



**Government of the People's Republic of Bangladesh
Ministry of Communications
Roads and Highways Department**

Road Safety Improvement Works Manual

May 2005



FOREWORD

Roads and Highways Department (RHD) is committed to provide safer roads and achieve the vision of the National Land Transport Policy (NLTP) 2004 –

“To develop and properly maintain a Road Network, which is able to fulfil the socio-economic needs of the country and is safe to use for all vehicles.”

In order to provide safer road environment on all roads under the jurisdiction of RHD, a number of proactive initiatives have been undertaken in recent years. RHD has already adopted Traffic Signs Manual, A Guide to Safer Road Design, and Road Safety Audit Guidelines Manual for safety auditing of all road projects at all phases, Revised Geometric Design Standards Manual (road safety issues in design standards incorporated). Application of these standards and manuals will radically change and improve the road engineering practices, ultimately enhancing road safety.

Until now, schemes for road safety improvement civil works were being prepared and designed following international practices, which are generally not appropriate and compatible to the unique traffic systems and road environment context of Bangladesh. The international practices could not meet practicalities of Bangladesh to identify appropriate safety improvement requirements and to prepare right schemes of civil works. Moreover, wider-scale application of the road safety works policy requires a “Road Safety Improvement Works Manual” for RHD; which contains the approach and methodology for selecting required cost-effective & low-cost measures, and model example designs for such safety measures etc. for preparation of safety improvement schemes for roads. This Manual shall meet such requirements.

Use and application of this Manual will enable RHD engineers and consultant engineers working for RHD to prepare practicable schemes of road safety improvement works, which are cost-effective as well as low-cost. The Manual including the recommended standards and requirements in it shall form the basis and guide for the engineers. The Technical Services Wing of RHD shall steer the use and application of the Manual.

However, in case of situations & issues not covered by this Manual, the engineers should exercise their professional judgments based on practical knowledge and skill, in consultation with the Road Safety Unit of RHD.

I wish to thank Mr. Md. Nurul Huda, Additional Chief Engineer RHD, & Project Coordinator CIDC-3 and Convener of the ‘RHD Committee for Finalization of the Road Safety Improvement Works Manual’ for the laudable work in preparing this important Manual. Also, my special thanks to Mr. A. R. M. Anwar Hossain, Additional Chief Engineer (ADB Projects), RHD for his initiative towards preparing this Manual.

Finally, I wish to appreciate and thank all members of RHD Committee for their contribution in finalizing this Manual with the support of the consultants Finnroad Limited under the Southwest Road Network Development Project (SRNDP), RHD.

This Manual will go a long way for providing safer roads in Bangladesh

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Date: 27.6.2005



PREFACE

One of the tasks of the consultant of the Road Safety Component of Southwest Road Network Development Project (SRNDP) of RHD is preparation of manuals on road safety. The consultant Finnroad Limited prepared a draft "Road Safety Improvement Works Manual" for Bangladesh for use by RHD engineers and consultant engineers working for Bangladesh.

The Chief Engineer, RHD formed a departmental committee headed by Mr. Md. Nurul Huda, Additional Chief Engineer RHD, & Coordinator CIDC-3 to finalize the preparation of "Road Safety Improvement Works Manual" for Bangladesh. The RHD Committee, with the support and collaboration of the consultant Finnroad Limited has finalized this Manual.

I am pleased with the efforts, close interaction between the consultant team of experts with RHD officers, and their work for finalizing this important manual. This Manual will be very useful and effective tool for application of road safety policy of RHD and the Government by selecting appropriate cost-effective practicable safety measures on roads and preparing schemes for road safety improvement civil works.

I am thankful to Mr. A. K. M. Faizur Rahman, Chief Engineer, RHD, for his guidance in regards to finalization of this manual. Also my special thanks to Mr. Md. Nurul Huda, Additional Chief Engineer, & Coordinator CIDC-3, RHD, for his efficiently leading the RHD Committee and for finalizing the manual.

I wish to thank all involved, the officers of RHD Committee, the SRNDP officers and Consultant Team of Finnroad Limited for their laudable contribution.

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PREFACE

The consultant team of the “Road Safety Component of Southwest Road Network Project (SRNDP) of RHD was required, in pursuance of the Terms of Reference for consultancy, to prepared a manual on road safety improvement works on road. The consultant team of Finnroad Limited prepared a draft version of the “Road Safety Improvement Works Manual” for Bangladesh for use by RHD engineers and consultant engineers working for Bangladesh.

The Chief Engineer, RHD formed a departmental committee headed by the undersigned to finalize the preparation of “Road Safety Improvement Works Manual”. The RHD Committee, with the support and collaboration of the consultant Finnroad Limited has finalized this Manual.

The RHD Committee’s work is lauded and I am pleased with the efforts, close interaction between the consultant team of experts with RHD officers, and their work for preparing and finalizing this important manual. This Manual will be very a useful and effective tool for application of road safety policy of RHD and the Government by selecting appropriate cost-effective practicable safety measures on roads and preparing schemes for road safety improvement civil works.

I convey my gratitude to Mr. A. K. M. Faizur Rahman, Chief Engineer, RHD, and Mr. A. R. M. Anwar Hossain, Additional Chief Engineer, ADB Projects, RHD for guidance in regards to finalization of this manual.

I wish to thank all involved, the RHD officers and consultant team of Finnroad Limited for their laudable contribution.

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THE “ROAD SAFETY IMPROVEMENT WORKS MANUAL”**

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Abbreviations

AADT	Annual Average Daily Traffic
ACE, RHD	Additional Chief Engineer, Roads and Highways Department
ADB	Asian Development Bank
ARC	Accident Research Centre of Bangladesh University of Engineering and Technology
BOQ	Bill of Quantities
BRTA	Bangladesh Road Transport Authority
BUET	Bangladesh University of Engineering and Technology
CE, RHD	Chief Engineer, Roads and Highways Department
CIDC-3	Consolidation Institutional Development Component.
CW	Carriageway.
FIR	First Information Report
GDP	Gross Domestic Product
GDS	Geometric Design Standard
IDC-3	Institutional Development Component.
ISD	Intermediate Sight Distance

KM	Kilometre
MV	Motorized Vehicle
NLTP	National Land Transport Policy
NMT	Non-Motorized Traffic
NMV	Non-Motorized Vehicle
NRSC	National Road Safety Council
PCU	Passenger Car Unit
RHD	Roads and Highways Department
SRNDP	Southwest Road Network Development Project
TRL	Transport Research Laboratory of UK
TSM	Traffic Signs Manual
UK	United Kingdom

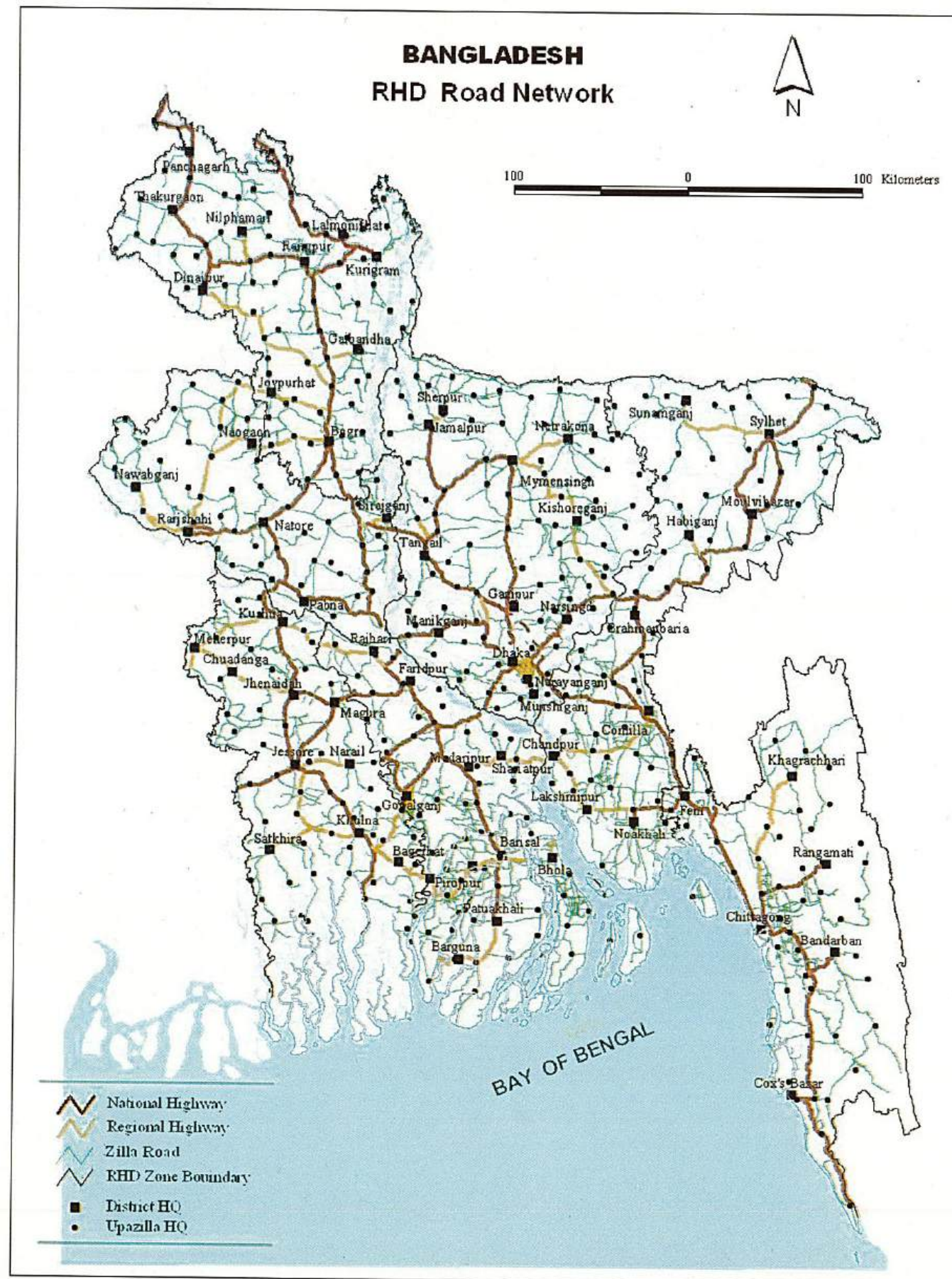


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RHD Committee & Consultants

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The problem is pedestrian/vehicle conflicts to which poor visibility and excessive speed make major contributions. Potential solutions will be based on three types of measures:

1. Remove the conflict.
2. Improve visibility.
3. Reduce speeds.

From the drivers' viewpoint, removing the conflict, implying stopping pedestrians from crossing, is preferable. This would not meet the need for crossing the road. The pedestrians would like speeds reduced. Drivers' would generally resist this. Improving visibility may give drivers and pedestrians more chance of avoiding conflicts but could result in higher speed of vehicles.

A balance of interest must be struck, depending upon traffic volumes, the extent of pedestrian demand and the cost-effectiveness of measures. Options under each of the three types of measures are:

1. Remove the conflict

- prevent pedestrians crossing.
- protect pedestrians whilst crossing.
- make grade separated crossing.

2. Improve visibility

- remove the object (like bill board, branches of trees, etc).
- relocate the crossing.

3. Reduce speeds

- speed limits.
- speed control device (like raised pedestrian crossing, circular speed reducing device).
- traffic control device (like traffic signs, road markings).

The contradiction can perhaps be seen most readily with the two means of improving visibility. Many would say that if the problem is the crossing cannot be seen, and then move whatever is in the way - a "move the mountains" approach. Yet it may well be just as effective and a good deal cheaper to relocate the crossing to a place where it can be seen more easily. There is nothing neither sophisticated nor technical in this - just a requirement to think around alternative solutions to a problem and occasionally to think laterally.

Practical experience is needed to confirm the way in which measures can be applied and work in a particular context. Experience in this respect is largely restricted to industrialised countries. So it cannot just be assumed that what is effective, say in the UK will be effective elsewhere. Over time, however, a body of expertise will build up and it should become increasingly possible to rely on this if monitoring is carried out. Schemes should always be closely monitored, to ensure that the 'improvement' implemented has not inadvertently worsened the situation.

Engineers are strongly recommended to experiment with local lower cost alternatives, especially when implementing temporary schemes.

INTRODUCTION

1 INTRODUCTION

[Source of data and information: National Road Traffic Accident Report 2002, Published by National Road Safety Council (NRSC) Secretariat; Reports of Accident Research Centre of Bangladesh University of Engineering and Technology (ARC, BUET)]

1.1 Purpose of the Manual

In Bangladesh, where the number of vehicles are increasing rapidly by about 9% a year, and the road infrastructure is being extended and improved, the traffic volume will increase by 6 to 8% a year. The road accident fatality rate has recently been estimated to 80-125 deaths per 10,000 registered motor vehicles annually. According to the Transport Research Laboratory (TRL) study report the road traffic accidents cost to the nation is approximately Taka 39 Billion (3,900 crore) per annum, which is more than 1.5% of the country's Gross Domestic Product (GDP).

This Manual has been prepared in response to a demand for a readily useable practical hand book for road safety engineering works in Bangladesh context. The contents of the Road Safety Improvement Works Manual will be simple discussions on safety improvements, concept drawings of cost-effective, but appropriate and low-cost safety measures. It is presented as an engineering document.

Road Safety Improvement Works Manual:

- Will help the practicing engineers to focus on important details of design of road safety works.
- Combines international and Bangladeshi experience and practices in road safety and traffic engineering.
- Will act as a source for ideas applicable to Bangladesh for new designs and measures.

1.2 Target Users of this Manual

All field level practicing engineers working in road sector in Bangladesh.

1.3 How to Use the Manual

The Road Safety Improvement Works Manual should not be considered as comprehensive stand-alone document. Many road safety related issues and aspects in the manual are drawn from international documents and also relates to existing RHD manuals, guidelines & standards. The user of this manual should refer to:

- Traffic Signs Manual (Vol. 1 & 2), Bangladesh Road Transport Authority (BRTA)
- Geometric Design Standards Manual, (Revised 2005), RHD
- Road Safety Procedure Notes Series – Note 1 to 10, IDC, RHD
- Guidelines for Selection of Sites for Safety Improvement Works for Bangladesh, IDC-3, National Road Safety Council (NRSC) Secretariat, BRTA
- National Land Transport Policy 2004, Planning Commission, Bangladesh.
- Pavement Design Standards, RHD
- Bridge Design Standards, RHD

- Bridge Designers' Handbook, RHD
- Bridge Designer's Handbook- Supplement, RHD
- Safety at Road Works - A Code of Practice for Signing, RHD
- Road Safety Design Guidelines, RHD
- Maintenance Manual, RHD
- Maintenance Policy for Roads and Bridges in Bangladesh, RHD
- Guidelines on Construction, Health and Safety, RHD
- Periodic Maintenance Programme: Design Advice Notes, RHD

1.4 Manual at a Glance

The Manual provide an overview and brief understanding of the perspective and background information in the Chapter 1. The Chapters 2 and 3 give information of traffic engineering, accident analysis and how to identify dangerous road links. The Chapter 4 gives guidelines how to reduce accident risk. The Chapter 5 gives information on how to reduce accidents by different measures. The Chapters 6 and 7 include transition & junction design principles, examples of transitions between cross sections and instructions how to improve existing junction. The Chapter 8 discusses speed reducing and traffic control devices. The Chapter 9 concentrates on pedestrian facilities. The Chapter 10 focuses on Traffic Signs Manual. The Chapter 11 discusses on work safety issues during construction phase. The Chapter 12 is conclusion chapter.

1.5 Road Safety Situation in Bangladesh

[Source of data and information: National Road Traffic Accident Report 2002, Published by National Road Safety Council (NRSC) Secretariat.]

1.5.1 Present Status and Possible Future

Bangladesh has a road traffic accident fatality rate, which is some 25 times higher than most of the developed countries, 8 times than Thailand

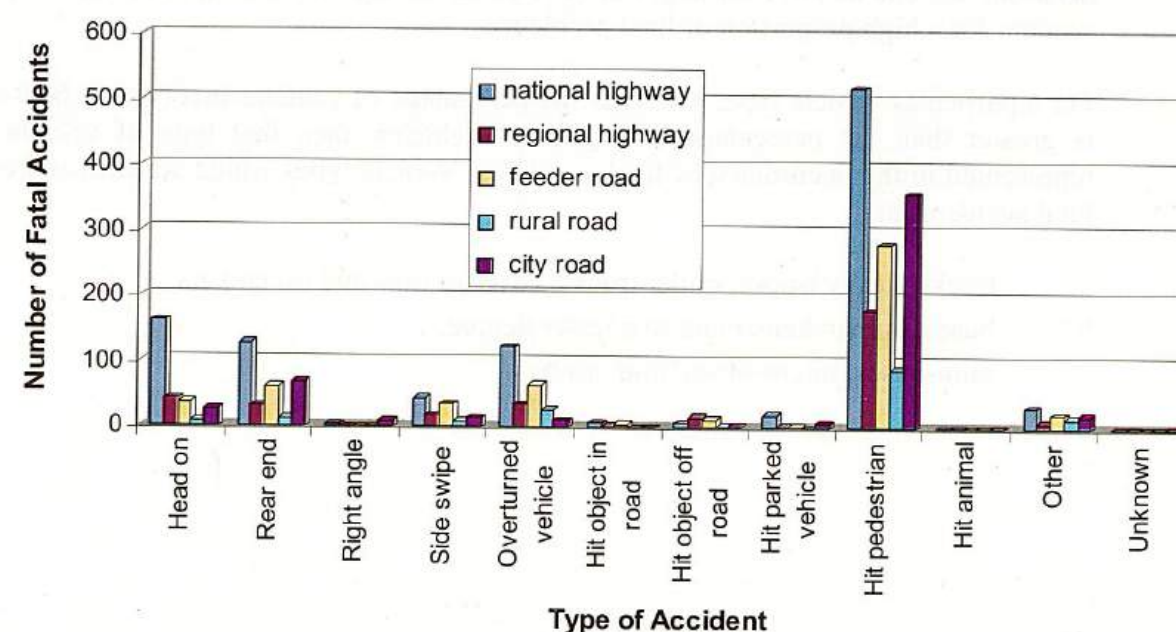


Figure: Fatal Accidents by Type of Accident and Road Class

TRAFFIC ENGINEERING AND ACCIDENT ANALYSIS

2 TRAFFIC ENGINEERING AND ACCIDENT ANALYSIS

[Principles and policies in this chapter are sourced from international standards and practices, like Austroads.]

2.1 Traffic Engineering Principles

The Traffic Engineer is in charge of both the existing traffic and the future generated traffic. The traffic engineer is to consider fluent and safe traffic flow.

The fluent and safe traffic flow could be achieved by applying the following principles:

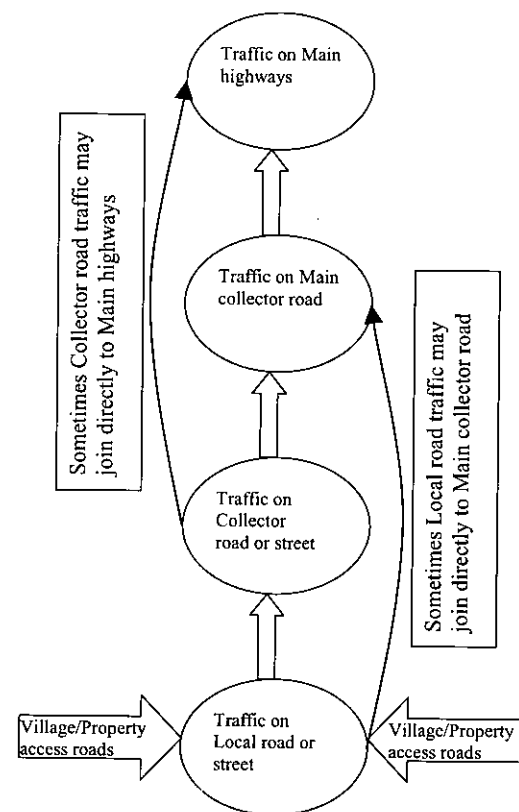
A. Classification of the Road Network (as per Planning Commission, Bangladesh):

Roads in the network are classified based on:

- Traffic (volume and composition), capacity and transportation demands.
- Actual functionality.

B. Differentiating the Traffic in a Classified Network:

- Property access roads join in with local roads or streets.
- Local roads join in with collector roads or streets.
- Collector roads join in with main collector roads.
- Main collector roads join in with main highways.



C. Separation of Different Types of Traffic

In application of this principle the following factors should dominate:

- Traffic safety.
- Capacity and fluency.
- Economy.

2.2 Traffic Safety

Traffic safety is often against those things, which traditionally are told as a freedom created by the use of motor vehicle, like high speed and free movement on the road. International studies have shown that small difference between minimum and maximum speed shall reduce the overtaking need and gives better traffic fluency than high speed. Same studies have also shown high speed as the most serious single factor for high accident rates and severity of accidents. The best way to improve traffic safety is to achieve traffic movement according to rules which all road users observe and cooperate with each other for road use.

Roads should be designed and constructed for all road users; not only for motor vehicles.

Proper design means paved roads to motor vehicles, adequate facilities for pedestrians, and separated lanes for NMV's and other slow moving vehicles. If there is no proper facility to all road users, it will soon happen that roads are filled with pedestrians, cyclists, slow moving vehicles etc. making a chaotic environment; and investment for road is wasted.

2.3 Traffic Capacity and Fluency

Capacity and fluency is a complicated matter. In a starting cue, vehicle cap is about 2 seconds. The capacity is 0.5 vehicle / second or 1800 vehicle / hour. The speed is approximately 50 km/h with maximum capacity. In a maximum fluent flow the speed may grow to 80 km/h and then the capacity is about 2800 vehicles / hour. Traffic variations cause their trick on the theoretical calculation. These are variation within the hour, between driving directions, within the day and even within the year.

2.4 Economy

If investments do not pay back no money will be available after few decades for further investments. Paying back comprises of savings in:

1. Vehicle operation costs.
2. Travel time.
3. Reducing accidents.
4. Environmental benefit.
5. Other social benefits.

Length of intermediate roads should be minimized. Where these roads are included they should have land use which generate a low degree of non-motorized traffic demands or incorporate access control or appropriate speed reducing treatment and other measures to reduce adverse impacts.

Local Roads

The main task in road design is to convey to motorists the impression that they are operating in an area which has not been designed solely for motorized traffic.

2.5.4 Functional Classification of Roads

Main Roads

The main function of the main road system is to provide safe and operationally efficient road network for major regional and inter-regional traffic movement.

Intermediate roads

A road which has additional traffic functions, like serving major traffic generator or providing some non-local traffic movements.

Local roads

A local road may serve many functions to a greater or lesser degree. Typical functions may include:

- Vehicular access to property/village.
- Vehicular access to other properties within a local area.
- Access for emergency and service vehicles.
- Pedestrian, rickshaw and cyclist facilities.
- Serving as a play area or community open space.
- Contributing visually to the environment.

2.5.5 Traffic Management Strategies

On main roads the strategy should generally be to identify desirable traffic management measures at various locations like intersections and major accesses.

The uniform and appropriate usage of traffic control devices is essential while developing the safe and efficient operation of road network.

**IDENTIFYING DANGEROUS ROAD LINKS AND
LOCATIONS**

3 IDENTIFYING DANGEROUS ROAD LINKS AND LOCATIONS

3.1 Road Safety Audit

[Source of data and information: Guidelines for Road Safety Audit for Bangladesh (2005)].

A road safety audit is a formal examination of an existing or future road or traffic project or any other project which interacts with road users, in which an independent, qualified team of examiners looks at and reports on the project's or the road's accident potential and safety performance.

Main objective of the safety audit is simply to improve traffic safety.

Member of the auditing team must be a road safety expert who is able to read drawings and can put himself to road user's position to find out safety deficiencies.

Outcome of the safety audit is an audit report in which the auditing team identifies safety deficiencies and gives their recommendations for improvement works.

3.1.1 Auditing of Road Designs before Construction

A safety deficiency may appear to design due to result of human error or conflicts between different targets. Therefore auditing team must be independent outside of the design team.

Possible safety deficiencies are cheaper to redesign during design stage than after opening road to traffic or after serious accidents.

Safety audit during design stage creates preconditions for safe road, fluent and safe traffic flow as well as traffic environment which suits for existing condition and surrounding. It is impossible to prepare a design without any mistakes, but critical examination of designs shall prevent preparation of flawed designs.

3.1.2 Auditing of Existing Roads in Priority Sequence

The whole existing road network should be audited to find out safety problems and cost effective as well as low cost measures to reduce number of accidents. Prioritizing of road network before the safety audit helps to find out such road links and locations where accident reduction shall be the most efficient. Prioritizing should be based on road description, traffic volume, traffic composition and number of accidents.

3.2 Accident Data Collection

3.2.1 Data from National Road Safety Council (NRSC) Secretariat

Major problem to get reliable information of accidents is under-reporting. For many reasons only 49 % of fatal accidents, only 7 % of minor injuries and hardly any of accidents with property damages are reported to the Police (IDC-3, *Guidelines for the identification of sites for road safety improvement works, 2002*).

Road Safety Cell of BRTA, which is the Secretariat of NRSC keeps accident records in Bangladesh. After receiving accident reports from the Police Department and other sources, they analyse those and transfer to accident record database. Engineers may ask accident statistics from Road Safety Cell whenever they need this information.

3.2.2 Data from Police

Police department should get information whenever there occur an accident on the road. Police department have at the moment 40 trained officers who are able to investigate accidents on the road. These officers are able to prepare reliable report about the accident with all relevant information about the accident type, road and weather condition etc. All reports should be submitted to Road Safety Cell for transferring into accident record file. Moreover, each police station keeps records of reported accidents as copies of First Information Report (FIR). Engineers should collect accident data directly from police station along the concerned road.

3.2.3 Data from Other Sources

Due to huge under-reporting of the accidents it is very difficult to the traffic engineers to get reliable picture of the real situation on the road. Therefore they have to lean on, not only official statistics, but also local newspapers, local "information sources" and even rumours when they try to find out safety performance on certain road links and specific locations.

Unfortunately this "unofficial" data distort official statistics, but it is extremely important when planning traffic safety improvement program and prioritizing locations and road links to be improved.

3.3 Site Selection

(Synopsis of the "Guidelines for The Identification of Sites for Road Safety Improvement Works" Prepared by IDC-3 in June 2002.)

Introduction

Guideline concentrate on the National and Regional Highways only, but its recommendations could be translated to other road classification system.

Road improvement projects typically make compromises between road structure, designed traffic volume, different traffic composition, needs of public transportation, safe interaction and land use. Road safety measures are added in new road improvement standards.

Road safety improvement programs to date have focused to address safety deficiencies on certain road links (typically length has been between 0.5 km to 1.0 km) and improve those locations.

If priority target in Bangladesh is to improve traffic safety on whole road network and reduce number of fatal accidents, instead of improving only specific locations (accident location), policy should be to improve longer Road link, say 10 km to 50 km.

Guideline states how to prioritize road links to be improved by measuring safety performance and ranking those.

The limitations of accident location safety treatments as applied in Bangladesh

Accident location is defined in Bangladesh as a location where is minimum two police reported fatal accident and one grievous accident per 0.5 km per year. These sites are candidates for a safety improvement project. Locations are primarily bazaars, villages and bus stops.

The primary measures of safety performance which can be used reliably for a site selection and the comparison of different sites are the fatal accident rate (fatal accidents / 10 000 vehicles / year) and fatal traffic density (fatal accidents / km / year).

The approach of accident location improvement does not improve safety performance of a significant length of road network.

PRINCIPLES OF REDUCING RISKS

4 PRINCIPLES OF REDUCING RISKS

4.1 Preventive Measures

[Source of data and information: Austroads]

4.1.1 Geometric Design

Consistent and Optimum Pavement Width

When traffic volume increase on two lane roads, obviously also the accident risk of head-on, side-swipe and run-off-the-road type accidents shall increase. When designing new road or rehabilitating existing one, prognosis for traffic volume in the future, say 5 to 10 years should be done to ensure consistent and optimum pavement width for designed operating period of the Road link. When single lane roads are upgrade to two lane roads in phases, consistency at width changes is vitally important. Provision of transition sections reduces accident risks.

Shoulders

Optimum wide, stable shoulders provide potential safety and reduce accident risk by allowing additional maneuver space to drivers and keeping non motorized traffic out of main traffic lane. Too wide shoulder shall increase the accident risk by misleading drivers to assume shoulder as an additional lane or encourage him to use shoulder as an overtaking lane. An international study has shown that the optimum width of shoulder varies between 1.8 and 2.2 meters.

Footpaths

Raised or physically separated footpaths on road network shall reduce pedestrian accident risk significantly, particularly in towns and bazaar areas.

Road Verge

Clear zone beyond the shoulder shall reduce the risk of hit-road-side objects type of accidents.

Medians

Separation of opposite direction traffic from each other with median reduces significantly head on accident risk.

Intersections / Junctions

Accident risk in T –type junction is inherently lower than in X –type or Y –type junctions. At major junctions on National Highways with proper geometric design and construction accident risk can be reduced significantly.

Pavement Surface

Skid resistant surface is essential to reduce accident risk of loss-of-control and slide-out-of-road type accidents in all weather conditions, prevailing in Bangladesh

4.1.2 Traffic Control Devices

All traffic signs, traffic signals, road markings and other devices, like cones, barriers, etc. also in temporary use during construction phase. They are placed or erected on the road or beside the road to control, warn or guide road users how they should respond in certain situation. With the correct and uniform usage of traffic control devices Road Authority gives correct information to road users and reduces accident risk significantly. Basic idea to usage of traffic control devices is to describe existing situation on the road to road users.

Road Markings

Even a driver has no idea of traffic regulations; he shall follow more or less correctly information given to him by road markings. While there are no markings, average driver in Bangladesh drives in the middle of the road. Providing of road markings is considered the most cost effective measure to reduce accident risk in Bangladesh.

Traffic Signs

Basic idea of traffic signs is to warn, inform and guide road users about the situation in front of him. Correct usage and location of traffic signs give more time to road users to act in the right manner which the Road Authority expect him to do. Message given to road users with markings and signs must be uniform and consistent all the way. Signs provide best result when associated along with road markings.

Traffic Signals

Road authority can prevent uncontrolled traffic flow through a junction with traffic signals. When road users respect guidance given by traffic signals junction shall be safe for all road user groups. Co-ordination of traffic signal system by creating “green wave” shall reduce irritation of drivers and air pollution by enable flexible traffic flow. It is essential to optimize signal program to satisfy demand of each approaching direction.

Delineator Posts

Delineator posts (marker posts) on curves shall reduce accident risk of slide-out-of-road type accidents by giving information about the road behaviour.

Rumble Strips

Rumble strips consist of series of rough strips placed crosswise the carriageway. Strips could be made of road marking material asphalt concrete mixture or by milling required deep strip crosswise the carriageway. Basic idea of the rumble strips is to warn or “wake up” driver to notice relevant traffic sign or hazard in front of him.

4.1.3 Pedestrian Protection

Road Authority may provide facilities to protect pedestrians while crossing the road, but Road Authority can not force pedestrians to use that facility.

To maximize usage of protective facilities, it is essential to study the behavior, like crossing points of average pedestrian on each location. All possible solutions listed hereafter must be equipped with reflective thermoplastic markings and adequate traffic signs:

- Pedestrian crossings.
- Raised pedestrian crossings.
- Pedestrian crossing with median or refuge island.
- Signalized pedestrian crossing.
- Overpass or underpass.

4.4 Monitoring of Measures & Impact Assessment

It is essential to monitor impact of completed traffic safety improvement works to see that correct measures have been selected for specific location. Later on monitoring results can be used to make selection of measures which are even more simple and efficient.

The best results of monitoring can be obtained when traffic safety performance is studied first time before commencement of safety improvement works and second time approximately three month after completion of safety improvement works. This enables to compare how road users' behavior has changed after implementation of measures.

Road Safety Unit of RHD is in-charge of monitoring of measures and impact assessment. This may be done by as in-house job by the Road Safety Unit itself or by an agreement with some consulting company or Accident Research Centre of BUET.

**ACCIDENT CAUSES AND REDUCING ACCIDENTS
BY MEASURES**

5 ACCIDENT CAUSES AND REDUCING ACCIDENTS BY MEASURES

[Source of data and information: Austroads]

5.1 Accident Types, Causes and Measures

[Source of data and information: National Road Traffic Accident Report 2002, Published by National Road Safety Council (NRSC) secretariat]

Selection of suitable measures to prevent accidents is consequence of accident analysis, research work and experience. Accident analysts' have studied possible causes for different type of accidents. NRSC has adopted the international classification of accident types as listed hereafter:

1. **Single vehicle accident**- only one vehicle is involved in this accident type (loss control)
2. **Pedestrian accidents**- accident between vehicle and pedestrian
3. **Accidents between vehicle and road users or accidents**- accident between rickshaw etc. or earlier happed accident
4. **Accidents between vehicles driving in the same direction** - accident during changing the driving lane
5. **Accidents between vehicles in converging (crossing) directions** - accident with turning vehicle
6. **Accidents between vehicles driving in opposite directions** - head on accident during overtaking.

5.2 Reducing Different Types of Accidents by Using Measures

[Source of data and information: Austroads]

Road safety depends much on the traffic environment. Sometimes the causes of an accident also derive from other factors. Sometimes the driver's expectations conflict with the environment (e.g. through traffic on roads with local bazaars). Sometimes the reasons of danger may be in a Road link before the actual accident spot. All measures, which have an impact on the environment, can also influence road safety. These measures do not only include reconstruction but also road maintenance and police enforcement.

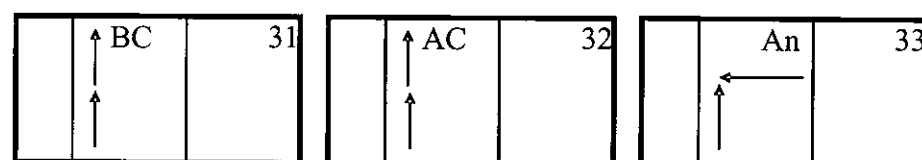
In the following pages are listed accident types, possible causes for each type of accident and also possible measure to prevent each type of accident. The list gives number of variations which can be used as a single measure or combination with other measures. Before selecting any measure engineers' should study the actual situation on the road, accident type and causes of accidents.

There are two ways of studying the accident location: one from the environmental point of view and the other from the main accident types. The circumstances should also be studied: the engineer should ask, whether there are measures that can improve the situation during difficult environmental circumstances, such as heavy rain, darkness etc. This is of great importance especially when great deal of the accidents occurs during these circumstances (e.g. in rainy season).

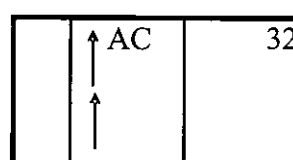
Possible causes of accidents, and the consequently adequate measures, are based mainly on experience from accident analysis in a number of different countries.

CASUALTY ACCIDENTS BY TYPES OF ACCIDENT			
Accident Types	2001+2002 Data		
	Highways (%)		Average (%)
	National	Regional	
1. Single vehicle accidents	18	18	18
2. Pedestrian accidents (vehicle(s) and pedestrian)	43	46	44
3. With other road user / Other accidents	3	4	3
4. Between vehicles driving in the same direction	19	18	18
5. Between vehicles in converging (crossing) directions	0	0	0
6. Between vehicles driving in opposite directions	17	14	16
Total	100	100	100

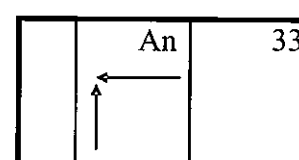
Accident types listed in the following pages are clarified with indicative principle drawings. Numbers shown in the drawings means type of accident and clarification of accident. Example 11= accident type 1 (single vehicle accident) and specific accident 1 (loss of control accident).

Type 3: Accidents between Vehicle and Other Road User(s)

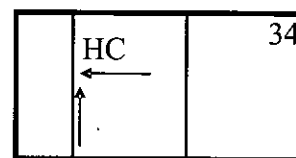
31 Bicycle accidents



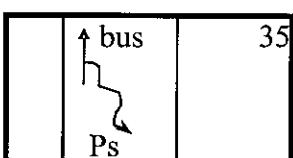
32 Animal Carts Accident



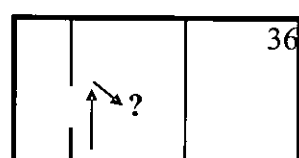
33 Accident with Animal



34 Accident with hand carts



35 Falling Passenger



36 Other accident. Define

CAUSES

- overloading
- inadequate sight distance
- driving bus doors open
- incorrect/improper parking
- no warning triangle at a stopped vehicle
- poor knowledge of traffic rules
- speeding
- inadequate control measures
- narrow road
- limited visibility
- inadequate bicycle/ pedestrian facilities
- animal on the road

MEASURES**Speed reducing measures**

- circular speed reducing device

Fencing

- pedestrian fencing between footpath and driving lane

Warning signs

- B26 cattle, B25 children

Construction of bicycle/pedestrian lane

- separation of slow moving traffic from fast moving traffic

Removal of kerbstones at a bicycle/rickshaw route / road crossing

- instead of kerbstones asphalt ramp

Improvement of railroad crossings

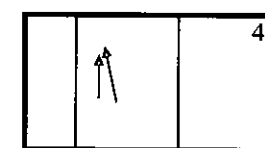
- reduce the number of crossings
- equip crossings with safety measures as warning
- signs, signals, audio signals, barriers
- improve visibility proper sight distance
- provide lighting
- erect warning signs / stop sign
- proper construction of railway crossing approaches (also between trucks)

Construction of shoulders

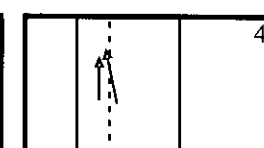
- paved shoulders

Removal of bushes etc. from the road side**Enforcement****Effective maintenance**

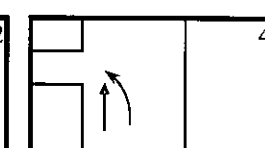
- cutting of branches over the road

Type 4: Accidents between Vehicles Driving in the same Direction

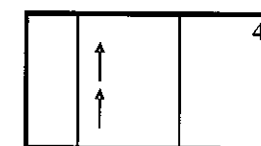
41 Side Swipe (collision) at overtaking



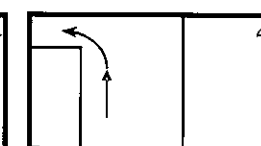
42 Side Swipe (collision) at lane change



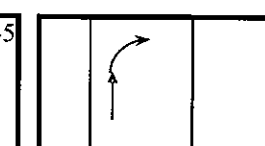
43 Side-swipe at wrong lane usage (one vehicle)



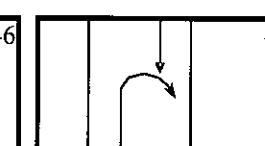
44 Nose-to-tail no vehicle turning



45 Nose-to-tail first vehicle turning left



46 Nose-to-tail first vehicle turning right



47 Side collision at U-turn

CAUSES

- ignoring lane markings
- lack of turning lanes
- overtaking at a junction
- overtaking without due free distance
- restricted visibility at junction
- too short amber period at traffic signals
- overtaking on wrong side
- driving too close
- incorrect parking/stopping in the middle of road
- lack of bus bays
- high speeds
- careless driving
- damaged edges/potholes on the road
- lack of proper signal indication
- ignoring a STOP or GIVE WAY-sign
- tailing for overtaking
- mechanical defect
- sudden stop

MEASURES**Improvement of road markings/traffic signs**

- (re)painting of lane marking
- erect traffic signs to prohibit parking/turning
- rumble strips for warning purposes
- erect warning signs as per Traffic Signs Manual

- painting of continuous barrier line at junction and/or its continuation

Rearrangement of junctions/access roads

- prohibit turning movements by central island
- provide chenalization at the junction
- removal of junctions by constructing a parallel road/bypass
- provide turning lanes
- prohibit/reduce U-turn

Improvement of road conditions

- pavement patching/resealing
- provide bus bays
- control and reduce number of access

Enforcement

5.3 Impact of Different Measures on Different Type of Accidents

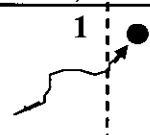
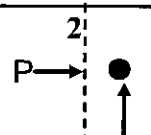
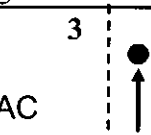
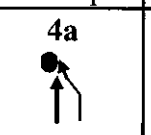
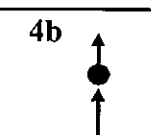
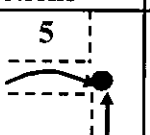
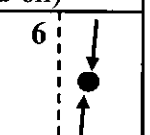
The matrix hereafter has been prepared on the basis of a large number of “before” and “after” studies in different developed & developing countries; as well as adjusting the findings of those studies to unique traffic compositions, road user composition and behaviour etc. in Bangladesh. The adjustments to arrive at the “weighted average for Bangladesh” are made by professional judgements based on review of reports and documents on road safety in Bangladesh and field observations of experts. The weighted average for Bangladesh given in the matrix is thus indicative, not conclusive for now. Accident research in Bangladesh is at its initial stage. Future research and

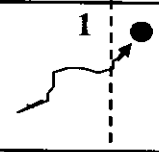
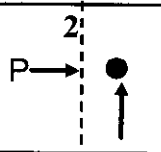
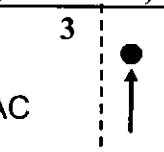
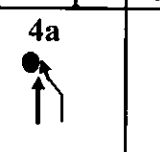
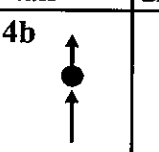
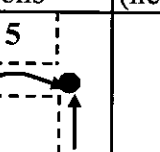
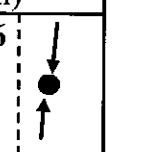
studies will enable arriving at more conclusive “weighted average for Bangladesh” in due course.

However, this matrix gives an indicative and useful guide to select a cluster of counter measures with respect to types of accidents.

Disclaimer:

Neither the RHD Committee for Finalization of Road Safety Improvement Works Manual nor the Consultant Team authenticates the “weighted average for Bangladesh” shown in the matrix hereafter as conclusive. The “weighted average for Bangladesh” shown in the matrix is indicative only to provide some guide.

		Type of Accident							Range of studies in other countries	Weighted Average for Bangladesh
		Single Vehicle acc.(loss of control)	Pedestrian Accident	Acc. With other road user (e.g.veh./ carts)	Same directions side-swipe	Same directions nose-to-tail	Converging (crossing) directions	Opposite directions (head-on)		
										
Distribution by Type of Accident		0.18	0.44	0.03	0.05	0.10	0.10	0.10		
MEASURE		ACCIDENT REDUCTION %								
Pavement Markings										
	Edgeline	25	5	18	0	0	15	5	5 - 20	9
	Centrelines	15	5	18	0	0	5	15	5 - 20	7
	Lane markings	0	0	12	10	5	10	5	0 - 30	3
	Audio Marking Edgeline	38	8	27	0	0	23	8	0 - 30	14
	Audio Marking Centrelines	23	8	27	0	0	8	23	0 - 30	11
	Zebra Crossing	0	20	5	-5	0	0	5	5 - 14	9
	Reflective hatch markings (median)	5	5	4	-2	0	5	7	5 - 30	4

	Type of Accident							Range of studies in other countries	Weighted Average for Bangladesh
	Single Vehicle acc.(loss of control)	Pedestrian Accident	Acc. With other road user (e.g.veh./ carts)	Same directions side-swipe	Same directions nose-to-tail	Converging (crossing) directions	Opposite directions (head-on)		
									
Distribution by Type of Accident	0.18	0.44	0.03	0.05	0.10	0.10	0.10		
MEASURE	ACCIDENT REDUCTION %								
Constructive Measures									
Sealing/constr. Pedest. walk way	0	30	20	10	0	0	0	6 - 18	14
Channelization -X	5	20	25	15	5	10	20	8 - 39	15
Channelization - T	-5	10	3	-2	-2	10	8	0 - 20	5
Change X-junction into roundabout	0	5	5	0	5	40	40	0 - 20	11
Change X-junction into two staggered T-junctions	0	5	5	5	10	20	20	0 - 20	8
Channelization - Right turn lane	2	10	5	5	30	10	20	10 - 21	11
Median	10	20	5	0	5	35	18	12 - 21	17
Central guard-rail	10	20	5	0	5	35	18	0 - 9	17
Guard-rail at road edge	35	5	15	0	0	0	5	10 - 80	9
U-turn without turning lane	-2	10	-5	-10	-5	30	1	0 - 8	6
Improve junction angle 135->90-75	0	10	5	15	15	45	25	10 - 60	14
Improve junction angle 105->90-75	0	5	3	7	8	22	13	8 - 25	7
Staggering X-junction	-2	15	5	10	10	25	18	12 - 23	12
Soft poles	12	0	0	0	3	0	0	10 - 20	2
Footpath	0	30	12	5	0	0	0	10 - 30	14
Cycle track	0	20	25	5	5	0	0	9 - 30	10
Under/overpass for pedestrians	0	60	30	0	0	0	0	20 - 37	27
Service road	0	20	20	10	10	0	0	20 - 26	11
Improve cross section	10	10	0	-5	10	-3	-5	0 - 26	6
Lighting	15	10	10	0	8	8	5	7 - 12	10
Access control	5	5	5	25	20	15	20	5 - 22	10
Overtaking/climbing lane	5	5	25	-5	25	0	10	4 - 19	7
Soften environment (bushes)	15	-3	0	0	0	0	0	2 - 16	1
slope reform less than 1:2 => 1:[3...4]	25	0	5	5	0	0	0	0 - 15	5

TRANSITION BETWEEN CROSS SECTIONS

6 TRANSITION BETWEEN CROSS SECTIONS

[Source of data and information: Geometric Design Standards of RHD, (2001)], Geometric Design Standards Manual (Revised) 2005 of RHD].

6.1 Introduction

Due to lack of information, identification of accident locations and causes on open road link may be difficult. However, accidents frequently occur on such locations and causes are more or less the same. Main accident cause on open road link is high speed.

Accident reports give clear picture about the accident locations on open road link. Inadequate curves are normal accident locations. Even more problematic location is short road link where cross section of the road changes to different type (for example suddenly four lane road changes to two lane road or two lane road changes to single lane or intermediate pavement width etc.). Often, accidents occur at such locations when vehicles cruising at high speed have to suddenly reduce speed resulting in loss-of-control.

Transportation needs, traffic (volume and composition) and other demands varies a lot in different part of country and the road authority's target is to offer appropriate road network to all road user groups and different needs, therefore road network consist of different cross sections. Transition between different cross sections must be designed properly and must be equipped with appropriate traffic control devices to ensure traffic safety. Proper design, consistent pavement width throughout the whole road network together with relevant traffic control devices shall reduce number of accidents even cross section changes.

Purpose of this chapter is to show road engineers how they can design transitions between different cross sections properly. This chapter includes also principle drawings with appropriate traffic control devices (traffic signs, road markings, etc.).

Before using principle drawings directly from this manual, the actual situation on the road must be studied and relevant corrections / adjustments to these example drawings must be done. User of this manual must consult also other relevant manuals as well as Road Safety Unit of RHD.

6.2 Design of Road Links

6.2.1 Road Cross Section Standards

Cross section of road should reflect road standard and geometry, so that drive expectations are in line with what the road offers. Driving speed (limit) and cross section depend on each other.

Recommendations for standard road types and cross sections by traffic volume (Vehicles/24hrs) are given in table hereafter:

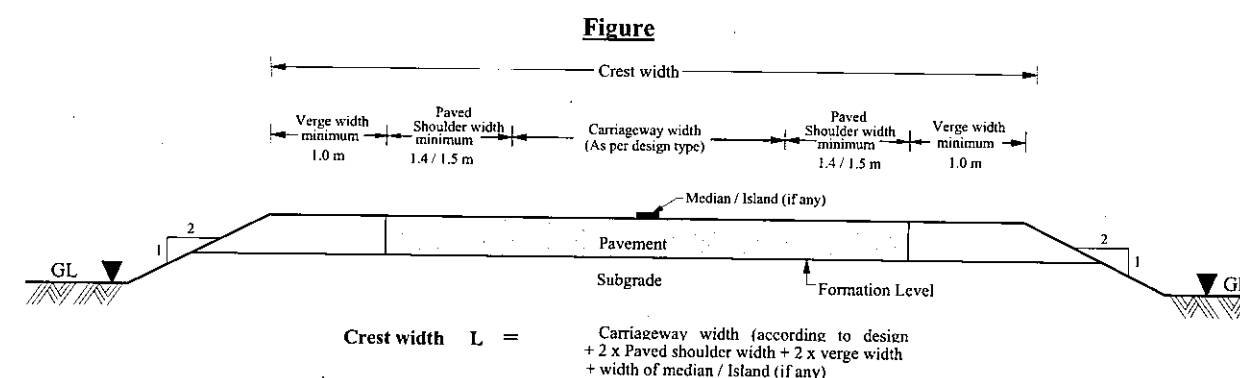
Road Cross-Section Standards

[Not fully applicable to urban / semi-urban / bazar areas.]

Design Type	Design year traffic volume PCU/peak hour (typical MV AADT)	Cross-section Widths in meters			Indicative Road Classification
		Crest	Carriageway (no. of lanes)	Paved Shoulders	
1	4500-8500 (19,000-36,000)	Carriageway width (according to design type) + 2 X paved shoulder width + 2 X verge width + median / island width (if any). See Figure hereafter.	2 x 11 (6)	1.5	National
2	2100-4500 (7,000-19,000)		2 x 7.3 (4)	1.5	
3	1600-2100 (5,000-7,000)		7.3 (2)	1.5	Regional
4	800-1600 (1,000-5,000)		6.2 (2)	1.5	
5	530 - 800 (600-1,000)		5.5 (2)	1.4	Feeder
6	<530 (<600)		3.7 (1)	1.4	

Notes

This is a summary table – refer to Section 4 before using these standards.



Note: Extracted from the Geometric Design Standards Manual (Revised) 2005 of RHD, (revisions decided by RHD committee for Revision of Geometric Design Standards)

6.2.2 Clear Zone (Side Object Distance)

Rigid objects closer than 1.8 m to carriageway shall reduce traffic capacity. Geometric Design Standard of RHD requires 4 meter clear zone beyond the shoulder.

6.3 Examples

This section of manual presents:

	Page
1. Actual existing situation	22
2. Transition between cross section type 3a and 2a	23
3. Transition between cross section type 3 and 2a	24
4. Transition between cross section type 3 and 2	25
5. Transition between cross section type 4 and 3a	26
6. Transition between cross section type 5 and 3a	27
7. Transition between cross section type 6 and 3a	28
8. Transition between cross section type 4 and 3	29
9. Transition between cross section type 5 and 3	30
10. Transition between cross section type 6 and 3	31
11. Transition between cross section type 6 and 4	32
12. Transition between cross section type 5 and 4a	33
13. Transition between cross section type 6 and 4a	34
14. Transition between cross section type 6 and 5	35
15. Transition between cross section type 4 and 6	36
16. Transition between cross section type 5 and 6	37

1. Actual Existing Situation



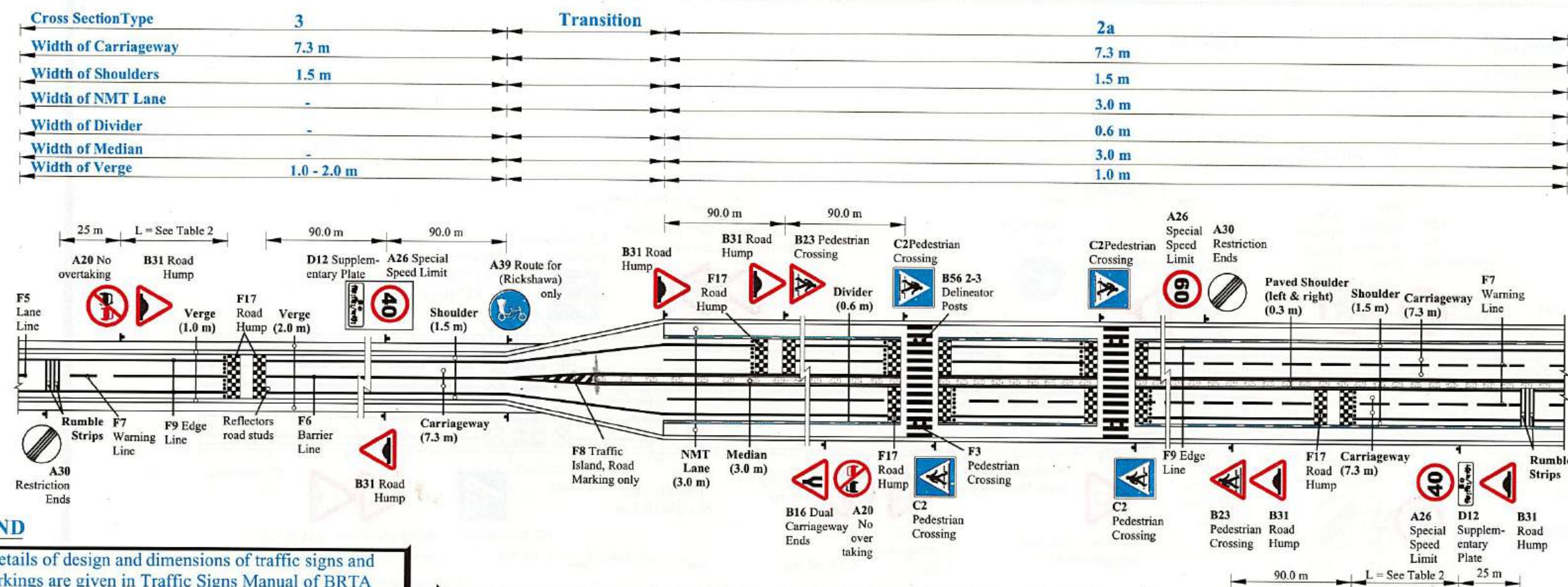
Photo from Dinajpur - Thakurgaon - Panchagarh National Highway

Sudden Change

3. Transition between Cross Section Type 3 and 2a

Example of lay-out plan with road safety measures at transition between the following sequence of Standard Cross-section Type 3 and 2a

Figure



LEGEND

Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

- A20 - No overtaking
- A26 - Special Speed Limit
- A30 - Restriction Ends
- A39 - Route for (Rickshaw) only
- B16 - Dual Carriageway Ends
- B23 - Pedestrian Crossing
- B31 - Road Hump
- B56 - Delineator Post
- C2 - Pedestrian Crossing
- D6 - Single Track Road
- D12 - Supplementary Plate
- F3 - Pedestrian Crossing
- F3+F17 - Raised Pedestrian Crossing
- F5 - Lane Line
- F6 - Barrier Line
- F7 - Warning Line
- F8 - Traffic Island
- F9 - Edge of Carriageway
- F17 - Road Hump

Rumble Strips -

Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km / h	750	90	160
70 km / h	750	90	200
80 km / h	900	150	250
If Specially hazardous	1200	90-150	-

Figure



Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

A20	-	No overtaking	F3	-	Pedestrian Crossing
A26	-	Special speed limits	F5	-	Lane Line
A30	-	Restriction Ends	F6	-	Barrier Line
A39	-	Route for rickshwas only	F7	-	Warning Line
B14	-	Road Narrows on both sides	F8	-	Traffic Island
B23	-	Pedestrian Crossing	F9	-	Edge of Carriageway
B31	-	Road Hump	F17	-	Road Hump
B56	-	Delineator Post			
C2	-	Pedestrian Crossing			
D6	-	Single Track Road			
D12	-	Supplementary Plate			

Rumble Strips - 

Diagonal Lines - 

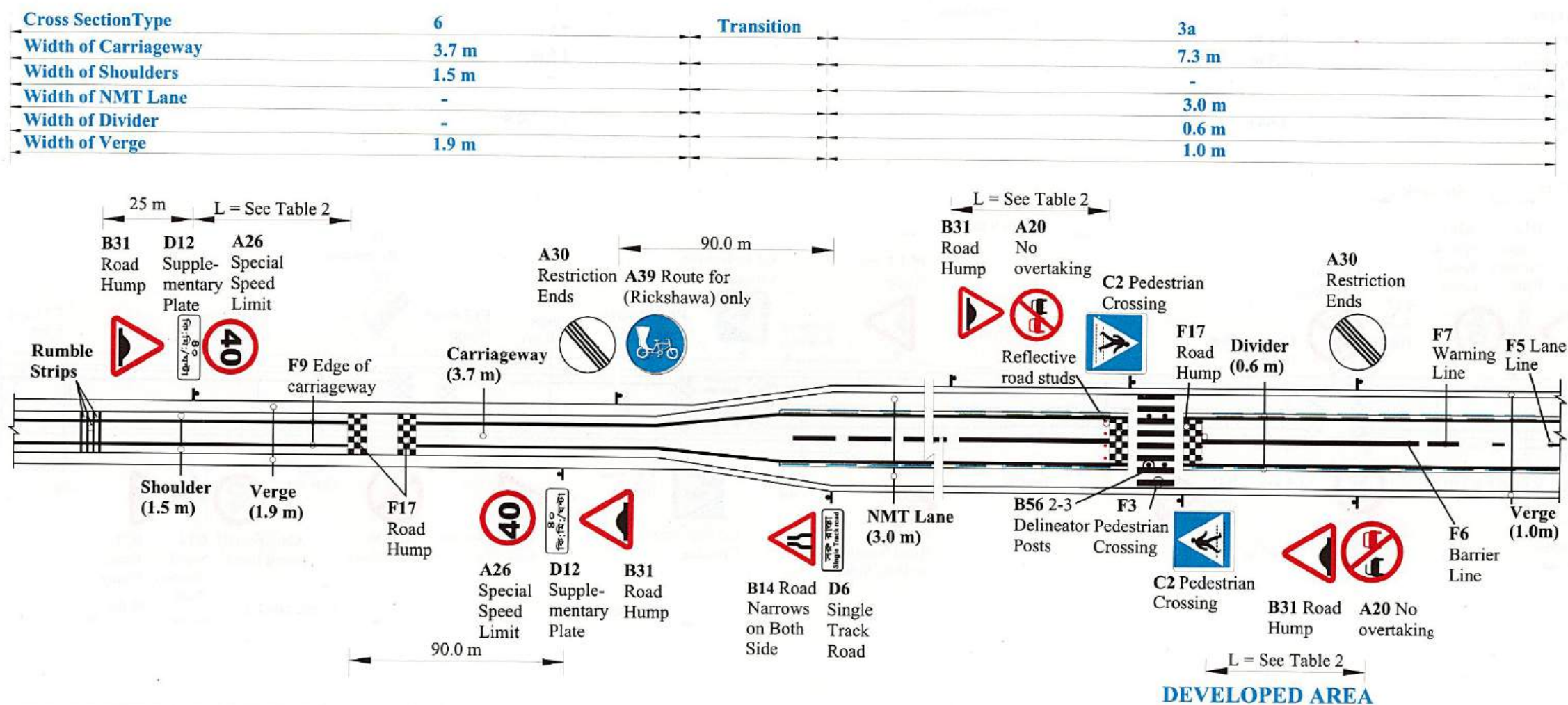
Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km /h	750	90	160
70 km /h	750	90	200
80 km /h	900	150	250
If Specially hazardous	1200	90-150	-

7. Transition between Cross Section Type 6 and 3a

Example of lay-out plan with road safety measures at transition between the following sequence of Standard Cross-section Type 6 and 3a

Figure



LEGEND

Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

A20 -	No overtaking	F3 -	Pedestrian Crossing
A26 -	Special speed limits	F5 -	Lane Line
A30 -	Restriction Ends	F6 -	Barrier Line
A39 -	Route for rickshaws only	F7 -	Warning Line
B14 -	Road Narrows on both sides	F9 -	Edge of Carriageway
B23 -	Pedestrian Crossing	F17 -	Road Hump
B31 -	Road Hump		
B56 -	Delineator Post		
C2 -	Pedestrian Crossing		
D6 -	Single Track Road		
D12 -	Supplementary Plate		

Rumble Strips -

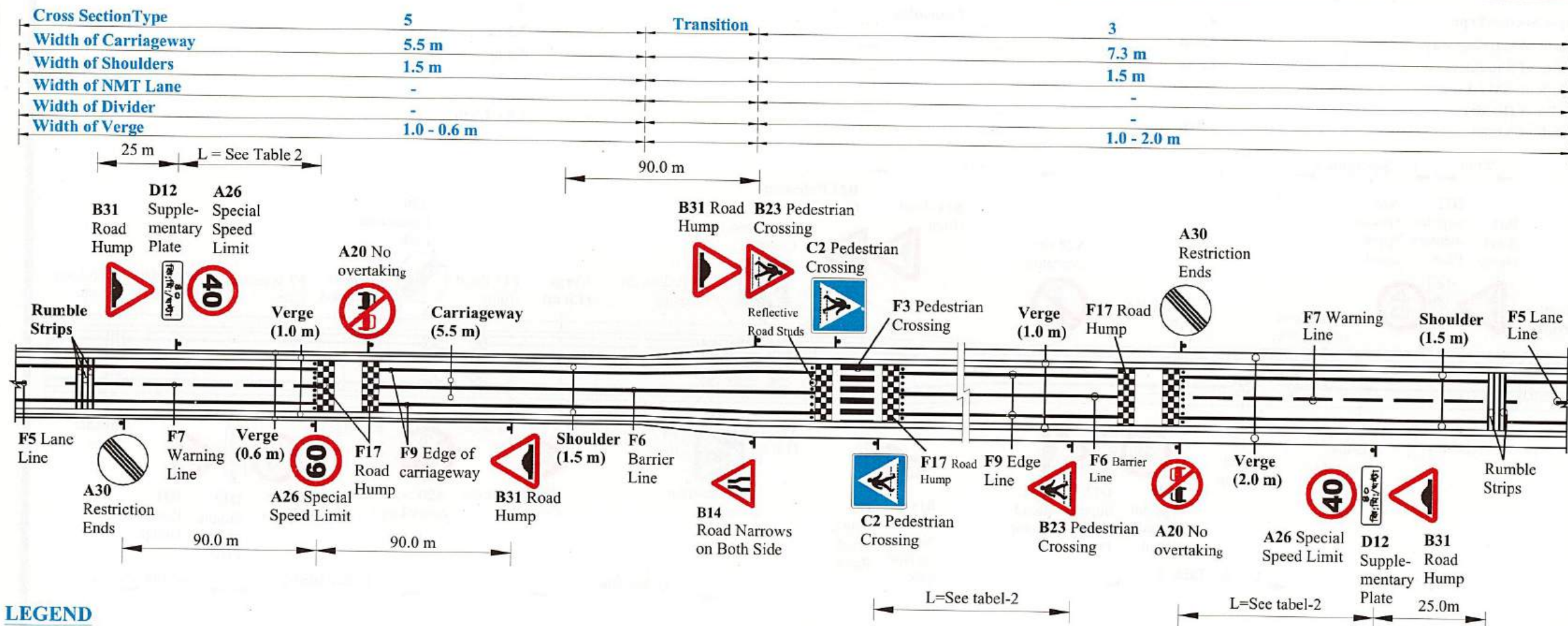
Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km / h	750	90	160
70 km / h	750	90	200
80 km / h	900	150	250
If Specially hazardous	1200	90-150	-

9. Transition between Cross Section Type 5 and 3

Example of lay-out plan with road safety measures at transition between the following sequence of Standard Cross-section Type 5 and 3

Figure



LEGEND

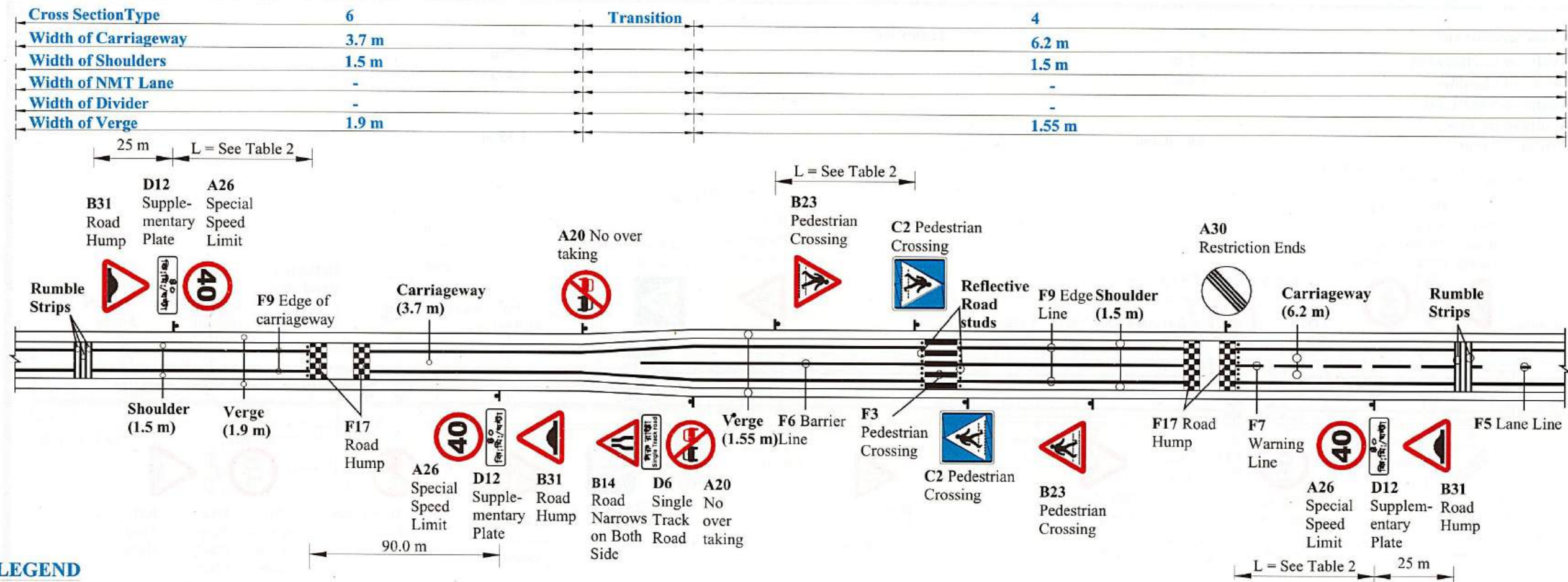
Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

A20 - No overtaking	F3 - Pedestrian Crossing
A26 - Special Speed Limit	F5 - Lane Line
A30 - Restriction Ends	F6 - Barrier Line
B14 - Road Narrow on the Both Sides	F7 - Warning Line
B23 - Pedestrian Crossing	F9 - Edge of Carriageway
B31 - Road Hump	F17 - Road Hump
C2 - Pedestrian Crossing	Rumble Strips -
D6 - Single Track Road	
D12 - Supplementary Plate	

Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km /h	750	90	160
70 km /h	750	90	200
80 km /h	900	150	250
If Specially hazardous	1200	90-150	-

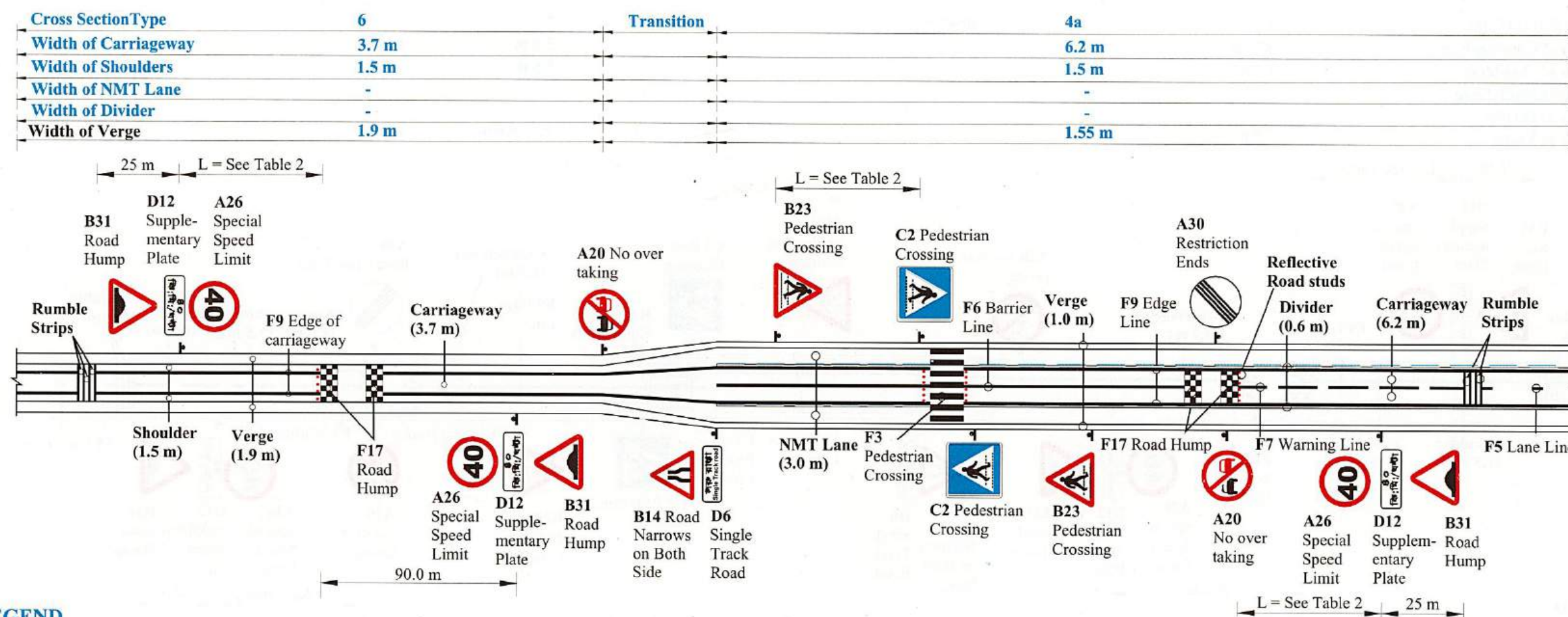
11. Transition between Cross Section Type 6 and 4

Example of lay-out plan with road safety measures at transition between Standard Cross-section Type 6 and 4 **Figure**

13. Transition between Cross Section Type 6 and 4a

Example of lay-out plan with road safety measures at transition between the following sequence of Standard Cross-section Type 6 and 4a

Figure

**LEGEND**

Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

- A20 - No overtaking
- A26 - Special Speed Limit
- A30 - Restriction Ends
- B14 - Road Narrow on Both Sides
- B23 - Pedestrian Crossing
- B31 - Road Hump
- C2 - Pedestrian Crossing
- D12 - Supplementary Plate
- F3 - Pedestrian Crossing
- F5 - Lane Line
- F6 - Barrier Line
- F7 - Warning Line
- F9 - Edge of Carriageway
- F17 - Road Hump
- Rumble Strips -

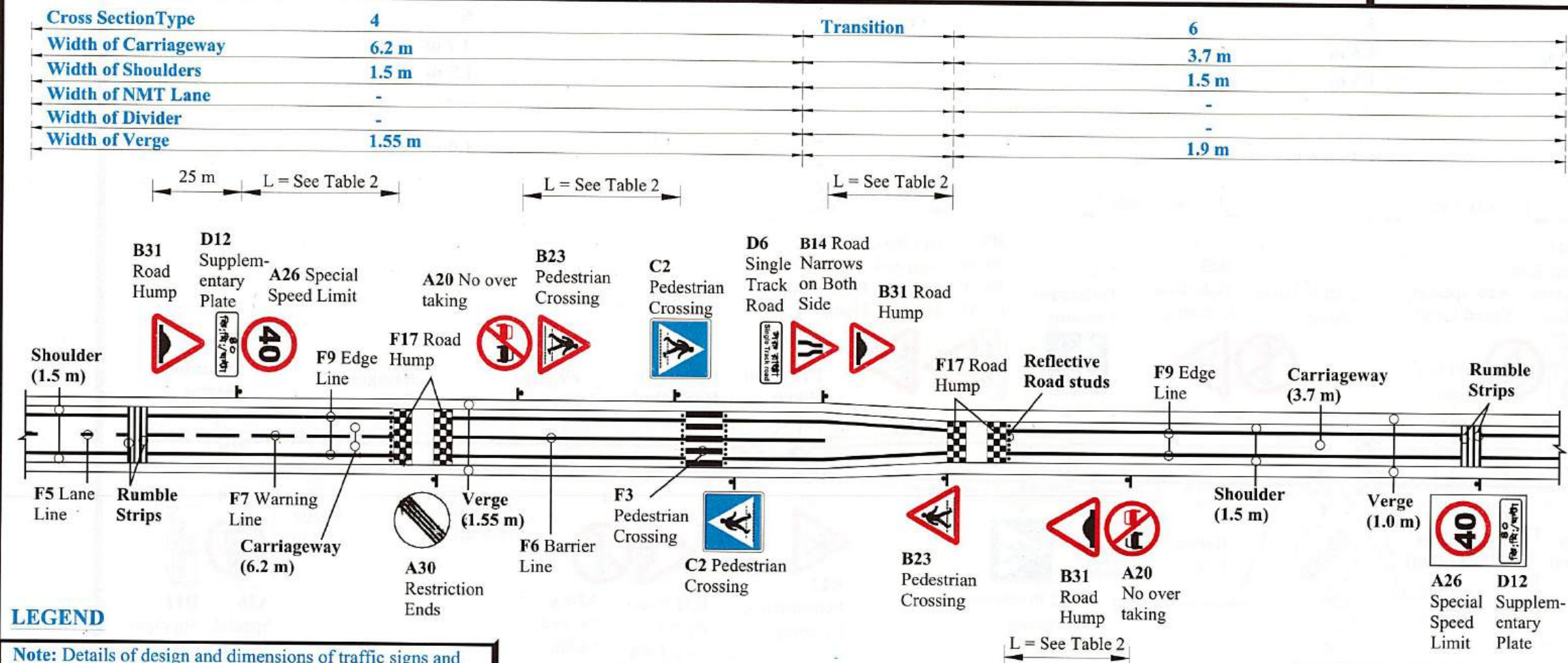
Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km / h	750	90	160
70 km / h	750	90	200
80 km / h	900	150	250
If Specially hazardous	1200	90-150	-

15. Transition between Cross Section Type 4 and 6

Example of lay-out plan with road safety measures at transition between the following sequence of Standard Cross-section Type 4 and 6

Figure



ROAD JUNCTIONS

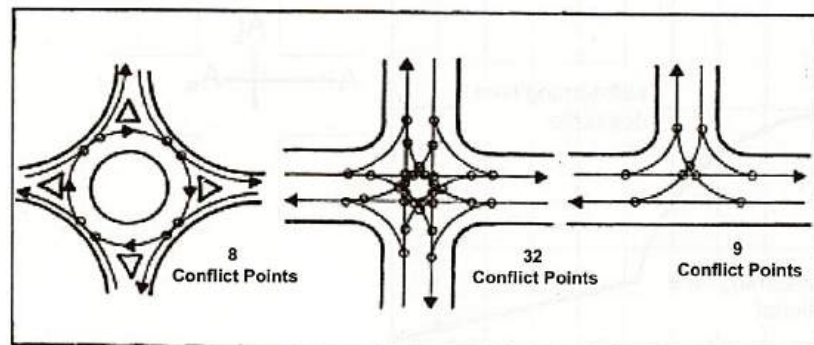
7 ROAD JUNCTIONS

7.1 Introduction

The higher accident risk in junctions is caused by different traffic composition (motorized vehicles, non motorized vehicles and pedestrians) comparing to open road link. Other reasons to higher accident risk are speed difference between vehicles, surprisingly sudden deceleration at the access or sudden appearing from a non visible minor road. Also different driving directions of vehicles shall increase the accident risk, especially when junction area is wide and open and do not give clear guidance to correct behavior (average driver try to take short cut when there is too much space in the junction).

Traffic safety at the junction could be improved by reforming the junction area, by using different traffic control measures and by improving visibility and sight distances.

The type of junction is connected with the accident risk. Possible conflict points may occur when driving routes of vehicles converge, diverge or cross, like illustrated hereafter:



In addition to conflict points, distribution and traffic flow volume have an impact to safety. For instance a four leg junctions is reformed to roundabout, which means that part of the traffic flow goes through several conflict points. Or a four leg junction is reformed to staggered junction (two T-junction), which means that part of the traffic flow passes both junctions.

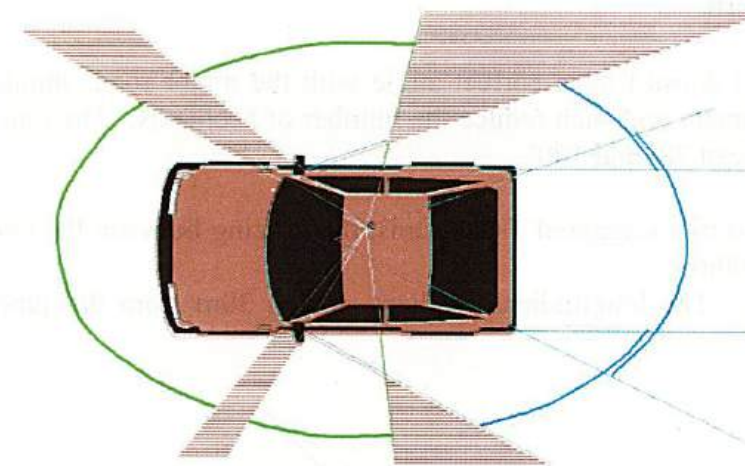
By changing a four leg junction to staggered junction (two T-junction) accident risk could be reduced 20 – 30 %. By constructing roundabout accident reduction is normally higher.

7.2 Junction Design Principles

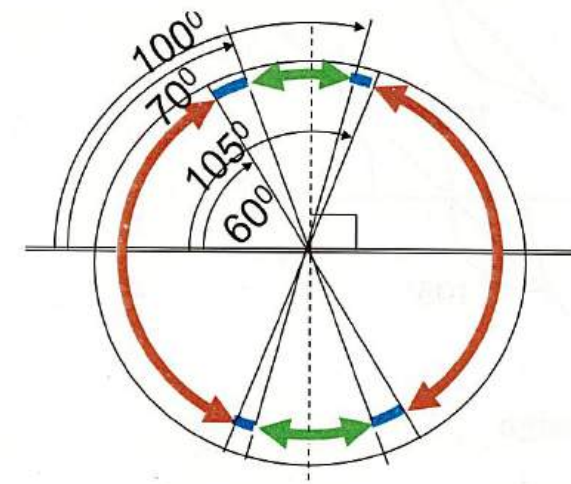
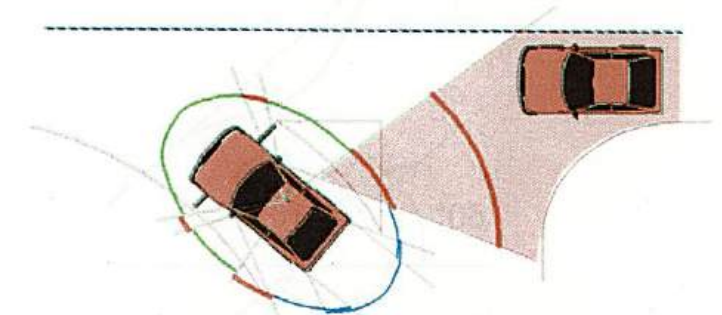
Engineers often prefer to make everything larger and wider - However, large open areas cause too many opportunities for shortcuts for individual a driver, which little by little leads to traffic chaos, conflicts and accidents. Traffic engineers should strictly watch that there is **enough and only enough space in correct locations but no extra space at all.**

The junction design should be based on zones which can be seen around the vehicle directly or via the vehicle's mirrors from driver's seat. The illustration hereafter indicates zones where observation is possible and what zones are so called "blind zones".

Blind zones



If the junction is designed with a triangular island protecting the left turners, like generally today in Bangladesh, the driver entering into main road cannot see the oncoming car.

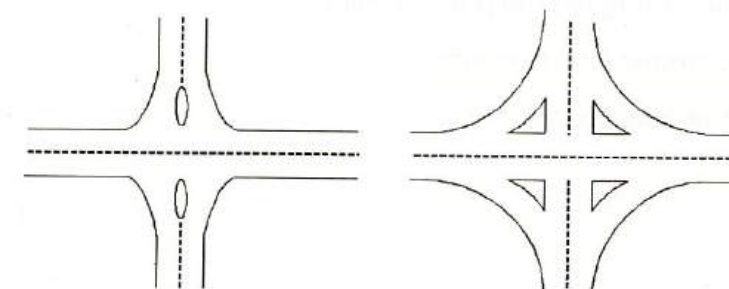


Due to mentioned "blind zones" the range of acceptable junction angles is between 70° - 100°. If required by surroundings and divisional island is constructed at minor road junction angle between 65° - 105° is acceptable.

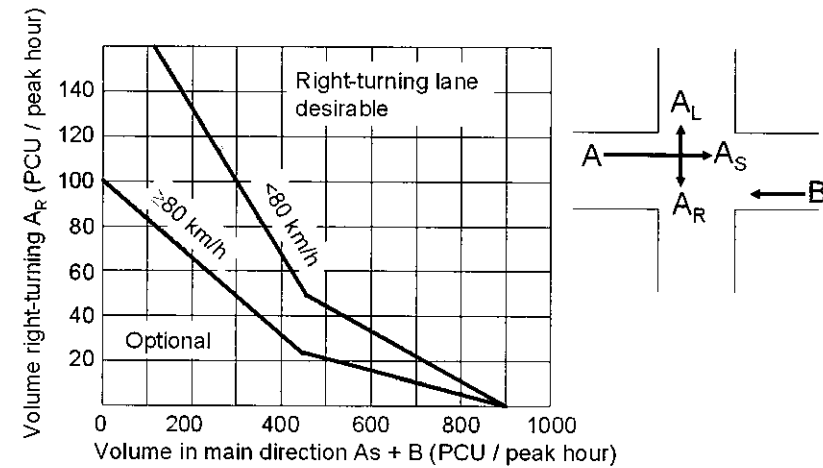
Hereafter is illustrated preferred and not preferred junction construction. Existing not preferred junction layout could be improved by constructing special accelerate lane for traffic joining into main road.

Preferred

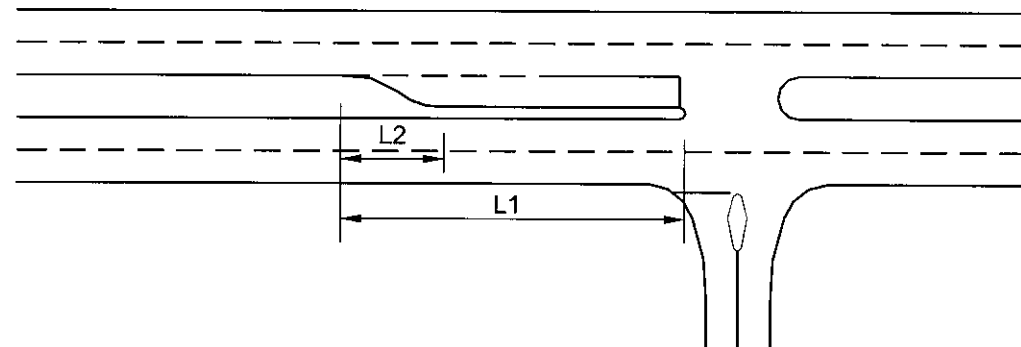
Not Preferred



Criteria for right-turning lane on primary road

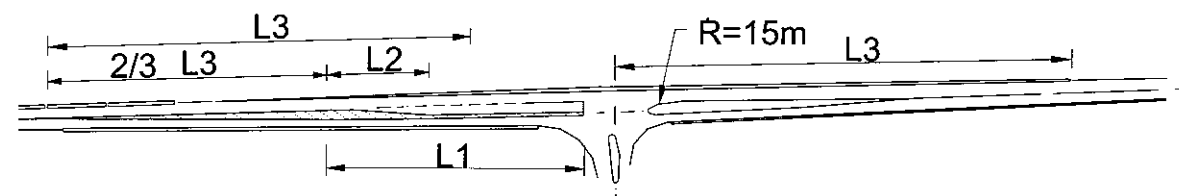


Length of right-turning lane in median



Design speed	Total length of left-turning lane L1	Length of transition curve L2
50 km/h	60 m	20 m
60 km/h	70 m	25 m
70 km/h	80 m	30 m
80 km/h	90 m	35 m
90 km/h	110 m	40 m
100 km/h	135 m	40 m

Length of right-turning lane



Design speed	Total length of right-turning lane, L1	Length of Transition curve, L2	Length of road widening, L3 (m)							
			D=							
			1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0
50 km/h	60 m	20 m	80	85	90	95	110	125	140	150
60 km/h	70 m	25 m	85	90	95	110	130	150	150	150
70 km/h	80 m	30 m	90	95	110	130	150	150	150	150
80 km/h	90 m	35 m	95	110	125	150	150	150	150	150
90 km/h	110 m	40 m	110	125	140	150	150	150	150	150
100 km/h	135 m	40 m	130	140	150	150	150	150	150	150

If road is widened at one side only:

$D = \text{sum (width of right turning lane + width of island/ painted lines)}$

If road is widened at both sides:

$D = \text{sum (width of right turning lane + width of island / painted line)}/2$

7.5 Traffic Signs and Road Markings in Junction Area

Size and locations of traffic signs, road markings and all other relevant information are set out in Traffic Signs Manual.

7.7 Examples of Existing Junctions Improvement (when main road is already widened)

Descriptions

Example of adjusting the junction to existing situation.

Junction can be modified.

Utilising the existing paved surface the safest possible way, using road marking and traffic signs only.

Introduction

Drawings must be made on basis of reliable map, on scale. Use one circle radius only. Clotoide transition curves should be used of both roads.

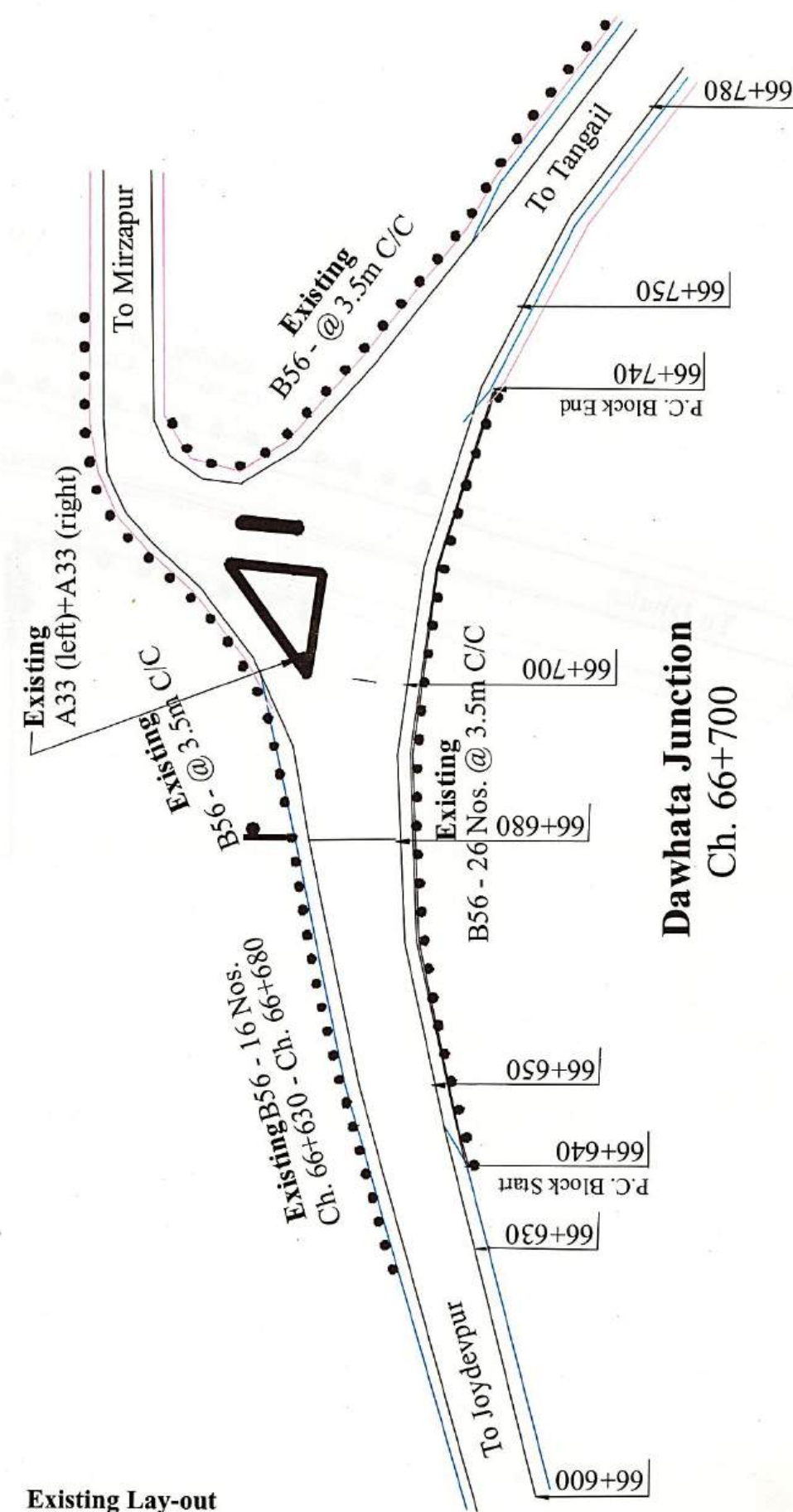
In situations where highway is already widened through the junction. Normally in Bangladesh the widening is done on a too short length, see sketch

See also modification

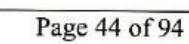
New two circles/curves in opposite's direction without straight line or clotoides/.. In-between.

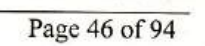
Design Steps

1. Draw the edge lines.
2. Find the two points whose the distance between the edgeline is made than 7.3 m (= the point where the CW is wider than 7.3m)
3. from this point onwards: draw two lines which follows line 1 (the edgeline) in a distance of 3.65m
4. The area in-between two lines should be marked, and will be divider between the two traffic directions, including separate right turning lane if widening permits sufficient space
5. Side Road
 - Make centreline to main road.
 - Curve up to meet first edgeline, and then straighten.
 - Divide the side road in two lanes for two traffic directions (min 3.75 + 3.75, if possible 4.5 + 4.5) + dividing island 2m to 4m.
 - Make edgeline correction between side road and main road by using $R=14.5m$ for traffic leaving the main road and $R=12m$ entering the main road.
 - Construct the divider island.



Existing Lay-out





7.8 More Examples of Improving Existing Junctions (even though main road is not widened)

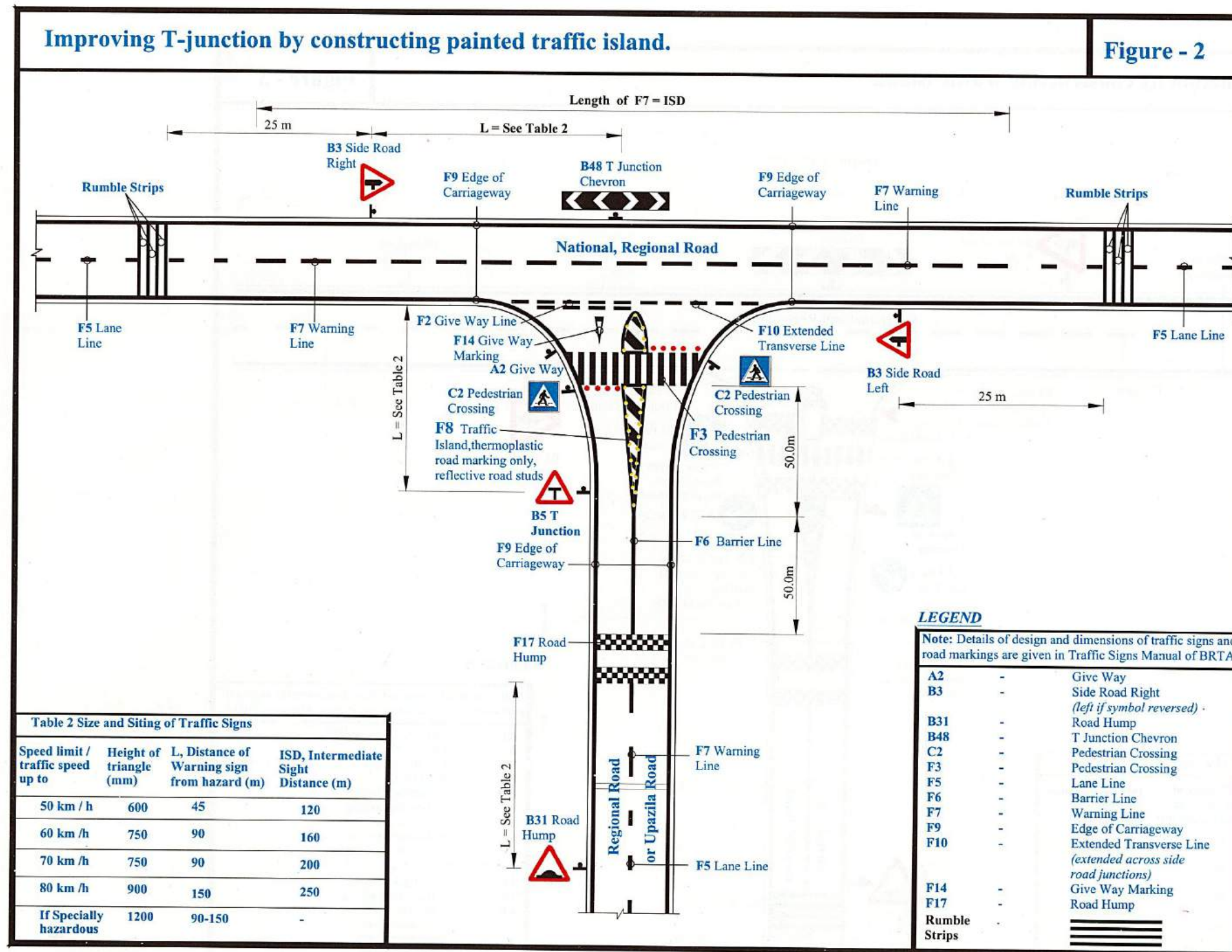
In the following pages, few examples of improving existing junctions are provided. Also few models “Bill of Quantity” (BOQ) as guide to prepare estimates safety work for schemes are included in this manual. The examples are:

	Page
1. Improving T-junction with Traffic Signs and Road Markings	49
2. Improving T-junction by Constructing Painted Traffic Island	50
3. Improving T-junction by Constructing Traffic Island	51
4. Improving Existing Straight Y-junction	52
5. Improving the Alignment of Y-junction with Road Markings and Traffic Signs	53
6. Improving the Alignment of Y-junction by Relocate the Junction	54
7. Improving Existing Equal Armed Y-junction	55
8. Improving Y-junction with Traffic Signs and Road Markings	56
9. Improving Y-junction to Roundabout	57
10. Medium Size Roundabouts	58
11. Large Size with Separate NMV Lanes	59
12. Railway Crossing (existing situation)	60
13. Railway Crossing (improved situation)	61

2. Improving T-junction by Constructing Painted Traffic Island

Example of improvement on T-junction by constructing painted traffic island and providing appropriate traffic signs and road markings.

Actual situation must be studied on the road and needed corrections & adjustments to the drawing must be done. User of this manual must study and refer to Traffic Signs Manual.



4. Improving Existing Straight Y-junction

Example of existing straight Y-junction by improving T-junction.

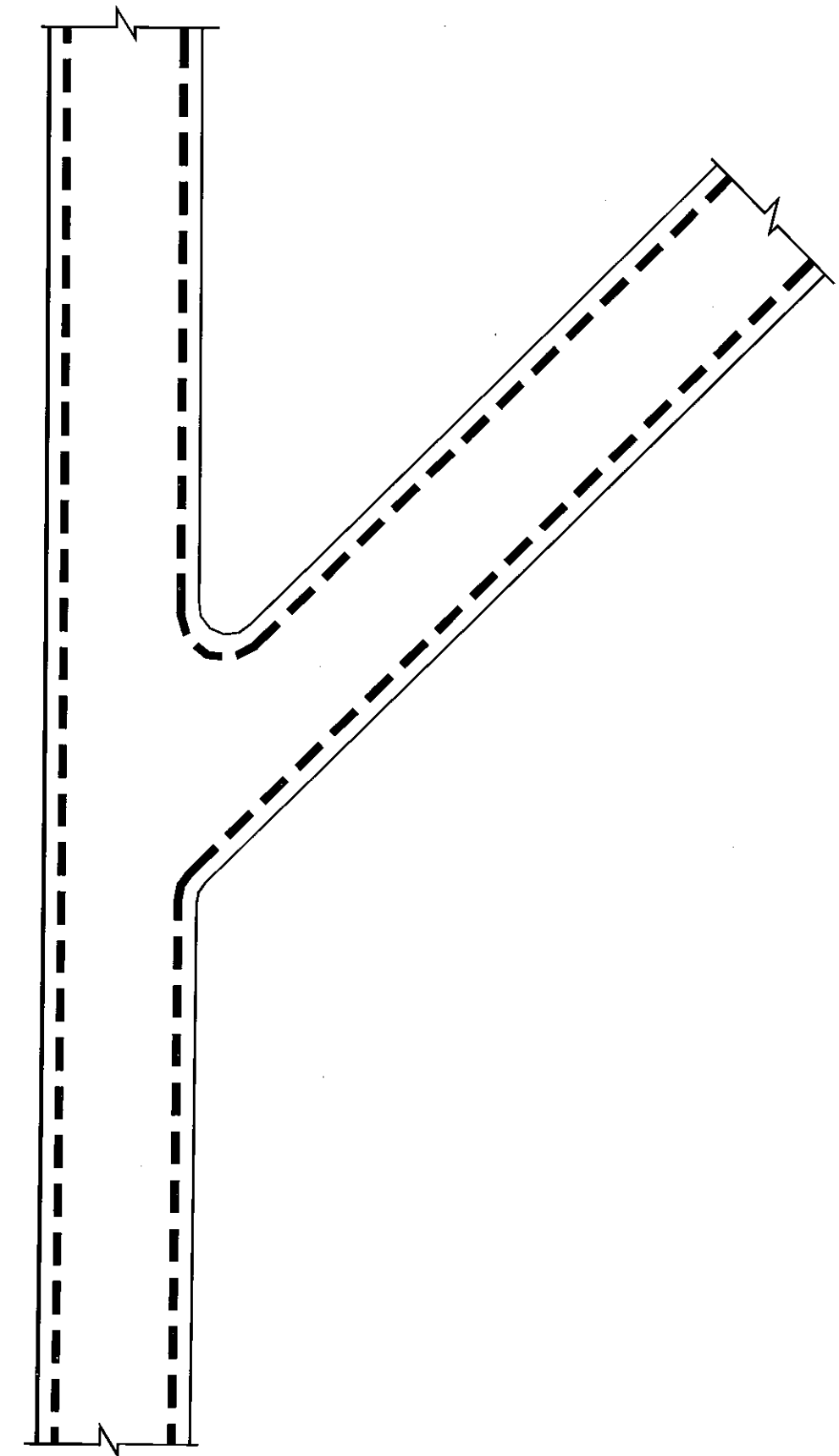
Two examples how to improve traffic safety in existing straight Y type junction by improving it T type junction. Other example is low cost and made with road markings and other one is more costly by improving the road alignment.

In most of the cases main road is going straight and side road is branch of Y. Typically existing Y junction is wide open area due to drivers' behavior. Average driver take a shortcut in the corners of junction and soon road authority must widen those corners.

Before using directly these principle drawings on any road section, the actual situation on the road must be checked and needed corrections must be done.

Examples of typical problems in existing situation:

1. Driving side road and turning left to main road
 - a. Blind zone on right side, difficult to observe those driving main road same direction
 - b. Easy to join in with high speed => loss control or head on accident
2. Driving side road and turning right to main road
 - a. Sharp curve to right is difficult especially to long vehicles
3. Driving main road and turning left to side road
 - a. Sharp curve to left is difficult especially to long vehicles
4. Driving main road and turning right to side road
 - a. Easy to join in with high speed => loss control accident
5. Driving straight to main road
 - a. Vehicle from side road join in with high speed
 - b. Vehicle front of me turn to side road with high speed
 - c. Sharp curve may lead vehicle to my driving lane



Existing situation

6. Improving the Alignment of Y-junction by Relocate the Junction

Example of Road Safety Improvement of Existing Y-Junction by improving alignment.

Figure - 5

Improving the Alignment of Y-junction by Relocate the Junction

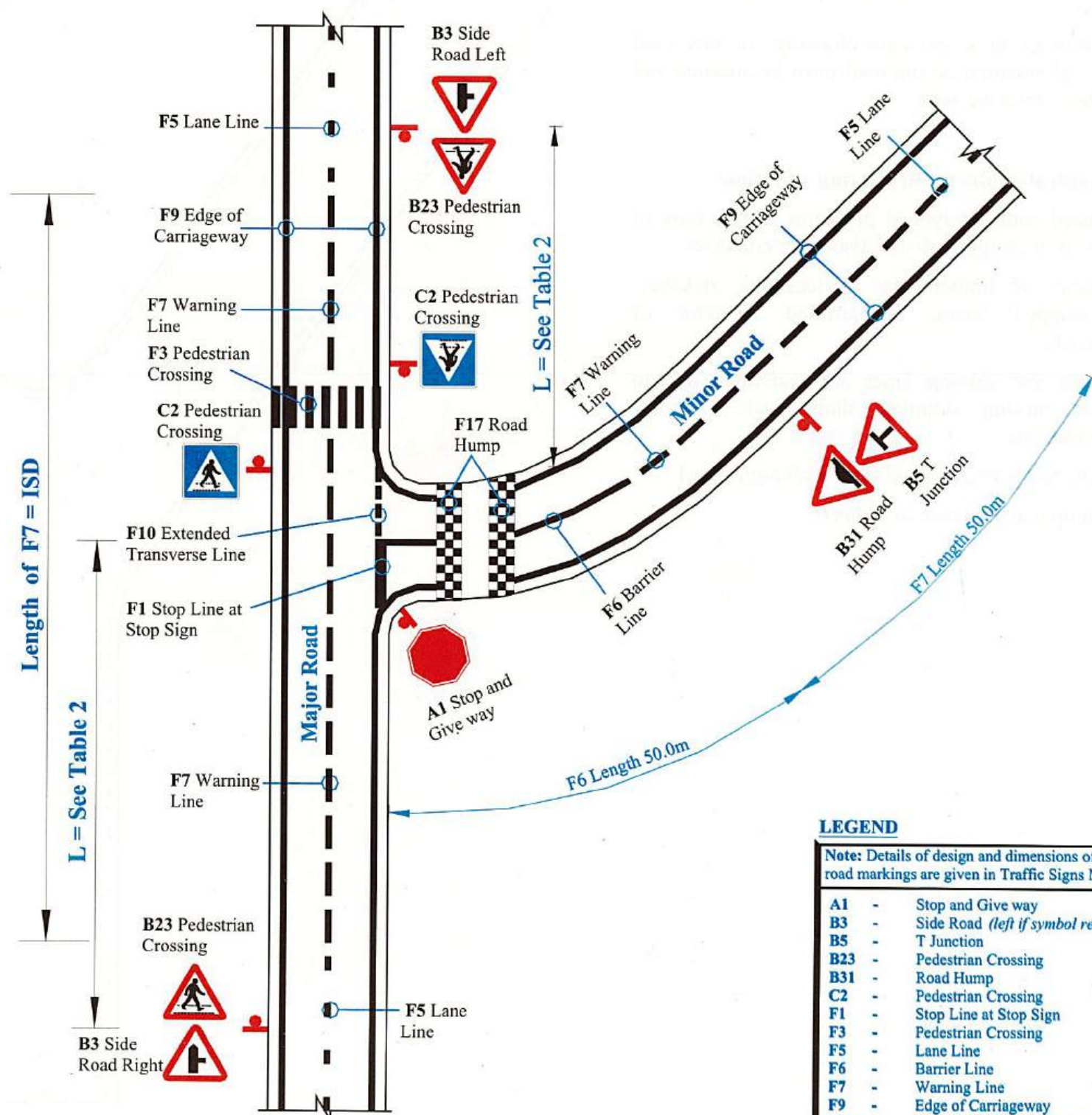
Realignment of existing straight Y type junction is more effective, even it is also more costly way to improve traffic safety. Improvement with road markings and traffic signs could be used as the first step on the way to more permanent solution

Realignment allows road authority to remove junction's location into safer place. Naturally repaired junction must be equipped with appropriate traffic control devices, like traffic signs and road markings.

It is essential to ensure optical guidance to road user with background signs or even better way is planting of old road groove.

Table 2 Size and Siting of Traffic Signs

Speed limit / traffic speed up to	Height of triangle (mm)	L, Distance of Warning sign from hazard (m)	ISD, Intermediate Sight Distance (m)
50 km / h	600	45	120
60 km / h	750	90	160
70 km / h	750	90	200
80 km / h	900	150	250
If Specially hazardous	1200	90-150	-



LEGEND

Note: Details of design and dimensions of traffic signs and road markings are given in Traffic Signs Manual of BRTA

A1	-	Stop and Give way
B3	-	Side Road (left if symbol reversed)
B5	-	T Junction
B23	-	Pedestrian Crossing
B31	-	Road Hump
C2	-	Pedestrian Crossing
F1	-	Stop Line at Stop Sign
F3	-	Pedestrian Crossing
F5	-	Lane Line
F6	-	Barrier Line
F7	-	Warning Line
F9	-	Edge of Carriageway
F10	-	Extended Transverse Line
F17	-	Road Hump

8. Improving Y-junction with Traffic Signs and Road Markings

Improving Y-junction with Traffic Signs and Road Markings

Improvement with traffic signs and road markings is low cost method and depending on actual situation on the road, it could be also cost effective. Due to location of existing junction (in a curve) all directions should be equipped with relevant traffic signs as well as speed reducing and warning devices, like circular speed reducing equipment, raised pedestrian crossings and rumble strips, etc.

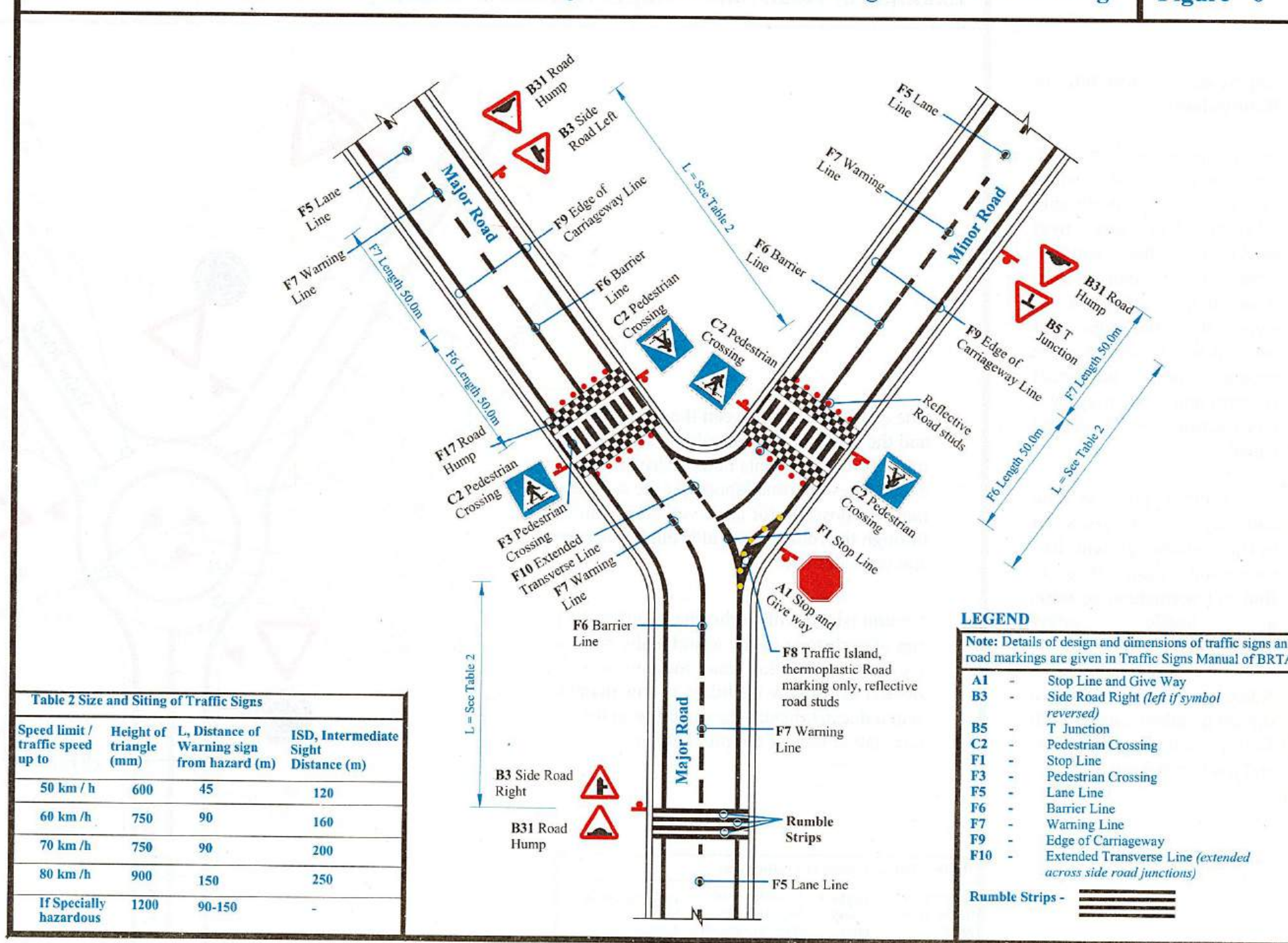
Depending on the actual situation on the road demolition of teashops, uncontrolled bus bays, rickshaw parking, etc. should be considered, to improve optical guidance and sight distance.

On the traffic safety point of view this solution should be considered very carefully, because junction remains on existing location (middle of curve).

This solution could be considered as "first aid" to existing extremely bad situation and the more permanent solution could be roundabout or even relocation of the junction.

Example of Road Safety Improvements of Existing Y-Junction with traffic signs and road markings

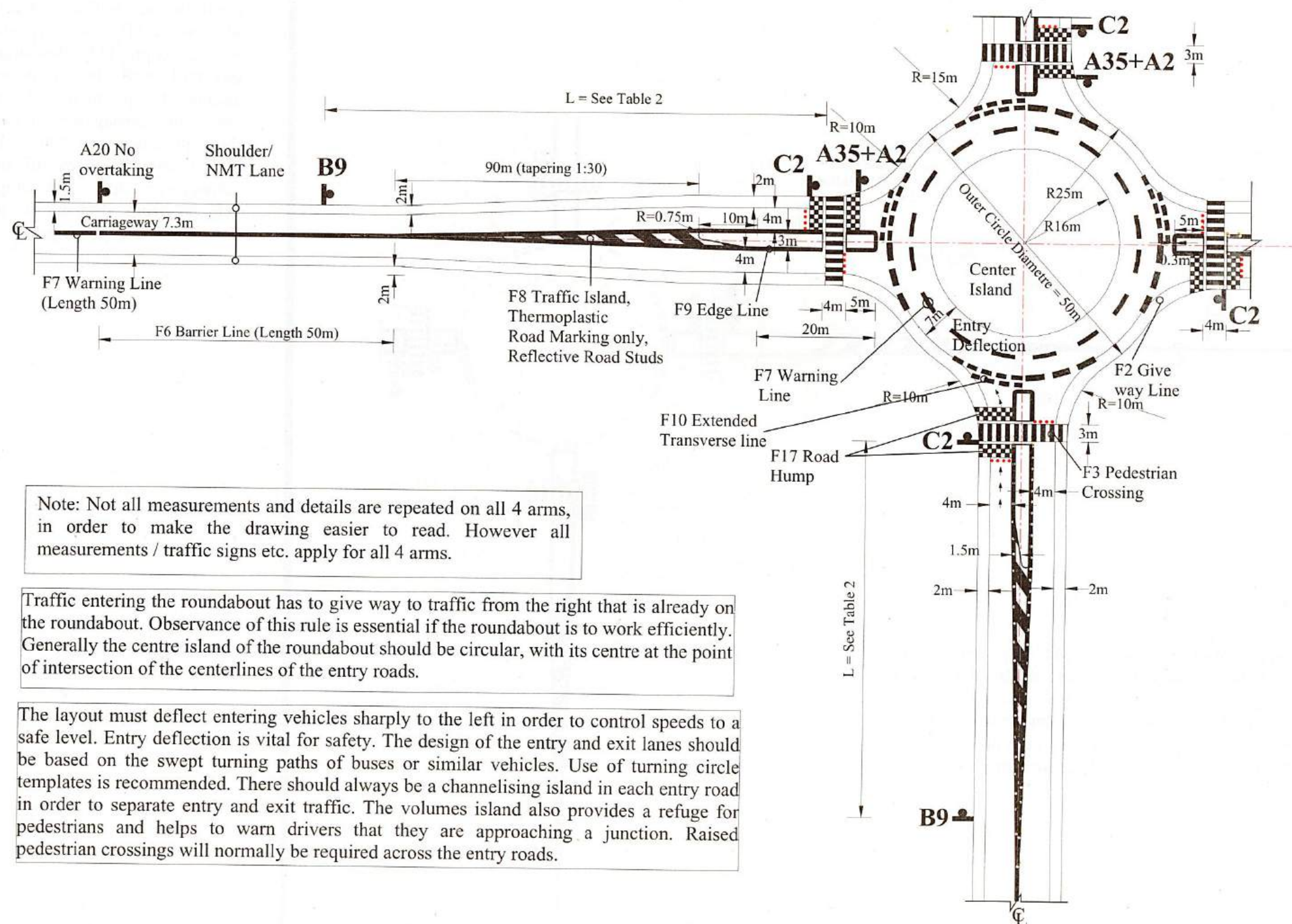
Figure - 6



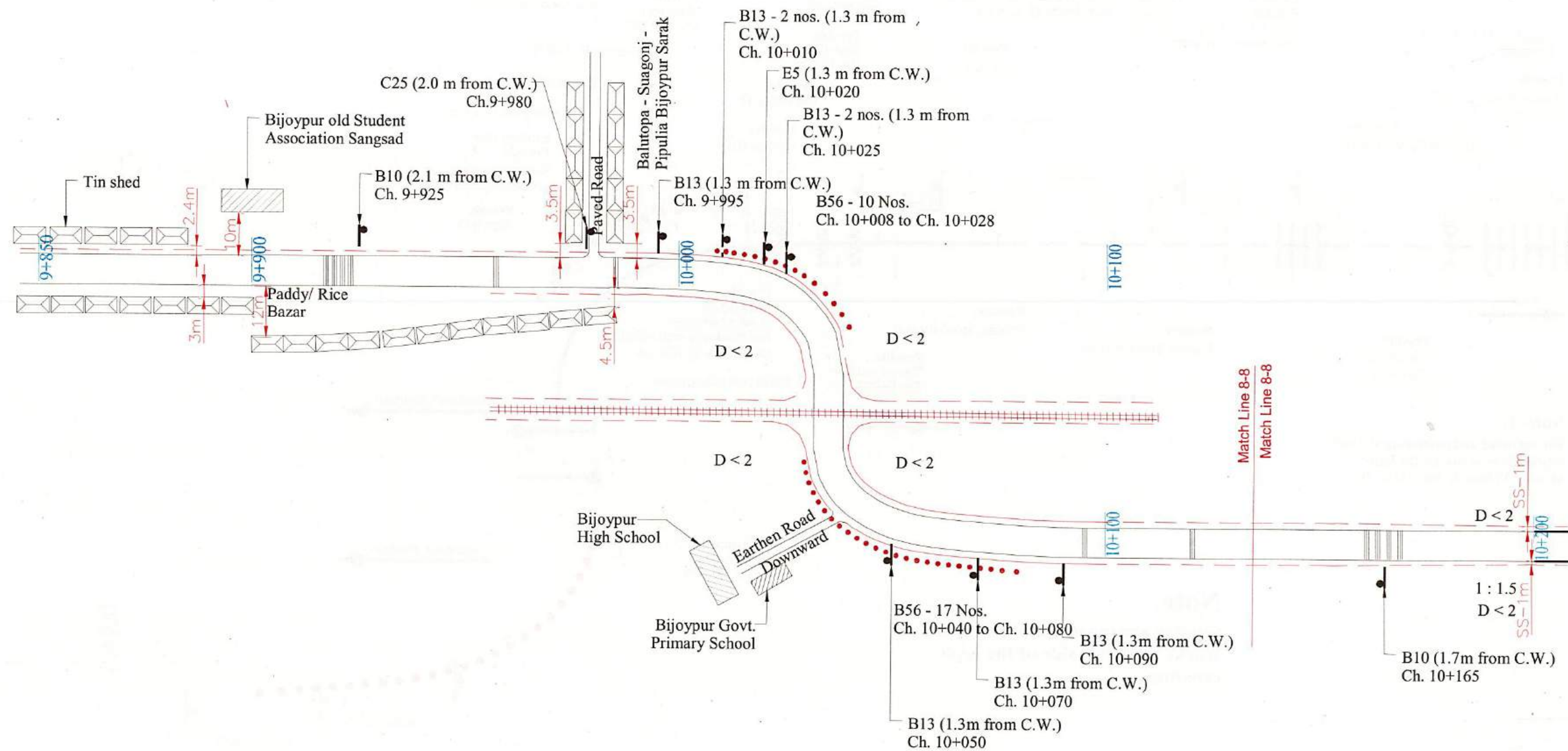
10. Medium size roundabouts

Design of medium size roundabout

Figure 8



12. Railway crossing (existing situation)



7.9 Model Bill of Quantities for Transitions and Junctions

Model Bill of Quantities (BOQ) is prepared in order to help designing and calculation of cross section transitions and junctions. Model BOQs are based on example drawings of transitions and junctions shown in this manual and they include typical civil works, quantities of traffic signs, road markings, etc.

These model BOQs must be considered very carefully, because they include several assumptions, like length of transition and tapering, number of needed pedestrian crossings (sometimes one or more or none), etc. Unit price given in model BOQ is also assumed to certain level and it will vary widely depending on year, site location and timing of the work, etc. It is assumed that land filling is not needed. Assumptions used in model BOQ are given at the beginning of BOQ Tables.

Before using these model BOQs, every site must be studied carefully by site investigations and relevant adjustments to model BOQ must be done to get correct items and real cost estimates.

SPEED REDUCING AND WARNING DEVICES

8 SPEED REDUCING AND WARNING DEVICES

8.1 Introduction

Character of some road links and specific locations, like bazaar area in a curve, requires more effective measures, in addition to relevant traffic signs to ensure traffic safety.

Average drivers ignore traffic signs, such as speed limit sign, observed earlier; unless the need for installed traffic sign is very clear. Recently rehabilitated road through a village tempt drivers to use high speed; even there is lots of pedestrians, therefore Road Authority should provide some physical devices in addition to traffic signs, which will force driver to reduce his speed.

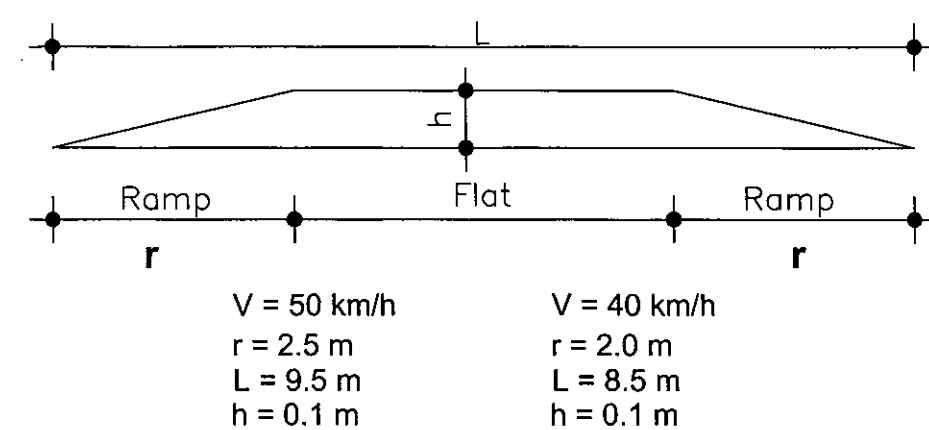
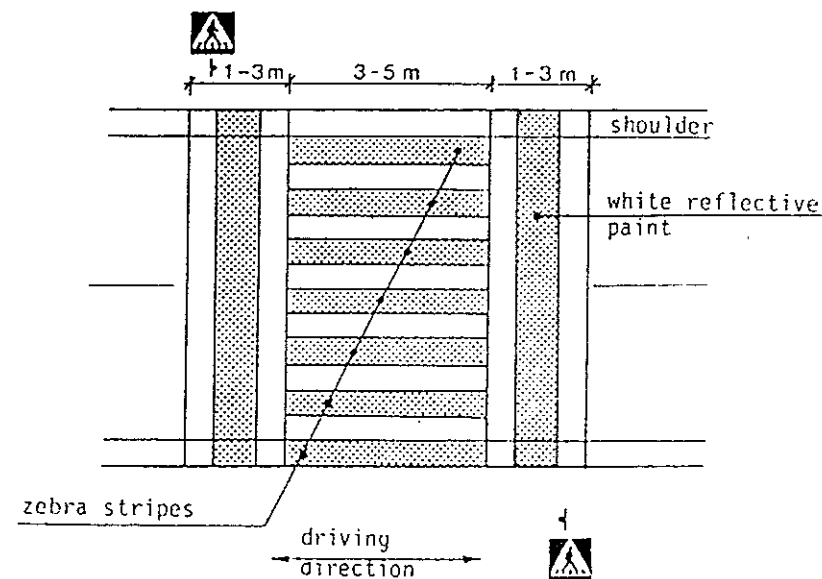
After driving several hours at same speed, drivers may become careless and do not see reason to reduce speed. This so called "speed blindness" effect could be prevented with warning devices, which shall "wake up" the driver to notice hazard in front of him.

8.2 Raised Pedestrian Crossing

Road link through a bazaar area or developed area may require several pedestrian crossings. By providing raised pedestrian crossings on required locations the Road Authority easily compel vehicle speed reduced to desired limit.

It is essential to give pre-warning about the raised crossings before the first crossing from both driving directions and mark each crossing separately with relevant traffic signs. Raised crossings must be marked with thermoplastic road marking to ensure visibility in dark hours (consult TSM).

To ensure maximum lifetime and maximum efficiency, the raised pedestrian crossing must be designed properly and only right quality materials should be used. Hereafter is given design principles of raised pedestrian crossing.



8.3 Circular Speed Reducing Device

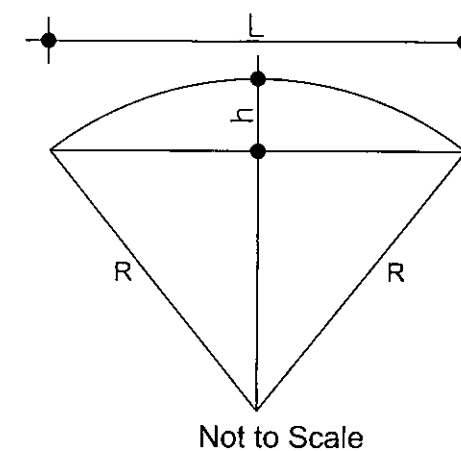
Road link, where pedestrian is less, but lower speed is still required, could be equipped with a series of circular speed humps.

Circular speed hump is totally different than speed breakers, commonly used today in Bangladesh. Circular speed hump is part of circle with the certain radius (depending on desired speed) and only small part of the circle is above the road surface (circular speed reducing device).

It is essential to equip speed hump with relevant traffic signs and retro-reflective thermoplastic road marking to ensure visibility during dark hours (consult TSM).

Similar to raised pedestrian crossings, speed humps must be designed properly and only high quality materials should be used to ensure maximum lifetime and efficiency. Hereafter is given design principles of circular speed hump.

However, when it is necessary to provide circular speed reducing device on National or Regional Highway; Road Safety Unit of RHD must be consulted and **approval must be taken from the higher authority of RHD.**



V = 50 km/h
R = 113 m
L = 9.5 m
h = 0.1 m

Average speed	Hump Length	Radius	Distance between humps
20 km/h	3.0 m	11 m	25 m
30 km/h	4.0 m	20 m	75 m
40 km/h	6.5 m	53 m	150 m
50 km/h	9.5 m	113 m	250 m

8.6 Median

Typical behavior of average driver in Bangladesh can be seen on road links without road markings. For some reason average driver drives along centreline of the road and risk of head on accident is thus increased significantly.

Road links where road markings have been provided, an average driver in Bangladesh more or less try to follow guidance given to him by road markings. This behavior is typical on open road links, but when approaching bazaar or village area or junction traffic flow moves back middle of the road.

The most effective way reducing number of head-on accidents and preventing hazard of unnecessary overtaking is to separate traffic flow driving in opposite directions, with physical equipment, median.

There are several types of medians and many variations of dimension. Median can be low, high, narrow and wide, depending on location, requirement, space, etc. Examples:

- Zia airport road in Dhaka is equipped with narrow “New Jersey” type median, which is designed to allow light vehicle to climb up half way to median without serious property damages.
- Low height median do not block sight distance of the driver.
- On National and Regional Highways, wide medians could be planted with small bushes or flowers to make road environment more comfortable, prevent dazzle during dark hours.



Picture from National Highway (Chittagong City)

PEDESTRIAN OVERPASS

9 PEDESTRIAN OVERPASS

9.1 Introduction

A grade separated crossing is the safest for pedestrians. However, if it is not properly planned and designed, nobody will use it voluntarily and the expensive investment is wasted. The principle is simple: the location and design of the overpass must convince the pedestrians that use of the overpass is more feasible, more comfortable and safer than crossing at road level.

Before design and constructing pedestrian overpass the Road Safety Unit of RHD must be consulted.

9.2 Location of Pedestrian Overpass

What is the correct location of the pedestrian overpass and the size of stairs should be considered carefully. The best location is where the additional walking distance for the pedestrians is kept to a minimum. Observations on where the pedestrians choose to cross the road during different times of the day must be done. The location should always be discussed with the Bazaar Committee or other representatives of the local community, who can give supplementary information of the pedestrian behaviour and advice on the best location. A concept drawing showing presentation of pedestrian crossing behaviour and the consequently chosen location of the overpass and stairs is given at section 9.5.

9.3 Pedestrians Use of Overpass and Fencing

Calculating walking distance ratio:

Without fencing in the median or along the footpaths, only a small portion of the pedestrians will choose to use the overpass. The fence needs to be of a certain length to convince/force the pedestrians to use the overpass. The necessary length of the fence can be calculated by the following formula and graph:

Pedestrians' choice of using / not using the overpass depends on the walking length ratio between the overpass and at level. The two walking lengths should be measured in "Modified distance", which includes

Dh = Horizontal ground distance (metres).

Dv = the sum of Vertical distances (metres) at the two ends of the overpass, multiplied by 10.

T = Delay due to traffic, if crossing at level (seconds).

Modified distance: $Dm = Dh + Dv + T$

The modified walking distance ratio is: $Dm(\text{overpass}) / Dm(\text{ground})$.

Example:

Dh: at a road with cross-section 7.3 m carriageway, divided by a 0.5 m median, and having 1.5 m shoulder on both sides, Dh = 10.8.

Dv: with standard free height under the overpass 5.5 m, and no difference in level between the two sides of the road:

$$Dv = (5.5 + 5.5) \times 10 = 110.$$

T: the delay due to waiting for gap in the traffic before crossing can be estimated by observations or more exact measured by traffic volume counts and speed measuring. In situations where pedestrian overpass are required, T will normally be between 10 and 40 seconds, in this example we use 20 seconds.

$$Dm(\text{overpass}) = 10.8 + 110 + 0 = 120.8$$

$$Dm(\text{ground}) = 10.8 + 0 + 20 = 30.8$$

$$\begin{aligned} \text{Walking Distance Ratio} &= Dm(\text{overpass}) / Dm(\text{ground}) \\ &= 120.8 / 30.8 = 3.9. \end{aligned}$$

Conclusion:

Hardly anybody will use the overpass. So, Fencing in the median or along footpath is needed.

Calculating length of fence

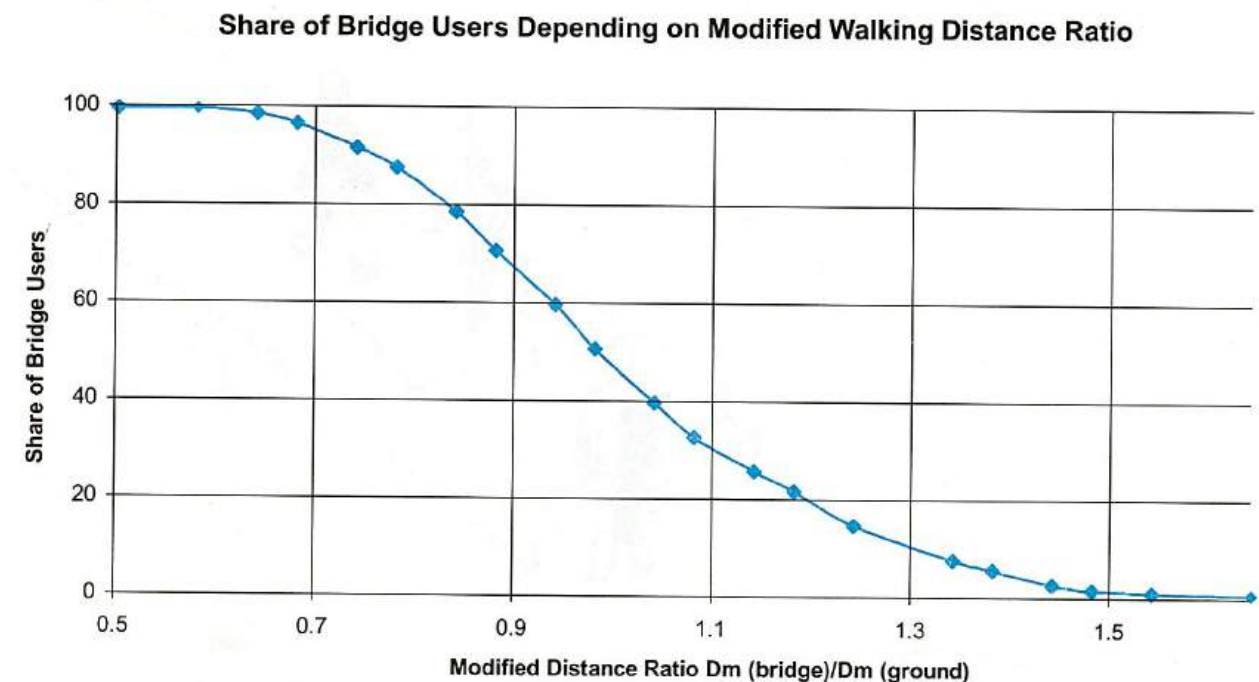
The necessary length of the fence can be calculated as follows:

If we want 90% of the pedestrians to use the overpass, the Modified Walking Length Ratio must be 0.7 according to the graph hereafter.

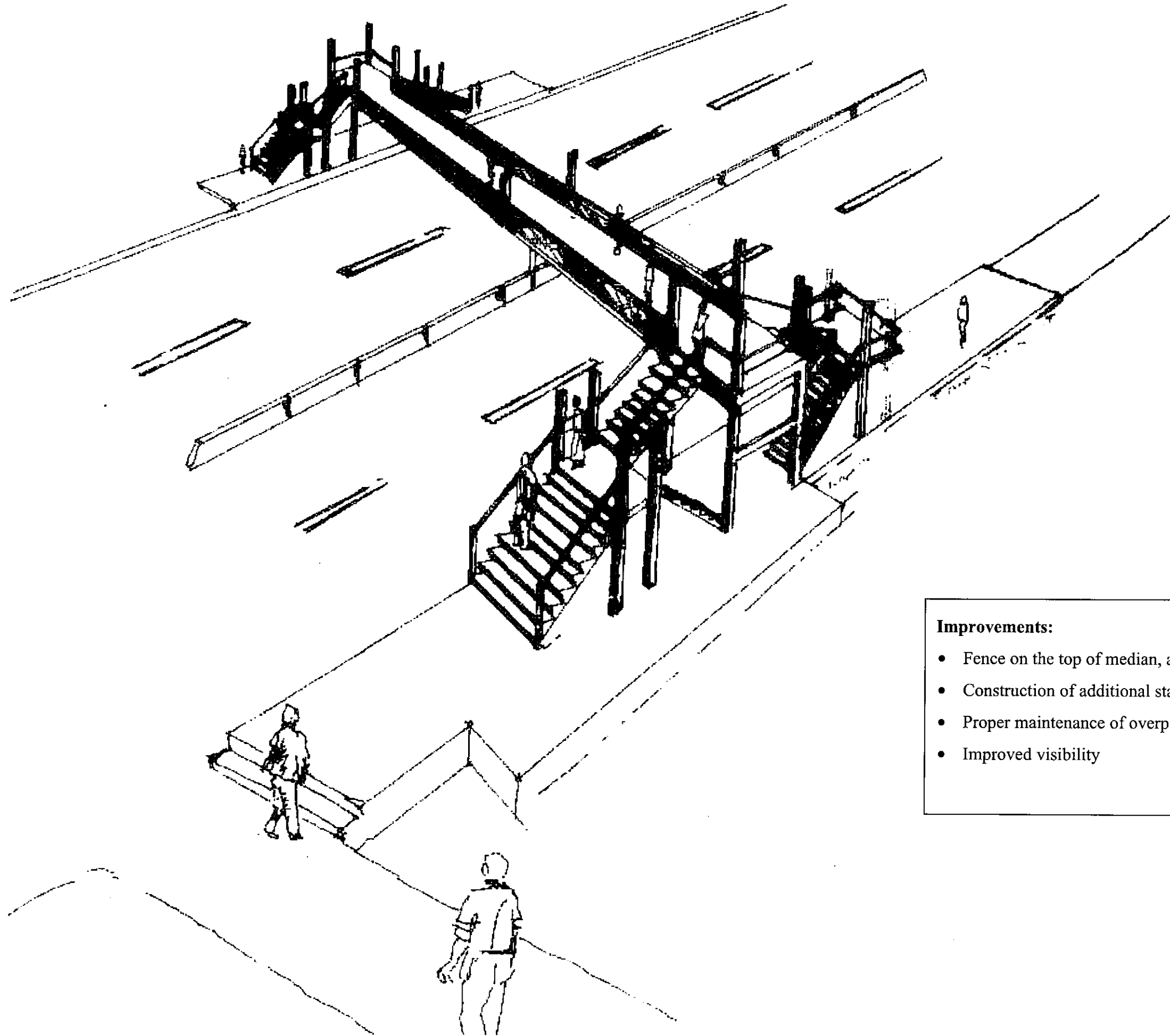
$$Dm(\text{overpass}) / Dm(\text{ground}) = 120.8 / X = 0.7$$

$$\text{Necessary } Dm(\text{ground}) = 120.8 / 0.7 = 172.6$$

$$\begin{aligned} \text{Necessary length of the fence (in each of the directions from the overpass): } Dm(\text{ground}) - Dh - T &= 172.6 - 10.8 - 20 = 141.8 \text{ m.} \end{aligned}$$



Improved Situation



Improvements:

- Fence on the top of median, adequate length to both directions
- Construction of additional stairs, existing stairs shall remain
- Proper maintenance of overpass
- Improved visibility

9.6 Example of User Friendly Overpasses

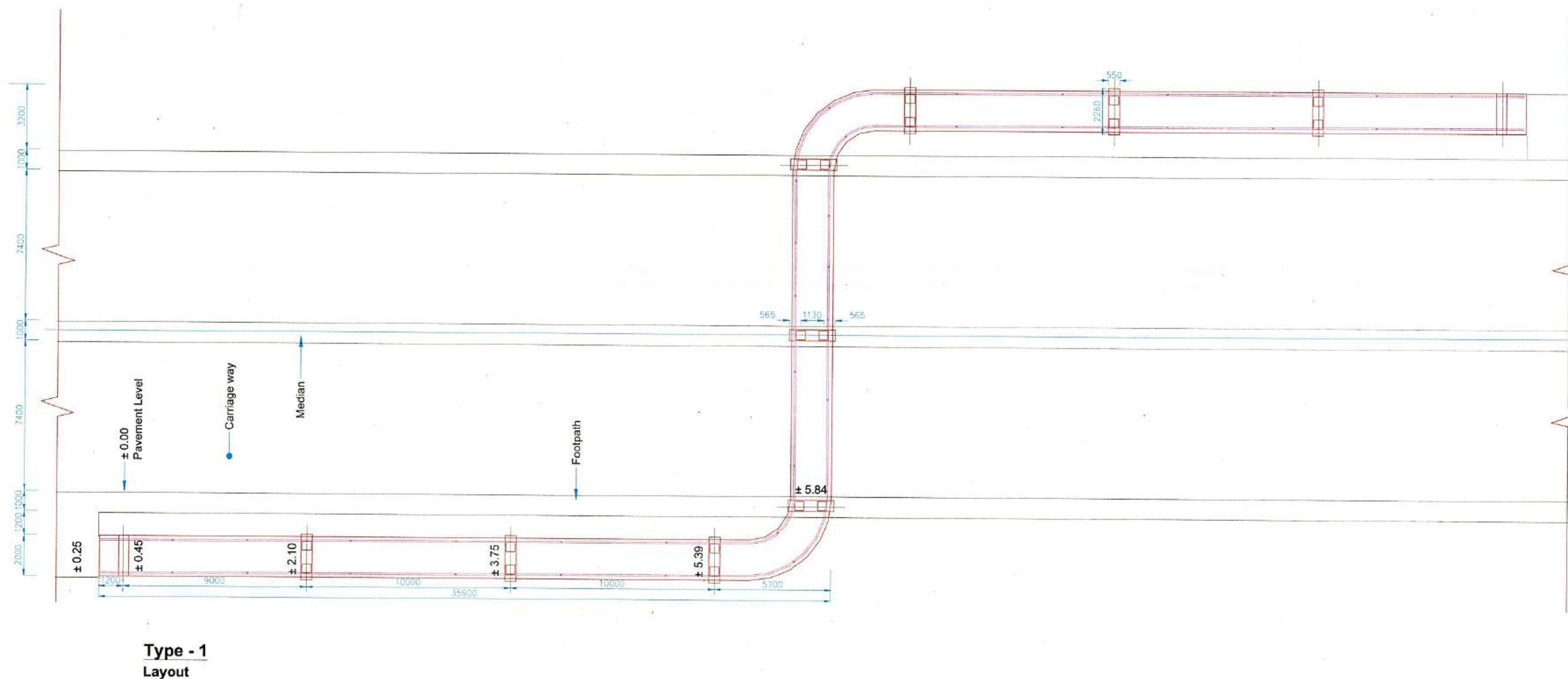
Before using any of examples shown hereafter, all dimension, and other technical and structural details must be studied, site investigations carried out and accordingly dimensions shown in the drawings must be corrected. Also, the user of this manual must consult other relevant manuals. Structural design details of pedestrian overpass must be prepared or vetted by the Structural Design Unit of RHD.

All Pedestrian Overpass Schemes (to be constructed by RHD budget or other agencies such as Municipalities, Cantonment Boards, etc.) **must** be submitted to Road Safety Unit of RHD for check up and approval. RHD Operational Divisions **should not take decisions without consultation and vetting of Road Safety Unit of RHD.**

Overpass Type-1: Layout

Overpass type-1

This is a reinforced concrete pre-cast pile supported slab type overpass consisting of superstructure with steel railing, lightning posts and pile caps for both ramps and superstructure over road. Square pre-cast piles have been arranged in groups of 3 nos. and groups have been tied to reduce buckling of slender piles. This type could be adapted to locations where foundation conditions permit continuous spans and demands the requirements of harmonizing with the surroundings from aesthetic as well as cost point of view. Superstructure is directly placed over the piles without having additional substructures or base and thus minimizes the overall cost of structure.

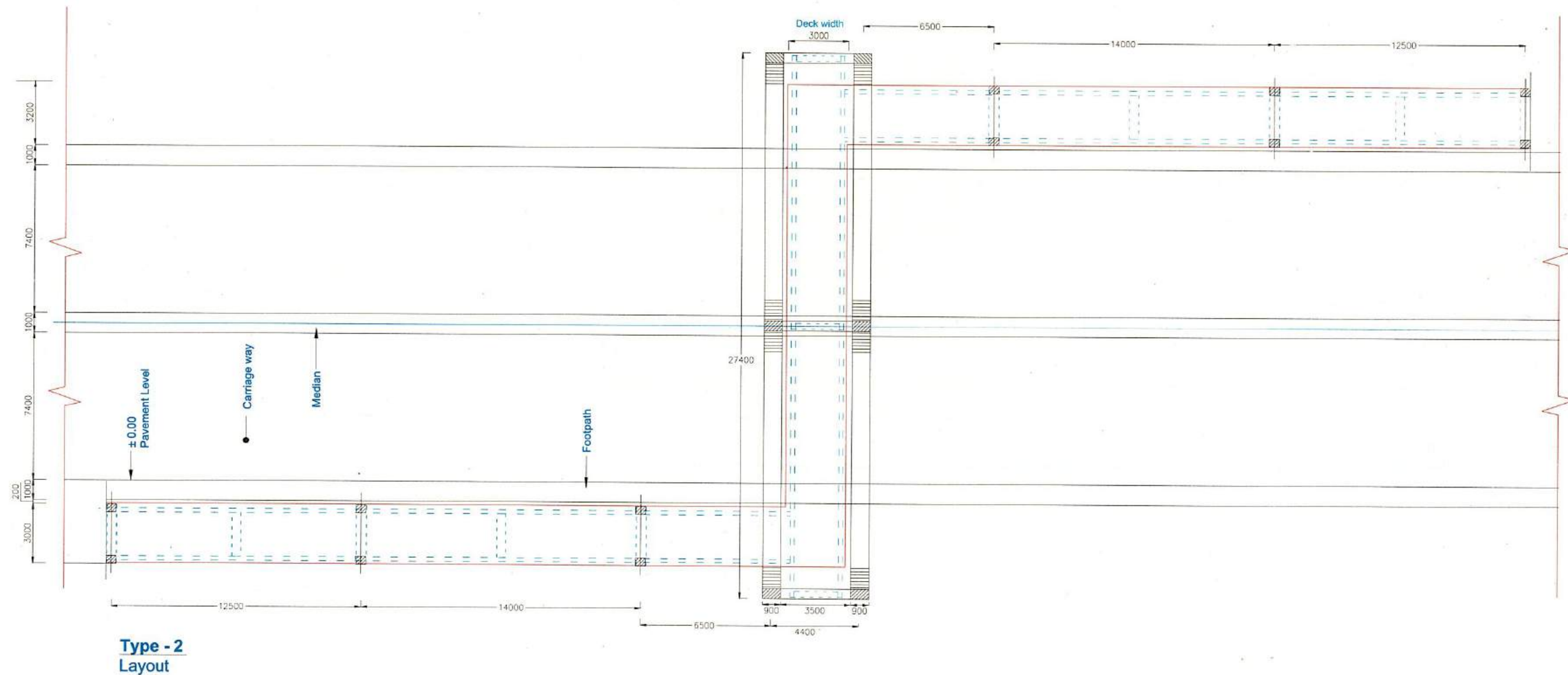


Overpass type-2

Pedestrian overpasses of semi-circular shapes possess aesthetically pleasant and graceful configuration and hence its use in highway industry are increasing rapidly. It is very simple and convenient to provide these structures with transparent colored (Blue/Green) plastic sheets to harmonize with surroundings in intelligent manner. The discontinuity of ramp modules from the roadway deck structure form individual performance of the units to counteract temperature stresses and stresses due to sinking of supports.

Overpass Type-2: Layout

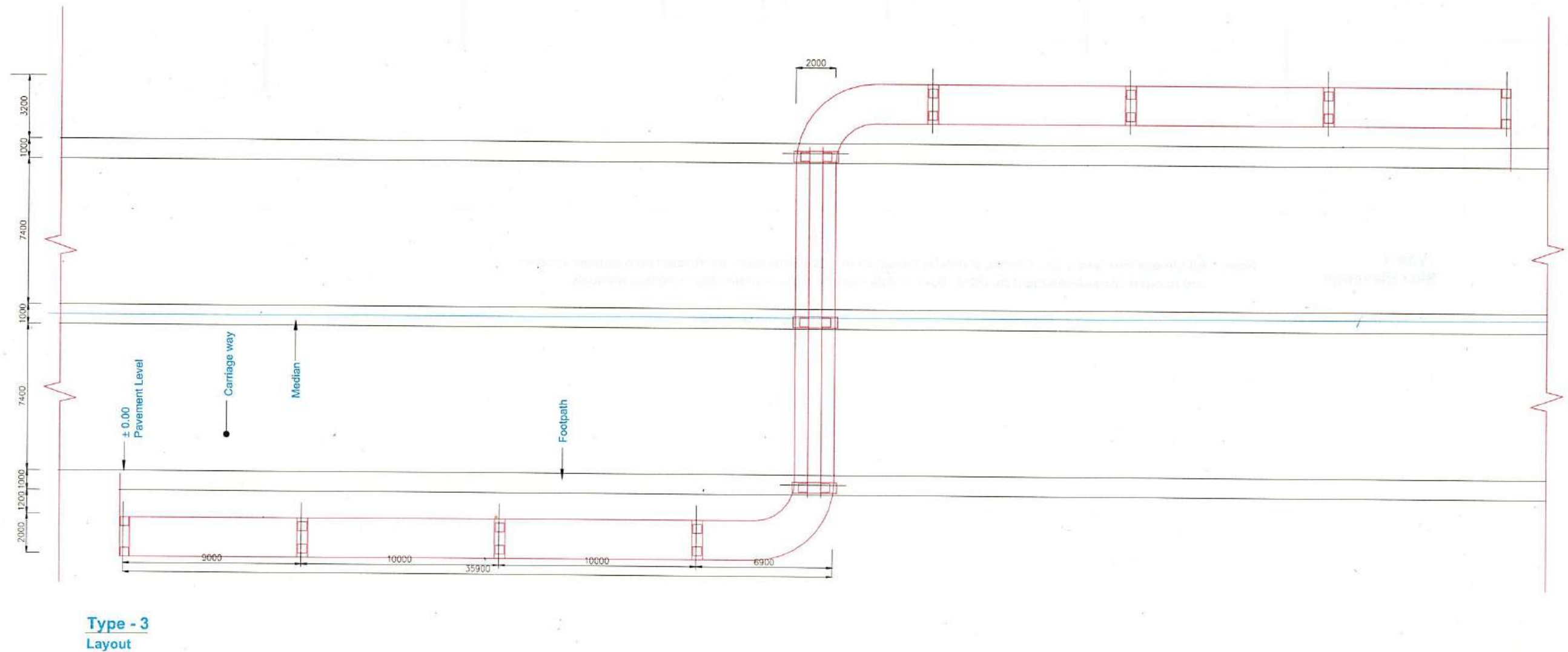
The deck is not directly exposed to weather and hence it will encourage full access of tired and aged pedestrians during summer or rainy seasons. Two semi-circular arches of 7.30m radius rest on a common roller and hinges for two other supports which are intended to be supported on straight reinforced concrete columns. Transverse beams connecting the arches serve as primary supports of slab which ultimately transfers the deck load on twin arches. The slab is assumed to be designed spanning longitudinally to the transverse beams which support the superstructure.



Overpass type-3

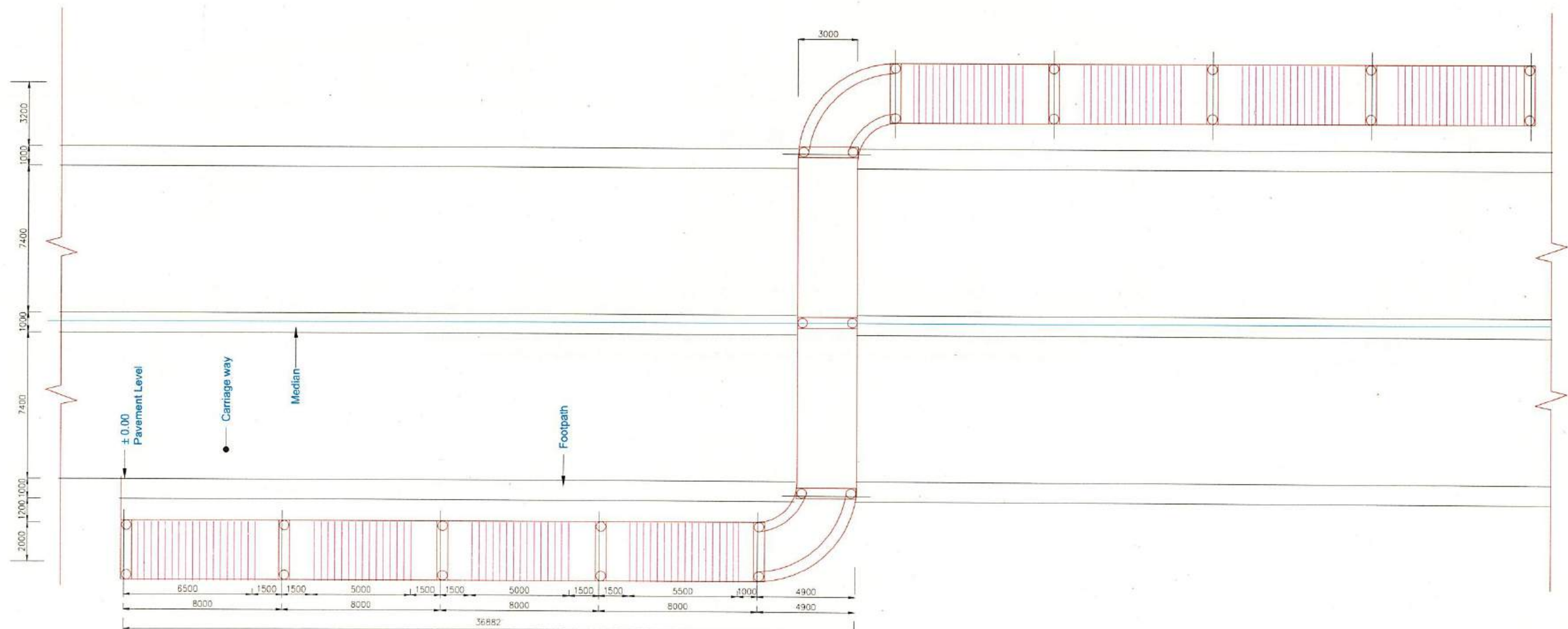
This is a trestle pier supported overpass of reinforcement concrete slabs and pre-cast channel beams of two individual modules for ramps and superstructure. The ramp has steel pipe railing and rough superstructure surface for easy movement on the overpass. The bases of columns will be placed on compacted sand fill on the depth, depending on site conditions to counteract additional stresses due to sinking of supports as well as for uniform distributions of loads on bearing strata. The channel beams of the superstructure over the carriageway are designed to carry an in-situ covering concrete layer after placing these side by side in position.

Overpass Type-3: Layout



Overpass type-4

This is reinforced concrete cast in-situ piles supported beams and waist slabs type overpass. It consists of continuous longitudinal beams between spans and transverse waist slabs. The piles have been arranged in groups of 2 nos. and tied to minimize buckling of piles. Piles without bases reduce overall costs of structure. The geometrical layout of stairways meets the requirements of design standard with global gradient less than 16.7%.

Overpass Type-4: Layout

Type - 4
Layout

USE OF TRAFFIC SIGNS MANUAL (VOLUME 1 & 2)

10 USE OF TRAFFIC SIGNS MANUAL (VOLUME 1 & 2)

Traffic Signs Manual for Bangladesh has been adopted and published in March 2000. All traffic signs, road markings and traffic signals shown in the manual are designed to meet road and traffic situation in Bangladesh at present and also in the future.

The Traffic Signs Manual has been prepared to follow signing practices in the region as well as in full understanding of the United Nations Convention on Road Signs and Signals (the Vienna Convention).

Traffic signs and road markings used as examples in this Road Safety Improvement Works Manual are in accordance with the Traffic Signs Manual. Direct copying of drawings given in this manual as examples should be avoided. After studying actual situation on the road these drawings could be considered as basis and relevant corrections need to be done.

Engineers who use this Road Safety Improvement Works Manual must consult the Traffic Signs Manual.

To improve visibility of the traffic signs in all weather conditions and also dark hours, only Diamond Grade film (or equivalent) should be used on National and Regional Highways. On lower road network High Intensity (or equivalent) film is at the moment appropriate. DG film's lifetime cost is lower than HI film, due to longer performance and better visibility.

Though the Traffic Signs Manual has provisions for normal road marking paint, the National Road Safety Council (NRSC) has decided in its 11th Meeting (in January 2004) that only retro-reflective thermoplastic road markings are allowed in Bangladesh. **RHD circular by the Chief Engineer directed all RHD offices to use only retro-reflective thermoplastic road markings.**

Some of the benefits of Traffic Signs Manual have been listed hereafter:

- Design details, drawings, installation and manufacturing instruction for each sign are set out
- Specifications, dimension details and models for road markings are set out
- Traffic sign and road marking materials are set out
- Layout of traffic signs in typical situation are set out
- Instructions and examples how to use traffic signs during road construction or maintenance are set out
- Lots of information of traffic signs are set out

10.1 Road Safety Information Boards at Strategic Locations

10.1.1 Introduction

A well informed road-user community is the best social prevention against road accidents. Vehicle drivers, passengers (of cars and buses), transport workers, general public, children, even members of enforcement agencies, all direct or indirect road users are normally unaware of accident risks, implications of improper road-use, economic and social implications of road accidents. Engineers normally tend to ignore the importance and advantages of a well informed road-user community for proper use of the road infrastructure; and expect that road-users should obviously use the roads properly.

10.1.2 General Practice of Boards along Roads

Generally, there are many eye-catching advertisement and commercial boards installed along roads. Road engineers are usually care-free about such boards along the roads. This is common in many countries. This phenomenon is very common in Bangladesh.

10.1.3 Problems by Advertisement / Commercial Boards along Roads

Commercial and advertisement boards along roads causes two vital problems:

- Distracts sight of the vehicle drivers, pedestrians, others on road etc. and thereby causes accidents; and
- Diverts attention of the vehicle drivers, pedestrians etc. and thereby increases risks of accidents.

Many developed countries have strict rules and regulations to control installation of advertisement and commercial boards along roads; and any violation of such rules and regulations are dealt with stringent punishments.

On the contrary, Road Authorities in many developed countries install boards at strategic locations (such as public gathering places, bus stops, bus terminals, fuel filling stations, roadside markets / bazaars etc.) along roads. These boards provide road safety related information – namely slogans on danger of over speeds, cost of accidents, 'surprises' / 'unusual' conditions ahead, etc. These boards warn, and make the road-users significantly aware about road safety.

10.1.4 Safety Related Message Boards along Bangladesh Roads

For Bangladesh situation, it is strongly recommended that:

- All road improvement / rehabilitation projects should include items of work for installation of safety related message / information boards along the roads; and
- All maintenance schemes, and safety improvement physical works schemes must include items of works for installation of safety related message / information boards along the roads.

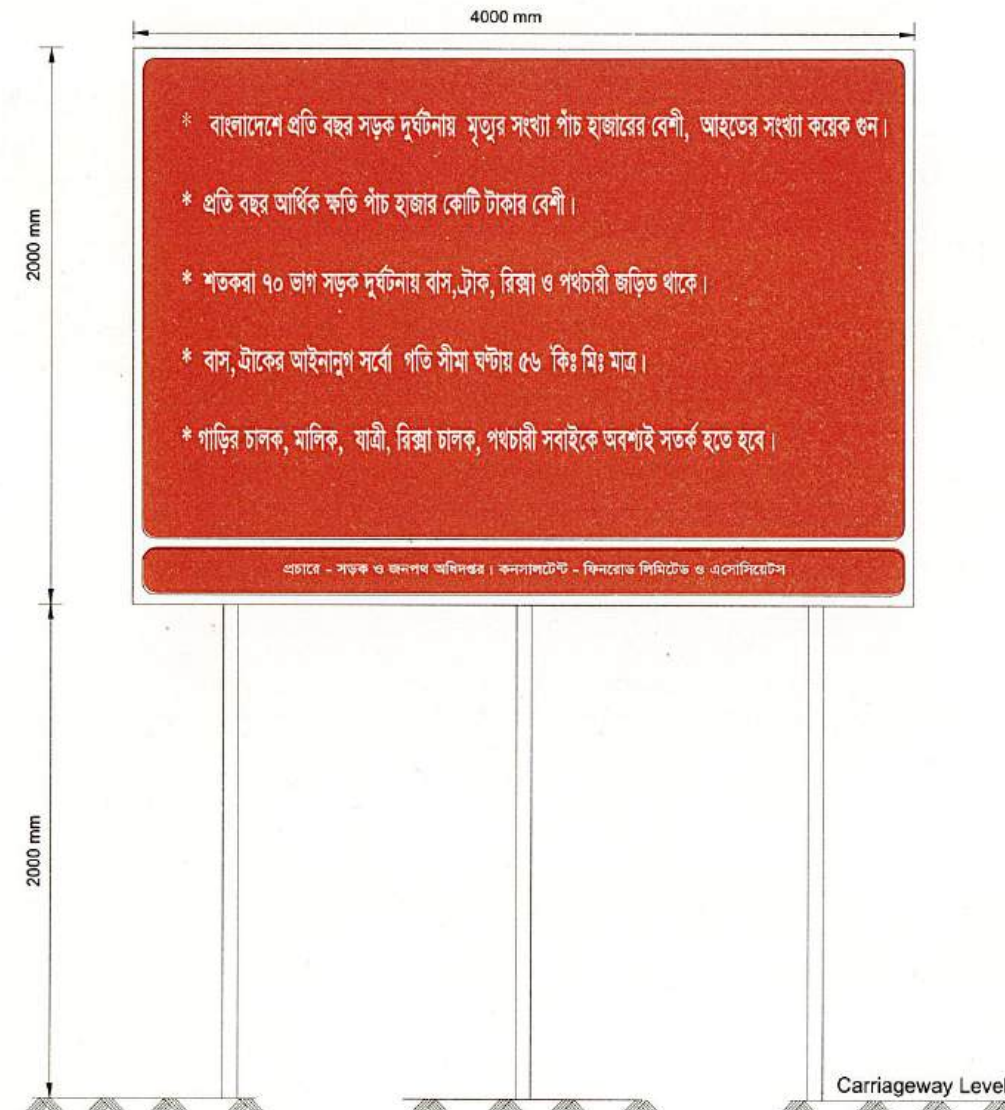
10.1.5 Examples

In the following pages, few example drawings of safety message boards containing messages are provided. These are low-cost, but designed to improve awareness level of road-users and public in general.



Billboard (Type-3)

(For installation within 60 km zone)



Billboard (Type-4)

(For installation at strategic locations)

Notes :

1. Colours :
 - Base - Reflective Red Colour
 - Letter - Reflective White Colour
 - Border - Reflective White Colour
2. Dimensions :
 - Border line width- 40 mm
 - Letter height - Shall be as per Traffic Signs Manual of BRTA keeping the size of Billboard as shown in drawings
 - Other dimensions - Shall be as per BRTA Manual.

**ROAD SAFETY AT WORKS SITE
AND
CONCLUSIONS**

11 ROAD SAFETY AT WORKS SITE

Drivers' behavior while driving on the road base on expectances. Drivers have relevant knowledge how to drive and how to respond on different situation. Typically average driver assumes that action after making same observation should remain the same (simple example: after observing red traffic signal driver stops and when signal changes back to green he shall continue driving).

Typically average pedestrian choose the shortest way between point A and point B. Every time pedestrians' tries to take shortcut between those points to save some steps (simple example: DCC has provided paved footpaths to Ramna park to save lawn areas in the park. Still in every corner or junction of footpath network there is non grass area due to visitors' shortcut). Same happen every time also at the construction site.

Above described examples is typical behavior to human being. Knowing typical behavior of average people is one of the key elements when construction within the traffic (motorized and non motorized traffic) and when designing operations within the traffic. Road engineering is not only technical matter but also psychological matter and when traffic volume increase the psychological matter shall increase also.

Road engineers' as well as contractors' should remember that working on the road does not permit anything; it only requires taking care of road users and workers safety.

Road work (no matter how small or large, maintenance or construction) is always unexpected situation to road users and it has input to road users behavior. Therefore one who changes the existing situation is in charge to arrange appropriate guidance and facilities to all road users. Hereafter are listed some examples what may need to consider during road work:

- Appropriate guidance and warning, like road work sign, speed limit sign, etc.
- Use of traffic control and speed reducing devices.
- Temporary diversion due to road work.
- Temporary pedestrian crossings or even overpass.
- Demolishing existing road markings and providing temporary ones.
- Visibility of the site, machinery and workers by using reflective materials and "safety vests".
- Behavior of workers and machinery, like certain driving and walking routes.

The user of this manual must consult Traffic Signs Manual, where are set out instructions and requirement for safety issues during road work.

12 CONCLUSIONS

12.1 Preamble

Safety improvement physical works on Bangladesh roads has been very recently initiated. Until now, much research and study on the effectiveness and appropriateness of physical measures has not been undertaken in Bangladesh. The physical measures and concepts of measures for safety improvement physical works defined and included in this manual are based on international knowledge and experience developed over many years, which has been amended / modified to suit the uniqueness of Bangladesh context. Such amendments / modifications are based on expert observations of the situation of traffic composition, traffic behavior, road-user behavior, and road environment now prevailing in Bangladesh.

12.2 Future Periodic Revision

It may be well considered that:

- Research and study on the effectiveness and appropriateness of physical measures will be continuously undertaken in Bangladesh; which will provide a strong body of knowledge and experience in future;
- The present situation of traffic composition, traffic behavior, road-user behavior, and road environment will change and improve in future.
- Consequently, over time, many physical measures and concepts of measures for safety improvement physical works defined and included in this manual will require amendments / modifications; and there will be need for many new inclusions.

12.3 Future Revision of the Manual

As such, it is obvious that this Manual will have to be revised with improved level of knowledge and experience of engineers; and significant improvement of traffic composition, traffic behavior, road-user behavior, and road environment in future. Generally, 5 to 7 years time is optimum for practicing manuals like this Manual to arrive at conclusions for amendments / modifications and inclusions or exclusions in the Manual. It may be anticipated that this Manual will be revised in due course.

ANNEXES

13 LIST OF ANNEXES

- 1. Reference**
- 2. Model Bill of Quantities for Transitions and Junctions**
- 3. Turning Radius Diagrams for Different Standard Types of Vehicles**

- Road Safety Work in Norway, first national Road Safety Conference in Tanzania 16-17 September 1998. B. K. Steinseth, Norwegian Public Roads Administration. August 1998.
- Highway and Traffic Engineering in Developing Countries. Edited by Bent Thagesen. First Edition 1996. ISBN No. 0-419-20530-6.
- Towards Safer Roads in Developing Countries. Transport and Road Research Laboratory, Overseas Development Administration. First Edition 1991. ISBN No. 1-85112-176-5.
- Trafikksikkerhetshandboka (The Road Safety Handbook). Norwegian Institute of Transport Economics, Oslo Norway.
- Manual on uniform traffic control devices. Government of Pakistan, Ministry of Communications, Highway safety wing. July 1989.
- Improvement of accident location: benefits and costs, 2nd technical report of engineering and infra-structure, the United Republic of Tanzania, Ministry of works tanzania national roads agency (tanroads), second integrated roads project ida credit 2598-ta, study for development of national road safety master plan for tanzania mainland and zanzibar, SweRoad, June 2004
- "Engineering Policy Issues and Practices for Road Safety in Bangladesh" – Authors: Mahbub U. Rahman and Deleep Kumar Guha. Published in the Engineering News, the Official Publication of the Institution of Engineers Bangladesh, Issue – No. 2, Year 30, March-April 2004.

Improving into Y – Junction by road marking and traffic sign

- Consider Main Road length 500 m. and side road length – 200m.
- Carriage way width Main road 7.5 m and side road 5.5 m with
 - shoulder 1.5 m both side
- One Pedestrians crossing at Main road,
- One Road hump at side road ,
- One painted island at side road.

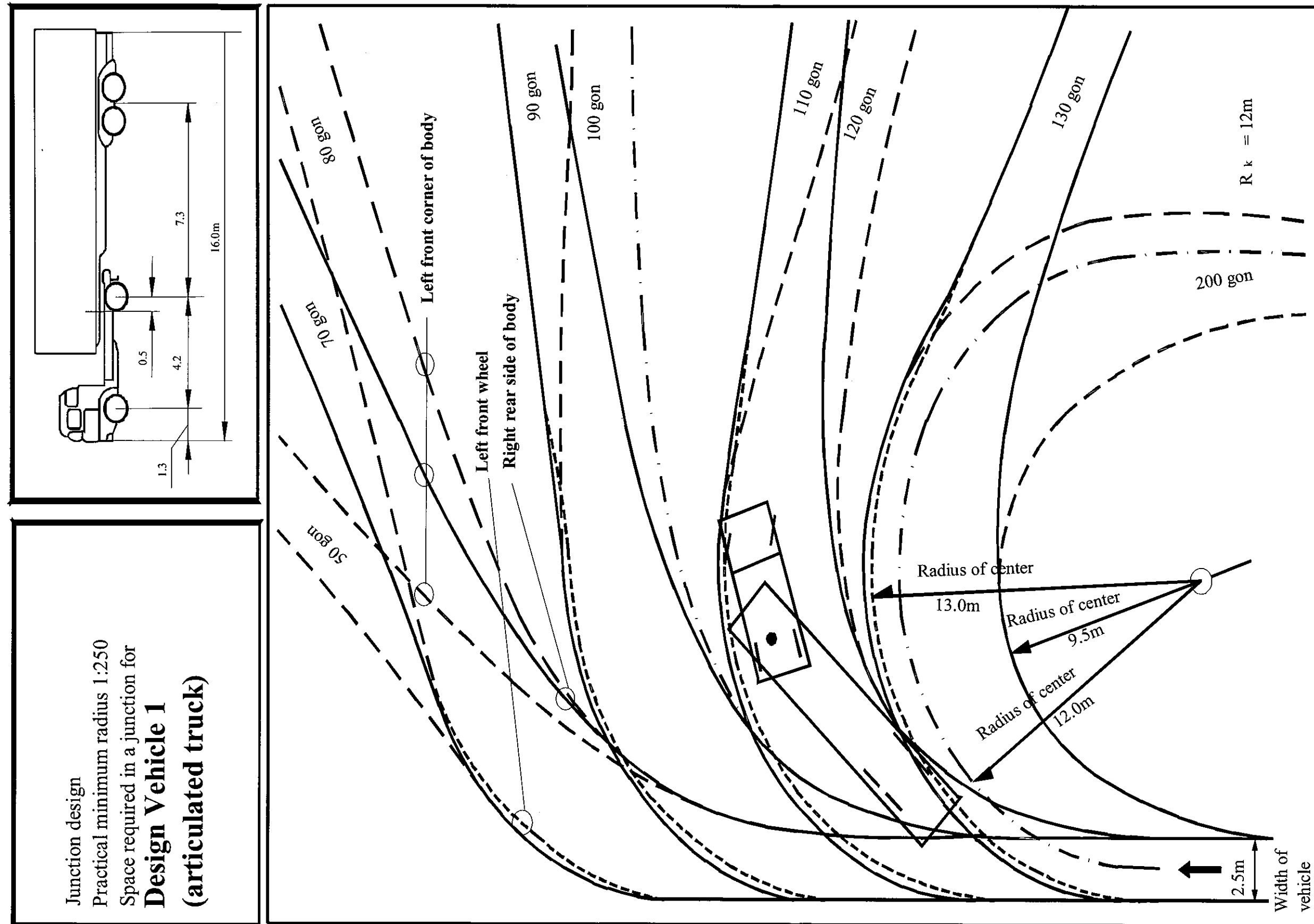
Sl. No.	Description	Unit	Quantity	Unit Rate (Taka)	Amount (Taka)
1	Roadway Excavation in Classified Suitable Material including stock piling on Site (applies to excess suitable excavated materials only)	cu. m	40	44.00	1760.00
2	Sub-grade upto 300 mm Depth	sqm	120	15.00	1800.00
3	Improved sub-grade	cum	16	400.00	6400.00
4	Sub-base	cum	16.5	1955.00	32257.50
5	Aggregate Base	cum	12	2353.00	28236.00
6	Bituminous Prime Coat	sqm	120	38.00	4560.00
7	Bituminous Tack Coat	sq.m	0	13.00	0.00
8	Premix Bituminous Carpeting	cum	5	5876.00	29380.00
9	Traffic sign of area upto 0.7 m ²	sq.m	4.62	6000.00	27720.00
10	Traffic sign of area more than 0.7 m ² and upto 2.0 m ²	sq.m	0	7000.00	0.00
11	Reflectors on road medians / New-Jersey barriers	No.	11	300.00	3300.00
12	Thermoplastic Road Marking	sq.m.	190	600.00	114000.00
13	New delineator Posts with reflectors	No.	0	800.00	0.00
14	Sand filling in the Road Medians / Lane Dividers	cum	20	604.00	12080.00
15	Installations of new kerb stones	Lin.m	53.5		0.00
16	Reflective painting on delineators / Kerbstone / Road medians / Wheel guard / Kerb etc.	sqm	0	500.00	0.00
17	RCC works (Class A-25) for foundation of structure	cum	3	5518.00	16554.00
Total Amount (Taka)					261493.50

Improving existing equal armed Y – Junction with small round about:

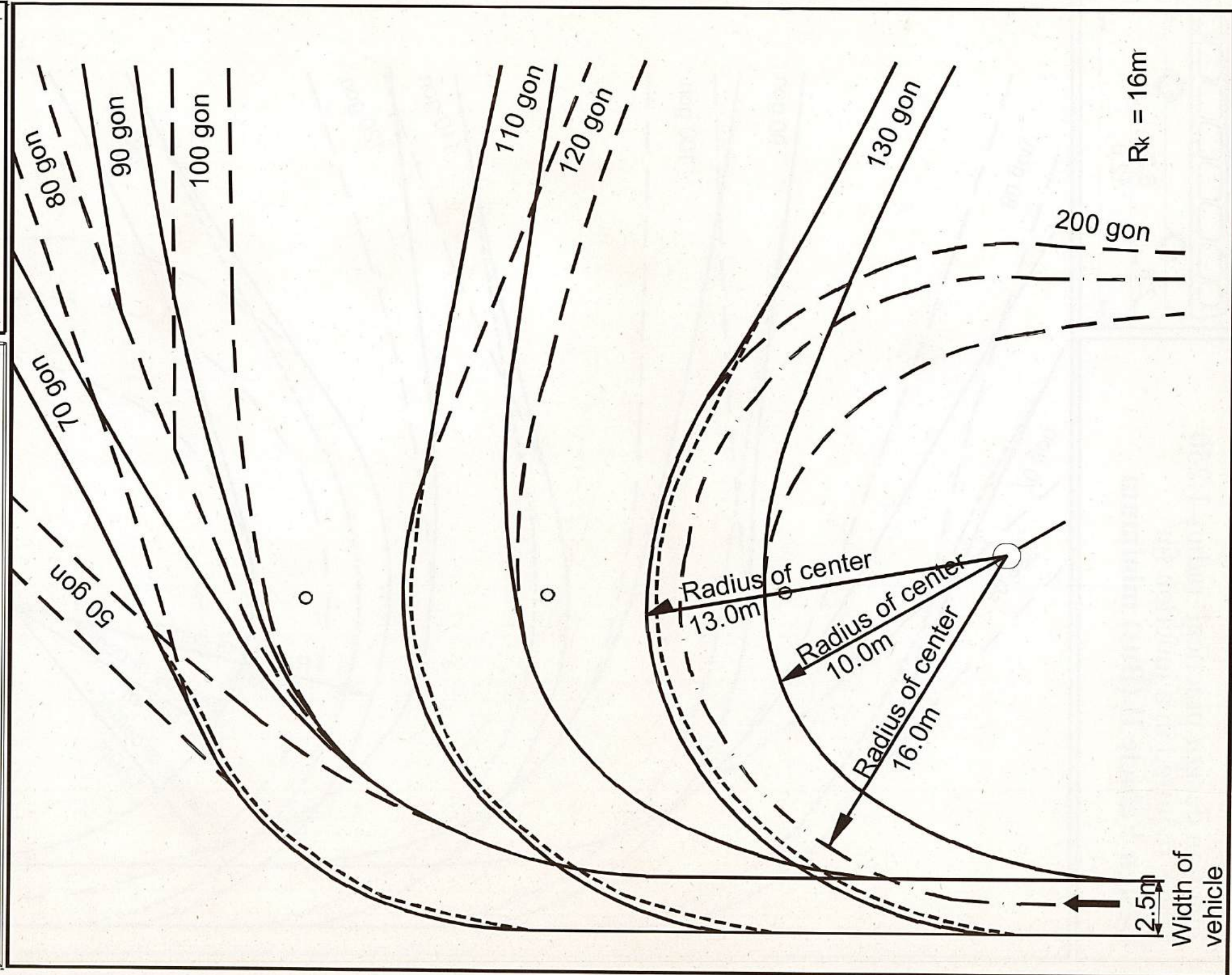
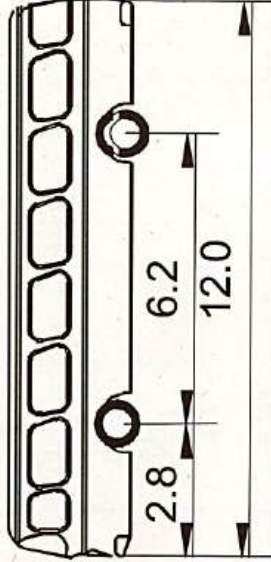
- Consider length of road 250 m of each around of the Y – Junction,
- Widening of carriage way at round about.
- Dia of round about consider – 7 m
- Construction of round about.

Sl. No.	Description	Unit	Quantity	Unit Rate (Taka)	Amount (Taka)
1	Roadway Excavation in Classified Suitable Material including stock piling on Site (applies to excess suitable excavated materials only)	cu. m	0	44.00	0.00
2	Sub-grade upto 300 mm Depth	sqm	0	15.00	0.00
3	Improved sub-grade	cum	0	400.00	0.00
4	Sub-base	cum	0	1955.00	0.00
5	Aggregate Base	cum	0	2353.00	0.00
6	Bituminous Prime Coat	sqm	0	38.00	0.00
7	Bituminous Tack Coat	sq.m	30	13.00	390.00
8	Premix Bituminous Carpeting	cum	2.25	5876.00	13221.00
9	Traffic sign of area upto 0.7 m ²	sq.m	3.1	6000.00	18600.00
10	Traffic sign of area more than 0.7 m ² and upto 2.0 m ²	sq.m	0	7000.00	0.00
11	Reflectors on road medians / New-Jersey barriers	No.	0	300.00	0.00
12	Thermoplastic Road Marking	sq.m.	210	600.00	126000.00
13	New delineator Posts with reflectors	No.	0	800.00	0.00
14	Sand filling in the Road Medians / Lane Dividers	cum	0	604.00	0.00
15	Installations of new kerb stones	Lin.m	0		0.00
16	Reflective painting on delineators / Kerbstone / Road medians / Wheel guard / Kerb etc.	sqm	0	500.00	0.00
Total Amount (Taka)					158211.00

13.3 Annex 3: Turning Radius Diagrams for Different Standard Types of Vehicles



Junction design practical radius 1:250
 Space required in a junction for
Design Vehicle II (Bus) maximum



Junction design Practical radius 1:250
Space required in a junction for

Design Vehicle III (truck) minimum

