestrian signal-heads display the following symbol in the most common design.

- Red standing man - Denotes that pedestrian are prohibited from crossing the road
- Green walking man - Denotes that pedestrians may cross the road with care.
- Flashing Green Man - Denotes that pedestrian are prohibited from crossing the road except where they have started to cross the road, in which case they should continue to cross the road.

There are various innovative improvements to the pedestrian signal-heads available in the market to improve their effectiveness or promote pedestrian safety with more prominent display to prompt drivers to give right-of-way to the pedestrian at such crossings. These range from signal-heads displaying the countdown time, special blue eye LED[8] display, etc.

[8] LED= light emitting diode

Special blue eye LED display

Pedestrian signal-head with countdown timer display

Source: Institute of Transportation Engineers, US

Figure 7.5 Innovative Pedestrian Signal-heads

(2) Phasing Arrangement in Pedestrian Signals

Table 7.3 illustrates the phasing of pedestrian signals with traffic signal.

Table 7.3 Phasing Arrangement in Pedestrian Signals

S/N	Pedestian Signal	Traffic Signal	Period
1	Red standing man	green	depend on cycle time
2	Red standing man	amber	3 s
3	Red standing man	red	Minimum to clear traffic in the intersection
4	Green walking man	red	6 -12 s depending on the carriageway width and pedestrian traffic volume.
5	Flashing green man	red	The time of periods for both flashing green and red standing man in seconds should be equal to carriageway width divided by 1.2.
6	Red standing man	red	1-3 s but subject to the time periods required for green and red standing for S.N. 5 and 6 as calculated above.

For added safety and to be universally accessible to persons with disability, it is preferable to install an audible pedestrian signal that emits an audible signal when the green man signal is displayed.

(3) Sitting, Layout of Pedestrian Signals

The signal head is normally sited on the same post as the traffic light with their face placed across the road and aligned so as to face the pedestrians crossing. The signal lenses must be hooded to prevent the signal being seen by drivers.

7.2.5 Schedule of Signals

At this time, the schedule of signals including the traffic and pedestrian signal-heads remains the same as that existing in the TSM 1997. DoTM may revisit this schedule based on emerging needs and update it accordingly in the future. Table 7.4 shows the schedule of signals for use in Nepal.

Table 7.4 Schedule of Signals

Signal Code	Description
E1	Traffic signals
E2	Stop (go left)
E3	Stop (go right)
E4	Stop (give way and go left)
E5	Go (stop right)
E6	Pedestrian signals

CHAPTER 8 SIGNAGE AT CONSTRUCTION WORK ZONE

8.1 GENERAL

An important aspect of transport planning for any roadworks is the delineation of the work zones during the constructions to safeguard all the road-users and workers alike.

The purpose behind the delineation of a work zone is that it warns, informs and directs the road-users about a hazard that lies ahead, protect them as well as the workers in such zones. The requirement for a safe planning in a work-zone is a legal requirement and if ignored, the road agency could be sued in court and fined. It is essential that all roadworks, no matter how small, are properly signed, so that drivers and pedestrians are warned well in advance. The following section discusses the means to do this.

An integral part of work zone planning is good signing which will warn, inform and direct road users. It warns road users that there is a hazard ahead, so that they can be ready to take action. It informs them of what kind of thing to expect, so that they know what maneuver or action they will need to make. And it directs them how to pass through the hazard in a safe manner. Good signing helps protect the men working on the road and keeps traffic delays to a minimum.

8.2 PLANNING REQUIRED

When planning for a work-zone, it is important for the road authority concerned to consider the following checklist.

- **Plan ahead** – Identify what signs and cones that are needed before demarcating the site. The following section assist in deciding these requirements. Seek police advice in difficult or dangerous situations.

- **Be seen** - All workers working on or near the roadwork must wear brightly-coloured clothing, preferably an orange or yellow waistcoat.

- **Face the traffic when setting out signs:** Put the *Road Works Ahead* warning sign out first and then move towards the works site, and always try and face the traffic when setting out the signs and cones.

- **Check the signs carefully:** Ponder if users will understand the signage provided. For example ask yourself if someone coming towards the work-zone in either direction will understand what is happening and what is expected of them. As the works proceed, alter the signage to be consistent with the work that is going on and also rectify any signage that need addressing.

- **Fix the signs properly:** Secure the signs so that they cannot be blown over or dislodged by the moving traffic. It is best to mount the signs on a metal or wooden frame which keeps the sign face off the ground. A sand bag or rock placed across the base of the frame will stop the sign being blown over. Check the signs regularly to see if they are all still in place.

- **Ensure the signs are visible at night:** Make every effort to finish the work before dark but if this is not possible, use reflective signs, cones, lighting beacons and flashing beacon for warning and visibility.

- **Remove unnecessary signs:** As per observation, remove signs that are no longer needed as it annoys drivers and leads to distrust of roadworks signing.

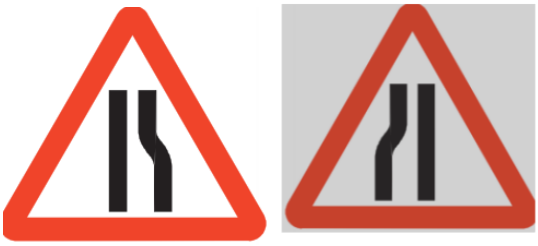
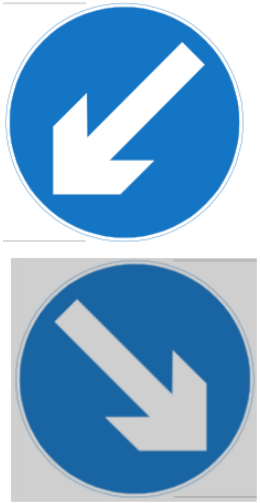
- **Keep the site tidy:** Take up as little road-space as possible and store construction materials, equipment off the road as much as possible. When work is completed, ensure that the road surface is properly reinstated, there are no dangerous holes or trenches and surface is clean from any mud or gravel.

- **Always use the standard signs: Use o**nly the standard signs in the subsequent section. The design details for these sign are given in Annex 1 and 2 of this manual.

8.3 BASIC SIGNS THAT ARE NEEDED

The basic signs that is necessary at work-zones is given in Table 8.1 .

Table 8.1 Schedule of Basic Signs that are Needed at Work-Zones

	The *Road Works Ahead* sign (B38) is the first sign to be seen by the driver. Therefore, place it well in advance to the work site (about 30 metres in town, 60 metres on rural roads, 200 m on a high-speed national highway, arterial). Place the sign where it is visible from a distance. For example, if the works are just after a bend in the road, put the sign before the bend.
	The Road Narrows Ahead sign (B15) warns drivers which side of the road is obstructed and is only needed on high-speed national highways and arterials. Place the sign in between the "Road Works Ahead (B38)" sign and the work-zone.
	Place the "keep left" or "keep right" sign (A29) as appropriate at the start and end to the point where the works extend.
	Place a line of traffic cones to guide pedestrians and traffic past the works. Leave some working space between the line of cones and the actual excavation or works area. The traffic cones should be red with white reflective sleeves if used at night.

	If traffic is heavy or the works-zone is very long, manually control the traffic with *STOP/ GO* boards (A24, A25 If the work-zone is less than 30 m long, on a straight section, only a single board operating at one end or in the middle of the zone is necessary. Do not use flags, as these can be confusing and make sure that the boards are operated by a responsible adult. On high-speed roads, 750 mm high signs should be used. On low-speed roads (50kph or less, the 600 mm high version will normally be adequate.

8.4 SIGN LAYOUTS

The typical layout for signage at work-zone is given below in Figure 8.1. For easy illustration, the advance signing is shown to be close to the work-zone but in practice it would be much further away.

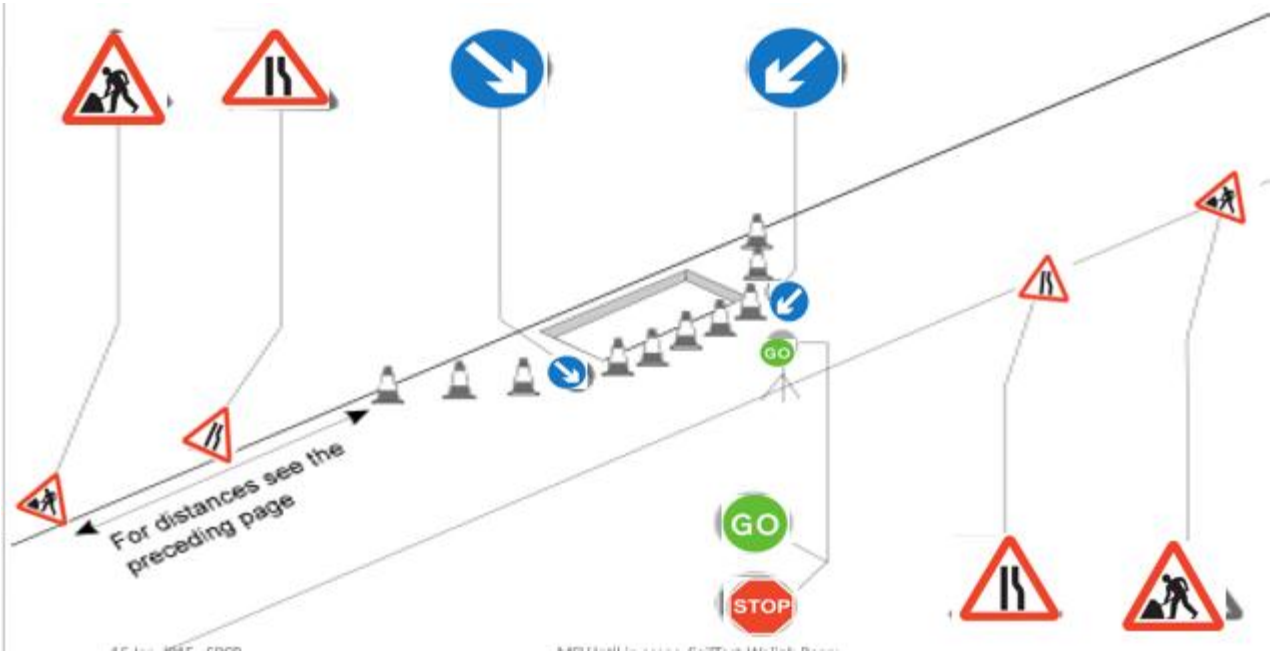


Figure 8.1 Basic Layout of Signage at a Work-zone

Source: Traffic Sign Manual 1997; GoN DoR.

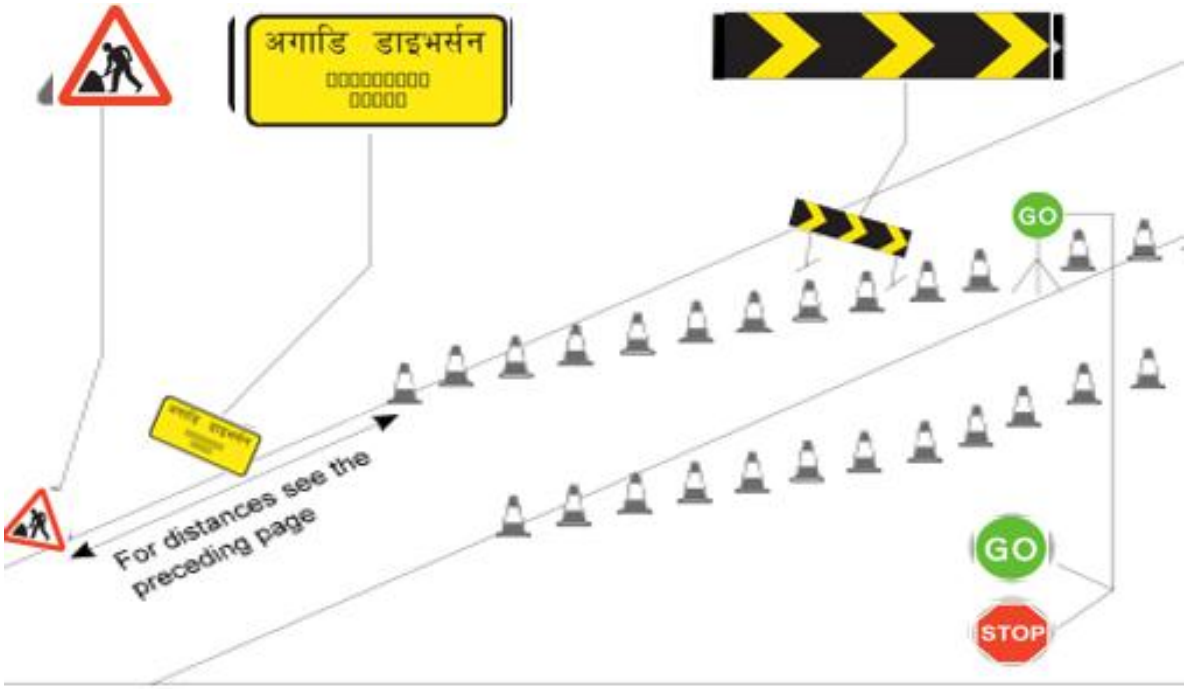


Figure 8.2 Signage at Temporary Diversion for a Work-zone

Source: Traffic Sign Manual 1997; GoN DoR.

8.5 CONTRACTOR'S RESPONSIBILITY FOR SIGNING

If the roadworks is contracted, ensure that the contractors responsible are mandated to plan work-zone as prescribed with the provision of the following clause in their contract.

"The contractor shall take all necessary measures for the safety of traffic, pedestrians and workmen during the roadworks. The contractor shall provide, erect, operate and maintain signs, markings, lights, barricades and traffic control equipment in accordance with the Department of Roads Code of Practice for Signing at Roadworks, as modified by the Engineer or the Client's Representative."

Supervising Engineers and the Client's Representatives have a duty to ensure that contractors meet their obligations, and should be prepared to impose such penalties as are provided under the contract, if the contractor fails to maintain an acceptable standard of signing. The contractor will be more likely to provide adequate signing, if signs and traffic control are included as items in the Bill of Quantities.

CHAPTER 9 ROAD MARKINGS

9.1 PURPOSE AND USE

Road marking have various function which can be understood to be as follows.

- Regulate traffic and enforce rules: They supplement the sign-post to regulate traffic and enforce traffic rules (e.g. prohibit crossing central-line, assign respective lanes, prohibit parking, etc.).

- Warn, delineate critical features, points: They warn about critical locations such adverse cross-slopes, steep vertical drops, zebra crossing, delineate intersections for these features to be more readable, etc.

Owing to their regulatory function where road marking are applied, it is legally mandatory to abide with the road marking. Users violating the rules that apply to a particular road marking can therefore be persecuted on the site.

9.2 SCHEDULE OF ROAD MARKINGS

Based on review of existing road marking and assessment for new requirements, an updated schedule of road marking is given in Table 9.1 for use in Nepal. In referencing the various road marking, the existing code reference adopted in TSM 1997 is maintained and therefore all the marking have prefix "F" before their number and the new marking subsequently follow serially after the existing reference number.

Table 9.1 Schedule of Road Marking

Road Marking Code	Description
F1	Stop Line and Stop sign on Traffic Lights
F2	Give Way to Traffic on major Road or Roundabout
F3	Drivers must give way to Pedestrians on the Crossing
F4	Pedestrians can cross when the traffic is stopped
F5	Lane Line
F6	Barrier Line Do Not Cross
F7	Hazard Line Warning
F8	Traffic Island
F9	Edge of Carriageway
F10	Extended Transverse Line extended across side road junctions
F11	No Parking
F12	Traffic lane arrows
F13	Angle parking
F14	Parallel parking

F15	Bus lane
F16	Bus and cycle lane
F17	Mandatory cycle lane
F18	Advisory cycle lane
F19	End of cycle lane
F20	Road hump
F21	Double solid central line
F22	Double central-line with permitted crossing one direction only
F23	Indented bus layby
F24	Truck loading bay
F25	Bus only
F26	Speed limit roundel
F27	Yellow box marking at four way intersection
F28	Yellow Box Marking at T intersection, side access or kerbside area

A description of all the road marking listed in Table 9.1 is given in Appendix 8 of this manual while example layout of the signage at different road locations is given in Annex 9.

CHAPTER 10 SPECIFICATION FOR MANUFACTURING SIGNS AND MARKING

10.1 SIGN LETTERING

As discussed in Sub-section 6.2, both "Milan TTF" and "Preeti" fonts is recommended for the Nepali text while the "UK Transport Medium" and "UK Transport Heavy" is recommended for the English text in sign-posts and road marking in Nepal. To inscribe the correct lettering spacing is when forming a word in signs and road-marking, the characters in each alphabet are placed on imaginary tiles. These tiles vary in width according to the size of the character involved but their height remained fixed to ensure correct line spacing. For the purpose of design, the line spaces are measured to the edge of the tiles and not to the actual characters. **Error! Reference source not found.** illustrates the sizes of the tile heights for the Nepali and English letter in terms of the capitalized English letter.

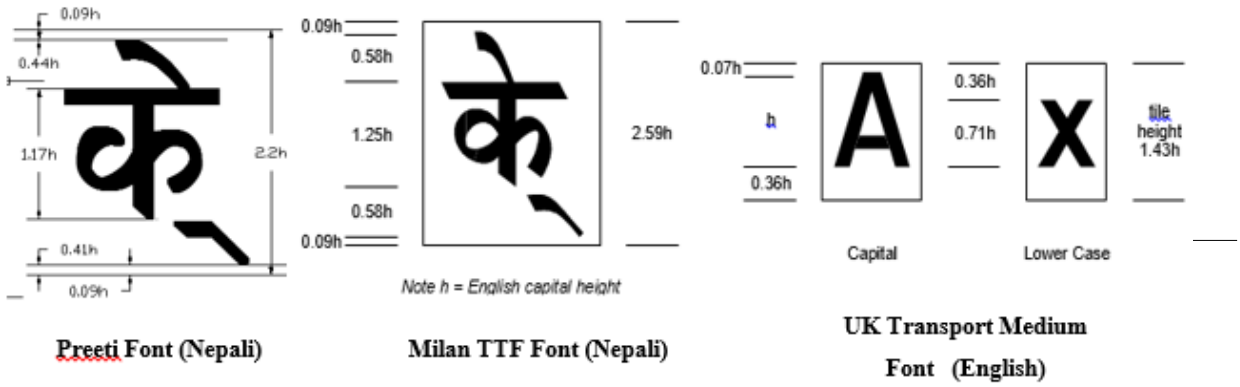


Figure 10.1 Size of the Nepali and English Fonts

The tile height is given on **Error! Reference source not found.**. Each letter was fitted onto a tile which is related to the height and width of each letter of the alphabet. The details of the Nepali and English texts are attached in Appendix 10.

10.2 STANDARDS FOR CONSTRUCTION

10.2.1 Traffic Signs

The materials to use and construction method for the signs will comply with BS873 'Road Traffic Signs and Internally Illuminated Bollards' and Part 6 of the Specification for Retro-reflective and non retro-Reflective signs. Alternative standards can be applied but they must conform to an internationally recognised standard. Retro-reflective sheeting used for the construction of sign plates can reflect light in the general direction of the light source.

The standard colours must be adopted for signs complying with BS873: Part 6: 1983 Table 4 :Chromaticity Co-ordinates and Table 5: Illuminance Factors, US FP-92 FHWA[9] 'Standard Specification for Construction of Roads and Bridges on Federal Highway Projects 1992 or ASTM[10] D4956-90 'Standard Specification for Retro-reflective Sheeting for Traffic Control". Table 10.1 shows the colour codes to adopt for the signs in Nepal.

Table 10.1 Colour Codes to Adopt for Signs

S	Colour	Code	Description
1.	Red	No. 537	Signal red
2.	Orange	No. 557	Light orange
3.	Yellow	No. 355	Lemon Yellow
4.	Green (1)	No. 226	Middle Brunswick green
5.	Green (2)	No. 225	Light Brunswick green
6.	Blue	No. 109	Middle blue
7.	Grey	No. 693	Aircraft grey

Source: BS 381c- 1980

Green in item 4 (Code No. 226) in Table 10.1 is adopted for the background colour in signs installed in national highways while the green in item 5 (Code 225) is used for the green parts of other signs.

10.2.2 Reflectorisation

Signs should preferably be fully reflectorised except for the parts of the sign that are coloured black. However, it is uneconomical to print one-off signs such as direction signs. If a sign need to have a reflectorised background, the sign face will have to be fabricated from reflective sheeting. In this case, it is best to cut out the letters, symbols, borders etc., from sheeting of the appropriate colour and fix them down onto the background. The design is normally printed on the sheeting using coloured inks. For example, the sign face for the A3 No Entry sign is made from white reflective sheeting which has been over- printed with red ink. Signs which are to be positioned parallel to the direction of traffic flow such as parking sign need not be reflectorised.

[9] FHWA = Federal Highway Administration Authority, US

[10] ASTM = American Society for Testing and Materials, US

Map-type direction signs for major routes can be very large and too expensive to be reflectorized entirely. In this case, it is preferable to fabricate the background from cheaper non-reflective sheeting or to economize even further to paint the background.

The reflective sheeting will generally be engineer grade reflective sheeting. However, engineer grade reflective sheeting does not perform well on urban roads that have some street lighting. Therefore, in critical areas of such cases, use of high intensity reflective sheeting may be more appropriate. The engineer grade reflective sheeting shall be of the enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, waterproof plastic. The adhesive backing shall be either of pressure-sensitive aggressive tack type requiring no heat, solvent or other preparation for adhesion or tack-free adhesive activated by heat using a heat lamp vacuum applicator as specified by the sheeting manufacturer. The adhesive shall be protected by an easily-removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the material used in as the sign plate. The adhesive should bond durably to the surface of the sign-plate (which should be smooth, corrosion and weather-resistant) to prevent removal of the sign sheeting from the sign plate. The reflective sheeting shall generally conform to the following requirements:

1. The sheeting shall have high reflectivity when vehicle headlight fall normal to it face, intensity varying on the angle of incidence. The reflective material shall be sharp, glareless and directed towards the light source at an approved angle of incidence.

2. The surface of the sheeting shall be smooth, highly durable under all weather conditions, strongly fungus-resistant. It should be flexible and should not crack when bent. The reflective surface should remain sharp during its expected service life. Bad weather conditions such as rain, dew, etc. shall not considerably reduce the reflectivity.

3. The sheeting shall not delaminate, blister, crack, peel and chip during the manufacturing process and during its expected service life.

4. The sheeting supplied shall be free from dirt, solid lumps, scales, ragged edges and non-uniformity of colour.

5. The colour of the sheeting shall be even, spot-free, not faded. It should not fade appreciably under local weather conditions during its expected service life. The colours adopted must correspond to the colours of the sheeting supplied as samples.

6. It should be easy to clean the reflective surface of the sheeting with soap and water without adversely effecting its reflectivity and durability.

7. The adhesive used on the backing of the sheeting should ensure a high quality bond with the clean, smooth and grease free sign-plates approved by the sheeting manufacturer.

10.2.3 Traffic Signals

The material used and the construction for traffic signals shall comply with BS 505:1971 "Specification for Road Traffic Signals". Alternative standards of construction may be proposed provided that they conform to an internationally recognised standards. Standard colours to adopt for signals must comply with BS1376:1974 or the equivalent American standards.

10.2.4 Frames Supports and Fittings

Steel frames shall be freed from scale and rust by blast cleaning or pickling and protected by one of the following methods:

1. Thermally spraying with aluminum or zinc in accordance with BS 2569: Part 1 to a nominal thickness of 100 mm;
2. Hot dip galvanizing in accordance with BS 729 followed by a coat of suitable pre-treatment primer where a finishing coat is to be applied;
3. Applying two coats of inhibitive primer followed by one of undercoat;
4. Applying a plastics coating.

When the frame is of welded construction the weld areas shall be freed of scale and treated to give a protection equivalent to that given to the remainder of the frame. The frame shall be fabricated prior to the application of any finishing coat.

Steel fittings and accessories such as clips, brackets, screws, bolts, nuts, rivets and washers shall be prepared and finished as above.

The reverse of signs should have a top coat finish colour of either grey or black. All post shall be painted in alternate black and white stripes at 200 to 250 mm band widths.

10.2.5 Back Support Frame

Unless otherwise specified, aluminum sign plates and steel sign plates greater than 0.4 square metres in areas, must be supplied with a back support frame of a size and design to avoid the plate being deformed due to wind pressure, or manipulation by vandals (other than severe attack). The frame will normally be made of a steel angle riveted or bolted to the sign plate, and shall incorporate brackets to enable the sign plate to be bolted to the sign post.

All screws, bolts, nuts, washers, rivets, etc., must be protected against corrosion. Steel fixings that come into contract with aluminum must be coated with zinc or cadmium to prevent corrosion through electrolytic action.

The complete sign when mounted on its support in accordance with the manufacturer's instructions, shall be rigidly locked in position to resist twisting.

10.2.6 Sign Plates. Sign Plate Preparation And Coatings

The choice of aluminum or steel will normally be governed by the type of sign being manufactured. Generally the sign plates for all fully reflective signs will be aluminium. Non-reflective or partially reflective signs will use steel sign plates. Wood or reinforced concrete is not acceptable for sign plates.

(1) Aluminum Sheeting

When aluminum is chosen, its sheeting shall be 2 mm thick unless otherwise specified. After any cutting and punching has been completed all sharp edges shall be uniformly rounded off and smoothed down. The metal plate shall be degreased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth, plain surface. After cleaning, metal shall not be handled except by a device or clean canvas gloves. There shall be no opportunity for metal to come into contact with grease, oil, or other contaminants prior to the application of the reflective sheeting.

(2) Steel Sheeting

When steel plate is chosen, it shall be 1.25 mm thick. However, plates 1.6 mm thick (which is more readily available) or 2.0 mm are acceptable. After any cutting, welding and punching has been completed all sharp edges shall be uniformly round off and smoothed down. All physically adhering contaminants shall be removed and the surfaces abrasive-blasted and then thoroughly cleaned and degreased. Unless the application of a primer follows within 4 hours of the abrasive blasting and before any oxidation of the prepared surfaces takes place, the surface shall be given one coat of wash primer immediately after blasting.

The prepared surface shall be given two coats of a zinc chromate primer. The first coat is to be applied within 12 hours in the case of wash-primed surfaces and within 4 hours, but before any oxidation of the surface takes place, in the case of abrasive-blasted surfaces that have not been wash-primed. There shall be no opportunity for the metal to come into contract with grease, oil or other contaminants prior to the application of the reflective sheeting.

(3) Coating

Parts of the sign plate not covered by reflective sheeting (including the reverse of the plate and the back support frame) shall be coated using either by painting, stove enameling or powder coating processes. The colour of the reverse of sign plates and support frame shall be grey or black.

10.2.7 Road Markings

The paint used for road markings should be manufactured specifically for this purpose and should comply with BS6044: 1987 (1995) 'Pavement Marking Paints' or the equivalent American Standards. It should be quick-drying, durable, and have a good skid-resistance. The paint may be applied by brush or machine, however before ordering paint the proposed method of application should be specified to the manufacturer to ensure that the correct type of paint is ordered. Hot sprayed plastic or thermoplastic may also be used but these should be checked that is suitable for use in tropical conditions. Adhesive-backed road marking tape is hard-wearing and has a very high reflective brightness, but it is too expensive for general use.

Road paint or plastic can be reflectorised by the addition of reflecting glass beads, called ballotini. They may either be mixed into the paint, applied to the marking while the paint is still wet, however the paint must be manufactured for use with ballotini. The ballotini should comply with BS6088: 1981 (1993) 'Specification for Solid Glass Beads for use with Road Markings'.

Markings must not be laid until the correct temporary traffic signs are in place. The road surface must be clean and dry, and completely free from dirt, grease or any other material that might prevent the paint from adhering properly. The outline of the marking should be marked on the road surface with chalk or paint spots. It is worth making templates for the more complicated markings such as arrows. The paint may be applied by brush or by machine. Traffic must not be allowed over the markings until they are dry. On completion the longitudinal lines should present a smooth visual flow to be the eye with no kinks or sudden bends.

10.2.8 Reflective Road Studs

(4) General

The reflective road studs or raised road pavement markers (RRPMs) shall comply with the BS873: Part 4: 1987 with exception to the adhesive prescribed, which may not be suitable for the Nepalese conditions. The RRPMs shall be either of the corner-cube and glass spheres encased in an acrylic or plastic shell with honeycomb or flat base but the former type is preferable owing to its effectiveness. The RRPMs may have one reflecting surface (uni-directional) or two (bi-directional), with each reflecting surface fitted either with a corner-cube reflecting plate or with groups of reflecting glass spheres.

The RRPMs should be about 15 – 20 mm thick and withstand a minimum of 200 kN compressive force. One reflecting surface of the comer-cube type should have at least 6100 - 7350 mm^2 reflective area. The glass-sphere type of markers should have a reflective number of at least 18. The RRPMs should be durable up to five years when installed in asphalt concrete roads.

(5) Colour Scheme

The colour-scheme of the RRRPMs to be adopted will depend on location where they are to be installed as outlined below.

White: lane, turning-path lines,

Yellow: central-lines, around ghost-islands, right-side edge of one-way carriageways

Red: around the physical traffic islands and left-side edge-lines.

Blue: to mark fire hydrants or water-supply locations only.

Table 10.2 indicates the spacing of the RRPMs to be adopted.

Table 10.2 Spacing of RRPMs (Road Studs)

Type of marking	Site	Spacing (m)
Conventional central line (dashed)	Urban	12
	Rural	18
Hazard central line	Urban	6
	Rural	9
Prohibitory central line (solid)	Urban	4
	Rural	6
Edge-line	Urban/Rural	24
Left/right turn path-line	Urban/rural	12
Through turn path-line	Urban/rural	24
Traffic islands, medians	Urban/rural	4 -12

(6) Warrant for RRPM Installation

i. General Warrants

Though RRPMs shall be installed at all types of roads in both rural and urban situations, they shall be confined at present to strategic roads and complex intersections in light of their high initial cost. Their installations will also be limited to roads having a surface that will not be subject to major repair for at least one year.

The RRPMs should be used to supplement the central-line of a single carriageway two-way road, if the annual average daily traffic (AADT) is in excess of the following:

- 3,000 vehicles on rural roads
- 6,000 vehicles on urban roads

These devices should be used to supplement the edge line if the AADT is in excess of the following:

- 5,000 vehicles on rural roads
- 10,000 vehicles on urban roads

ii. Special Warrants

On single carriageway, two-way roads, RRRPMs should be provided where the following conditions exists.

- Average annual rainfall in excess of 1000 mm or road is subject to frequent fogs
- Sharp curves
- Hazardous locations, such as narrow bridges
- Roads with high incidence of accidents during night and when wet

iii. Exceptions to the Warrants for Installations

1. RRPMs may not be necessary on edge lines of rural divided or undivided roads if the edge-lines and delineator-posts are properly maintained.
2. On single lane carriageways, e.g. ramps. RRPMs should not be used to supplement edge lines unless they are also used, at the same location, to supplement separation, barrier or lane lines. They should not generally be used on edge lines where the shoulder is less than 1 m wide.
3. RRPMs should not be used on continuity lines at lane drops in areas subject to frequent fogs, as they may inhibit rather than enable correct merging maneuvers under such conditions.
4. In urban areas, especially on narrow lanes, noise generated by traversing motorists may cause concern in or near residential areas. An alternative form of delineation (large glass beads) may be considered.
5. RRPMs may not be necessary in tunnels, which are illuminated and are unlikely to get the pavement markings obliterated due to water. It is recommended to use profile lane and edge lines instead.

CHAPTER 11 SPECIFICATIONS FOR INSTALLATION OF SIGNS

11.1 INSTALLATION OF SIGN-POSTS

11.1.1 Mounting Posts

Standard sections used for steel mounting posts for permanent sign-posts should be manufactured in accordance with the British Standards applicable. Where there is no relevant British Standard, it shall be in accordance with the generally accepted practice of manufacture. The most common practice is to use 50 mm internal diameter steel tube but 78 mm by 38 mm C channel is equally acceptable and has the added advantage of giving a flat surface on which to bolt the sign plate. Posts constructed from wood or reinforced concrete will not be acceptable.

Before accepting other types of steel section for posts, the road agency need to be satisfied that the proposed post will not suffer any permanent deformation or other form of failure when it is subjected to the estimated working stresses.

11.1.2 Fixing

The method of fixing the sign-plate (and frame if used) to the mounting post or posts should be such as will facilitate its removal for replacement purposes. A typical method of fixing unframed signs to a circular post is by the use of half clips which are riveted, bolted or welded to the sign plate. A typical method for fixing a larger framed sign is for the back support frame to have two flanges one at the top and one at the bottom. The sign is then fixed to the sign post by bolting through the flanges.

Each type of sign plate and mounting post presents its own fixing problem, but the aim should be to provide a fixing for the sign plate (and frame if used) so that although it can be easily removed for replacement purposes, it is held firmly enough to withstand the loading to which it will be subjected. All nuts, bolts, washers etc., must be protected against corrosion. Steel fixings that come into contract with aluminum must be coated with zinc or cadmium to prevent corrosion through electrolytic action.

In order to help prevent theft of the sign, the ends of the threads of fixing bolts should be filled down, deformed with a hammer or the thread spot welded. Where a sign is mounted on a single post, care should be taken to prevent the forced rotation of the sign round it. In the case of a circular post this may be achieved by means of a pointed grub screw in the clip which is screwed into the post.

Care should be taken to prevent the rotation of the post in its foundation which may be achieved by passing a length of the bar through holes drilled in the base of the post below ground level. For additional rigidity, the bar can be welded to the base of the post.

11.1.3 Foundations

The type of foundations required, particularly for larger direction signs, will vary with the local soil conditions. These may be in mass concrete or reinforced concrete. The buried section should be at least one-third the overall length of the post. Unless otherwise specified the foundation for a single post should be at least 450 mm x 450 mm and 600 mm deep. The concrete should be a 1:3:6 (cement: sand: gravel) mixture. After pouring, it should be properly compacted with a tamper. The top surface should be smooth with a slight slope outwards from the post to ensure proper drainage. The top surface of the finished concrete should not be proud of the surrounding ground surface as the provision of foundation blocks or plinths will enable vandals to reach the sign plate more easily.

The foundation should be designed and placed at such a depth that it will safely support the sign under its loading conditions without causing failure due to shear or heave in the surrounding soil. Special precautions should be taken to ensure the adequacy of foundations in made up ground. Foundation for the large directions signs should not be 'covered up' until they have been inspected and approved by the Engineer.

Temporary struts should be used to hold the post in position until the foundation is complete, making sure that the post is vertical and that the sign plate is level and at the correct angle to the road. It is recommended that the installation date is painted on the back of the sign.

11.2 APPLICATION OF ROAD MARKINGS

Carriageway markings may be laid either by hand or by machine. The choice will depend on such factors as the type of material, the pattern of the marking, how frequently the pattern is repeated, and on the amount to be laid. In busy urban areas consideration has to be given to clearing the street of parked vehicles; the only alternative may be to operate at night, or at weekends.

It is essential that all types of carriageway markings should be skid-resistant in wet conditions. Adequate skid resistance is particularly important where the camber or cross-fall is steep and at junctions where turning traffic includes an appreciable number of two-wheeled vehicles. As it is not possible to lay carriageway markings to precise dimensions and in order to allow for the markings "spreading" in service, certain tolerances to the prescribed dimensions are permitted as below.

Specified Dimension Involved	Permitted Tolerance Dimension
(a) 3 m or over	±15%
(b) 300 mm or over, but under 3m	±20%
(c) Under 300mm	±30%

The maximum projection of the line marking above the surface is 6 mm. It is particularly important that this should not be exceeded because of the danger to traffic, especially to two-wheeled vehicles, and to pedestrians. Where markings are re-laid over existing markings after surface dressing of the carriageway, care should be taken to ensure the overall projection of the markings should also not exceed 6mm.

11.3 RRPM (ROAD STUDS) INSTALLATION

11.3.1 General

Prior to the installation of the RRPMs, the road surface should be cleaned and dust, oil, grease and other contaminants removed. The surface should, where possible, be allowed to weather and compact for a minimum period of six to eight weeks depending on the traffic conditions prior to the installation of these devises.

The retro-reflective face of the RRPMs should face the oncoming traffic rather than being placed perpendicular to the tangent of the turning path. These devices should be oriented in such as way so that the full reflective effect is realized when vehicles make their approach. The RRPMs shall be bonded to the asphalt road-surface through either of the following methods:

1. Bituminous or epoxy adhesive
2. Thermoplastic pads adhesive
3. Heavy duty road nail plus epoxy adhesive.

For surface-dressed road-surfaces, the same method of installation may be followed taking extra precaution to ensure that a good bonding.

The RRPMs should be installed at the mid-point of the gap between the broken lines or at a lateral offset of 25 -50 mm in the case of solid lines at the interval stipulated in Table 10.2, to avoid interference or prevent degradation of their reflective properties during the re-painting works of the road-markings.

Normally, the RRPMs shall be laid immediately after applying the adhesive. However, some markers may be require a groove to be cut into pavement for proper siting and anchorage. One shall refer to the manufacturer's manual to ensure that such groove are properly made using the right equipment and prevent undue damage to the pavement structure.

11.3.2 Applying the Adhesive to the RRPM

The bonding should be in accordance with the manufacturer's instructions. The quantity of adhesive should be just sufficient to completely cover the area of contact between the RRPM and

the pavement and any excess adhesive around the edges of the markers should be removed to prevent it from obscuring the reflective face of the RRPM.

It is advisable to install the RRPMs when the road surface is completely dry and the road surface temperature is greater than 4°C unless the adhesive manufacturer recommends its suitability for use in other conditions as well. A blowlamp may be used to prepare the road surface in damp or cold weather but care should be taken not to overheat the road surface as this can weaken it. In cases of doubt the adhesive manufacturer's advice should be sought to ascertain whether the adhesive is appropriate to the road-surface in question.

Any settling of fillers or pigments in the adhesive components should be completely dispersed by stirring before the components are mixed.

Just before use the components should be thoroughly mixed to give a homogeneous mixture of uniform colour. The manufacturer's instructions should be followed regarding the application of the adhesive and any safety precautions.

The RRPM bonded with bitumen, thermoplastic pads should be heated as per the manufacturer's instruction and laid over the road surface. The adhesive should be used as quickly as possible after mixing and never after it has started to set in the container. Once the adhesive is applied, the RRPM should be laid over it by pressing it as per the manufacturer's instruction. The whole of the bottom surface of the RRPM should be allowed to set sufficiently before allowing traffic to overrun it.

11.3.3 Installing anchored RRPMs

The anchor bolts shall be properly inserted into the RRPM as per the manufacturer's literature. The cavities formed in the bituminous surfaces should be thoroughly cleaned. In cold weather, the temperature of the bituminous material immediately surrounding the cavities formed to accept the anchored part of a marker, may be gently heated in order to prevent rapid cooling of any heated bituminous adhesive or grout used in the cavity. Care should be taken not to overheat the road surface as this can weaken it.

CHAPTER 12 MAINTENANCE OF SIGNS AND MONITORING

12.1 GENERAL

It is necessary to have a high standard of maintenance regime in place for traffic signs, traffic lights and road-markings so these devices can effectively function. All signs and markings, reflective/ solar road-studs (pavement markers) should be inspected regularly at frequent intervals during daytime and at night-time, where appropriate, to check reflective quality of the signs, road-marking and road studs. Signs become less effective when they fade, become dirty, damaged or displaced following a road crash or an act of vandalism. Damaged or dirty signs lessen road users' respect for the signs.

The defective or damaged signs should be identified during regular inspection, sign audit and replaced promptly while the dirty sign-posts should be cleaned regularly. All of these maintenances such as cleaning of signs, trimming vegetation obstructing sign and repainting is included under routine maintenance that DoR follows throughout the strategic road network and other agencies should also adopt this maintenance policy.

Road-markings should normally be repainted some weeks after resurfacing or after completion of the road works. There should be measures in place to protect road-studs during surface dressing operations.

A suitable interval for re-painting road-marking depend on the type of the marking, the material used and the road traffic conditions that prevails. Nevertheless, a marking maintenance programme should be adopted and the renewal interval should be constantly refined to ensure that the markings are maintained to a high state of effectiveness at all times, particularly on heavily trafficked roads.

12.2 MAINTENANCE SCHEDULE

(1) Inventory and Inspection

All signs, road-markings, traffic control devices should be inventoried to effectively plan their maintenance. This inventory should include the following details of an item.

i. Its description

ii. Its location (preferably by geographical reference and chainage)

iii. Date of installation, inspection and repair, as applicable

iv. Coded reference for sign-posts and other traffic control devices

v. signs that are missing or wrongly installed

vi. Sign-posts that are damaged, displaced, tilted following crash or other causes

vii. Signs that are faded, worn out;

viii. signs that are obscured by vegetation;

ix. signposts that are loose or have loose foundations;

x. Signposts and plates that have corroded;

xi. Signs that poorly reflect (best checked at night);

The coded reference should be painted on the back of the sign plate or traffic control device themselves. Inspections should be conducted at least twice yearly, preferably after routine cleaning has been done. The following items should be noted during these inspections. The record of the faults and the action that was taken should be well maintained.

(2) Cleaning of Sign-posts and Clearing Obstruction

Sign-posts should be cleaned at least twice a year with priority to low-mounted sign-posts. Use water and a mild detergent to wash the sign and take care note to scratch the surface. Rinse the sign in clean water to remove all traces of detergent. Road tar can be cleaned off with petrol or white spirit, but be careful not to dissolve the paint, and rinse well afterwards.

All vegetation obscuring sign-posts should be trimmed down but if big trees obscure the sign-post, it is preferable to relocate such sign-post at another location for improved visibility. Install supplementary sign-board below such primary sign-board thus relocated if the sign is installed at a distance from the hazard shorter than specified.

(3) Repairs

Minor repairs, re-painting can be done on-site but repainting should only be done in dry weather and after proper preparation of the surface. Painting should not be applied over reflective sheeting as this will make it non-reflective. Similarly, ordinary road paint should not be applied over reflectorised road markings.

12.3 STORING AND TRANSPORTING SIGNS

Signs should always be stored where they cannot be damaged and stacked vertically, if possible. The sign faces should be protected from scratches by inserting cardboard or thick paper between them. They should be carefully loaded and unloaded on and off the trucks and not allowed to bounce around while being transported.

12.4 IMPROVED SIGNAGE TO IMPROVE ROAD SAFETY

Either the road maintenance programme, a crash mitigation study or a road safety audit should identify the location where crashes take place frequently (a crash blackspot). At these locations, improved signage is often the most cost effective countermeasure. Therefore, such blackspots

should be analysed in more detail to establish whether better signage would mitigate crashes and improve road safety in general.

12.5 MAINTENANCE OF RRPMS OR ROAD STUDS

Driver behaviour and cleanliness of the road surface affects the durability of the RRPMs. For example, when the RRPMs are frequently run over by heavy vehicles, the reflectors may get scratched and when dirt accumulates on the reflectors, their reflective quality diminishes. Thus the reflectors should be brushed and cleaned at a regular interval.

APPENDIX - 1: DESCRIPTION OF REGULATORY SIGN-POSTS

APPENDIX - 2: DESCRIPTION OF WARNING SIGN-POSTS

APPENDIX - 3: DESCRIPTION OF INFORMATORY SIGN-POSTS

APPENDIX - 4: REFERENCE CODE FOR THE STRATEGIC ROADS

APPENDIX - 5: SAMPLE SRN DESTINATIONS TO DENOTE IN DIRECTIONS SIGNS

APPENDIX - 6: DESCRIPTION OF SUPPLEMENTARY PLATES

APPENDIX - 7: DESCRIPTION OF TRAFFIC SIGNALS

APPENDIX - 8: DESCRIPTION OF ROAD MARKINGS

APPENDIX - 9: SAMPLE LAYOUTS OF SIGNAGE

A9.1 EXAMPLE LAYOUT OF SIGNS AND ROAD MARKING

A9.1.1 General

Based on the principle of signage as discussed in the previous section, some example of good practice for signage at common locations along the road is given in the subsequent sections. In all the examples, both sign-posts and road-marking that is essential are illustrated with the placement of the various signs conforming to the prescribed standard in the previous section. Many of the examples is reproduced from the DoR TSM 1997.

A9.1.2 Signage at a Road Hump

As discussed previously, road humps in Nepal are neither designed appropriately while signage is virtually absent. Figure A1 shows the signage that is necessary at road hump.

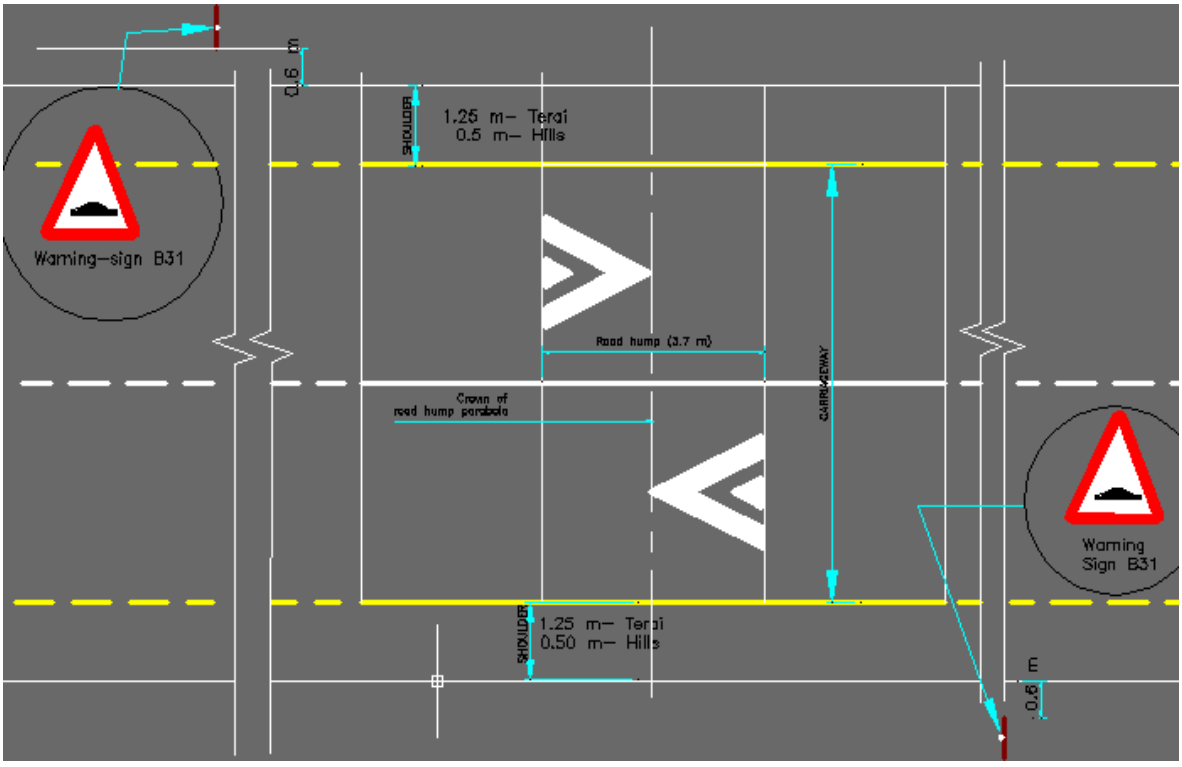
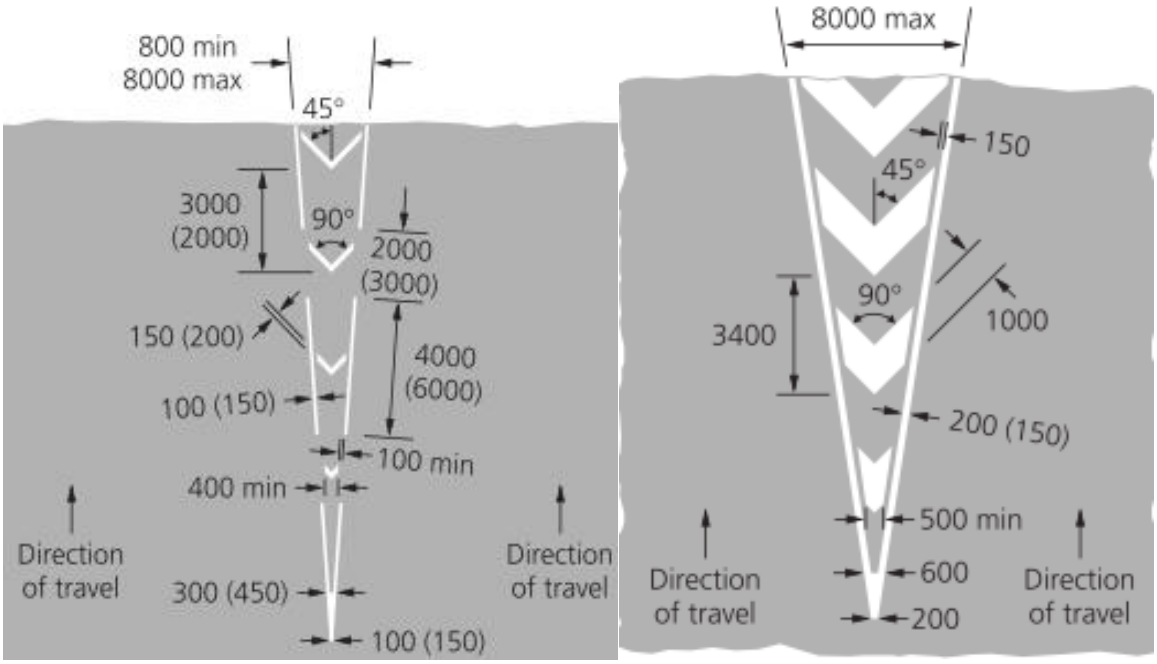


Figure A9-1 Proper signage to be Provided at Road Hump

A9.1.3 Chevron Markings

Chevron marking is included in this manual under the code F8 and form an important feature of the delineation that effectively guide road users to channelize into different path in a split island or to merge. The angle of inclination of the diagonal hatching on each side of the chevron is inclined towards the direction of travel as shown in **Figure A9-2**. In turn these marking give

useful, effective visual clues to the road users to safely navigate and users readily understand the traffic regulation in place.



(a) In One-way Approach (b) In a High Class Arterial Road

Figure A9-2 Chevron Marking for Bifurcation

A9.1.4 Diagonal Strips

Where the traffic merges, the corresponding marking will be diagonal owing to the practice of aligning the transverse diagonal towards the approaching traffic. The resulting diagonal strips to be applied in this case is illustrated in **Figure A9-3**.

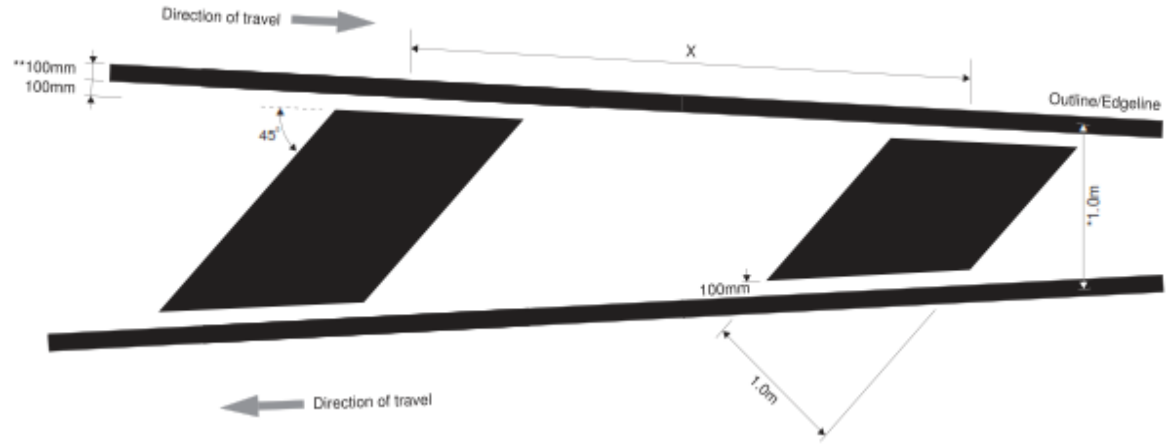


Figure A9-3 Diagonal Strips at Vertex of Median Island (Ghost, Raised)

A9.1.5 Delineating Ghost Island

The use of very small corner islands (less than 3m sides) should be avoided as these confuse drivers regarding give way responsibilities when turning at intersections. In these cases, chevrons and diagonal stripes may be used between the outline and the kerb of a raised island as shown in Figure A9-4 where better turning control is required. However they should only be augmented with diagonal stripes where the distance between the kerb and outline is greater than 1.0 m.

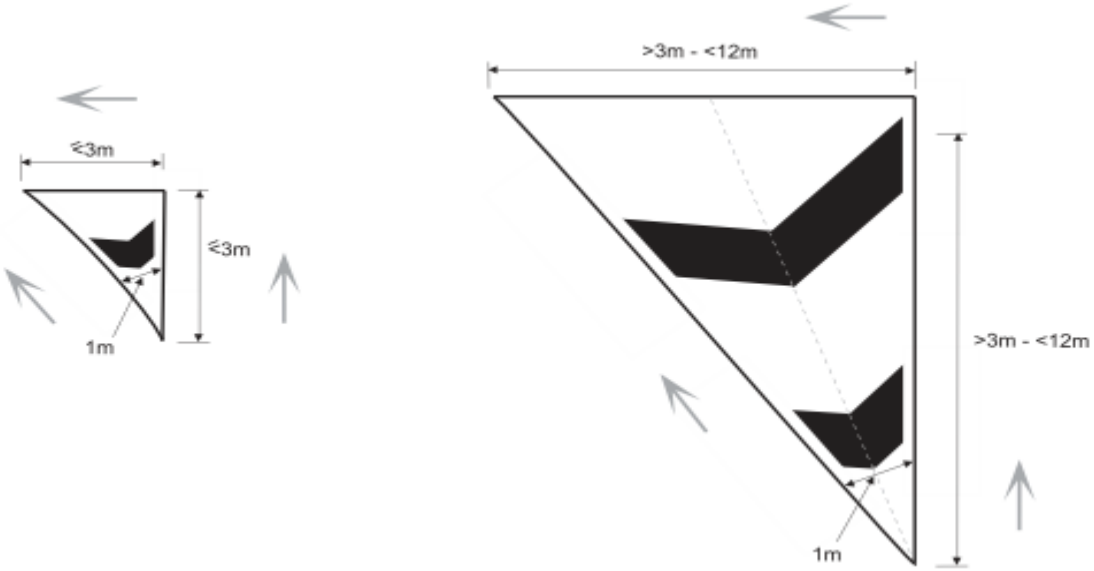


Figure A9-4 Virtual (Ghost) Island using Chevron Marking

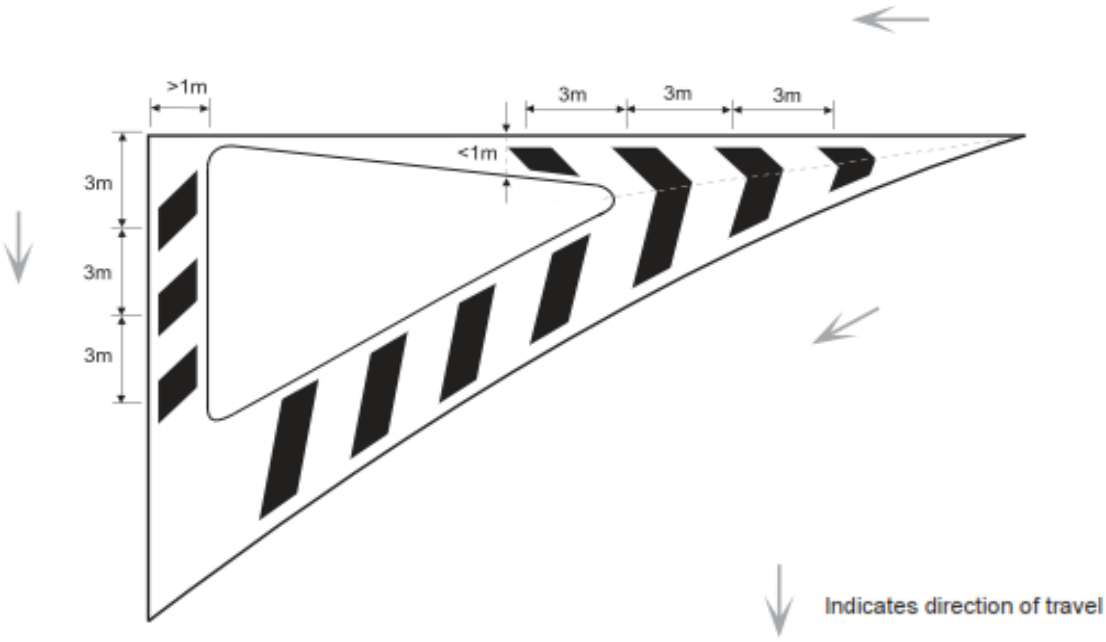


Figure A9-5 Chevron Marking Around Raised Island

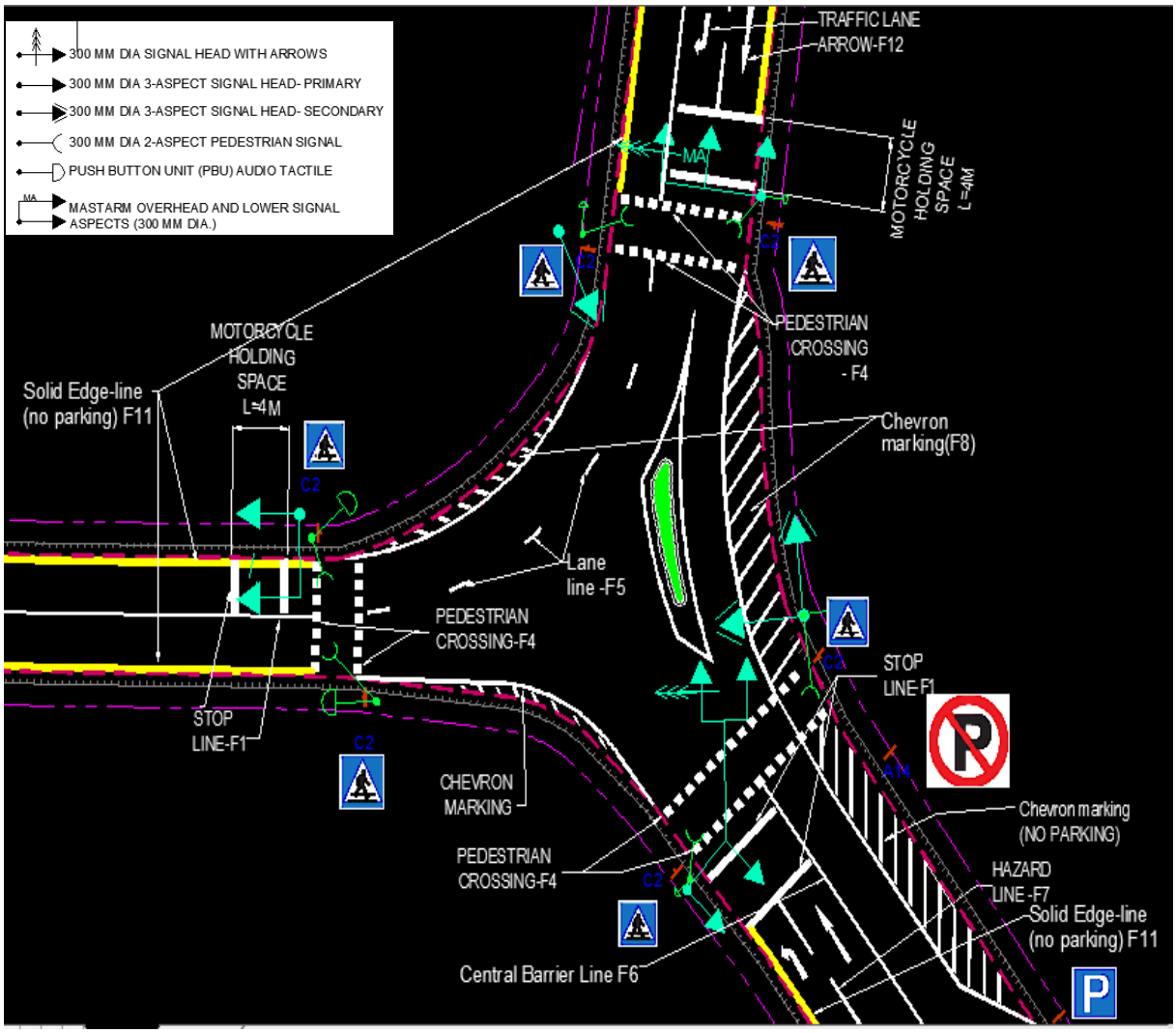


Figure A9-6 Example Delineation of Signalised Y- Intersection

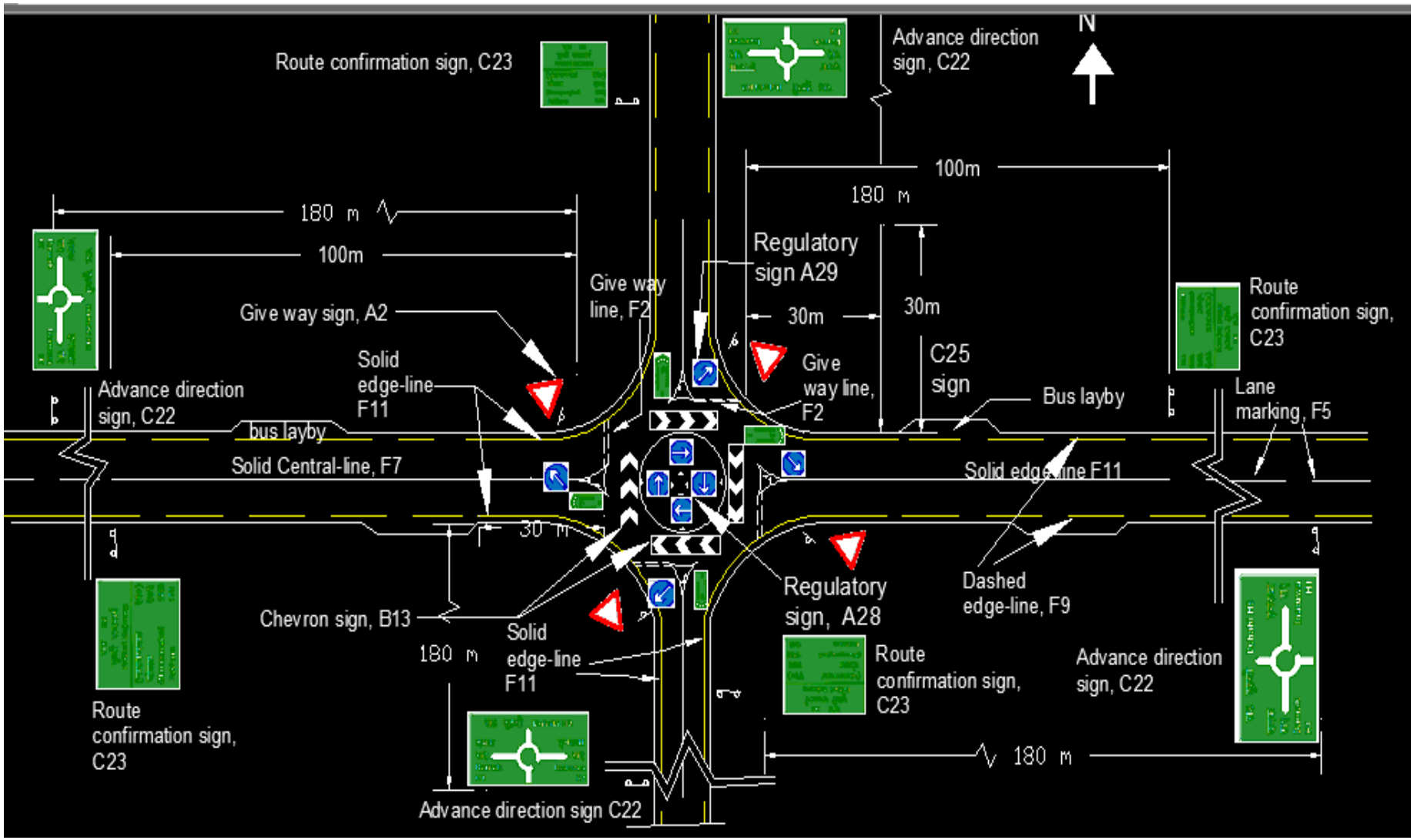
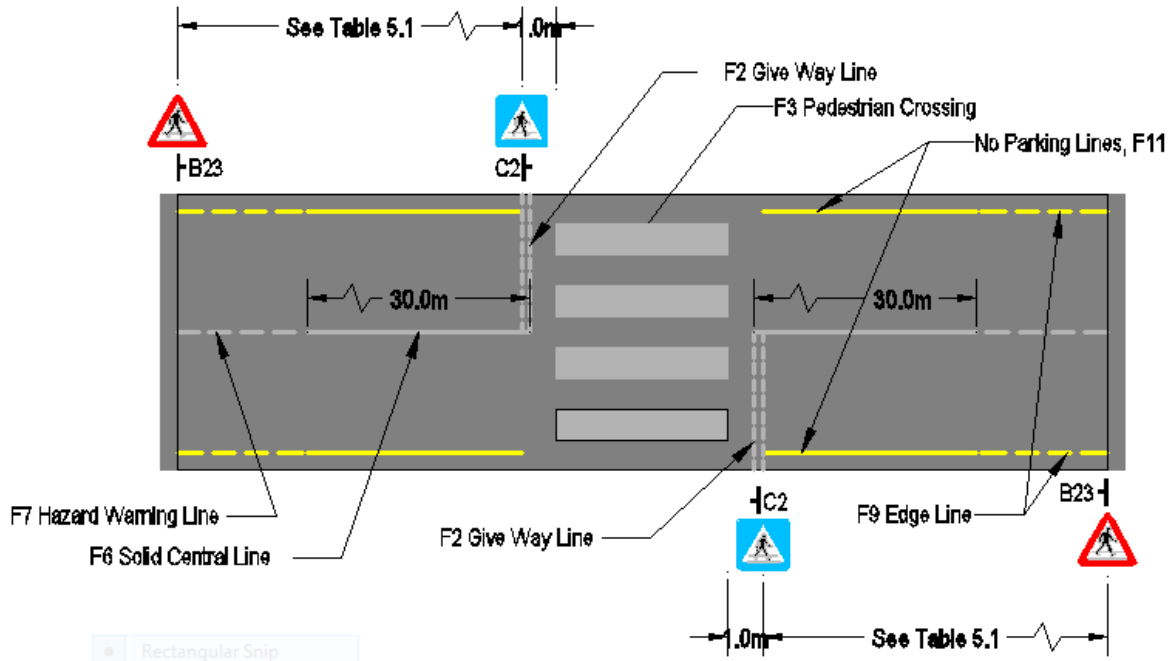
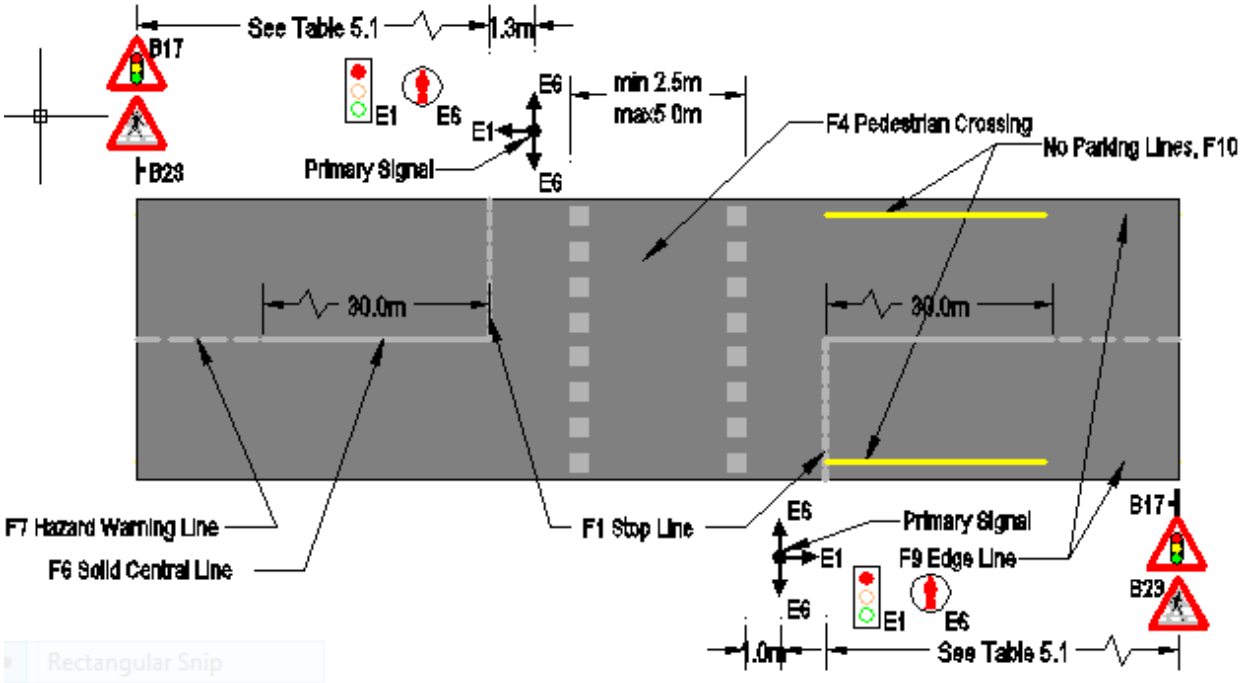


Figure A9-7 Example Delineation at Roundabout



Zebra-crossing (unsignalised)



(Signalized crossing)

Figure A9-8 Signage at Mid-block Pedestrian Crossing

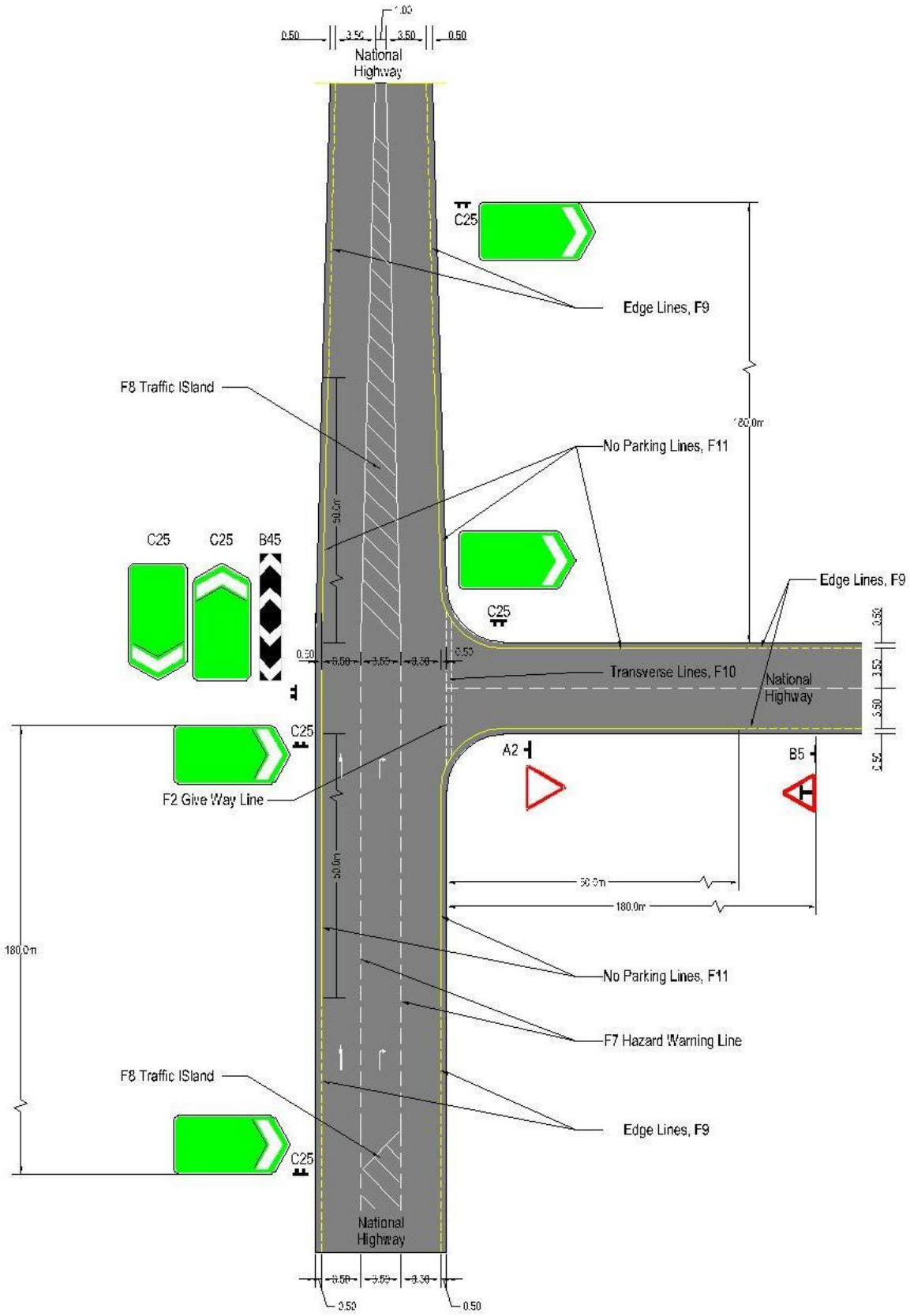


Figure A9-9 Major Intersection with Ghost Island (Virtual Island)

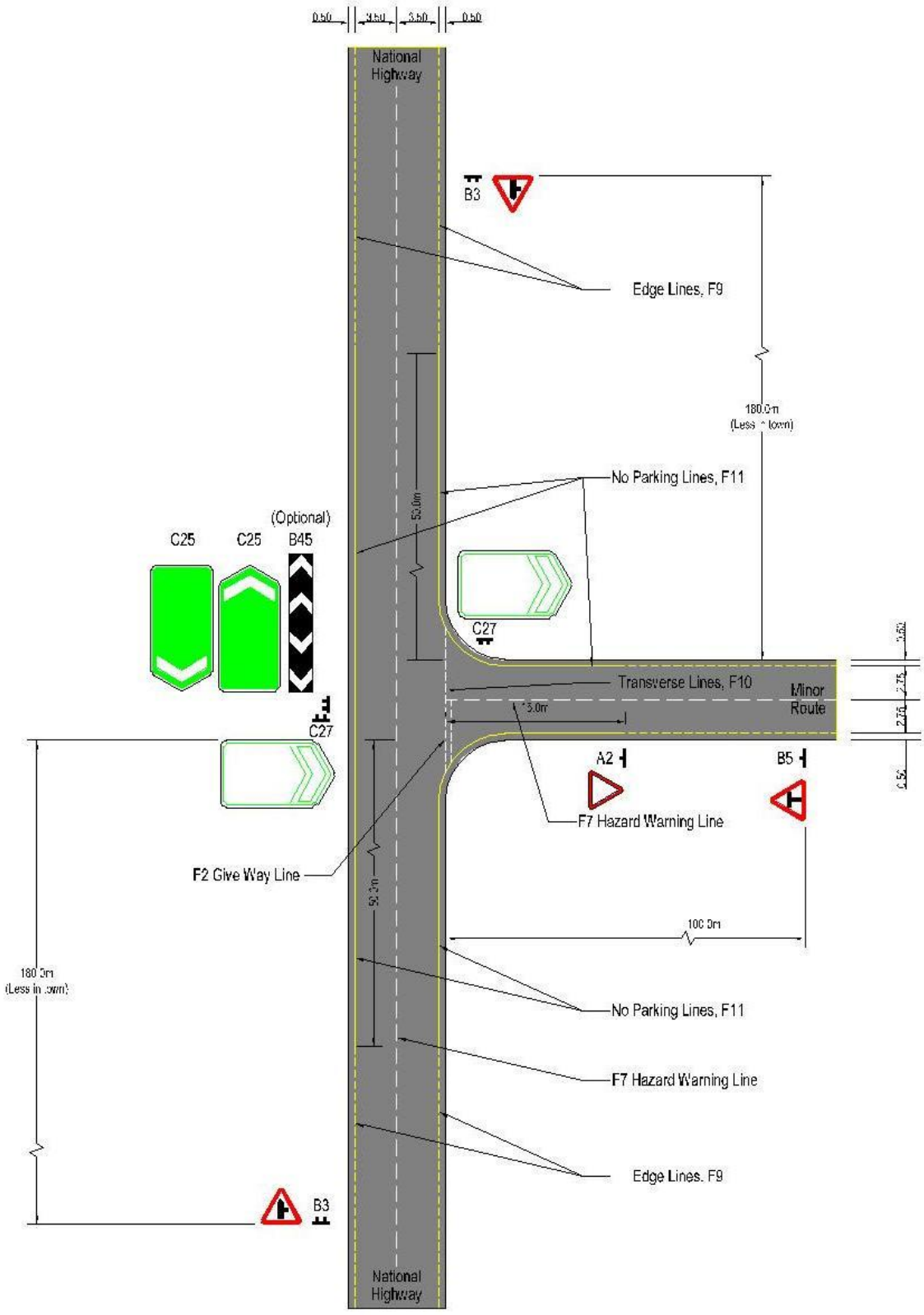


Figure A9-10 Major T Intersection (Intersection of a National Highway with a Minor Road)

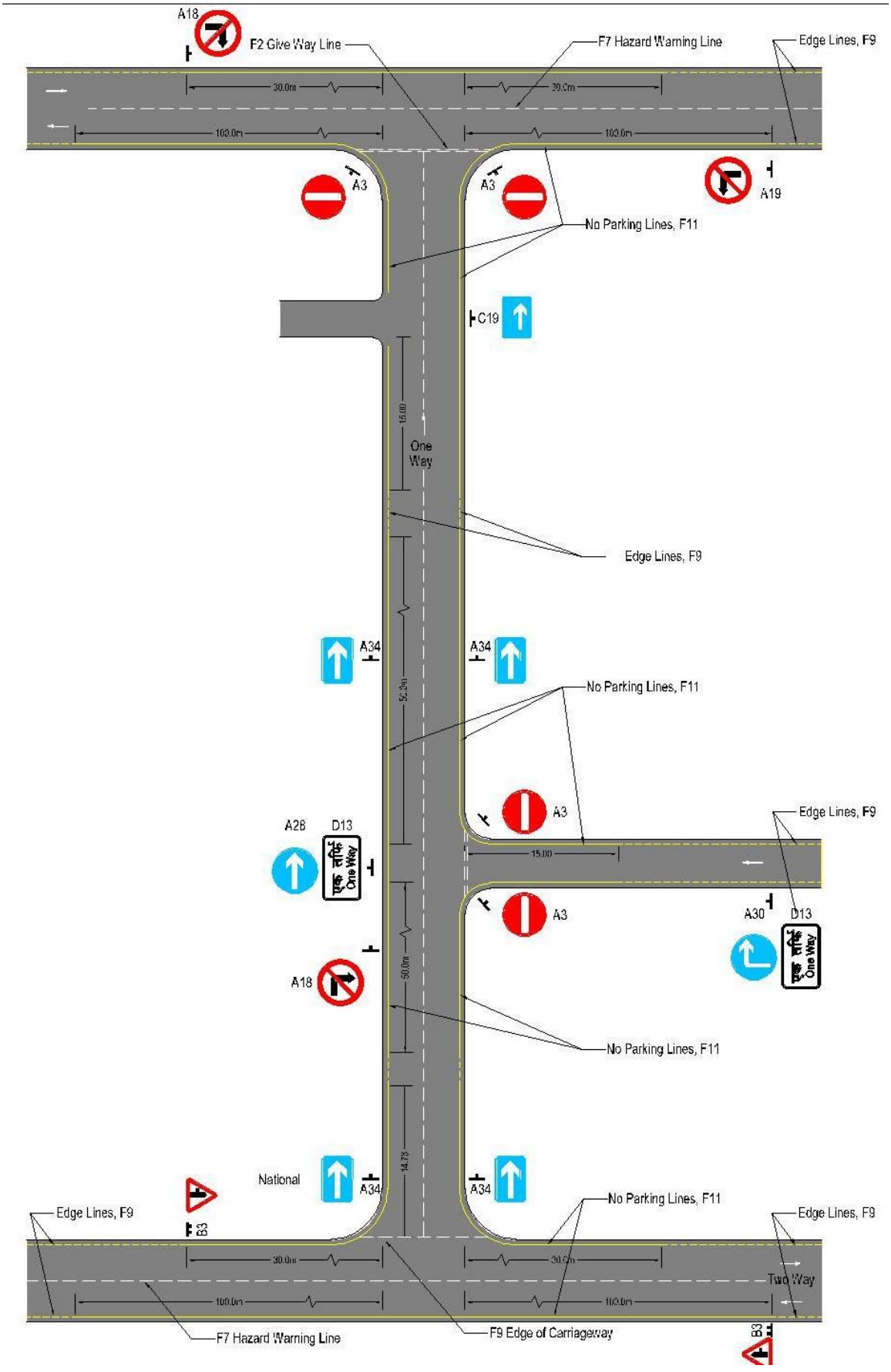


Figure A9-11 Signage on One-Way Network

APPENDIX - 10: DETAIL OF NEPALI AND ENGLISH LETTERING

A10.1 SIZE OF THE NEPALI AND ENGLISH TEXT USED IN DIRECTION SIGNS

The width of the Transport Heavy alphabet for English texts is given in terms of the height of their capitalized text in the table below.

Upper Case		Lower Case		Numerals	
A	1.01	a	0.79	1	0.60
B	1.04	b	0.87	2	0.89
C	1.08	c	0.76	3	0.97
D	1.07	d	0.85	4	0.99
E	0.97	e	0.79	5	0.93
F	0.86	f	0.56	6	0.92
G	1.11	g	0.84	7	0.76
H	1.14	h	0.85	8	0.99
I	0.52	i	0.39	9	0.92
J	0.68	j	0.51	0	1.04
K	0.99	k	0.81	&	0.91
L	0.84	l	0.45	(	0.82
M	1.33	m	1.24	)	0.82
N	1.20	n	0.85	?	1.04
O	1.13	o	0.82	.	0.40
P	0.96	p	0.86	:	0.40
Q	1.15	q	0.86	‘	0.49
R	1.06	r	0.61	-	0.51
S	1.04	s	0.71		
T	0.84	t	0.60		
U	1.12	u	0.86		
V	0.95	v	0.76		
W	1.38	w	1.14		
X	0.93	x	0.79		
Y	0.91	y	0.76		
Z	0.85	z	0.66		

The Widths of the Nepali alphabet

The widths are given in terms of their capital height h

क	1.55	क्	1.21	१	0.69	ा	0.65	◌	0.63	ऋ	1.84
ख	1.85	ख्	1.20	२	0.89	ि	1.16	◌	0.51	ट्र	1.06
ग	1.18	ग्	0.79	३	0.92	ी	0.91	◌	0.43	ठ्ठ	1.09
घ	1.32	घ्	1.09	४	1.16	क	1.55	कृ	1.55	ड्ड	1.10
ङ	1.61	ङ्	1.61	५	1.13	का	2.13	प्र	1.10	द्व	1.19
च	1.48	च्	0.96	६	1.00	कि	2.09	र्क	1.55	द्ध	1.64
छ	1.37	छ्	1.37	७	1.12	की	2.06	◌	0.76	द्य	1.45
ज	1.50	ज्	0.99	८	0.98	◌	0.78	◌	0.88	त्त	1.22
झ	1.70	झ्	1.70	९	0.87	◌	0.75	◌	0.74	द्दा	1.58
ञ	1.56	ञ्	1.01	०	0.90	◌		कँ	1.55	च्च	1.51
ट	1.12	ट्	1.11	अ	1.40	◌		ट्र	1.11	रु	1.24
ठ	1.16	ठ्	1.16	आ	2.01	कु	1.55	ट्	1.12	श्र	1.38
ड	1.30	ड्	1.30	इ	1.00	कू	1.55	◌	0.89	द्व	1.08
ढ	1.15	ढ्	1.15	ई	1.00	के	1.55	.	0.33		
ण	1.69	ण्	1.10	उ	1.09	कै	1.55	(	0.60		
त	1.26	त्	0.76	ऊ	1.57	◌	0.65	)	0.60		
थ	1.22	थ्	0.83	ए	1.21	◌	0.65	च्य	2.01		
द	1.16	द्	1.16	ऐ	1.21	◌					
ध	1.15	ध्	0.78	ओ	2.01	:					
न	1.28	न्	0.77	औ	2.01	को	2.13				
प	1.10	प्	0.71	अं	1.40	कौ	2.13				
फ	1.62	फ्	1.62	अः	1.40	कं	1.55				
ब	1.29	ब्	0.77			कः	2.02				
भ	1.20	भ्	0.91								
म	1.25	म्	0.80								
य	1.27	य्	0.76								
र	1.00	र्	1.00								
ल	1.46	ल्	0.95								
व	1.25	व्	0.74								
श	1.47	श्	1.03								
ष	1.28	ष्	0.78								
स	1.45	स्	0.98								
ह	1.12	ह्	1.12								
क्ष	1.32	क्ष्	0.95								
त्र	1.27	त्र्	1.27								
ज्ञ	1.35	ज्ञ्	0.93								