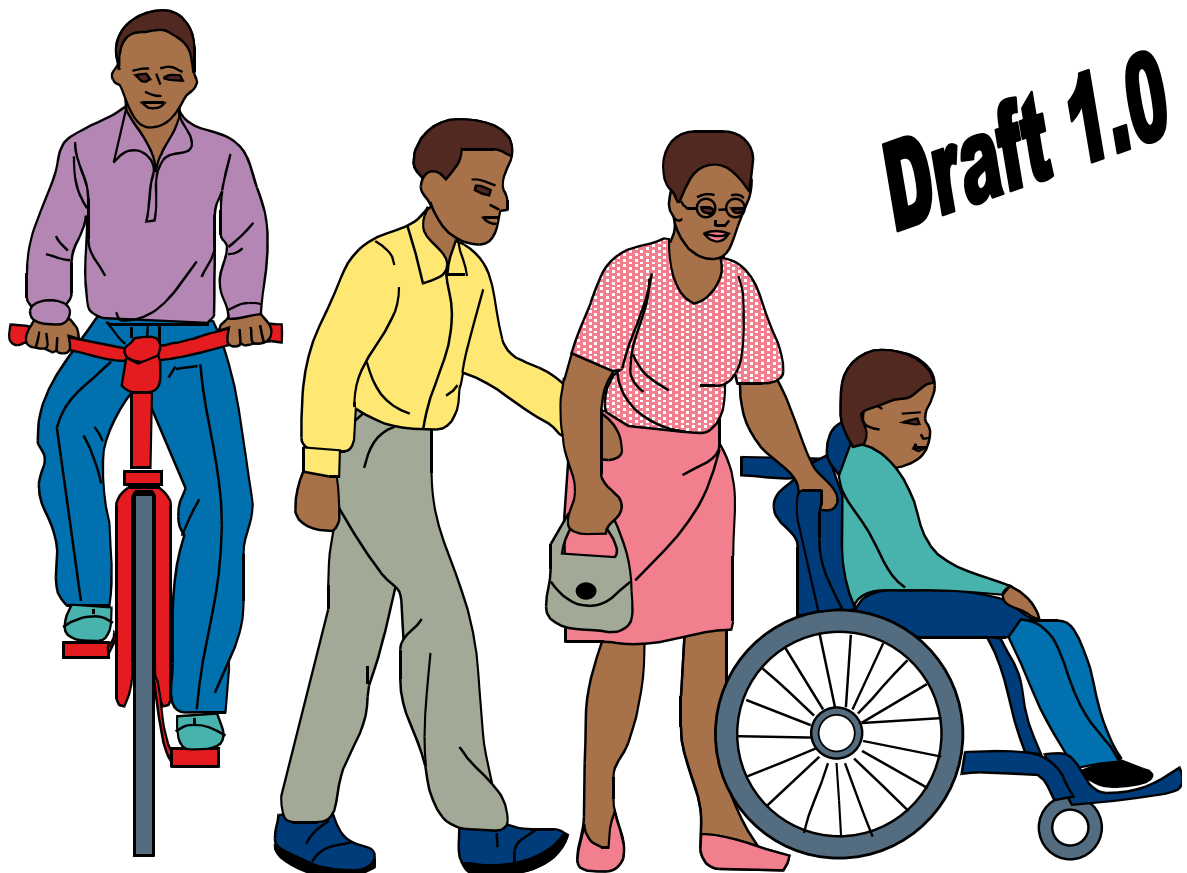




Department of Transport

Pedestrian and Bicycle

Facility Guidelines



TITLE: PEDESTRIAN AND BICYCLE FACILITY GUIDELINES Engineering manual to plan and design safe pedestrian and bicycle facilities			
STATUS DRAFT FOR COMMENTS	VERSION Draft 1.0	DOT FILE	DATE August 2003
CARRIED OUT BY: Transportek, CSIR PO Box 395 PRETORIA, 0001 SOUTH AFRICA		COMMISSIONED BY: National Department of Transport Private Bag X193 PRETORIA 0001 SOUTH AFRICA	
SYNOPSIS <p>The purpose of this manual is to provide guidance on the planning and design of safe pedestrian and bicycle facilities, both across and alongside roads and streets. Practical guidance and typical layouts are provided for various types of facilities, and on the process of planning such facilities.</p> <p>The manual is targeted at national, provincial and local road authorities, private developers, and professionals involved with the provision of pedestrian and bicycle facilities. The primary user group is the transportation and traffic engineering profession, but other groups such as town planners, architects, landscape architects, urban designers and traffic officers will also find valuable information in the manual.</p> <p>Throughout the manual, specific attention is given to the needs and requirements of people with special needs, such as children, the old and the disabled. The importance of addressing the needs of these people is highlighted in the manual.</p>			
COMMENTS Comments on, and other contributions, to this publication will be welcomed and appreciated. Such contributions and comments should be forwarded to the National Department of Transport at the above address.			
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KEY WORDS Pedestrians, Bicycles, Cyclists, Facilities, Guidelines			

DISCLAIMER

The views and opinions expressed in this document are those of the authors and do not necessarily represent Department of Transport policy.

RESOLUTION

This document has been approved for general distribution by the Committee of Transport Officials (COTO)

ACKNOWLEDGEMENTS

Illustrations in this manual were done by Mr Willem Loots of DesignALine



FOREWORD BY THE NATIONAL MINISTER OF TRANSPORT

Abdulah M Omar, MP

Pedestrians and cyclists are the most vulnerable road user groups within the road network of South Africa and are often seriously or fatally injured in road crashes. Pedestrians, in particular are one of the major road casualty categories in road crash statistics. Apart from the ill-disciplined behaviour of road users (drivers, cyclists and pedestrians), the road environment is not always conducive to safeguarding the different modes of non-motorised transport. Many examples exist where inadequate facilities have been provided for pedestrians and cyclists to cross or move alongside roads. This is even more evident in the previously disadvantaged areas, including the rural parts of the country.

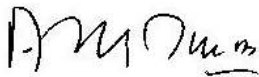
In 1987 and 1993, the National Department of Transport published manuals to address the needs of cyclists and pedestrians respectively. These manuals, however, became outdated due to new technologies and developments in the provision of facilities for non-motorised transport. The Department decided to evaluate, review and combine these previous manuals into one, practical, user-friendly manual and to add new relevant, efficient and cost-effective guidelines. In addition, it was agreed that this new manual should be used to capacitate practitioners regarding engineering aspects on pedestrian and cyclist safety.

This new manual seeks to integrate pedestrian and cyclist facilities with other government initiatives to improve the physical environment for these road users. These include initiatives such as Integrated Development Planning (IDP), Integrated Sustainable Rural Development Strategy (ISRDS), Moving South Africa (MSA), Shova Kalula, and others. The new manual is also linked to other planning tools and standards such as the Road Traffic Act and Regulations, the South African and SADC Road Traffic Signs Manual, the South African Road Safety Manual and numerous other standards and guidelines as referenced in the bibliography.

The manual covers a wide spectrum of pedestrian and cyclist issues. It ranges from the design parameters for pedestrians and cyclists, the facilities required to ensure safe road crossings, facilities to be provided alongside roads, the places where these facilities are normally needed, pedestrian and cyclists amenities such as lighting, to bicycle parking and storage. The manual also deals with pedestrian and bicycle planning processes.

Although the latest local and international thinking and best practises have been incorporated into the new manual, there are still areas where development of the manual should take place, especially in rural areas and on higher order roads.

I would like to encourage all authorities and practitioners to use this manual and to give feedback on the existing guidelines, but also to propose additions that they think should be incorporated into the manual.

A handwritten signature in black ink, appearing to read 'A. M. O'Brien'.

Minister of Transport, October 2003

Pedestrian and bicycle facility guidelines

Engineering manual to plan and design safe pedestrian and bicycle facilities

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Preface

INTRODUCTION

This manual on the planning and design of safe pedestrian and bicycle facilities was commissioned by the South African National Department of Transport to replace the following two manuals that were previously used for this purpose:

- Pedestrian Facility Guidelines: Manual to plan, design and maintain safe pedestrian facilities, 1993, Report No 92/126.
- Guidelines for the planning and design of bicycle facilities, 1987 Report No PG 3/87.

The manual covers two modes of transport that, although they differ in many important respects, share many similarities. One of these similarities is that pedestrians and cyclists are very vulnerable to traffic accidents, and are often seriously or fatally injured in accidents. Another similarity is that pedestrians and cyclists are often neglected in transportation planning, while they are important modes of transport, particularly for persons who cannot afford other modes of transport. This manual therefore brings together under one cover information for the planning and design of facilities for the two modes of transport.

WALKING AND CYCLING AS MODES OF TRANSPORT

Walking and cycling are important modes of transport. People often walk more than they realise. Many daily activities involve walking, even if for short distances. Walking and cycling are not only inexpensive means of transport but are also attractive as a form of recreation or sport, for both the young and the old.

For poor people, walking and cycling are indispensable forms of transport. These people cannot afford to spend any money on travel and they depend on the lowest cost form of transport, namely walking. When they can afford to spend some money on transport, most of them have to rely on public transport, which still includes a significant amount of walking. The provision of adequate pedestrian and bicycle facilities can be

of great benefit to poor people, in urban areas as well as rural areas. Although previously neglected in South Africa, bicycle transport is becoming more popular in the country due to initiatives of the South African National Department of Transport.

The South African Minister of Transport, Mr Abdullah Omar (2001), in an address at the launch of the Shova Kalula (Pedal Easy) Bicycle Transport Demonstration Programme, said:

The biggest challenges to address in order to promote widespread bicycle use are safety concerns, affordability and lack of awareness of the advantages of cycling on the part of both transport planners and potential users. If we are to put bicycles back on the transport agenda in South Africa, we will need to provide proper facilities for cyclists to travel safely. This is a big challenge for all of us from local to national government. Without well designed and safe bicycle infrastructure, we will continue to be underachievers when it comes to the use of the bicycle."

In order to promote safe cycling, especially in areas with large numbers of motor vehicles, we will need well-designed bicycle infrastructure and facilities. Ultimately, we would like all local road development and upgrading to cater for safe pedestrian and bicycle use. It makes little sense to upgrade a road or to build a new road without including pedestrian and bicycle facilities up front. To achieve this will require a change of mindset in the transport profession. I would like to remind my transport colleagues that private motor cars are not the only transport mode in South Africa. Therefore, we need to cater properly for pedestrians, cyclists and public transport users as well.

The transportation profession has given relatively little attention to the needs of both pedestrians and cyclists, in spite of these being important modes of transport. Facilities are often inadequate, while insufficient attention is given to measures that can be introduced to improve the safety of pedestrians and cyclists. Hopefully, these guidelines can assist in promoting awareness of walking and cycling as important modes of transport, and in the improvement of facilities provided for use by pedestrians and cyclists.

PURPOSE OF THE GUIDELINES

The main purpose of this manual is to provide guidelines for the planning and design of safe pedestrian and bicycle facilities in road and street systems.

The guidelines provided in this manual are targeted at national, provincial and local road authorities, private developers, and professionals involved with the provision of pedestrian and bicycle facilities. The primary user group is the **transportation and traffic engineering profession**, but other groups such as town planners, architects, landscape architects, urban designers and traffic officers will also find valuable information in the manual.

The manual supports many initiatives of the South African Government. These initiatives include the following:

- The Integrated Sustainable Rural Development Strategy initiated by the South African State President. Many people living in rural areas are very poor and often have to walk long distances for various purposes. Investment in pedestrian and bicycle infrastructure can be of great benefit to such people and speed up service delivery in rural areas.
- White Paper on Integrated National Disability Strategy (1997). The rights of people with disabilities are protected by the South African Constitution. This manual recognises these rights and provide guidelines on how such people can be accommodated when designing pedestrian facilities.
- White Paper on National Transport Policy (1996). One of the major policy aims in South Africa is to promote public transport. This policy aim is fully supported by the provision of pedestrian facilities.

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- Department of Transport Moving South Africa. The purpose of this project was to develop a strategy for ensuring that the transportation system of South Africa meets the needs of the country in the 21st Century, and that it would contribute to the country's growth and economic development. This importance of walking and cycling is confirmed in the strategy, which is supported by this manual.
- Department of Transport National Bicycle Programme. A national bicycle transport initiative known as Shova Kalula (or Ride Easy) has been initiated by the Department. The programme is aimed at disadvantaged rural and urban people who have to walk long distances. The intention of the project is to procure low-cost new and used bicycles and develop a delivery chain for the distribution of the bicycles. This manual fully supports the aim of this project.

PROMOTION, EDUCATION AND LAW ENFORCEMENT

The primary focus of the manual is on the planning and design of pedestrian and bicycle facilities. It should, however, be realised that planning and design is only one component of the successful accommodation of pedestrians and bicycles. Effective promotion, education and consistent law enforcement are essential components of a successful pedestrian and bicycle programme. The guidelines in themselves will not guarantee safety unless drivers and pedestrians are educated and disciplined to use the facilities correctly.

Traffic police should be encouraged to enforce traffic laws and regulations that impact on pedestrians and cyclists. Such law enforcement applies to both drivers of vehicles as well as pedestrians and cyclists. A serious problem is that many young pedestrians and cyclists learn that it is possible to violate basic traffic rules with impunity. These youngsters are being poorly prepared to become responsible vehicle drivers.

A particular problem in South Africa, but also in other countries, is that many pedestrians and cyclists ignore traffic rules, and sometimes even direct instructions given by traffic police. An effective law enforcement system is urgently required to address the current widespread abuse of traffic laws and regulations by pedestrians, cyclists as well as drivers in the country.

SCOPE OF THE GUIDELINES

This manual should not be interpreted as standards, specifications, requirements or regulations, but as guidelines for the planning of pedestrian and bicycle facilities.

Guidelines is given on aspects such as the following:

- The type, location and layout of pedestrian and cyclist facilities (across or alongside roads) to be provided under specific conditions.
- The safeguarding of pedestrians at different places such as public transport termini, pedestrian malls, construction sites and other pedestrian orientated areas.
- The process of planning pedestrian and bicycle facilities, including the identification of hazardous locations and the establishment of facility inventories.
- The accommodation of persons with special needs, such as the disabled, elderly and children in the street environment.

In a manual of such as this, it is not possible to address all aspects in detail, and in some instances, it is only possible to provide introductory material on some topics. The manual presupposes a basic knowledge of the transportation and traffic engineering field.

ROAD TRAFFIC SIGNS MANUAL

Reference is often made in this manual to the Road Traffic Signs Manual of the South African National Department of Transport. It is not possible to plan and design facilities for pedestrians and cyclists without providing road traffic signs and markings, and it is therefore important that the Road Traffic Signs Manual be consulted. Some reference to road signs and markings is included in this manual, but not to the same depth and detail as covered by the Road Traffic Signs Manual.

The Road Traffic Signs Manual comprises the following four volumes:

- Volume 1: Uniform Traffic Control Devices – Details signing policies and design principles together with specific information on the meaning and individual application of all traffic control devices.
- Volume 2: Traffic Control Device Applications – Covers the use of sets of signs, markings and signals for specific applications.
- Volume 3: Traffic Signal Design – Details requirements for the selection and installation of traffic signals and their methods of control.
- Volume 4: Traffic Signs Design – Provides dimensional details for all road traffic signs and their sign face components.

The first three volumes of the manual are of particular interest to the planning and design professional. Volume 4 contains dimensional details for the manufacture of road signs.

WARRANTS

Warrants are often used to indicate whether a particular pedestrian or bicycle facility should be provided and installed. These may include facilities such as midblock crossings, traffic signals, grade-separated crossings, sidewalks, walkways, bicycle lanes, bicycle roads, etc. The warrants typically indicate a level of activity above which a facility can or should be installed. Various such warrants have been given in the two manuals that have been replaced by this manual.

The one danger of warrants is that it is usually based on the existing traffic demand for a facility, and it does not take into account the potential of a facility to attract traffic or to generate additional traffic. Walking and cycling as modes of transport will not be promoted or encouraged if a lack of infrastructure and facilities is allowed to continue. More such facilities should be provided in order to attract more people to walk and cycle.

In this manual, the standpoint is taken that pedestrian and bicycle facilities should be provided where there is a reasonable expectation that such facilities will be used by pedestrians and cyclists, even if the numbers of pedestrians and cyclists are currently relatively low. Pedestrian and bicycle facilities should therefore be provided where possible and reasonable. It is not possible to provide detailed warrants for this purpose, which means that the planning and design professional will have to exercise judgement to establish whether a facility would be reasonably required. No warrants are given in this manual for the installation of pedestrian and bicycle facilities, but some indication is given on when such facilities will be needed and where they would be the most appropriate.

PERSONS WITH SPECIAL NEEDS

This manual recognises that provision must be made for persons with special needs. This not only includes persons with disabilities, but also other groups such as young children and older persons.

In South Africa, the rights of people with disabilities are protected by the country's Constitution. Government departments and state bodies in the country therefore have a responsibility to ensure that, in each line

function, concrete steps are taken to ensure that people with disabilities are able to access the same fundamental rights and responsibilities as other persons. This implies that resources must be employed in such a way as to ensure that every individual has equal opportunities.

An Office on the Status of Disabled Persons has been established in the Office of the Deputy President with the purpose of furthering the development of a disability friendly environment in South Africa. A legislation framework is foreseen which would comply and give substance to the requirements of the South African Constitution. At the time of writing of this manual, however, there was no coherent or comprehensive legislation available pertaining to people with disabilities.

Access to the built environment in South Africa is controlled by the National Building Regulations and its associated code. These regulations, however, are applicable to buildings and not to transport facilities such as roads and sidewalks. Except for the standards included in the National Building Regulations, no other standards are available for persons with disabilities in South Africa. The recommendations included in this manual are therefore based on standards prescribed in the United States in terms of the Americans with Disabilities Act (ADA) (United States Architectural and Transportation Barriers Compliance Board, 1989, 1999). This act is a civil rights statute in the United States that prohibits discrimination against people with disabilities. Under the ADA, designing and constructing facilities that are not usable by people who have disabilities constitutes discrimination. Standards are therefore prescribed for facilities such as sidewalks, kerb ramps, etc. All new and altered facilities must comply with these standards where technically feasible.

MINIMUM AND DESIRABLE REQUIREMENTS

The guidelines in this manual are sometimes presented in terms of “desirable” and “minimum” requirements. Such requirements should be applied with professional judgement and according to circumstances. The desirable requirements would typically be more appropriate when a facility is used by large numbers of pedestrians or cyclists, while minimum standards would be more appropriate when such numbers are low.

The guidelines also apply to normal situations encountered in practice. Unique design problems sometimes require flexibility and adjusting to circumstances.

LAYOUT OF THE MANUAL

The manual provides guidelines under a variety of topics. A listing of the topics is given in the list of contents at the start of this manual.

The manual is divided into a number of main parts. These are:

- Part A: Design controls important to the design of pedestrian and bicycle facilities. These controls include accommodating the needs of pedestrians and cyclists, safety concerns and basic characteristics of the pedestrian and cyclists.
- Part B: Pedestrian and bicycle crossings, either at midblock locations or at road junctions. Pedestrians and cyclists are at their most vulnerable when crossing roads and streets, and attention must be given to improving the safety of such crossings.
- Part C: Pedestrian and bicycle ways, including sidewalks, walkways, bicycle lanes and bicycle roads are very important facilities that can improve road safety.
- Part D: Pedestrian and cyclist amenities and support facilities that can improve the experience of walking and cycling. Aspects such as road lighting and traffic calming are addressed.
- Part E: Pedestrian and bicycle places where priority is given to pedestrians and cyclists, while vehicular traffic is discouraged.

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- Part F: The planning process and considerations aimed at ensuring the successful provision of pedestrian and bicycle facilities.
- Appendices in which various information is given, including road traffic signs and markings used at pedestrian and cyclist facilities, as well as a bibliography of available literature on pedestrian and bicycle facility planning and design.

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Issues

Introduction

The manual provides information and guidelines on a variety of aspects related to pedestrian and bicycle facilities, and should therefore be of value to engineers and practitioners. During the development of the manual, however, a number of issues have been identified which requires further study and research and which could not be adequately addressed in this edition of the manual. With further research, these issues can be addressed in later versions. In the meanwhile, however, users of the manual will have to exercise professional judgement when confronted with these issues.

Various of the identified issues relate to the National Road Traffic Regulations and the Road Traffic Signs Manual of the National Department of Transport. Proposals have been made regarding these issues, and the manual may have to be amended once these proposals have been studied in more detailed and regulations changed accordingly.

The following list of issues is provided with the intention of not only indicating the need for further research but also to indicate various known deficiencies of the manual. Any information that can be provided by users and which could be incorporated in future versions of the manual would be of great value. All comments and contributions will be welcomed and appreciated and should be forwarded to the National Department of Transport.

PART A: DESIGN CONTROLS

Chapter A.4: Pedestrian and cyclist safety

More information and statistics are required on the causes and types of accidents involving pedestrians and cyclists in South Africa. Most of the recommendations given in the manual are based on accident studies

undertaken in other countries. The accident rates involving pedestrians in South Africa are significantly higher than in these countries and the causes of the accidents are probably not the same. Accident studies are required to identify the reasons for accidents with the intention of establishing the most cost effective and appropriate remedial measures.

Chapter A.6: Acceptable walking and cycling distances

Recommendations are given in the manual on maximum walking and cycling distances acceptable to pedestrians and cyclists. These recommendations are based on research undertaken in developed countries where most persons probably own a vehicle, and are therefore probably not applicable to local conditions. Research is required on maximum walking and cycling distances acceptable to the local population.

Chapter A.7: Gap acceptance sight distance requirements

No information could be found on acceptable gap acceptance sight distances for pedestrians and cyclists. The recommendations given in the manual are based on the judgement of authors and research is urgently required to develop requirements based on factual information.

PART B: PEDESTRIAN AND BICYCLE CROSSINGS

Chapter B.1: Implicit pedestrian crossings at road junctions

According to the National Road Traffic Regulations, pedestrian crossings are implicitly defined at all road junctions – they do not have to be marked. Pedestrians therefore have right of way at junctions, irrespective of whether an approach to a junction is controlled or not. In practice, most drivers are probably not aware that this requirement also applies to uncontrolled approaches to junctions.

This is a very important issue that requires urgent investigation. Consideration must be given to removing the requirement from the regulations. Pedestrians should only be given priority when an approach to a junction is controlled (e.g. by traffic signals or a stop or yield sign), or when a pedestrian crossing has specifically been marked.

Chapter B.3: Pedestrian crossings on uncontrolled legs of road junctions

The marking of pedestrian crossings over uncontrolled approaches to priority controlled junctions is a major issue. Although such marked crossing would strengthen the existing regulation that drivers must yield to pedestrians, they could result in drivers stopping within a junction, which could create an unsafe situation.

An alternative solution is to provide a midblock crossing near to the junction. Previously, a 20 m separation distance was recommended. Such a distance, however, is inadequate in terms of the traffic engineering requirement that decisions should only be made one at a time, and that decision points should be separated by a distance equivalent to a travel time of 2,5 seconds – the perception and reaction time of drivers. At 60 km/h, this would be equivalent to a separation distance of 45 m. Pedestrians will not walk this distance to a midblock crossing – they are even unlikely to walk a distance of 20 m to the crossing.

No solution could as yet be found to provide a marked pedestrian crossing over an uncontrolled approach to a junction. Innovative ideas are urgently required to address this problem.

Chapter B.3: Marked pedestrian crossings over junction slipways

The provision of marked pedestrian crossings over yield-controlled junction slipways also poses a problem. According to the Road Traffic Sign Manual, only the “yield to pedestrian” sign has to be provided when the pedestrian crossing is near to the roadway. The problem is this sign only requires drivers to yield to pedestrians – not to other traffic. The standard yield sign may therefore be more appropriate for this situation. This issue requires further investigation.

Chapter B.3: Advance stop lines

Advanced stop lines are promoted in Europe as being advantageous to cyclists. No provision is made for such stop lines in South African Regulations, while serious questions have been asked about the safety of these stop lines. Research is required before any recommendations can be made in this regard.

PART C: PEDESTRIAN AND BICYCLE WAYS

Chapter C.3: Prioritising improvements

A simple system has been proposed for the prioritising of pedestrian sidewalks that do not rely heavily on the collection or availability of traffic and accident data. The system should be of great value to practitioners. However, the system is only applicable to the prioritising of sidewalks, and should be extended to also include other types of pedestrian (and bicycle) facilities. Research is required to develop such a system.

Chapter C.5: Bicycle lanes

According to the current road regulations, drivers may not drive, park or stop in a lane marked as a bicycle lane. According to the Road Traffic Signs Manual, such lanes should be stopped just ahead of an intersection to allow turning across the lanes. No signs or markings, however, are available for indicating a reserved bicycle lane at the junction itself.

The situation concerning driveways is also not clear – it appears if the lanes should also be stopped at each driveway to allow vehicles to turn across the bicycle lanes.

The above issues can be addressed if vehicles are allowed to cross the bicycle lane, but not to use it. The onus should be on the driver to ensure that such crossing is safe. This issue should be further investigated and the road regulations amended if necessary.

Chapter C.6: Bicycle roads within road reserves

The provision of a separate bicycle road parallel to a street or road within the reserve boundaries poses a serious problem when there are driveways along the road. Drivers exiting from such driveways are not generally attentive to cyclists, which increase the danger of accidents.

Bicycle roads on streets and roads with driveways will probably only be successful if such bicycle road is provided directly adjacent to the street and road itself (similar to a bicycle lane), and it is clear to drivers that they must yield to cyclists. This issue urgently needs further research.

PART D: AMENITIES AND SUPPORT

Chapter D.4: Barricades and fences

Research is required to develop more cost effective barricades and fences for use along roads to prevent pedestrians and cyclists entering the road reserve. The most effective form of barricade appears to be a concrete or brick wall, but the cost of such barricades is very high.

Chapter D.5: Traffic calming

Traffic calming is particularly important for pedestrians and cyclists. National guidelines are locally available for traffic calming, but these guidelines are outdated and need urgent update.

PART E: PEDESTRIAN AND BICYCLE PLACES

Chapters E.2 to E4: Urban/Rural/Disadvantaged areas

These chapters need further expansion to include land use planning and urban design principles as related to pedestrians and cyclists. These principles can be of value to engineers when planning and designing pedestrian and bicycle facilities.

Many traffic accidents involving pedestrians occur in rural and disadvantaged areas. There are, however, not many options available for addressing this problem, and innovative ideas are required for these areas.

Chapter E.5: Schools

School students are particularly vulnerable to traffic accidents due to various reasons, and priority should be given to improving road safety at schools. The chapter should be expanded considerably, and innovative ideas are urgently required which would improve road safety at schools, particularly those schools located adjacent to high speed roads.

Chapter E.7: Development sites

Pedestrians and cyclists are often not given the same level of attention than given to vehicular traffic at commercial, business and office developments. This chapter should be expanded to also include a section with specific requirements that authorities can impose on developers.

PART F: PEDESTRIAN AND BICYCLE PLANNING

All chapters in this part of the manual need considerable expansion to provide more detail on planning for pedestrians and cyclists. A broad overview of the planning process is given, but significantly more detail should be included. A textbook example should also be included that can serve as a benchmark against which other studies can be judged.

APPENDICES

Appendix A: Pedestrian and bicycle road signs and markings

Concern has been expressed about the suitability of *Bicycle Lane Reservation Sign R304* and road markings *RM9 Exclusive Use Lane Lines* and *WM11 End of Exclusive Use Lane Arrows*. The cost of the lane lines is deemed to be high, while the opinion has been expressed that most drivers are probably not aware of the meaning and significance of the road sign and road markings. These concerns should be further investigated.

PART A

PEDESTRIAN AND BICYCLE DESIGN CONTROLS

A. Design controls

Introduction

1.1. THE IMPORTANCE OF WALKING AND CYCLING

Walking is the most basic form of transportation, while cycling is also a relative basic form of transportation by mechanised means. Nearly every persons walks, while many people have used a bicycle for either recreational or commuting purposes.

People walk more than they realise. Many daily activities involve walking, even if only for a short distance. Even vehicular trips involve walking to and from the vehicle at the origin or destination of each trip.

In spite of walking (and cycling) being important modes of transport, relatively little attention is often given to the needs of pedestrians and cyclists. They often have to face impediments such as roads designed primarily for motor vehicles, lack of protection from the weather, inadequate parking for bicycles at destinations and inadequate connections with other modes. Pedestrians and cyclists are the most vulnerable road users, being less protected from traffic and the weather.

Walking and cycling are regarded as essential transportation modes, and should therefore be developed and promoted in all urban areas to provide safe, direct and convenient access to all destinations. There is an urgent need for transforming the car-orientated environment to one that is conducive to walking and cycling, as illustrated in Figure 1.1.

1.2. ADVANTAGES OF WALKING AND CYCLING

Walking and cycling have a myriad of advantages. Not only is it cheaper, it is also healthier and it has many social and economic benefits. It can help in meeting the transportation needs of a large

Pedestrian and Bicycle Facility Guidelines

segment of the population who do not have access to private or public transport (the “transportation disadvantaged”). These include the poor, the young, the elderly and people with disabilities.

Good pedestrian and bicycle facilities benefit other transportation modes, such as:

- Public transport benefits from safer and more convenient access.
- Vehicular traffic benefits from reduced congestion and lower maintenance cost of roads and streets.

A most important advantage of walking and cycling is that it can improve the environment. Pedestrians and cyclists are beneficial to a neighbourhood because of reasons such as the following:

- Walking and cycling do not result in air and noise pollution to the same extent as other modes of transport. In many cities, the motor vehicle traffic is the most important cause of environmental degradation.
- Pedestrians and cyclists are essential components for the creation of a neighbourhood’s “sense of community”. Such a sense of community occurs when people recognise and acknowledge each other. This sense of community is often impossible in the motor-orientated society since there is little chance for people to get to know each other.
- There is a possibility that the mere presence of pedestrians can deter vandalism and crime (although the opposite may also be possible). Pedestrians and cyclists can often detect outsiders and see irregularities such as vandalism and crime. Pedestrians and cyclists can also watch out for other people living in their area and report on possible problems that may occur at their houses.
- People who walk and cycle are more aware of conditions and maintenance problems in an area and report on such problems to authorities. Many such problems are related to road infrastructure.

Walking and cycling can also have real economic benefits. Pedestrian and bicycle facility improvements can revitalize small community shopping areas, creating new jobs in areas that otherwise could have been economically unfeasible.

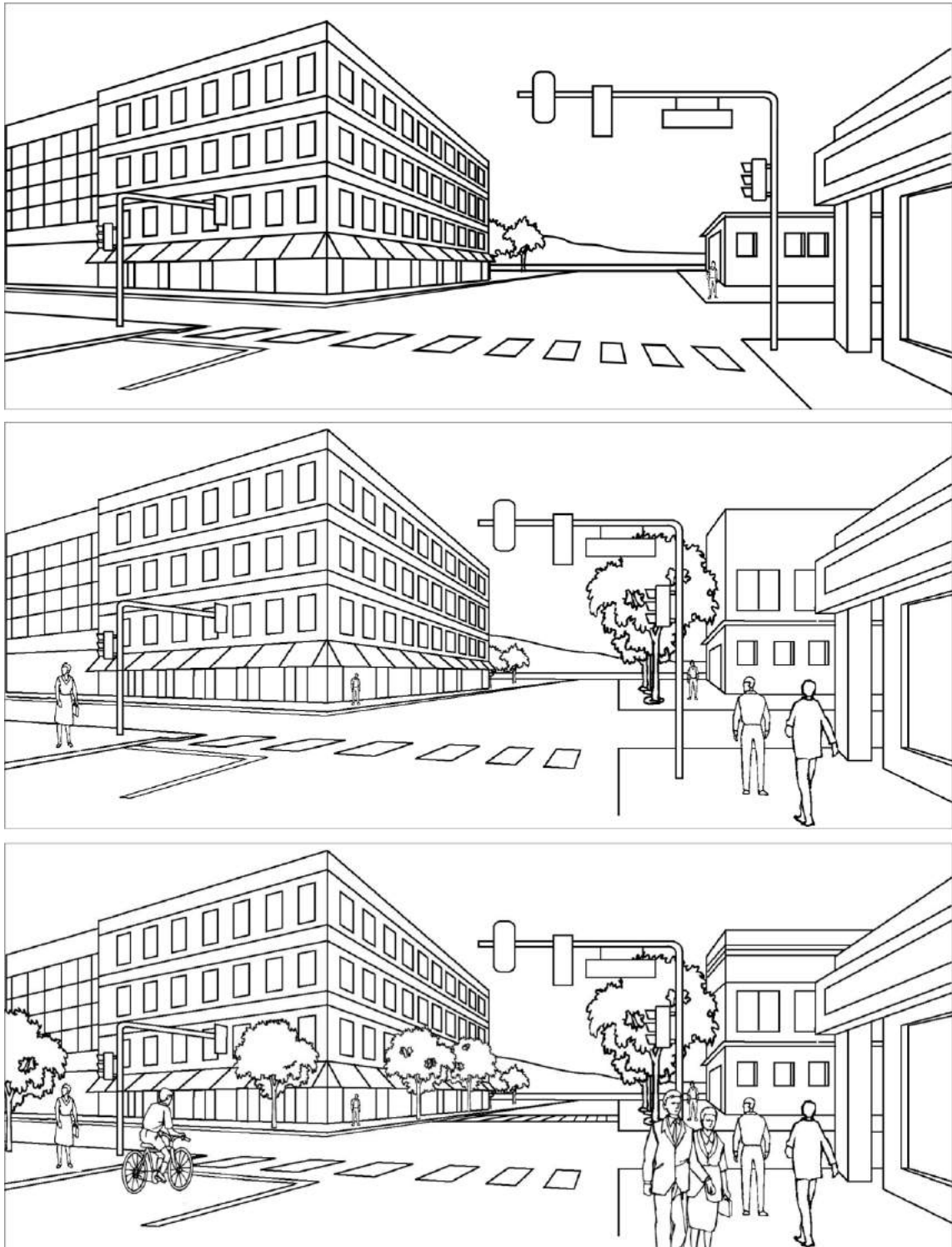


Figure 1.1: Transforming the environment to accommodate pedestrians and cyclists

Pedestrian and Bicycle Facility Guidelines

Many persons that use walking or cycling as their modes of transport do so because they do not have access to other modes of transport, either because they can not afford such modes of transport, or because such access is not available. Persons that can afford motorised forms of transport, however, do not often walk or cycle, while most of those who do walk or cycle do so for health or recreational purposes rather than commuting. The recreational and exercise role of walking and cycling is therefore very important in attracting people to walking and cycling as modes of transport. Facilities can initially be provided with the aim of attracting recreational walkers and cyclists, and this can eventually be expanded for other uses.

A. Design controls

2. Pedestrian and cyclist groups

2.1. INTRODUCTION

Although pedestrians and cyclists have many characteristics that are in common, they should not be considered to resemble each other in their requirements. Bicycles are treated in law and regulations as a form of vehicle, and cyclists are required to comply with the same rules of the road applicable to vehicular traffic. Pedestrians, on the other hand, have their own specific rules and regulations that are only applicable to pedestrians and not to cyclists (except that a cyclist becomes a pedestrian when he or she disembarks the bicycle).

Pedestrians walk at a slower pace than the speed at which cyclists typically travel. Cyclists, on the other hand, are probably more vulnerable than pedestrians due to the higher speed at which they travel.

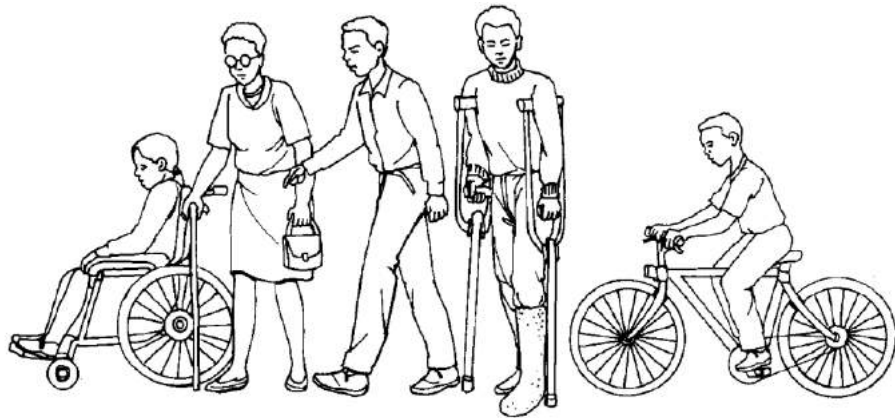


Figure 2.1: Different groups that must be considered in planning

2.2. PEDESTRIAN GROUPS

Pedestrians are very vulnerable to traffic accidents. They are probably the least visible of all road users, but also at the same time the least disciplined and predictable group. Pedestrians are less tolerant of out-of-direction travel and will often take short cuts where there is no convenient or direct facility.

There are various types of pedestrians that must be considered in planning. Pedestrians are highly diverse, and include children, adults, older people and persons with disabilities (see Figure 2.1).

The pedestrian population is subdivided into two groups for planning and design purposes:

- Adult pedestrians.
- Other pedestrians, including pedestrians with special needs, such as children, older people and the disabled.

Pedestrian facilities should be planned and designed to accommodate both the above two groups. The lack of a pedestrian facility may mean little to the able adult pedestrian, who can side step an inconvenience, but it may become a major barrier to a person with some disability or special need.

2.3. BICYCLE GROUPS

Bicycles are legally defined as road vehicles, but they have certain unique characteristics, which differentiate them from other vehicles. Cyclists travel at lower speeds than motorised vehicles, are exposed to the elements, use their own power, are more vulnerable to accidents and are less visible in the traffic stream.

Three general categories of cyclists have been identified by degree of expertise, namely the child cyclist, the inexperienced cyclist and the experienced cyclist. The needs and requirements of these groups tend to differ.

a) The child cyclist

The child cyclist uses the bicycle for recreational purposes as well as for utilitarian trips, e.g. schools, shops, etc. Young children generally lack the experience, judgement and training to deal with busy roads and streets. The needs of a young cyclists (and anxious parents) are streets that are free from excessive through traffic and with low vehicle speeds.

b) The “inexperienced” cyclist

In the South African context, this is a major group of cyclists. The bicycle is used for all trip purposes including commuting, shopping and recreation. Although this group may have acquired some cycling knowledge and skill, many of its members do not possess a car driver's license or have not received any training on the safe use of bicycles under normal traffic conditions.

c) The “experienced” cyclist

In South Africa, this group is probably in the minority. This group consists of persons who not only acquired extensive cycling knowledge and skill, but also received formal training on the basic rules of traffic.

2.4. PERSONS WITH SPECIAL NEEDS

There is an urgent need to make the road and street environment more accessible for persons with special needs. Roads are designed for a wide range of vehicle types, and the same approach should be used when designing pedestrian and bicycle facilities.

Persons with special needs include the following:

- Children and older people. Children and older adults are often avid pedestrians while children are particularly keen cyclists. These people have more time to enjoy walking for various purposes and they also have to rely more on walking and public transport to do their daily errands, rather than drive.

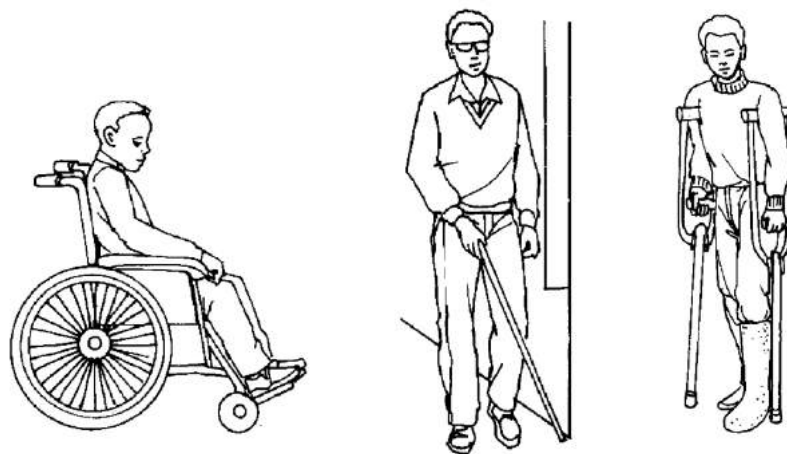


Figure 2.2: Disabled persons – an important user group

- People with trolleys, prams and wheelbarrows, and those that carry children and other items such as wood and water have particular needs that should be considered when planning and designing pedestrian facilities.
- Persons with disabilities, including those that have mobility, sight and hearing impairments (see Figure 2.2). These persons have particular requirements that need to be given specific attention.

2.5. PERSONS WITH DISABILITIES

People with disabilities face many problems and impediments. These problems are not only encountered in the social and economic spheres of life, but also in the transportation system.

There are a number of barriers in the environment that prevent disabled people from enjoying equal opportunities. This include structural barriers in the built environment, inaccessible service points, inaccessible entrances due to security systems, poor town planning and poor interior design (Office of the Deputy President, South Africa, 1997).

Poor people in particular, face a greater problem of impairment or disability. These people are often pressed deeper into poverty because of disability, and do not have the means to address their transportation needs. Many of these people live in areas where the infrastructure for the provision of basic services is at its weakest (Office of the Deputy President, South Africa, 1997).

In South Africa, the rights of the people with disabilities are protected by the Constitution (Office of the Deputy President, South Africa, 1997). It is therefore important that facilities are provided that would provide access to such persons.

At the time of writing of this manual, no comprehensive legislation was available that pertain to people with disabilities (although such legislation is foreseen that would give substance to the South African constitution). The recommendations included in this manual are therefore based on standards and guidelines published in the United States in terms of the Americans with Disabilities Act (ADA) (United States Architectural and Transportation Barriers Compliance Board, 1989, 1999).

Various standards have been published in the United States by the Architectural and Transportation Barriers Compliance Board (1989, 1999). The recommendations included in this manual are based on a national set of guidelines prepared by the Public Rights-of-Way Access Advisory Committee in 2001. The committee, however, expect that further refinements to the standards will be developed in future.

The ADA Access Guidelines (ADAAG) have been developed from research that measured the responses of a wide range of people with disabilities. The guidelines were developed to encourage standardisation in the accessible design and construction of sidewalks, kerb ramps, street crossings and related pedestrian facilities.

A. Design controls

3. User needs and requirements

3.1. INTRODUCTION

In order to plan and design pedestrian and bicycle facilities, the needs and requirements of the users of these facilities must be recognized and, where possible, accommodated when designing for pedestrians and cyclists.

Pedestrians and cyclists share many common needs. When planning and designing facilities, it may be possible to implement measures which could be beneficial to both these groups.

3.2. SECURITY AND SAFETY NEEDS

The security and safety needs of pedestrians and cyclists are the most fundamental of all needs. Pedestrians and cyclists will not use a facility if there is a real or perceived security or safety problem.

3.2.1. Security

Security is perhaps the most important need of pedestrians and cyclists. Fear of muggers and other criminals is a concern of all pedestrians and cyclists. The elderly, women, children and the disabled are particularly vulnerable to criminal attacks and other antisocial behaviour. The following are particular problems:

- Routing through secluded or deserted areas with high security risks. These include areas where there is a low level of activity and traffic, such as unused alleyways and back streets.
- Noisy and polluted environments which cause people not to pay attention to the need of other persons.
- The provision of subways without open sight lines.
- For cyclists, bicycle theft is a major concern at parking or storage areas.

3.2.2. Safety

Pedestrian and bicycle facilities should be designed and built to be free of safety hazards. These hazards include the following:

- Slippery walkways or walkways that are not level, which may result in persons slipping, tripping, stumbling and falling.
- Protruding obstacles, which pedestrians sometimes inadvertently walk into. Such obstacles can create severe bodily harm, such as loss of sight because of an object that was located at eye level.

3.2.3. Traffic safety

Traffic safety is an important need of pedestrians and cyclists because of their vulnerability. Pedestrians and cyclists should be protected from vehicular traffic, while pedestrians should also be protected from bicycle traffic. Traffic safety problems can be expected when:

- Pedestrians and cyclists have high levels of contact and exposure to vehicular (and bicycle) traffic, such as at crossings and adjacent to roads and streets. Pedestrians and cyclists should be separated from vehicular traffic, and where they can not be separated, the level of exposure should be reduced to a minimum.
- Vehicles travel at high speed. A pedestrian or cyclist has little chance of surviving a collision with a vehicle travelling at high speed.
- There is inadequate visibility and sight distance, and insufficient lighting.
- Insufficient provision is made for the safety of people with special needs, such as children, the elderly and the physically handicapped.

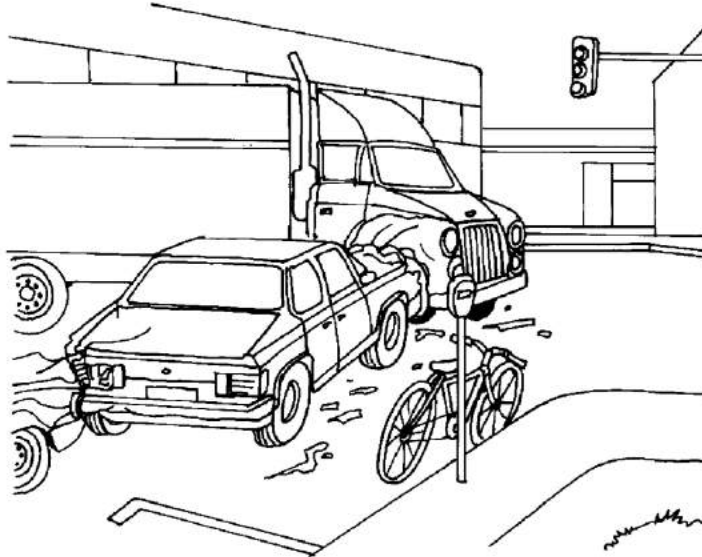


Figure 3.1: The important need for traffic safety

3.2.4. Legal requirements

Road traffic signs and markings in South Africa may only be installed and provided in accordance to requirements contained in the National Road Traffic Act and its Regulations, as well as the Road Traffic Signs Manual developed by the South African National Department of Transport. The installation of road signs and markings that do not comply with these requirements can result in traffic safety problems, which could have serious repercussions for the road authority concerned. The Road Traffic Signs Manual continuously warns authorities about the risk of litigation in the event of an accident resulting from non-compliance to requirements.

In South Africa, road authorities have permissive duties to provide, maintain and repair roads and related facilities, but are under no obligation to do so. There can thus be no liability for damages occasioned by non-performance of powers which are merely permissive. Where, however, a road authority undertakes such work, it would be liable for any damages caused by its negligence, even where no obligation rests on the authority to undertake such work. A road authority therefore has an active duty to guard against introducing a new source of danger when undertaking work on a road or street. The condition after completion of work should not be more dangerous than before the work was undertaken.

3.2.3. Law enforcement

It is not possible to address the needs of pedestrians and cyclists through the provision of facilities only. Effective law enforcement is an essential component of a successful pedestrian and bicycle programme. Police should be encouraged to enforce traffic laws and regulations that influence pedestrians and cyclists.

Pedestrians and cyclists are adversely affected by the drivers violating basic traffic rules. Typical and frequent violations made by drivers include the following:

- Speeding in the vicinity of pedestrians and cyclists. Pedestrians and cyclists are very vulnerable to high speeds, and speeding in areas where high volumes of pedestrians and cyclists occur should be regarded as a very serious violation.

- Careless driving without regard to pedestrian and cyclist safety. Many drivers are of the opinion that pedestrians and cyclists do not have the right to use a road.
- Failure to stop for pedestrians at crossings. This is a widespread violation that has resulted in pedestrian crossings becoming totally ineffective, and probably very dangerous. Specific law enforcement and education programmes should be introduced to address this problem. There is very little advantage in providing pedestrian facilities if rules and regulations are ignored by road users.
- Vehicles parked on the sidewalks. It often appears that drivers are of the opinion that sidewalks are provided for their own private use as parking spaces. Such parking often require pedestrians to divert on to the adjacent road and street, which increases the danger of accidents.

Law enforcement programmes should encourage pedestrians (and cyclists) to report violations of the above nature to police. The police should respond immediately to such complaints in order to encourage greater co-operation from pedestrians, cyclists and drivers.

3.3. OPERATIONAL NEEDS

A facility will not be of benefit to pedestrians and cyclists if operational needs are not addressed. These operational needs include aspects such as accessibility for all user groups (including the disabled), convenience of travel and comfort.

3.3.1. Accessibility

Pedestrian facilities should be accessible to all users, regardless of age or ability. Persons with disabilities have the following needs with regard to public travel ways (Public Rights-of-Way Access Advisory Committee, 2001):

- Larger dimensions to accommodate mobility aids such as crutches, wheelchairs and guide dogs.
- Continuous travel corridors (in three dimensions) along sidewalks, across driveways and roadways.
- Wayfinding for pedestrians who are blind or who are visually impaired.

3.3.2. Convenience

A variety of pedestrian and cyclist facilities should be available and convenient to use. The following aspects are particularly important:

- The pedestrian and cyclist desire quick, direct and convenient routes to chosen destinations. Detours and delays will deter use of the facilities.
- Pedestrian and cycling infrastructure should form a coherent unit that links origins and destinations. Routes should be continuous and be of a consistent standard – there should be no gaps in a route. People should easily find routes to their destinations.

- Pedestrian and bicycle facilities should be integrated with other transportation systems.
- Adequate parking and storage space should be provided for bicycles where they will be secure from theft and vandalism.

3.3.3. Comfort

Pedestrian and cyclist facilities should be easy and comfortable to use. The following aspects are particularly important:

- Topography affects both pedestrian and cyclist and may have a considerable effect on route selection. Grades more than 5% are undesirable, especially if they are fairly long. Preference should be given to gentle road gradients.
- The pavement should be fairly smooth and well maintained, without potholes and other undulations, which make it difficult for pedestrians and cyclists to use. Walk and bicycle ways should be properly cleaned and not covered by debris, dirt, leaves and other loose matter which can be hazardous for both pedestrian and cyclist.
- Walking and cycling are not all-weather transport modes and many people will be discouraged from walking and cycling in extreme weather. Shelters are required in areas with very high and frequent rainfall or where very cold weather prevails for long periods.

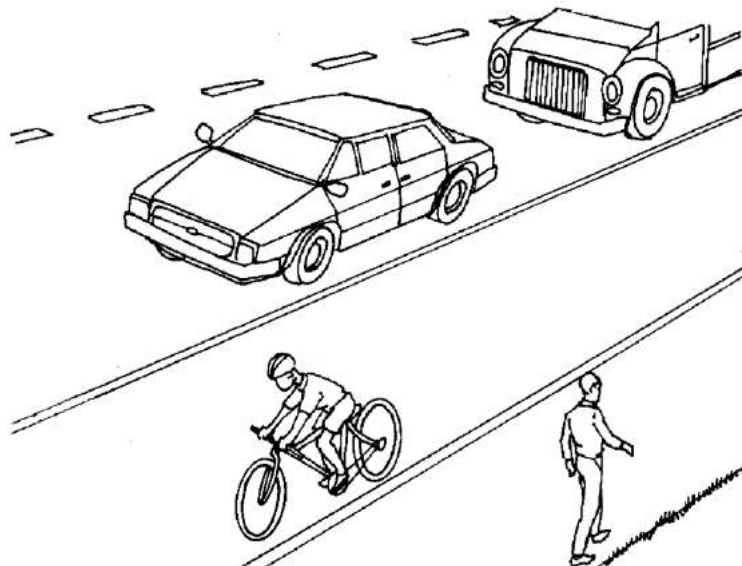


Figure 3.2: Operational needs – accessibility, convenience and comfort

3.4. ENVIRONMENTAL NEEDS

Pedestrians and cyclists prefer environments that are attractive to use. Pedestrians and cyclists are closely involved with the environment surrounding them, and great care must be taken in providing an environment that encourages walking and cycling. This environment includes all spaces used by pedestrians and cyclists, including sidewalks, walkways, plazas, courtyards, squares etc. The following aspects are important for pedestrians and cyclists:

- An interesting, attractive, clean and noise-free environment should be provided. Such an environment eases boredom and makes walking and cycling more enjoyable. Variety makes a walking and cycling trip feel shorter.
- Social interaction with other people. The pedestrian environment should be a place where public activities are encouraged.
- Amenities such as shelters, ablution facilities, lighting, etc.

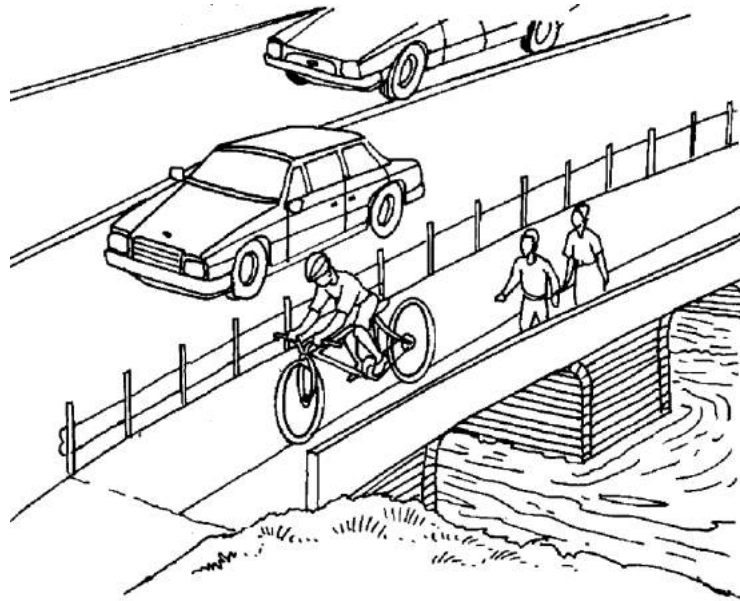


Figure 3.3: Environmental needs of pedestrians and cyclists

3.5. ECONOMIC NEEDS

Although not a direct need of pedestrians and cyclists, it is however important that pedestrian and cyclist facilities must be affordable and cost effective to ensure the optimal level of service delivery. Where funds are limited, it is important that such funds be allocated where they are needed most by pedestrians and cyclists. Improvements should be planned and designed to achieve the maximum benefit for their cost. This includes less reliance on more expensive modes of transportation.

A. Design controls

4. Pedestrian and bicycle safety

4.1. INTRODUCTION

Traffic accidents involving pedestrians and cyclists are a serious problem throughout the world (ITE, 1998; Zegeer, Seiderman, et al, 2002). Many pedestrians and cyclists are being killed or seriously injured in traffic accidents. These two groups of people are the most vulnerable on our roads, and if walking and cycling are to be promoted as modes of transport, serious attention must be given to traffic safety issues.

4.2. SOUTH AFRICAN ACCIDENT EXPERIENCE

Road traffic collision statistics in South Africa show that pedestrian fatalities represent a large proportion of all the road traffic fatalities in the country. Some statistics on road traffic fatalities are given in Tables 4.1 and 4.2. The tables shows that about 40% of persons killed on South African roads are pedestrians, although this is down from the nearly 50% level in the 1980's.

Table 4.1: Road Traffic Fatalities in South Africa					
Year	Pedestrian fatalities		Cyclist fatalities		All fatalities
	Total	%	Total	%	
1984	4 348	45,2%			9 621
1985	4 042	45,0%			8 972
1986	4 359	46,6%			9 343
1987	4 723	47,7%			9 905
1988	4 990	46,7%			10 691
1989	5 118	47,0%			10 877
1990	4 985	44,7%	307	2,8%	11 157
1991	4 897	44,2%	316	2,9%	11 069
1992	4 445	43,8%	238	2,3%	10 142
1993	4 115	43,5%	282	3,0%	9 470
1994	4 122	41,3%	304	3,0%	9 981
1995	4 165	40,6%	277	2,7%	10 256
1996	3 718	37,8%	236	2,4%	9 848
1997	3 722	38,4%	244	2,5%	9 691
1998	3 452	38,1%	220	2,4%	9 068
South African Central Statistical Services (1991, 1997)					
AA Road Traffic Safety Foundation (1998)					

Table 4.2: Pedestrian accidents according to age and action							
Pedestrian killed and injured according to age							
0-5	6-10	10-19	20-29	30-39	40-49	50-59	60+
1 364	2 266	2 109	8 938	6 337	2 478	3 603	2 130
Pedestrian killed and injured according to action							
Crossing road		Walk in road		Walk on verge		Unknown	
20 804		4 431		3 606		2 393	
South African Central Statistical Services (1997)							

The above percentages are in line with studies that have been undertaken at South African mortuaries (Butchart, 2000). These studies are undertaken to establish the causes of fatal injuries in the country. It is estimated that about 60 000 persons are killed annually in fatal injuries, 34% of which are transport related (all modes of transport, including rail). Homicide is the leading manner of death and accounts for 46% of cases. Pedestrians accounted for 39% of transport related deaths.

The number of cyclists killed in road accidents is a relatively small percentage of the total number of fatalities. The level of bicycle use in the country, however, is also low and it is likely that the fatality rate (per kilometre travelled) for cyclists is higher than that of other modes of transport.

The statistics given in Table 4.2 show that persons of all ages are killed or injured when walking along or across roads. Most of the persons are in the age group 20 to 40, but this could be because most pedestrians are in this age group.

Table 4.2 also shows that a large proportion of persons are killed or injured while crossing the road. This is one action in which pedestrians are most exposed to traffic.

4.3. ACCIDENT FACTORS

4.3.1. Typical locations

Accidents occur where pedestrians and cyclists are exposed to vehicular traffic. These accidents typically occur at locations such as the following (Otak, 1997):

- Where pedestrians and cyclists cross a road or street such as at road junctions and at midblock locations.
- Where pedestrians and cyclists travel along a roadway.

High accident rates can be expected when large volumes of pedestrians and cyclists are exposed to large volumes of vehicular traffic. Higher accident rates can also be expected when pedestrians and cyclists are exposed for longer periods of time to traffic (such as on very wide crossings or along very long stretches of roads).

Exposure to traffic can occur in urban as well as rural areas where there are high concentrations of pedestrians and cyclists. Such concentrations usually occur at locations such as:

- Commercial and industrial centres.
- Near educational facilities such as schools.
- Informal settlements.
- Near public transport facilities.

4.3.2. Vehicle speed and accidents

Vehicle speed is an extremely important factor in pedestrian and cyclist injuries and fatalities. ***This is such an important factor that pedestrians and cyclists should only be allowed to be exposed to vehicular traffic when the speed of the traffic is restricted.***

The likelihood that injuries to a pedestrian or cyclist will result in death increases as the speed of the vehicle increases (Otak, 1997; Zegeer, Seiderman, et al, 2002):

- At a speed of 30 km/h, only 5% of pedestrians struck by a vehicle are killed.
- At a speed of 50 km/h, the death rate is 45%.
- At a speed of 65 km/h, the death rate increases to 85%.

Faster speeds do not only increase the probability of a fatality, it also increase the likelihood of a pedestrian being hit. At higher speeds, drivers are less likely to see and react to the presence of pedestrians and cyclists, and are even less likely to be able stop in time to avoid becoming involved in an accident.

4.3.3. Children and younger people

Accident studies indicate a disproportional representation of children and younger people being injured in accidents involving pedestrians (ITE, 1998; Otak, 1997; Untermann, 1984; Zegeer, Seiderman, et al, 2002). Pedestrian accidents could be one of the major causes of hospitalisation for unintentional injuries for children.

The same also apply to young cyclists. Studies indicate that a large number of cycle casualties involve children and young people (United Kingdom Department of Transport, 1978; OECD Organisation for Economic Co-operation and Development, 1978). This is probably the group which use bicycles the most.

Children are likely to be pedestrian (and cyclist) accident victims because of the following reasons (Untermann, 1984):

- Children's small sizes may hinder them from seeing over vehicles and other obstacles, and also from being seen by drivers.
- Children tend to have an unpredictable nature which, coupled to their tendency to play and run, may cause them to dart into a road or street without care or concern.
- Lack of familiarity with driving and understanding of vehicle handling prevent children from perceiving traffic dangers.

4.3.4. Older persons

Older persons are less likely to be involved with traffic accidents, which may reflect a greater caution by such persons, and also a reduced level of walking (Zegeer, Seiderman, et al, 2002). However, older pedestrians are particularly vulnerable to serious injury or death when struck by a vehicle than a younger person. Pedestrians over 65 are two to four times more likely to die when involved in an accident than other age groups (Otak, 1997).

Older pedestrians are more likely to be involved with accidents because of reasons such as the following (Otak, 1997; Untermann, 1984):

- Older pedestrians require more time to cross a street, and there is therefore a greater likelihood for the older pedestrian to be struck by a vehicle.
- Older people have reduced depth perception, less side vision and hearing as well as slowed reaction and slowness.

The above problems typically occur at junctions and at midblock crossings where most older pedestrians cross and where they need to be attentive of possible vehicle conflicts.

The driver population is also becoming older because more and more people drive until an older age. This may have an impact on pedestrian and bicycle safety due to various limitations. The older driver typically experiences greater difficulty when (Staplin, Lococo, et al, 2001):

- Reading road traffic signs, including traffic signals.
- Responding to traffic signals and stopping at priority controlled junctions.
- Seeing potential conflicts well and quickly and to respond appropriately

- Finding the beginning of a turn lane, finding the “correct” turning lane, following road markings, seeing roadside kerbs and making turns at junctions.
- Turning their heads at skewed (non-90-degree) angles to view intersecting traffic.
- Merging at a roadway width reduction, when the lane drop occurs near (i.e. within 150 m) an intersection.

4.3.5. Alcohol impairment

Studies in other countries indicate that alcohol impairment is a very serious problem for pedestrians (ITE, 1998; Zegeer, Seiderman, et al, 2002). This is most likely also the situation in South Africa. Studies at South African mortuaries (Butchart, 2000) indicated that 65% of pedestrians who died in transport related accidents had elevated levels of alcohol in their blood levels.

Alcohol related accidents are more likely to occur at night, and probably weekend nights. The combination of reduced visibility and the effects of alcohol on attention, perception, vision and judgement increase the risk of accidents at night.

4.4. PEDESTRIAN ACCIDENT TYPES

Accidents involving pedestrians can occur due to a large number of reasons. Accident studies have, however, indicated that some types of accidents occur more often than others. An understanding of these accident types can assist in providing safer pedestrian facilities.

The types of pedestrian accidents that occur often are illustrated in Figure 4.1 and are the following (Zegeer, Seiderman, et al, 2002):

a) Midblock dart/dash

The midblock dart/dash accident type involves a pedestrian who walked or ran into the roadway and was struck by a vehicle. The pedestrian may be a child who ran into the street or it may be a person who has tried to cross a high-speed or heavily traffic road. The driver did not see the pedestrian until an instant before the accident (or the driver may have been speeding).

The midblock dart/dash accident type is the one which is most prevalent in the United States (ITE, 1998). Many of these accidents involve young children.

b) Multiple threat

The multiple threat accident involves a pedestrian that enters the traffic lane in front of a stopped vehicle and is then struck by a vehicle travelling in the same direction as the stopped vehicle in an adjacent lane. The stopped vehicle has blocked the visibility between the pedestrian and other vehicle, or the other vehicle may have been speeding.

c) Other midblock

This type of accident involves a pedestrian who was struck while getting into or out of a parked vehicle, or while crossing the road to an ice-cream vendor or similar destination.

d) No yield (unsignalised location)

The no-yield type of accident involves a pedestrian who was struck while crossing at a yield controlled pedestrian crossing. The driver failed to yield to the pedestrian, or the pedestrian stepped directly into the path of the oncoming vehicle. The pedestrian may also had difficulty in crossing the road.

e) Bus-related

The bus-related accident involves a pedestrian who was struck by a vehicle either by crossing in front of a bus stopped at a bus stop or going to or from a bus stop.

f) Turning vehicle at a junction

This type of accident occurs when a pedestrian is struck by a turning vehicle at a junction.

g) Through vehicle at a junction

This accident type occurs when a pedestrian is struck by a vehicle travelling straight through at a junction.

h) Walking along roadway

The pedestrian was walking or running along the roadway and was struck from the front or from behind by a vehicle.

i) Working/Playing in the road

A vehicle struck a pedestrian who was either standing or walking near a disabled vehicle, working in the road or playing in the road.

j) Not-in-road accidents

The pedestrian was standing or walking adjacent to the roadway when struck by a vehicle.

k) Backing vehicle

The pedestrian was struck by a backing vehicle on the street, a driveway, parking area or at another location.

l) Crossing an expressway

The pedestrian was struck while crossing a limited access expressway or freeway.

It is important that planners and designers should keep the above types of accidents in mind when planning and designing pedestrian and cyclist facilities. Road safety can significantly be improved by either eliminating the causes of accidents, or by providing safer facilities

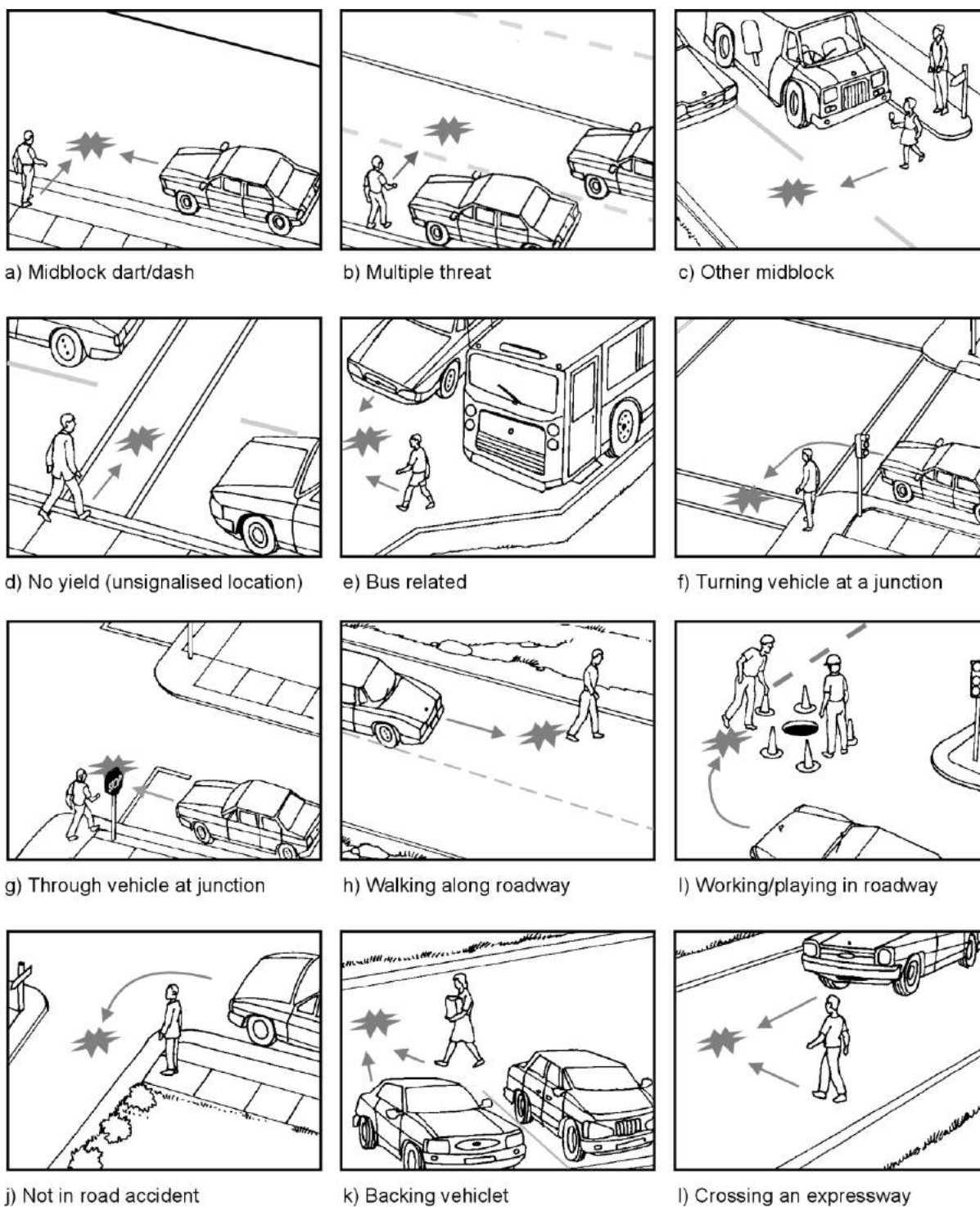


Figure 4.1: Typical pedestrian accident types

A. Design controls

5. Design dimensions

5.1. INTRODUCTION

Pedestrians and cyclist with their bicycles come in various forms and sizes. For the design professional, it is important to have design dimensions available which can be used to establish minimum facility sizes.

5.2. PEDESTRIANS

A pedestrian can be presented by a body ellipse of 600 x 500 mm with a total area of about 0,3 m² (see Figure 5.1). This size represents the practical minimum for standing adult pedestrians. For the design of facilities, a minimum of 0,75 m² is used for each pedestrian (TRB, 2000), although a larger space is preferred to provide a better level of service.

The body ellipse given in Figure 5.1 does not take into consideration the space required by persons using canes, crutches, shopping carts, baby carriages or wheelbarrows. While the need to design for this element of the pedestrian constituency may be small, it is important that the needs of these user groups should be taken into account.

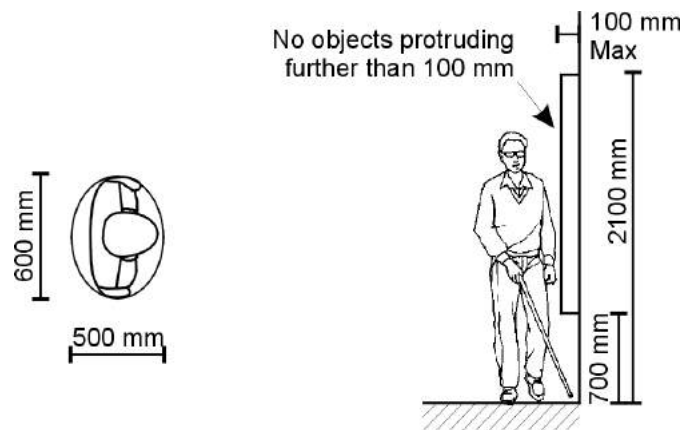


Figure 5.1: Pedestrian body ellipse and clear area

5.3. BLIND PERSONS

Blind persons walking with a cane cannot detect objects protruding into the travel way above a height of about 700 mm (up to a maximum of 2,1 m). No objects should therefore protrude by more than 100 mm into the walkway between these heights, as indicated in Figure 5.1 (U.S. Architectural & Transportation Barriers Compliance Board, 1998).

5.4. PERSONS IN WHEELCHAIRS

The minimum area needed to accommodate a single, stationary wheelchair and occupant is 750 mm by 1 200 mm (U.S. Architectural & Transportation Barriers Compliance Board, 1998). A larger area, however, is required by a person when moving in a wheelchair as shown in Figure 5.2. A minimum clear width of about 800 mm is required at a point while a width of 900 mm is required continuously along a passage. A minimum width of 1 500 mm would allow two wheelchairs to pass each other and also a wheelchair to make a 180 degree turn in a circular motion. A wheelchair can also turn in a T-shaped space as shown in the figure, provided that a clear space of 1 500 mm is available for the turn.

If a person in a wheelchair must make a turn around an obstruction, the minimum space required for the turn is also shown in Figure 5.2.

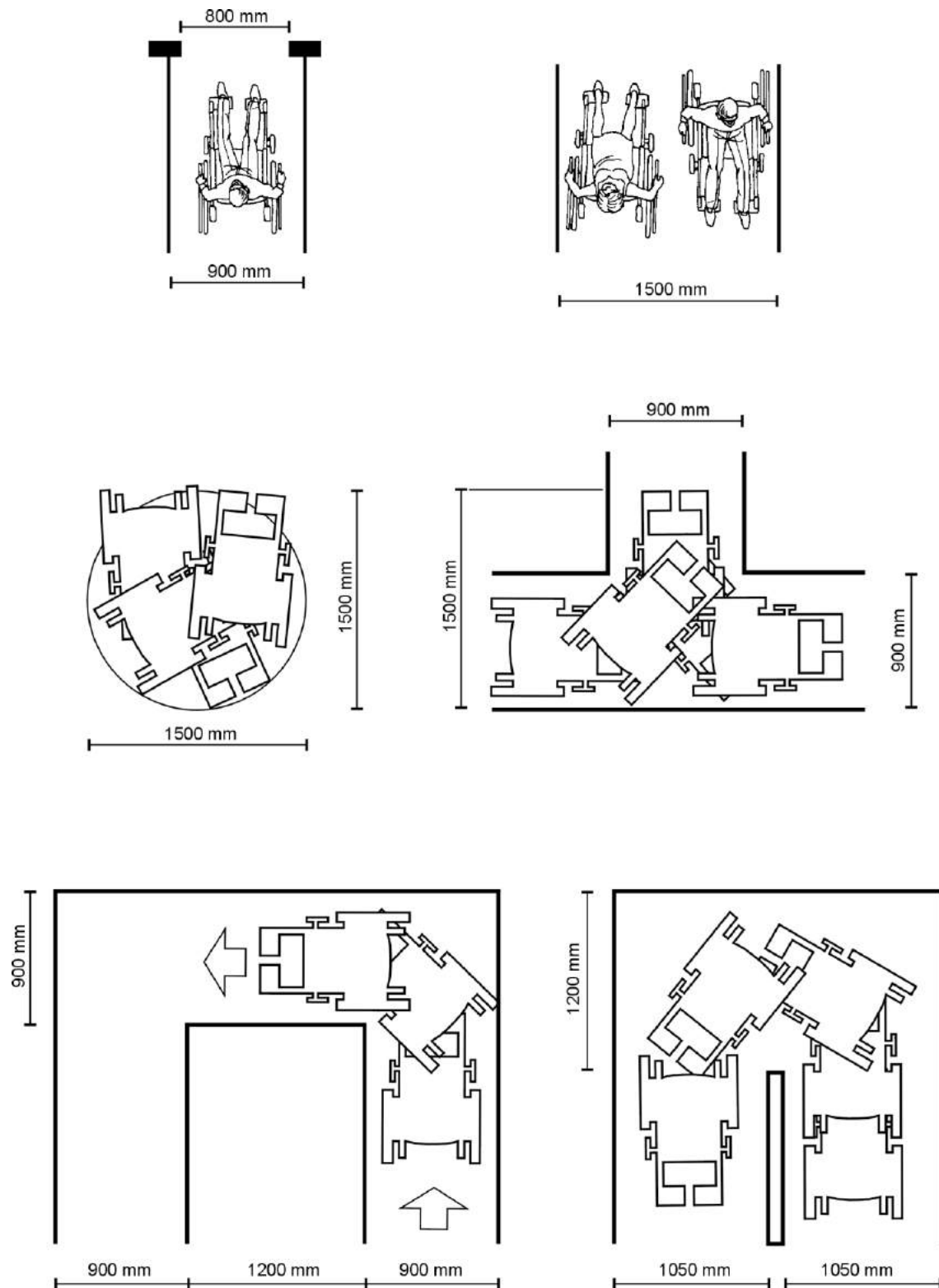


Figure 5.2: Minimum clear space required by wheelchairs

5.5. BICYCLE DIMENSIONS

Various types and sizes of bicycles are available, ranging from the smallest bicycle used by young children to the largest cycle used by adults. For design purposes, however, conservative dimensions are selected which provides for most cyclists.

The design space for a bicycle is shown in Figure 5.3. Provision is made for the following:

- A clear vertical height of 2,5 m. Few persons will reach this height when seated on a bicycle, but heights below this would be perceived as unsafe by cyclists.
- Under normal conditions, a moving bicycle needs a corridor of at least 1 m wide in order to maintain balance when riding at low speeds. To ride comfortably and avoid objects and other users such as pedestrians, a cyclist needs an additional 0,25 m of clearance on each side, bringing the basic width to 1,5 m.
- In enclosed areas, a space of 3 m is desirable for two opposing cyclists to comfortably pass each other. In an open area, slightly less space can be provided.

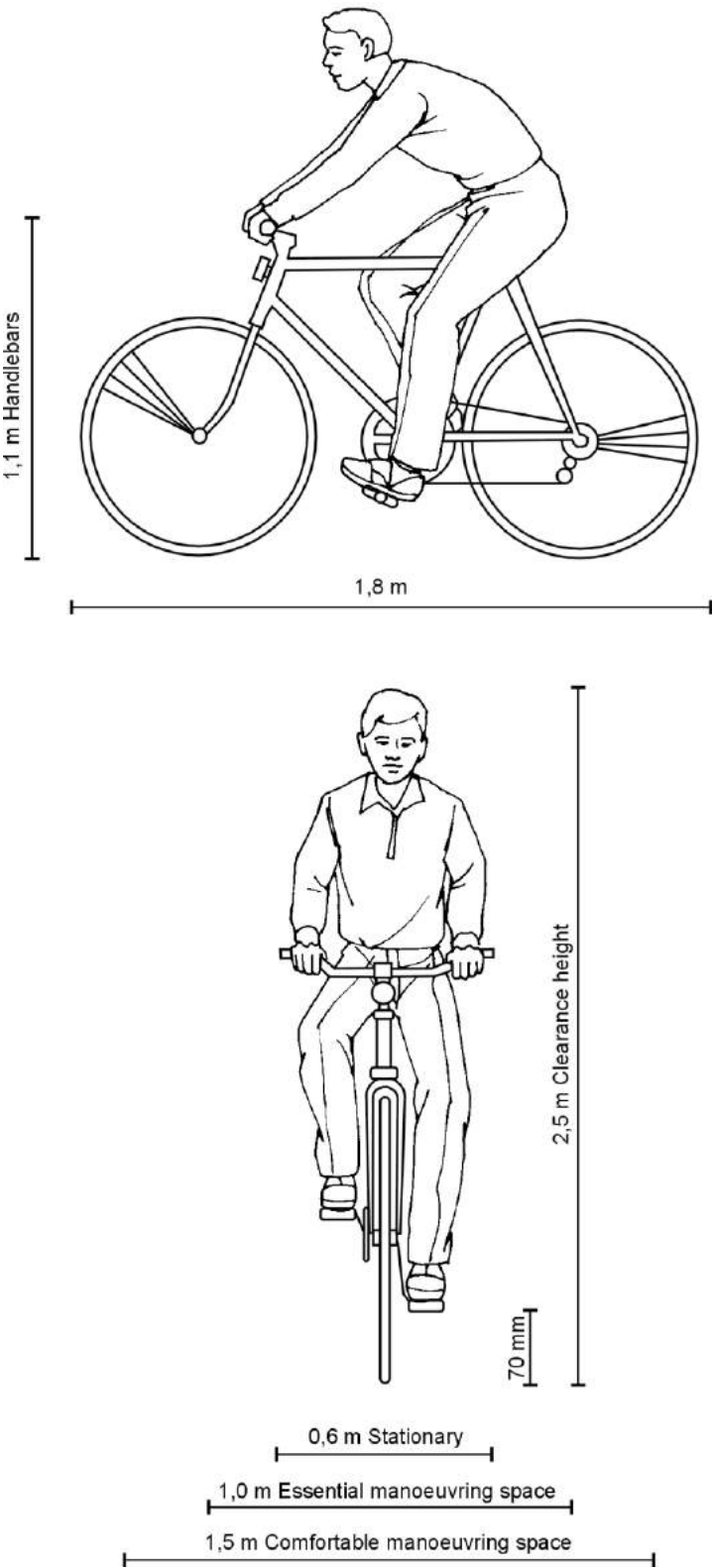


Figure 5.3: Bicycle operating space (CROW, 1993; Minnesota Department of Transportation, 1996)

A. Design controls

6. Walking and cycling speed and distance

6.1. INTRODUCTION

Walking and cycling speeds and distances are important parameters in the planning and design of pedestrian and bicycle facilities. Cyclists can travel at relatively high speeds (compared with motorised vehicles), while pedestrians travel at relatively low speeds – both of which must be adequately accounted for. The distances over which people are prepared to walk and cycle are also important limitations that should be considered in establishing the location of pedestrian and bicycle facilities.

6.2. ACCEPTABLE WALKING DISTANCES

Acceptable walking distances depend on a variety of factors, such as topography, climate conditions, time of day, trip purpose, land use and many other. Many people will walk longer for recreational purposes, but prefer shorter distances when they are commuting or when they are in a hurry.

A large number of factors influence acceptable walking distances. The distance that people are willing to walk can be extended by measures such as providing exclusive pedestrian walkways separated from vehicles, by providing weather protection, and by ensuring an attractive environment.

Walking is a relatively convenient mode of transport for distances up to 500 m (Untermann, 1984), but as distance increase, it becomes less attractive. It becomes more attractive when shorter walking distances are provided. Most persons would prefer walking trips shorter than 1 to 2 kilometres.

Guidelines for acceptable walking distances are given in Table 6.1. These guidelines can be used in the planning of pedestrian facilities.

TABLE 6.1: ACCEPTABLE WALKING DISTANCES	
To road and street crossings	50 – 100m
Parking to building entrances	100 m
Public Transport stops	300 m
Community facilities and parks	400 m
Commuter rail stations	500 m

6.3. ACCEPTABLE CYCLING DISTANCES

Acceptable cycling distances, like walking, depend on various factors such as gradient, climate, trip purpose, and other. Many people will cycle long distances for recreational and exercise purpose, but prefer shorter distances when they are undertaking a trip for commuting purposes.

Most cyclists would prefer cycling distances shorter than 5 km in length, although some cyclists may travel longer distances, particularly those from poorer communities who are unable to afford public transport.

6.4. WALKING SPEED

The walking speed of pedestrians is an important parameter in the planning and design of pedestrian facilities.

The average speed of pedestrians is approximately 1,5 m/s (TRB, 2000). This speed, however, is highly dependent on the proportion of disabled and elderly people in the walking population. There are also several other factors that influence walking speed. An upgrade of 10% or more reduces the speed by about 0,1 m/s. Walking speed is also dependent on the volume of pedestrians.

An important factor in walking speed is the condition of the pavement (De Langen & Tembele, 2001). A pavement in poor condition can reduce walking speed to about 1,0 m/s. A very bad pavement can reduce walking speeds even to as low as 0,7 m/s, half the average walking speed on a good pavement.

The above walking speeds are those of the average pedestrians. Many pedestrians, however, walk either faster or slower than the average. For design purposes, provision must be made for the slower pedestrian (typically the 15th percentile walking speed). The following speeds should be used for design purposes (Road Traffic Signs Manual):

- 1,2 m/s - Normal operating conditions.
- 1,0 m/s - Significant proportion of pedestrians are elderly or disabled.

The above design walking speeds are also used for cyclists that push their bicycles across a road. The speeds are used for purposes such as setting traffic signal timings and establishing gap acceptance sight distances.

6.5. CYCLING SPEED

Cycling speed is a basic parameter in the design of bicycle facilities. The design of various aspects of bicycle facilities depends on the speed at which cyclists travel. These aspects include horizontal curvature and stopping sight distance.

Cycling speed depends on many factors such as the type of bicycle, type of user, trip purpose, gradient and type of facility. The facility should be designed for a relative high speed above which few cyclists would travel (typically the 85th percentile speed). Recommended design speeds for various gradients are given in Table 6.2.

Cyclists tend to slow their speeds as they approach locations such as road junctions (Minnesota Department of Transportation, 1996). At such locations, the design speeds given in Table 6.2 can be reduced by about 10 km/h.

Table 6.2: Design speed for different downhill grades	
Downhill grades	Design speed
< 3%	30 km/h
3% to 7%	40 km/h
> 7%	50 km/h
Reduce design speed by 10 km/h at locations such as road junctions.	

A. Design controls

7. Sight distance

7.1. INTRODUCTION

The provision of sight distance is crucial for traffic safety. Sufficient sight distance must be provided for pedestrians and cyclists to view safety hazards and react accordingly. The following sight distance requirements should be provided in the design of pedestrian and bicycle facilities:

- Stopping sight distances required by cyclists to perceive a hazard and to stop safely.
- Decision sight distance required by cyclists to view their environment and to make decisions.
- Gap acceptance sight distance required wherever pedestrians and cyclists must cross a road or street by looking for gaps in traffic.

Sight distances are not only restricted by physical obstructions, but also by vehicles that are either travelling or stopped or parked on a road. The restriction of sight distance by vehicles could create a dangerous situation and must be carefully considered in the planning and design of pedestrian and bicycle facilities. The problem is illustrated in Figure 7.1.

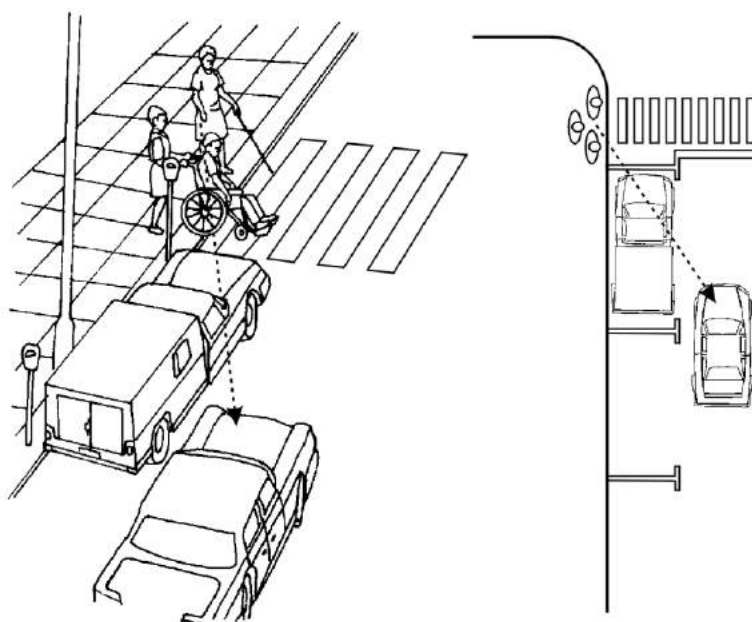


Figure 7.1: Restriction of sight distance by vehicles

7.2. STOPPING SIGHT DISTANCE FOR CYCLISTS

Stopping sight distance is the distance required to perceive, react and stop safely in adverse conditions. The distance is established as the distance travelled during perception and reaction time plus the distance required to stop safely.

The following parameters are used for establishing stopping sight distance (Scotland Department of Transport and the Environment, 2000; Minnesota Department of Transportation, 1996):

- Reaction time of 2,5 seconds.
- A deceleration rate of 2,5 m/s².

The minimum stopping sight distances using the above parameters are given in Table 7.1. The stopping sight distances in the table were calculated by means of the following formula:

$$D = 2,5 \times V / 3,6 + 0,5 (V / 3,6)^2 / (2,5 + 9,8 \times G / 100)$$

where:

- D = Stopping sight distance (metre)
- V = Bicycle design speed (km/h)
- G = Gradient (%)

Table 7.1: Stopping sight distances for cyclists							
Bicycle design speed (km/h)	Stopping sight distances (metre) for gradients of:						
	-15%	-10%	-5%	0%	5%	10%	15%
20	30	25	25	20	20	20	20
30	55	45	40	35	35	35	30
40	90	70	60	55	50	50	45
50	130	100	85	75	70	65	60

7.3. DECISION SIGHT DISTANCE FOR CYCLISTS

Cyclists will usually attempt to take evasive action rather than to stop for a hazardous object. They also need time to make various other decisions, such as direction of travel, making turns, etc. Sufficient decision sight distance should be provided along a bicycle facility to provide sufficient time for cyclists for making such decisions and to make the task of riding feel safe and comfortably.

Decision sight distance should be the distance covered by a cyclist in a travel time of 8 seconds (Scotland Department of Transport and the Environment, 2000). The decision sight distances needed to meet this requirement are shown in Table 7.2.

Table 7.2: Decision sight distances for cyclists	
Bicycle design speed	Decision sight distance (metre)
20	45
30	70
40	90
50	115

7.4. GAP ACCEPTANCE SIGHT DISTANCE FOR PEDESTRIANS AND CYCLISTS

Sufficient gap acceptance should be provided at a junction or crossing to allow a pedestrian or cyclist to view conflicting traffic and make a decision on gap acceptance. Sufficient time must be available for a pedestrian to walk and for a cyclist to push his or her bicycle across the road.

Gap acceptance sight distance for pedestrians and cyclists must be provided from the location where they wait on the side of the road, as indicated in Figure 7.2. The sight distance should be measured from a point 2 m from the edge of the roadway to the middle of each conflicting traffic lane. Where refuge islands are provided, gap acceptance sight distance must also be measured from the islands, but the sight distances are only required for the portion of the roadway crossed during each stage of crossing.

Pedestrian and Bicycle Facility Guidelines

Gap acceptance sight distance is also required when the conflicting vehicle turns left to enter the road at an upstream junction as shown in Figure 7.3. Due to the turning movement, a lower vehicular design operating speed may be used. It is recommended that a speed of 40 km/h in urban areas and 50 km/h in rural areas be used for establishing minimum required gap acceptance sight distance for this situation.

Minimum gap acceptance sight distances required by pedestrians and cyclists depend on traffic speed and the width of road to be crossed. Recommended minimum gap acceptance sight distances for various conditions are shown in Table 7.3 for normal operating conditions. At locations where there is a high proportion of elderly or disabled pedestrians, longer gap acceptance sight distances as given in Table 7.4 should be provided.

Tables 7.3 and 7.4 show that relatively long sight distances are required to allow a pedestrian or cyclist to cross a road safely, particularly when the road is wide and vehicular speeds are high. This indicates the need for reducing crossing widths (by kerb extensions or by providing refuge islands), and by controlling pedestrian and bicycle access to high-speed roads. Where pedestrians and cyclists do gain access to a road, vehicle speeds should be controlled (e.g. by means of traffic calming).

The gap acceptance sight distances in Tables 7.3 and 7.4 have been calculated by means of the following formula:

$$D = (T + W/U) \times (V/3,6)$$

where:

- D = Gap acceptance sight distance (metre)
- T = Reaction plus clearance time (taken as 3 seconds)
- W = Crossing distance (metre).
- U = Pedestrian or cyclist walking speed
- V = Speed limit (km/h)

A design walking speed for pedestrians and cyclists of 1,2 m/s should be used for normal operating conditions. A slower speed of 1,0 m/s, however, should be used when there is a significant proportion of elderly or infirm pedestrians.

Table 7.3: Gap acceptance sight distances for pedestrians and cyclists – 1,2m/s crossing speed			
Vehicular speed limit (km/h)	Gap acceptance sight distances for crossing widths of		
	7,5m	15,0m	22,5m
40	105	175	245
50	130	215	305
60	155	260	365
70	180	305	425
80	210	345	485
100	260	435	605
120	310	520	725

Table 7.3: Gap acceptance sight distances for pedestrians and cyclists – 1,0m/s crossing speed			
Vehicular speed limit (km/h)	Gap acceptance sight distances for crossing widths of		
	7,5m	15,0m	22,5m
40	115	200	285
50	145	250	355
60	175	300	425
70	205	350	500
80	235	400	570
100	295	500	710
120	350	600	850

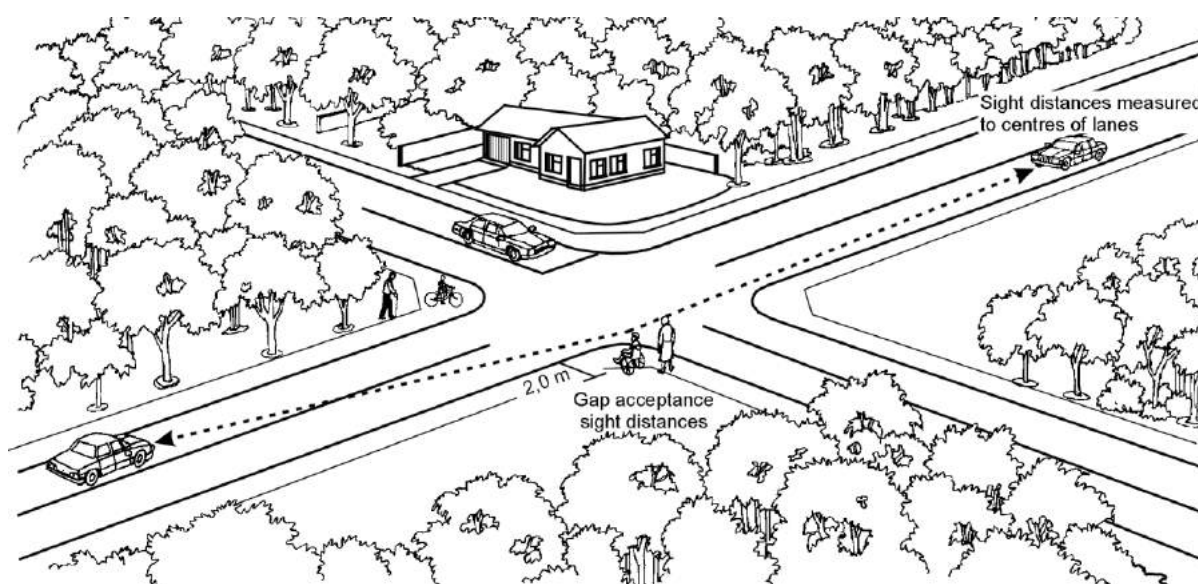


Figure 7.2: Gap acceptance sight distance for pedestrians

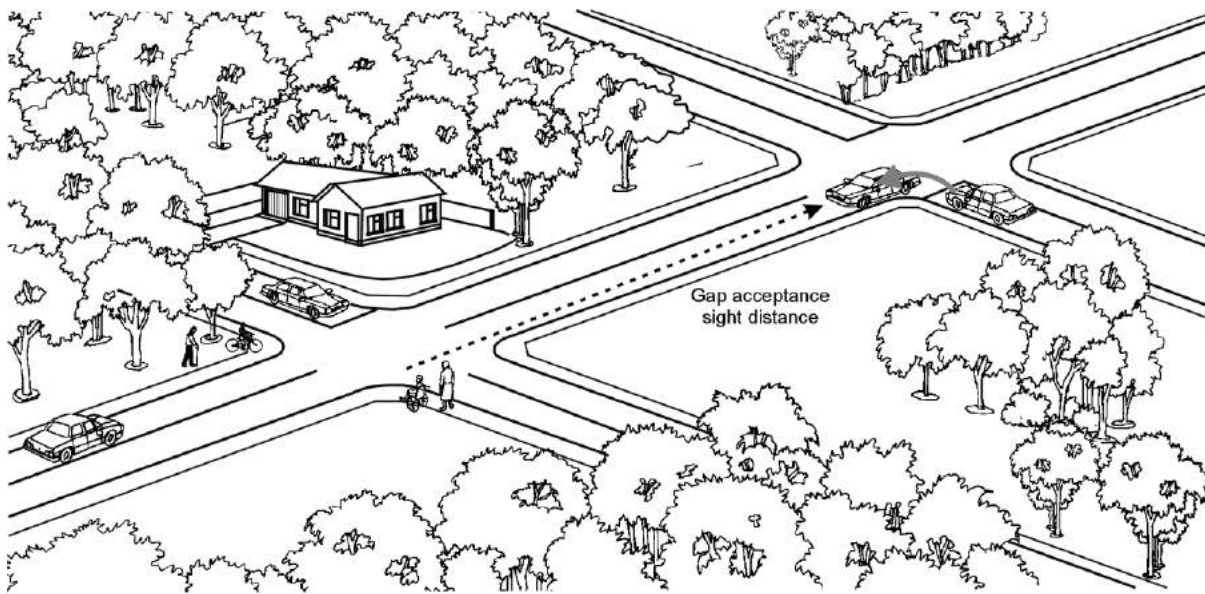


Figure 7.3: Gap acceptance sight distance to entering vehicle

7.5. EYE AND OBJECT HEIGHTS

Sight distances are measured from an eye to an object height as shown in Figure 7.4. Different eye and object heights are used for the different types of sight distances.

a) Stopping sight distances for cyclists

For stopping sight distance required by cyclists, an eye height of 1,40m is used together with a zero object height to allow for hazards such as loose sand, pools of water, potholes, pieces of glass, etc (Minnesota Department of Transportation, 1996).

b) Decision sight distance for cyclists

For decision sight distance required by cyclists, an eye height of 1,40 m is used together with an object height of 0,3 m. This allows for hazards such as small animals.

c) Gap acceptance sight distance for pedestrians and cyclists

For gap acceptance sight distance, an eye height of 1,05 is used which is adequate for child pedestrians as well as persons using wheelchairs. Persons riding on bicycles would normally have a higher eye height (of about 1,4 m), but the lower height of 1,05 m should still be used to accommodate children pushing their bicycles. It is interesting to note that the eye height of 1,05 m is also used for drivers of passenger cars (a height of 1,8 m is used for buses and heavy vehicles).

An object height of 1,35 m is used which represent the top of passenger car. This represents the height of a relatively low vehicle.

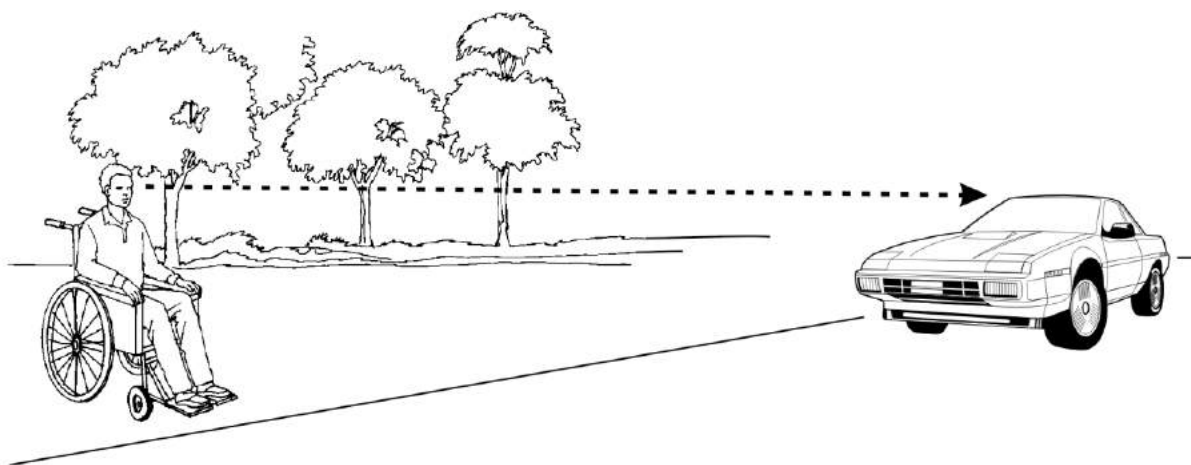


Figure 7.4: Measuring sight distance for a person in a wheelchair

PART B

PEDESTRIAN AND BICYCLE CROSSINGS

B. Pedestrian and bicycle crossings

1. Introduction

1.1. TYPES OF CROSSINGS

The pedestrian and bicycle crossing is the one location where pedestrians and cyclists are most exposed to traffic, and the danger of accidents is at its highest. The provision of efficient and safe crossings is therefore of vital importance. Considerable care must be taken in the planning and design of pedestrian and bicycle crossings.

Pedestrian and bicycle crossings can be provided at one of two locations:

At midblock locations, between two road junctions, normally as marked crossings.

At road junctions, either as marked or as unmarked crossings.

There are various types of road junctions, each of which require different types of treatments to accommodate pedestrians and cyclists.

1.2. REGULATIONS APPLICABLE TO PEDESTRIAN CROSSINGS

An amendment to the definition of a pedestrian crossing has been proposed in which part a) of the definition is omitted. This paragraph will have to be checked if the proposed amendment is accepted.

A pedestrian crossing is formally defined in the National Road Traffic Regulations (2000). A pedestrian crossing is defined as:

- a) *that portion of a public road at an intersection included within the prolongation or connection of the kerb line and adjacent boundary line of such road, whether such portion is marked or not; or*
- b) *any other portion of a public road designated as a pedestrian crossing by appropriate road traffic signs;*

According to the regulations, pedestrians have the following right of way at pedestrian crossings:

315. (1) Where a pedestrian crossing is situated in conjunction with a traffic signal, a pedestrian shall not enter such crossing except in accordance with the indications of such traffic signal as prescribed in these regulations.

(2) In circumstances not referred to in subregulation (1), the driver of a vehicle shall yield the right of way, slowing down or stopping if need be to so yield to a pedestrian crossing the roadway within a pedestrian crossing when the pedestrian is upon that half of the roadway upon which the vehicle is travelling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.

(3) No pedestrian shall suddenly enter a pedestrian crossing and walk or run into the path of a vehicle which is so close that it is impossible for the driver to yield as contemplated in subregulation (2).

(4) Whenever any vehicle is stopped at a pedestrian crossing to permit pedestrians to cross the roadway, the driver of any other vehicle approaching from the rear shall not pass such stopped vehicle.

Pedestrians, however, also have specific duties when using a pedestrian crossing. These are:

316 (3) No pedestrian shall cross a public road without satisfying himself or herself that the roadway is sufficiently free from oncoming traffic to permit him or her to cross the road in safety.

(4) A pedestrian, when crossing a public road by means of a pedestrian crossing or in any other manner, shall not linger on such road but shall proceed with due despatch.

(5) No pedestrian on a public road shall conduct himself or herself in such a manner as to or as is likely to constitute a source of danger to himself or herself or to other traffic which is or may be on such road.

(6) A pedestrian may cross a public road only at a pedestrian crossing or an intersection or at a distance further than 50 metres from such pedestrian crossing or intersection.

1.3. REGULATIONS APPLICABLE TO BICYCLE CROSSINGS

The National Road Traffic Regulations have no specific regulations applicable to bicycle crossings. The National Road Traffic Act (Act No. 93 of 1996), however, includes a bicycle in its definition of a motor vehicle, and a bicycle crossing can therefore be provided as a normal road junction. The act defines a "motor vehicle" as *any self-propelled vehicle and includes a) a trailer; and b) a vehicle having pedals and an engine or an electric motor as an integral part thereof or attached thereto and which is designed or adapted to be propelled by means of such pedals, engine or motor, or both such pedals and engine or motor.*

1.4. ATTRIBUTES OF GOOD PEDESTRIAN AND BICYCLE CROSSINGS

In the planning, designing and construction of pedestrian and bicycle crossings, it is important that the basic needs of the users are addressed. These needs are discussed in detail elsewhere in this manual, and can be summarised as follows:

- **Security.** A fundamental consideration in the planning and design of crossing is the security of persons. Crossings should not be provided in secluded and deserted areas where there is a high security risk.
- **Safety.** Crossings must be designed and built free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Traffic safety is an important consideration because of the vulnerability of pedestrians at crossings. The highest level of exposure to traffic accidents occurs at crossings. The marked pedestrian crossing is perhaps the one location where pedestrians have the greatest false sense of security.
- **Accessibility.** Crossings should be as accessible as possible to all users, including those with disabilities.
- **Convenience.** Crossings should be provided in the most convenient (and safe) locations. The pedestrian and cyclist desire a fast, direct, continuous, convenient route of access to chosen destinations.
- **Comfortable.** The crossing should be comfortable to use. Gradients on the crossing should be restricted, while a smooth well maintained pavement should be provided.
- **Environment.** Crossing construction standards should be of a high quality. People will make greater use of crossings if some attractive features are provided that attract people to crossings.
- **Economy.** Crossings should be cost-effective and provided in locations where they are most urgently needed.

1.5. TRAFFIC SAFETY AT PEDESTRIAN AND BICYCLE CROSSINGS

Pedestrians and cyclists are most vulnerable to traffic accidents when they must cross a road. The safety of pedestrians and cyclists at crossings can be improved by measures such as the following:

Pedestrian and Bicycle Facility Guidelines

- Restriction the number of times traffic must be crossed through route planning, by providing grade separated crossings or by implementing access control. Access control can assist in reducing the number of driveways that must be crossed by pedestrians, but care must be taken to ensure that walking distances are not unnecessary increased.
- Reducing the crossing distance to a minimum, or by providing refuge islands which would allow crossing of wide roads in stages.
- Provide crossings where traffic volumes are the lowest.
- Provide crossings where vehicle speeds are low or where the speeds can be moderated by traffic calming or law enforcement measures.

A particular problem with the provision of crossings is that pedestrians do not utilise such crossings unless the crossings are located on their desire lines. Pedestrians also tend to cross roads over various points of the roads, and not at one particular location. ***Under such circumstances, it would be better not to provide crossings, but to implement traffic calming measures which would reduce vehicular speeds over the length of the road*** (De Langen & Tembele, 2001).

B. Pedestrian and bicycle crossings

2. Midblock crossings

2.1. INTRODUCTION

Midblock crossings are provided between junctions to assist pedestrians in crossing a road. An example of a midblock crossing is shown in Figure 2.1. Midblock crossings can be either yield or signal controlled.

At yield controlled crossings, the National Road Traffic Regulations require drivers of vehicles to *yield the right of way, slowing down or stopping if need be to so yield to a pedestrian crossing the roadway within a pedestrian crossing when the pedestrian is upon that half of the roadway upon which the vehicle is travelling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.*

At signal-controlled crossings, pedestrians and drivers of vehicles have right of way only when green signals are displayed. A signal controlled midblock crossing can also operate in “pelican” mode when a flashing red signal is indicated to pedestrians and vehicles (refer to the chapter on traffic signals).

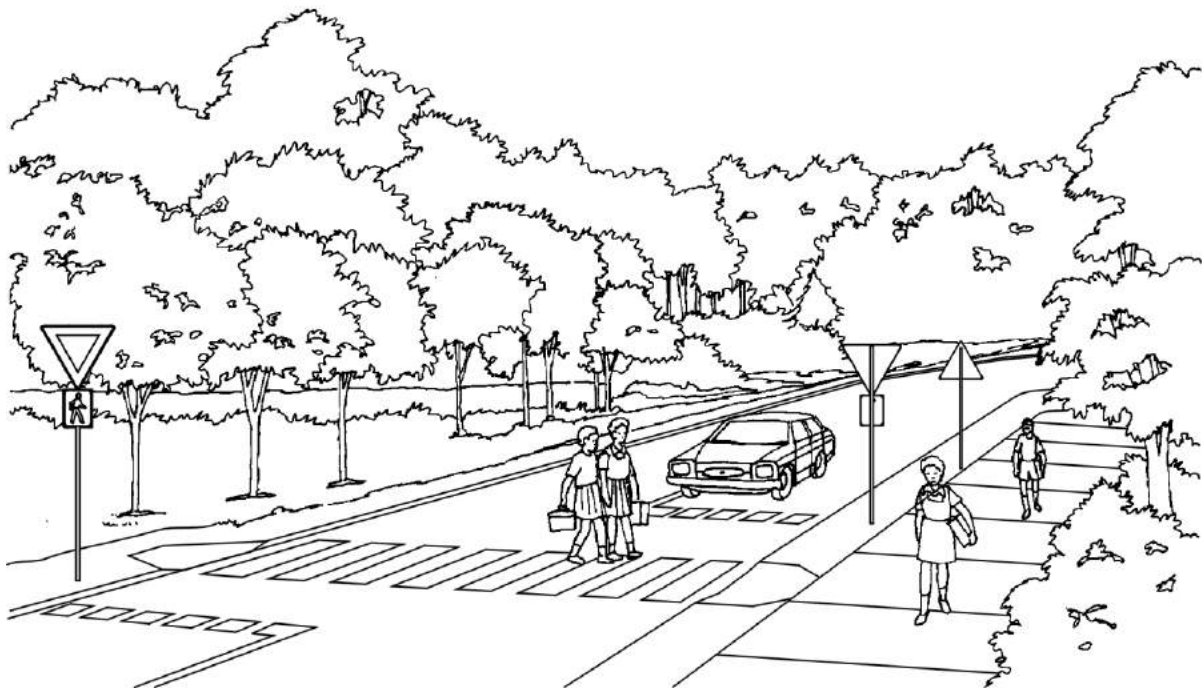


Figure 2.1: Example of a midblock crossing

2.2. ADVANTAGES AND DISADVANTAGES OF MIDBLOCK CROSSINGS

The signal controlled midblock crossing has the advantage that priority is clearly indicated by a traffic signal. At yield controlled midblock crossings, pedestrians always have right of way according to the National Road Traffic Regulations. In many cases, this probably does currently not occur, with the result that pedestrians have no advantage in using such crossings. The safety of pedestrians can in fact be endangered by this situation, and it is therefore imperative that drivers should be educated and the law enforced to ensure that pedestrians are given priority as prescribed by the regulations.

A midblock crossing that operates according to regulations has the following advantages:

- Waiting time (delay) is minimized since a pedestrian does not have to wait for a gap in the traffic stream. Where gaps are inadequate, pedestrians tend to accept gaps that are too short, thus endangering their own safety and that of other road users.
- Pedestrian crossings have the advantage that pedestrians are concentrated at a reduced number of locations on the road, and not scattered over the length of the road. This reduces the information burden on drivers, which contributes to road safety.
- Marked pedestrian crossings can be useful to indicate to drivers that they are in an area used by pedestrians, and that they must be on the lookout for pedestrians.

Midblock pedestrian crossings, however, have a number of disadvantages that reduces their utility:

- Pedestrians have to follow a detour to reach the pedestrian crossing, which could effectively increase their travel time, even though they may save time crossing the road. Pedestrian crossings should therefore ideally be located at positions with the highest pedestrian concentrations.
- Vehicles can experience very long waiting times, particularly when pedestrian volumes are high. There should therefore be a trade-off between the delay experienced by pedestrians and those by vehicles. This problem can be addressed by providing signals at crossings.

2.3. THE NEED FOR MIDBLOCK CROSSINGS

Although midblock crossings have a number of disadvantages, and even if drivers do not yield to pedestrians as they should, midblock crossings have the advantage that they concentrate pedestrians at one point and that they serve to warn drivers of the presence of pedestrians. There is therefore a need for midblock crossings at locations where pedestrians cross a road in some numbers.

Pedestrian crossings should be provided adjacent to all developments that attract significant volumes of pedestrians. These locations include the following:

- Schools and other educational facilities.
- Public transport termini.
- Where a road divides an integrated community.
- Community centres.
- Homes for the elderly, infirm or blind.
- Hospitals and clinics.
- Shopping centres and central business districts.
- Industrial areas.

No need typically exists for a pedestrian crossing when:

- Pedestrian volumes are low (less than about 50 persons per hour).
- Near to another pedestrian crossing, either a midblock crossing or at a junction.

A midblock crossing would not normally be required within about 180 m from another crossing, except where there is well defined need such as in central business districts (Otak, 1997). In such cases, crossings can be provided as near as 50 m from another crossing.

2.4. ATTRIBUTES OF GOOD MIDBLOCK CROSSINGS

In planning, designing and construction of crossings, it is important that the basic needs of pedestrians are addressed. Some of these needs have been described in the introductory chapter to this part of the manual, but the following needs are specifically applicable to midblock crossings:

- **Traffic safety.** Traffic safety is a particularly important consideration because of the vulnerability of pedestrians at crossings. The highest level of exposure to traffic accidents occurs at midblock crossings and at road junctions. Shortening the length of the crossing, for example, can reduce the level of exposure at midblock crossings.
- **Accessibility.** The provision of kerb ramps at midblock crossings is important to ensure that such crossings can be used by disabled persons, particularly those in wheelchairs.

2.5. LOCATION OF PEDESTRIAN CROSSINGS

Pedestrian crossings should be located at positions where they would attract the maximum number of pedestrians who would otherwise cross the road at various positions. Crossings should be located on the desire lines that would serve the majority of pedestrians.

Pedestrian crossings should not be located so near to other midblock crossings or road junctions that drivers do not have sufficient time to react to the presence of pedestrians. Drivers may need as much as 2,5 seconds to perceive and react to hazards and dangers. Minimum separation distances that provide adequate time for reaction are given in Table 2.1.

The separation distances given in Table 2.1 should be provided between pedestrian crossings and other important elements of the road network that can distract the attention of the driver. These include elements such as other midblock crossings, road junctions, merge areas, bus and mini-bus stops, etc.

Table 2.1: Minimum separation distances between midblock crossings and other elements of the road network	
Operating speed or speed limit (km/h)	Separation distance (metre)
20	15
30	20
40	30
50	35
60	45
70	50
80	55

2.6. LAYOUT OF YIELD-CONTROLLED PEDESTRIAN CROSSINGS

The basic treatment of a yield-controlled pedestrian crossing is shown in Figure 2.2. According to the Road Traffic Signs Manual, the following road signs and markings should be provided:

- Block pedestrian crossing RTM4 that demarcates the crossing point.
- Yield line markings RTM2 across all approach lanes to the crossing together with the Yield symbol WM5 in advance of the yield line marking.
- Yield to pedestrians sign R2.1 placed at the Yield Line marking RTM2. This sign imposes a mandatory requirement that the driver of a vehicle approaching such a sign shall yield right-of-way to pedestrians crossing the public road, or waiting to cross the public road.
- Pedestrian crossing warning signs W306 placed between 90 m and 180 m in advance of the crossing.

The road signs and markings to be displayed at all yield-controlled midblock pedestrian crossings are described in Appendix A of this manual. More details regarding the required road signs and markings can be found in the Road Traffic Signs Manual.

The yield-controlled pedestrian crossing can also be provided as a **raised crosswalk**. Such a raised crosswalk is a speed hump which is wider than a normal speed hump, and which is marked as both a speed hump and a pedestrian crossing. More information regarding such raised crosswalks is also given in the Road Traffic Signs Manual.

2.7. LAYOUT OF SIGNAL-CONTROLLED PEDESTRIAN CROSSINGS

The basic treatment of a traffic signal controlled pedestrian crossing is shown in Figure 2.3. According to the Road Traffic Signs Manual, the following road signs and markings should be provided:

- Pedestrian crossing lines RTM3 that demarcates the crossing point.
- Stop line markings RTM1 across all approach lanes to the crossing.
- Pedestrian crossing warning signs W306 placed between 90 m and 180 m in advance of the crossing.
- The traffic signals designed in accordance to the requirements of the Road Traffic Sign Manual.

If the signalisation is an upgrade in control level of a crossing already marked with block pedestrian crossing marking RTM4, it is not recommended that any attempt be made to remove the block marking. A combination of the block and line markings can then be used as indicated in Figure 2.4.

2.8. ZIG-ZAG LINES AT MIDBLOCK CROSSINGS

Zig-zag lines RM11 are regulatory markings which may be used on the approach to a pedestrian crossing to indicate to drivers that they are nearing a pedestrian crossing. According to the National Road Traffic Regulations (2000), the zig-zag markings impose a mandatory requirement that drivers of vehicles shall not bring their vehicles to a stop within the zone marked by the zig-zag lines, except to yield to pedestrians on the crossing, or to stop in a queue of vehicles. Vehicles may also not change lanes within the zig-zag zone. Pedestrians should also not cross in the road in this zone.

The zig-zag lines should be used in situations which are considered potentially dangerous for pedestrians, and particularly where there are pedestrian visibility problems.

Zig-zag lines replace lane edge markings (RM4.1), dividing line (WM3) and no-overtaking line markings (RM1) on both approaches to a midblock crossing as shown in Figure 2.5. The dividing line and no-overtaking line markings may, however, be retained in addition to the zig-zag lanes where required for reasons of safety, as indicated in Figure 2.6.

When parking bays are provided near to a crossing, zig-zag lines may be provided adjacent to the parking bays as indicated in Figure 2.7. Parking should preferably not be provided closer than 9 m from the yield or stop line of a signal controlled crossing and 30 m from a yield-controlled crossing.

2.9. SPEED LIMITS AT MIDBLOCK CROSSING

The provision of yield-controlled pedestrian crossings on roads not subject to a 60 km/h speed limit presents special problems because pedestrians are not able to judge vehicle speeds or stopping distances for faster traffic.

Some installations on roads with a higher than 60 km/h speed limits may operate well because of features that have been installed which restrict high speeds, such as approaching a traffic circle. Such installations would also be associated with other safety features like absence of parked cars, good lighting and low traffic flows.

According to the Road Traffic Signs Manual, pedestrian crossings may not be signalised on roads with a speed limit higher than 80 km/h.

2.10. SIGHT DISTANCE AT MIDBLOCK CROSSINGS

Sufficient sight distance must be available at midblock crossings. As a minimum, sufficient sight distance must be available to allow a vehicle to come to a stop in case of a hazard or danger (stopping sight distance for vehicles). Longer sight distances, however, are usually required, as follows:

- At yield-controlled midblock crossings, sufficient sight distance should be provided to allow safe gap acceptance by pedestrians. This is due to the tendency of drivers not to stop at such crossings.
- At signal controlled crossings, sufficient decision sight distance should be provided for vehicle drivers as prescribed by the Road Traffic Signs Manual.

2.11. MINIMISING THE CROSSING DISTANCE AT MIDBLOCK CROSSINGS

Minimising the crossing distance at midblock crossings enables pedestrians to cross the street more safely and comfortably. It has the significant advantage that the level of exposure to traffic is reduced, thus lowering the risk of accidents. It also has the added benefit of improving timing of signalised crossings, without sacrificing the need for the adequate protection of pedestrians.

Crossing distance should where possible be restricted to a distance of not more than 15 to 20 metres or a maximum of four lanes of traffic. On wider roads, the crossing distance should be reduced by means of kerb extensions or refuge islands.

Crossing distance at midblock crossings can be reduced by providing kerb extensions as shown in Figure 2.8. Such extensions have the added advantage of making a pedestrian more visible to drivers at intersections.

Where it is not possible to reduce crossing distance, a median or a central refuge island can be provided to eliminate the need for pedestrians to cross the intersection at once. Where sufficient space is available to provide a pedestrian refuge island, it is possible to provide a staggered midblock pedestrian crossing as shown in Figure 2.9. Such stagger allows pedestrians to cross one half of the road at a time.

2.12. SHARED-USED MIDBLOCK CROSSINGS

Midblock crossings may be provided for the exclusive use of pedestrians, or they may be combined with a crossing for cyclists, as indicated in Figure 2.10. The crossing is provided immediately adjacent to the pedestrian crossing, and is marked by means of bicycle guidelines GM5.

It is important to note that the bicycle guidelines GM5 are guidance markings and do NOT have the same legal requirements as pedestrian crossing lines RTM3. They do not impart any priority to the cyclist, and are solely used to provide information to the cyclist.

2.13. CROSS FALL AND GRADIENT

The cross fall and gradient of a midblock crossing should comply with the following requirements:

- The cross fall on the crossing should not be more than 1:50 (2%) measured perpendicular to the direction of travel.
- The gradient of the crossing should not exceed a maximum of 1:20 (5%) in the direction of travel.

For persons travelling in wheelchairs, a flat cross fall is often more important than a flat gradient (Public Rights-of-Way Access Advisory Committee, 2001). A steep cross fall will require the person on the wheelchair to push forward on one wheel, while braking on the other wheel – an action that requires a significant amount of effort and energy.

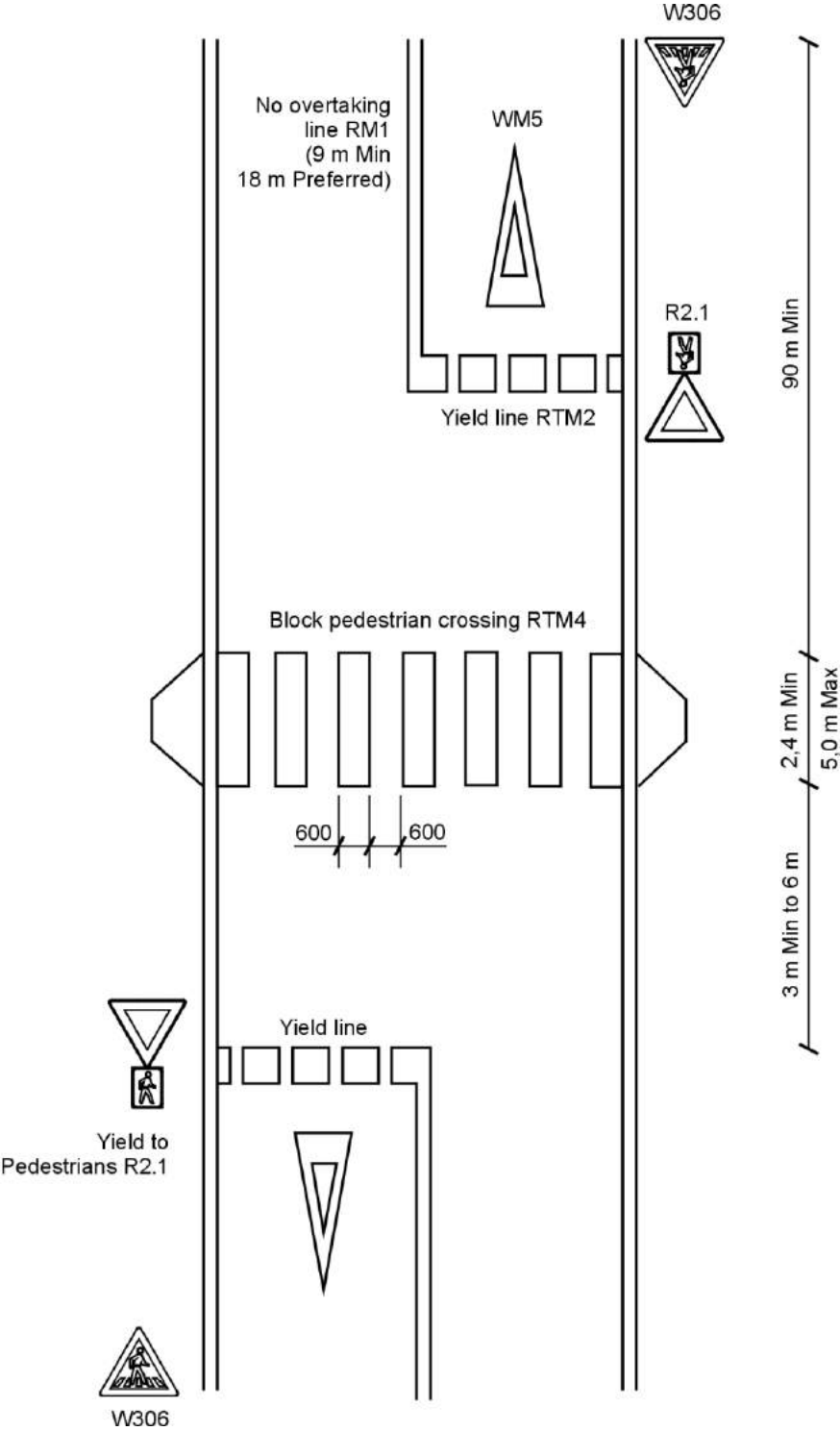


Figure 2.2: Basic yield-controlled midblock pedestrian crossing

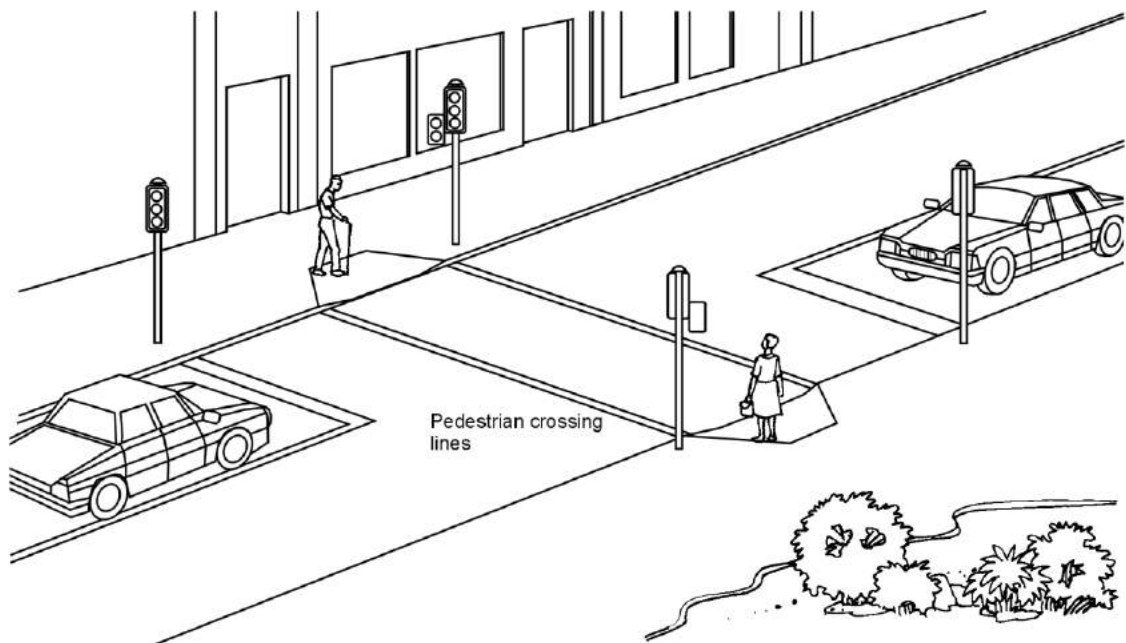


Figure 2.3: Traffic signal controlled midblock pedestrian crossing

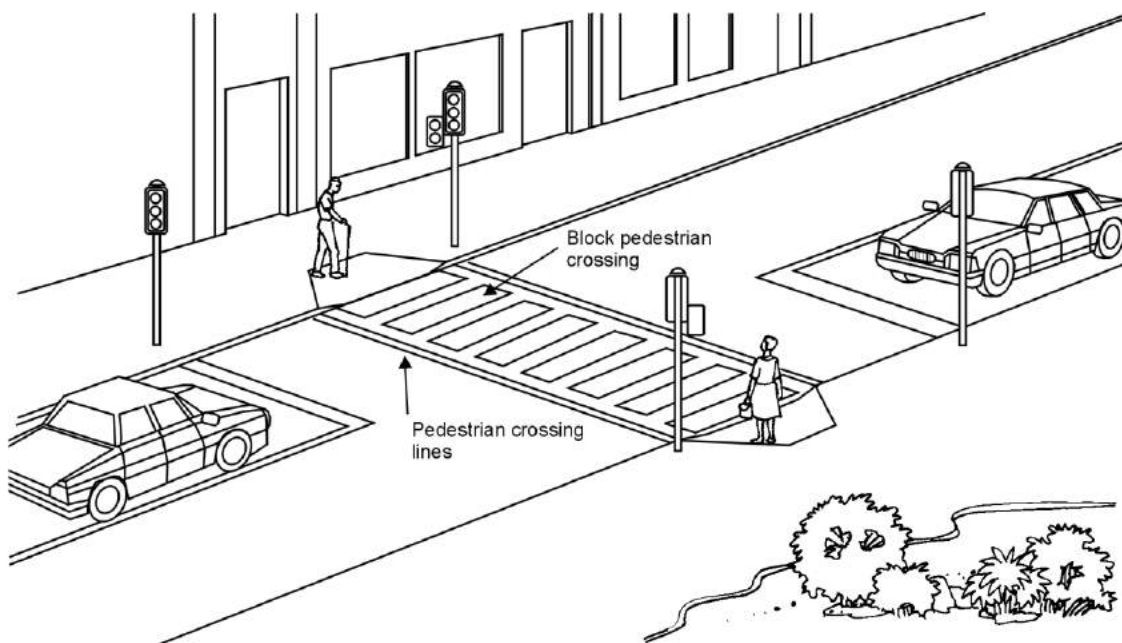


Figure 2.4: Upgrading of a basic midblock pedestrian crossing to a signalised pedestrian crossing

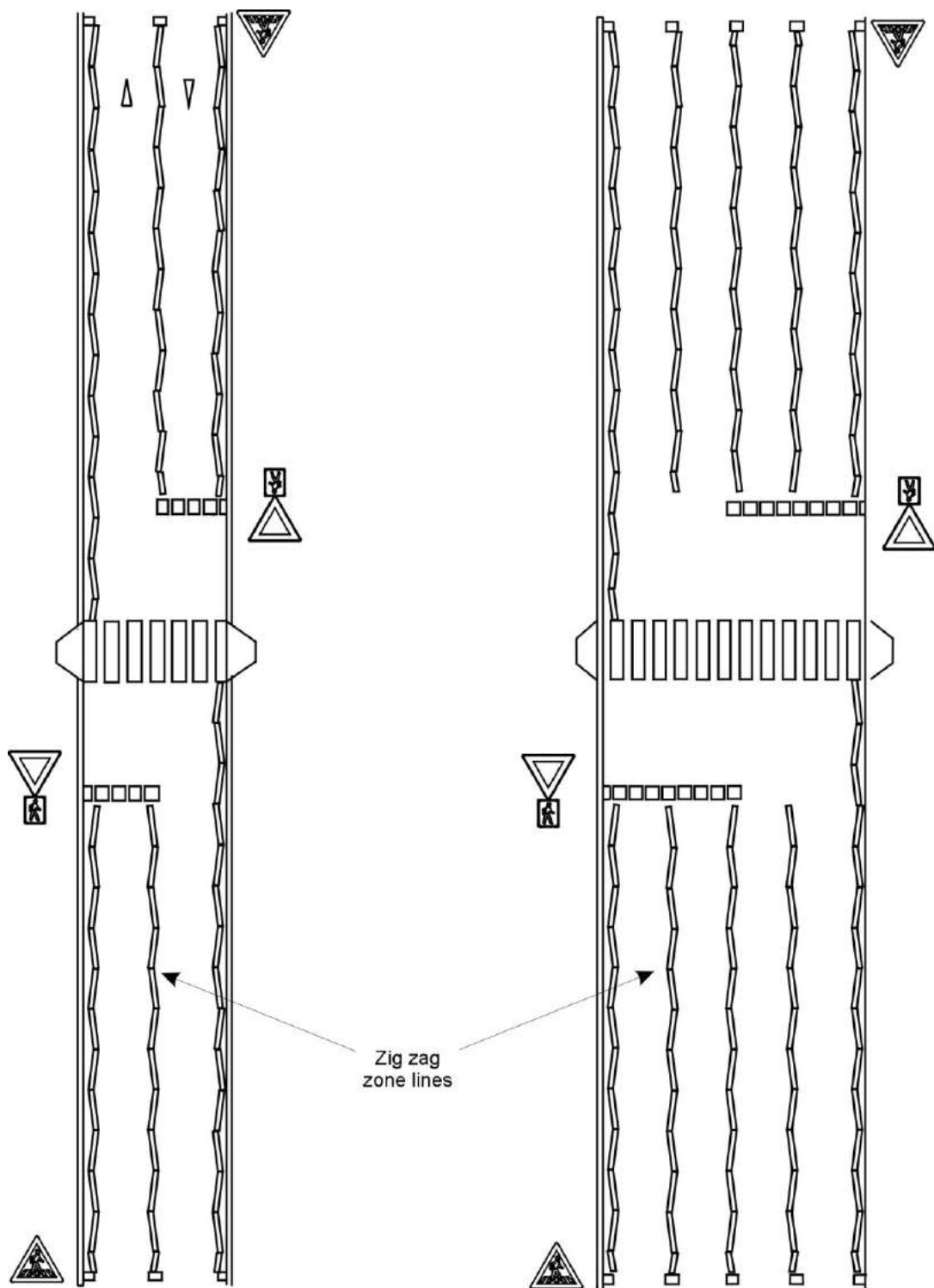


Figure 2.5: Zig-zag markings at midblock pedestrian crossings

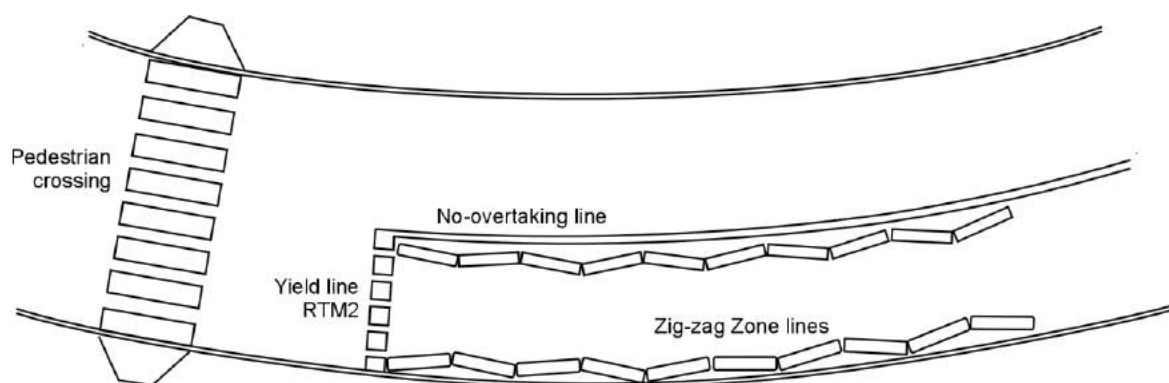


Figure 2.6: Zig-zag markings with no-overtaking line retained

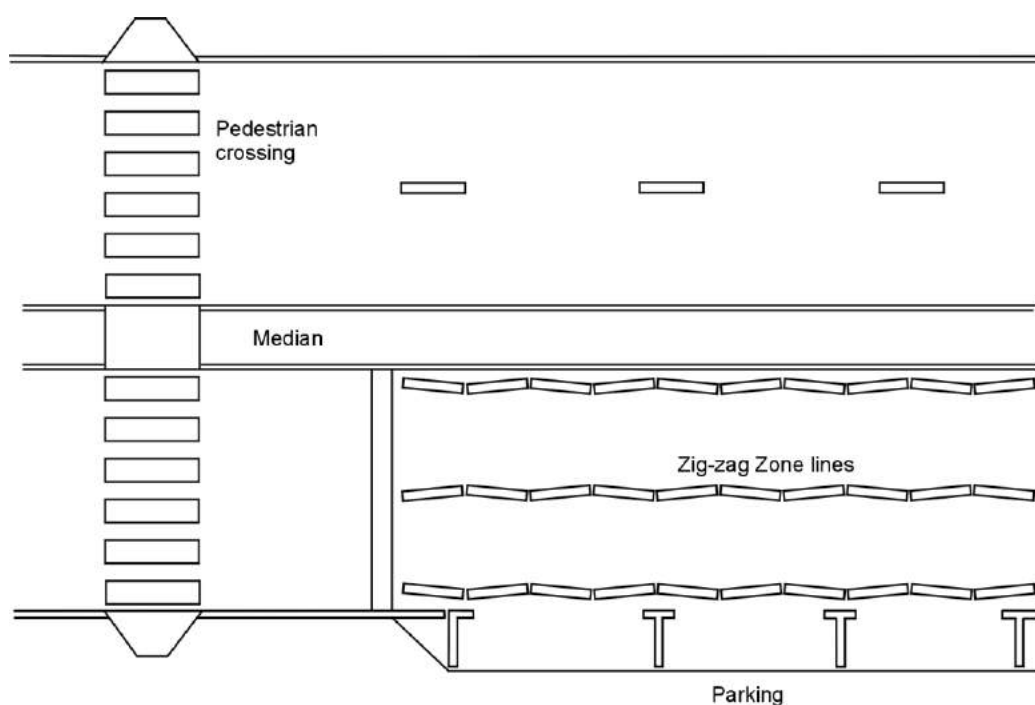


Figure 2.7: Accommodation of parking on approaches to signalised pedestrian crossing

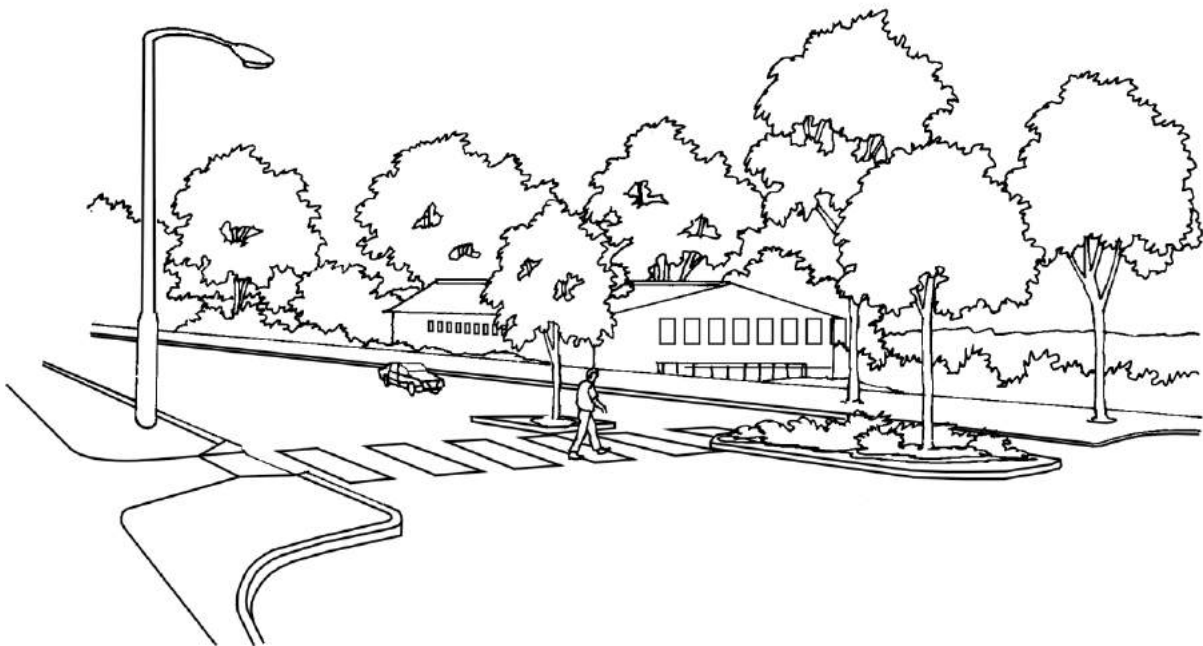


Figure 2.8: Shortening crossing distances at midblock crossings

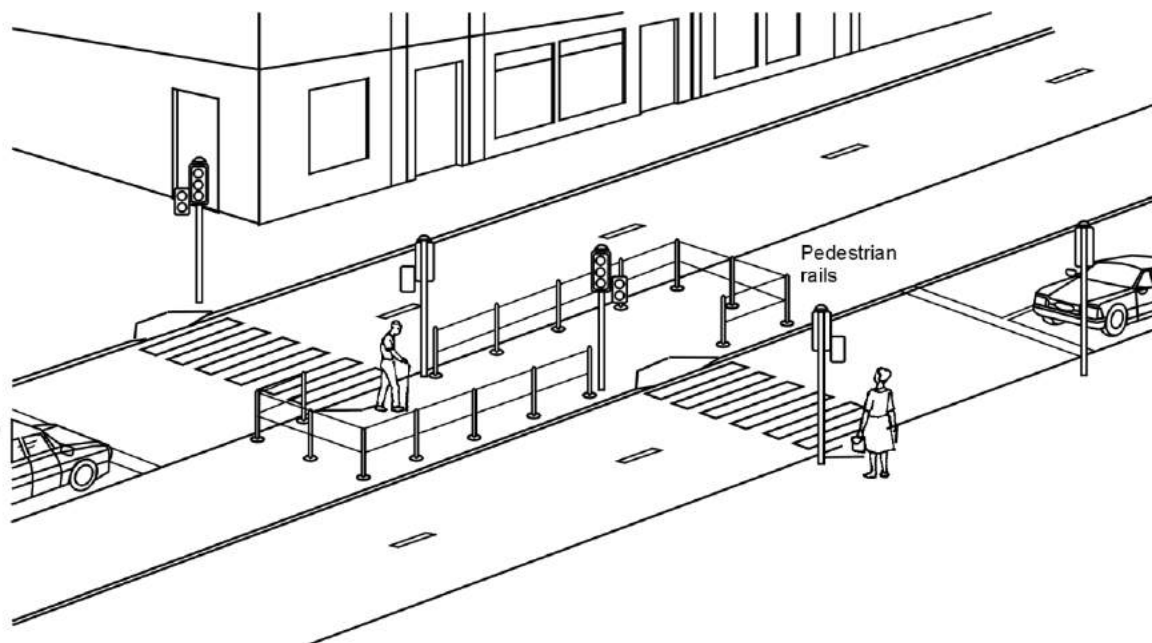


Figure 2.9: Staggered midblock pedestrian crossing

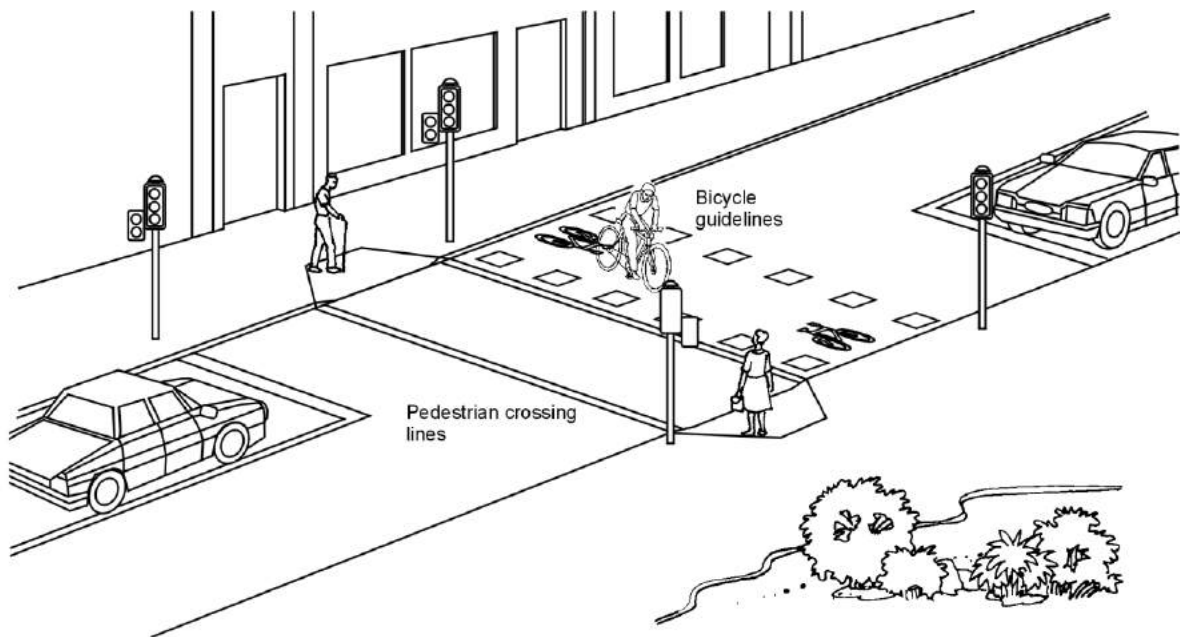


Figure 2.10: Shared pedestrian/bicycle crossing

B. Pedestrian and bicycle crossings

3. Road junctions

3.1. INTRODUCTION

Road junctions are often designed with a focus towards motor vehicles rather than pedestrians and cyclists. The need of all road user groups should, however, be considered and balanced when planning and designing road junctions, including those of pedestrians and cyclists.

According to the National Road Traffic Regulations (2000), the term “intersection” is used to define the intersection between two road reserves. The term “junction” defines the intersection of two roads. The term “junction” is therefore used in this manual in order to ensure compatibility with the regulations. The specific definitions from the regulations are as follows:

- An intersection is defined as the *“the area embraced within the prolongation of the lateral boundary lines of two or more public roads, open to vehicular traffic, that join one another at any angle, whether or not one such public road crosses the other”*.

- A junction is defined "as that portion of an intersection contained within the prolongation of the lateral limits of the intersecting roadways and include any portion of the roadway between such lateral limits, and any stop or yield line marking which is painted at such intersection".

3.2. PEDESTRIAN CROSSINGS AT ROAD JUNCTIONS

This paragraph may have to be changed if the Traffic Regulations are amended.

According to the National Road Traffic Regulations (2000), a legal pedestrian crossing exists at all road junctions, whether they are marked or not. Pedestrians have priority at such crossings (except when they are specifically prohibited from crossing, and subject to some conditions), and drivers must yield to pedestrians, whether the crossing is marked or not.

The advantage of the marked crossing at a junction is that the pedestrian may only cross the road at the marked position. When a crossing is not marked, the pedestrian may cross at any point between the junction and the road reserve boundary. The marked crossing therefore has the advantage that pedestrian movements are focussed at one location.

The marked crossing at a junction gives a very clear message to the driver, namely that there is a defined crossing space for pedestrians and that pedestrians have priority. Pedestrian crossings should therefore preferably be marked where appropriate.

3.3. PEDESTRIAN CROSSINGS AT PRIORITY CONTROLLED JUNCTIONS

Pedestrian crossings can be provided at priority (stop or yield) controlled junctions, as shown in Figure 3.1. The crossing may be used in conjunction with the required stop (or yield) sign and line as indicated in the figure.

The pedestrian crossing lines should not be used on uncontrolled legs of the junction. In Figure 3.1, guideline markings GM2 have been used with the purpose of indicating the preferred position of crossing. **Care should, however, be used in using the guideline markings since pedestrians may infer a false sense of security from these guideline markings.**

3.4. PEDESTRIAN CROSSINGS AT SIGNAL CONTROLLED JUNCTIONS

According to the Road Traffic Signs Manual, pedestrian crossings at traffic signals should be marked across all approaches irrespective of pedestrian volumes, except where pedestrian movements are specifically prohibited.

Either pedestrian crossing lines (Road mark RTM3) or a block pedestrian crossing (Road mark RTM4) may be used to indicate the pedestrian crossing (or both), as shown in Figures 3.2 and 3.3. The crossing lines are used most often at signalised junctions, but the block crossing can be used to improve the visibility of the crossing. Details regarding the required road markings and signs are given in the Road Traffic Signs Manual.

3.5. ROAD JUNCTION SLIPWAYS

Midblock pedestrian crossings may be provided on slipways of major junctions which use channelisation islands to split and direct left-turning traffic. An example of such application is shown in Figure 3.4.

As standard practice, the South African Road Traffic Signs Manual recommends that block pedestrian crossing markings (RTM4) be used for the crossing rather than the RTM3 marking, unless the latter is combined with the vehicle control on the slipway.

Many slipways have been designed to allow turning by vehicles at high speeds, which can create problems for pedestrians. Speeds can be reduced by providing a smaller turning radius on the slipway, as shown in Figure 3.4.

3.6. PEDESTRIAN CROSSINGS AT FREEWAY INTERCHANGES

Freeway interchanges are primarily designed to maintain smooth vehicle flow; and often do not cater for the needs of pedestrians and cyclists. This would typically not be required at system interchanges between two freeways, but pedestrians and cyclists can be expected to use access interchanges between freeways and surface roads.

Pedestrian crossings can be provided at on- and off-ramp junctions at freeway interchanges as shown in Figure 3.5. Block pedestrian crossings can also be used when pedestrian volumes are high, as indicated in Figure 3.6.

3.7. GEOMETRIC DESIGN PRINCIPLES

The following are some basic principles of road junction design related to pedestrians and cyclists (Otak, 1997):

- Junctions that function well for pedestrians and cyclists are typically small and compact.
- Free flow vehicular movements should either be eliminated or vehicles should be forced to significantly reduce speed through the junction. The left-turn slipway is an example of a design element that allows free flow movement and which is not pedestrian friendly.
- All approaches to a junction should preferably be available for pedestrian and cyclist use. At some junctions (such as T-junctions), however, it may not be desirable for pedestrians to cross in front of right-turning vehicles.
- Pedestrians should be able to travel in a direct line across the junction leg.
- The level and duration of pedestrian exposure to vehicular traffic should be reduced.

3.8. JUNCTION CORNERS

The attributes of good junction corners are as follows (City of Portland, 1998):

- **Clear space.** Street corners should be clear of obstructions, and have enough space to accommodate the typical number of pedestrians waiting to cross. Typical obstructions at street corners include road signs, street lights, utility poles, hydrants, trees, benches, controller boxes, rubbish bins, etc.
- **Visibility.** It is a critical requirement that pedestrians on the corner should have a good view of all travel lanes. It is also very important that vehicle drivers should be able to see pedestrians waiting at the junction.

- **Legibility.** Symbols, road markings and road signs used at corners should clearly indicate the actions the pedestrian should make.
- **Accessibility.** All corner features, such as ramps, landings, textures, etc. should meet accessibility standards.
- **Traffic separation.** Corner design and construction must be effective in discouraging turning vehicles from driving over the junction corner.

3..9. MINIMISING CROSSING DISTANCE AT ROAD JUNCTIONS

Minimising the crossing distance at road junctions enable pedestrians to cross the street more safely and comfortably. It also has the added benefit of improving timing of signalised junctions, without sacrificing the need for the adequate protection of pedestrians.

A number of design techniques are discussed below aimed at reducing pedestrian crossing distances at intersections.

3.9.1. Kerb return radius

The use of sharper kerb return radii at intersections is beneficial to pedestrians because it reduces the crossing distance of the intersection. Reduced radii also help to slow vehicles when turning and travelling through intersections.

The need for shorter pedestrian crossing distances must be balanced with the need to accommodate large heavy vehicles at an intersection. A radius that is too small can cause large vehicles and buses to jump the kerb, which could be dangerous to pedestrians.

If truck and bus turning activities occur at minimum levels, 5 to 8 m turning kerb return radii may be used on minor streets. On major streets, a minimum turning radius of 9 m is required where heavy vehicles turn occasionally (Otak, 1997). At urban intersections where trucks and buses turn frequently, a larger turning radius will be required.

A small radius may be used where a larger effective kerb radius is created by parking or bicycle lanes, as shown in Figure 3.7.

3.9.2. Kerb extensions

Kerb extensions are very beneficial in reducing pedestrian crossing distances. Such extensions also have other advantages, such as making pedestrian more visible to drivers at intersections.

An example of a kerb extension design is shown in Figure 3.8.

3.9.3. Medians and central refuge islands

Where it is not possible to reduce crossing distance, a median or a central refuge island can be provided to eliminate the need for pedestrians to cross the intersection at once.

Where sufficient space is available to provide a pedestrian refuge island, it may be possible to provide a staggered pedestrian crossing as shown in Figure 3.9. Such stagger allows pedestrians to cross one half of the road at a time.

3.10. ACCOMMODATING BICYCLE LANES AT ROAD JUNCTIONS

Bicycle lanes are cycle paths that are provided within the road carriageway, and are indicated by specific lines of demarcation and bicycle symbols. Cyclists are most vulnerable at road junctions, and special care must be taken with accommodating them at junctions.

Where there is no conflict with turning traffic at a junction, a bicycle lane can be continued through the junction. Alternatively, the bicycle lane can also be diverted to outside the junction. Locations where a bicycle lane can be continued through a junction without being in conflict with traffic, are the left-turn movement at a junction or the straight-through movement on the one side of a T-junction. At most junctions, however, it is not possible to accommodate bicycles in this way.

According to the National Road Traffic Regulations, no traffic other than bicycles may use a bicycle lane, and allowing vehicles to cross the bicycle lane would result in a contravention of the regulations. In such cases, the bicycle lane must be stopped just prior to the junction to accommodate turning traffic as well as turning cyclists. According to the Road Traffic Signs Manual, the bicycle lane must end at least 20 m before the junction.

Where no auxiliary turning lanes are provided at a junction for either left- or right-turning traffic, there is no choice other than for cyclists to merge with traffic and to use vehicular lanes to continue through the junction. In such cases, the basic bicycle turning movements must be accommodated as shown in Figure 3.10. Two of the major types of conflicts between cyclists and vehicular traffic involved the following turning movements:

- Right turning cyclists having to cross the path of motor vehicles in both directions.
- Left turning motor vehicles crossing the path of straight through bicycles.

The right-turn bicycle movement can be made in one of two ways as shown in Figure 3.10. The movement can be undertaken in two stages, as pedestrians would, or cyclists can stay in the vehicular lane and turn right with vehicular traffic. Both methods are allowed, and the most suitable method depends on circumstances as well as the experience of the cyclist.

Where auxiliary turning lanes are provided at a junction, the bicycle lanes must be stopped just ahead of the start of the auxiliary lanes. At the road junction itself, provision can be made for cyclists by providing normal but narrow traffic lanes (where necessary such lanes continued through the junction by means of bicycle guide lines). Examples of narrow bicycle lanes are shown in Figure 3.11.

Where an auxiliary left-turn lane is provided, the bicycle lane can be continued through the junction for the left-turn movement. Such bicycle lane will not be crossed by traffic, and there is thus no contravention with the National Road Traffic Regulations. For cyclists travelling straight through the junction, a narrow normal traffic lane can be provided over which traffic can change lanes to turn left to reach the auxiliary turning lane.

Where auxiliary right-turn lanes are provided, an additional narrow traffic lane can also be provided for right-turning cyclists as shown in Figure 3.11. Such lanes are particularly required where two or more right-turn lanes are provided for traffic.

3.11. ADVANCED STOP LINES AT TRAFFIC SIGNALS

Advance stop lines can be provided at signalised junctions as shown in Figure 3.12 with the purpose of increasing the available queuing space for bicycles. The advance stop lines can not be

used at stop controlled junctions since this would require drivers to stop twice, and it would also serve very little purpose at such junctions.

The advantage of the advance stop line is that significantly more cyclists can be accommodated compared to a narrow bicycle lane. The advanced stop lines have therefore been found to be extremely advantageous for cyclists (CROW, 1993).

At the time of writing of this manual, there were no specific road signs or markings available in South Africa for reserving one stop line for the exclusive use of cyclists. No law enforcement is therefore possible, and it is likely that drivers will misuse the system. Without road signs or markings, the purpose and use of the stop lines would also not be clear to many drivers.

A matter of great concern is the possibility of an accident should a bicycle enter the queuing area just as the traffic signal turns green. This risk is particularly serious when there is no queue of vehicles waiting at the traffic signal and a vehicle is on the approach to the stop line when the signal turns green.

Further research regarding the use of the advance stop line is required before such stop lines can be recommended in South Africa.

3.11. ACCOMMODATING BICYCLE LANES AT ENTRANCE AND EXIT RAMPS (NON-FREEWAYS)

It is difficult for bicycles to traverse the undefined area usually created at entrance or exit ramps on a road or street (note that bicycles are not allowed to use freeways). The reasons for this are:

- The acute angle of approach creates visibility problems.
- Drivers are distracted due to the merging and diverging traffic movements.
- Speed differentials may be high.

Methods for accommodating bicycle lanes at ramp entrances and exits are shown in Figures 3.13a and 3.13b. Both methods attempt to address the problems by providing right-angled crossings in an area where the driver's attention is not entirely focussed on the merging or diverging traffic movement. Speed differentials, however, remain a problem at both ramp entrances and exits.

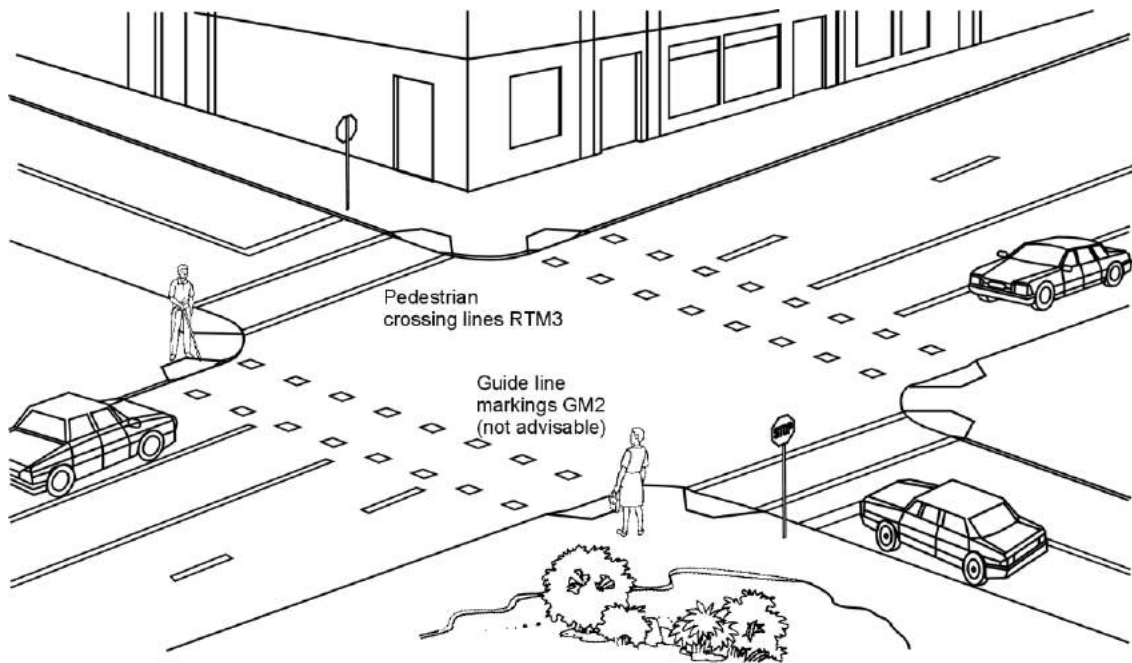


Figure 3.1: Pedestrian crossings at priority controlled junctions

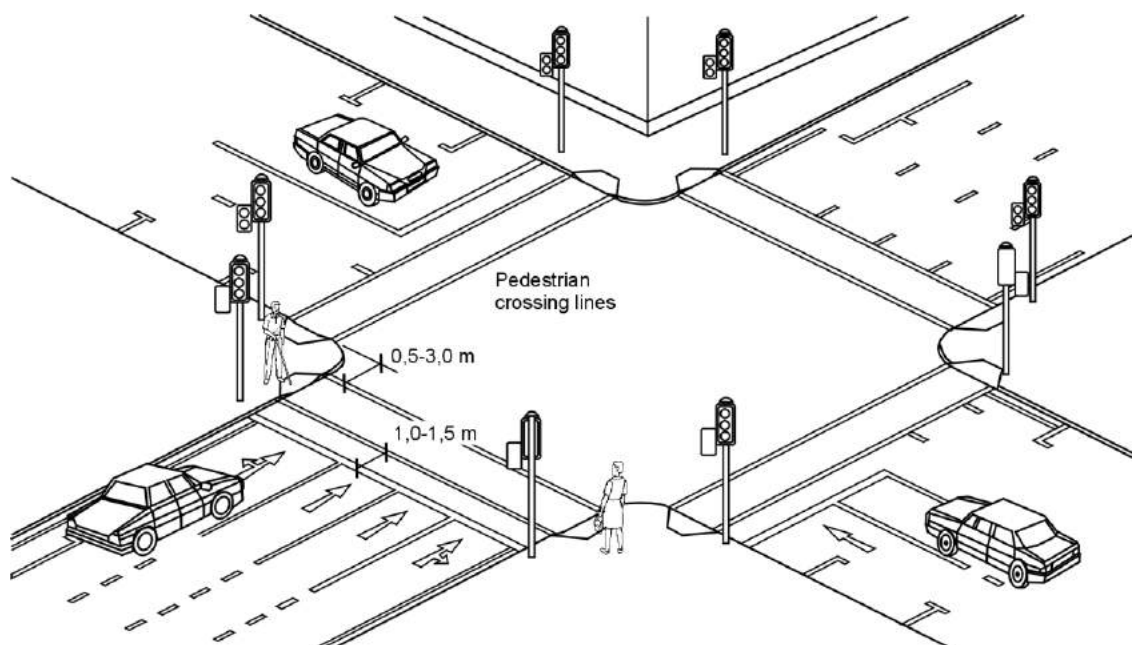


Figure 3.2: Pedestrian crossings at signal controlled junctions

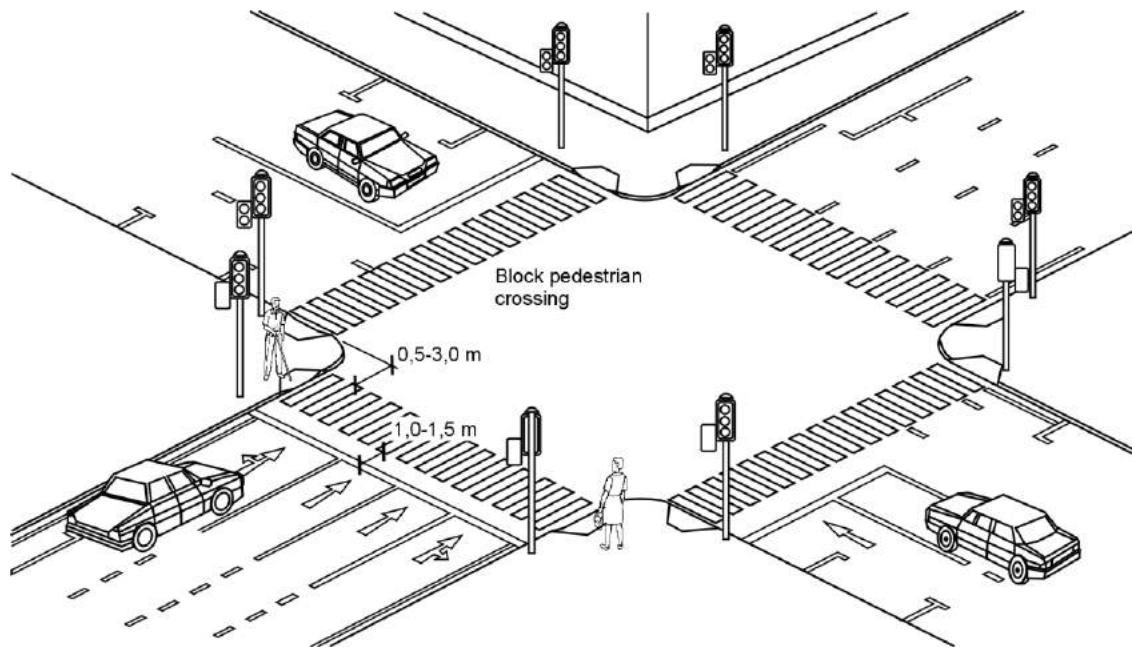


Figure 3.3: Block markings at signal controlled junctions

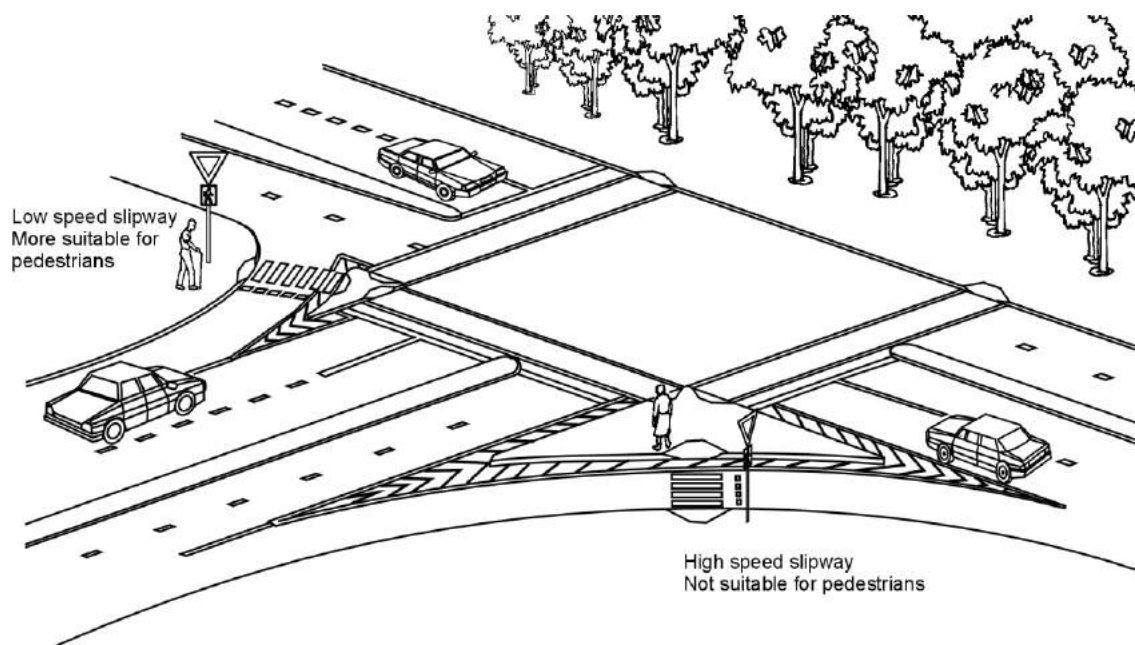


Figure 3.4: Midblock crossings on junction slipways

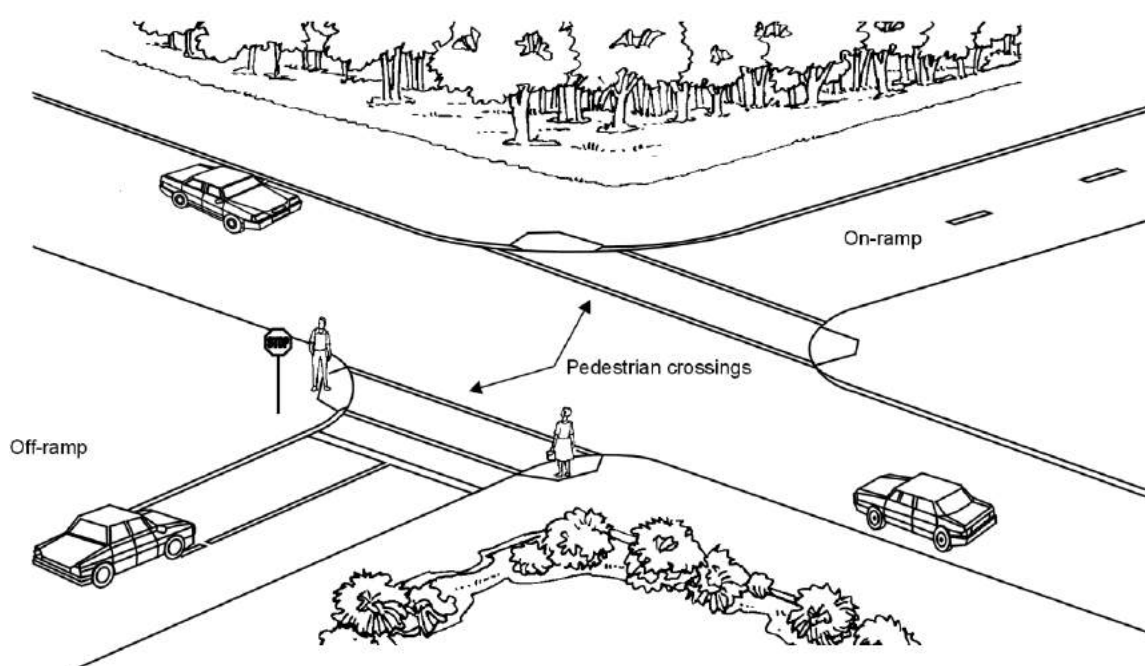


Figure 3.5: Pedestrian crossings at freeway interchange terminals

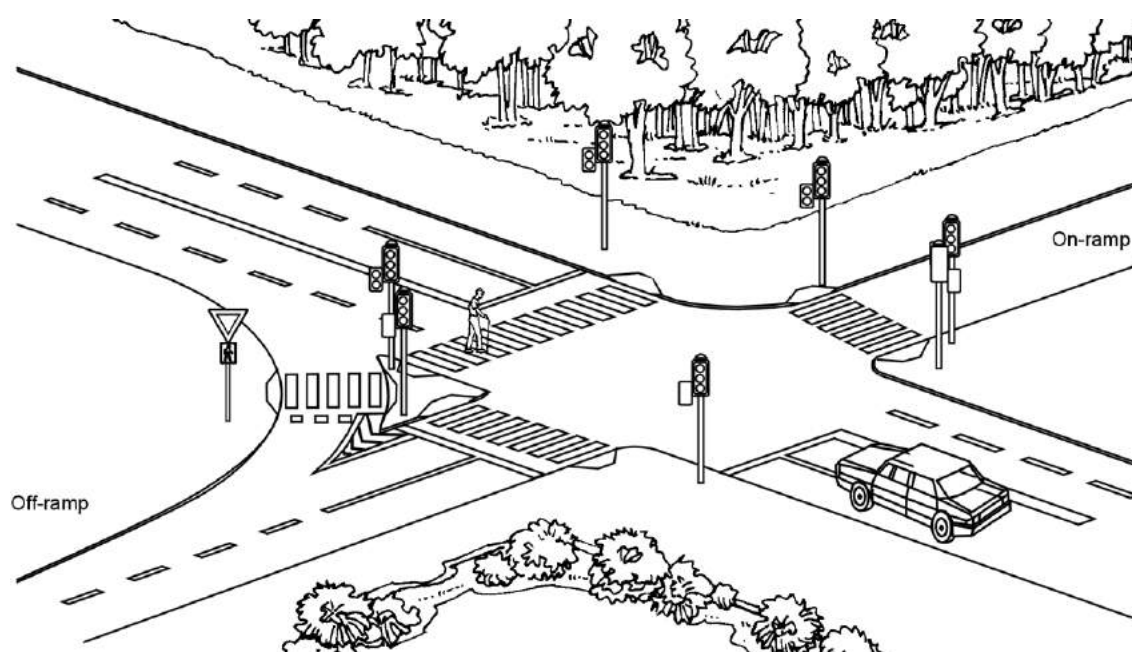


Figure 3.6: Pedestrian crossing at freeway interchange terminal – High pedestrian volumes

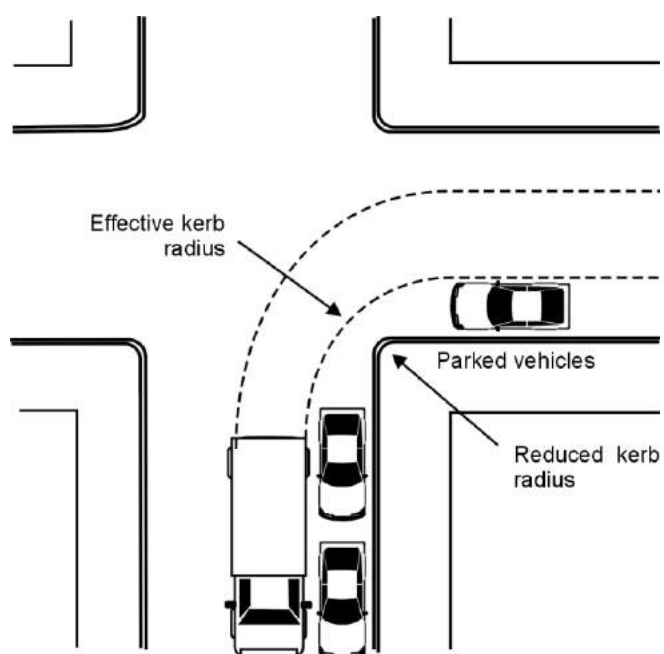


Figure 3.7: Effective kerb radius

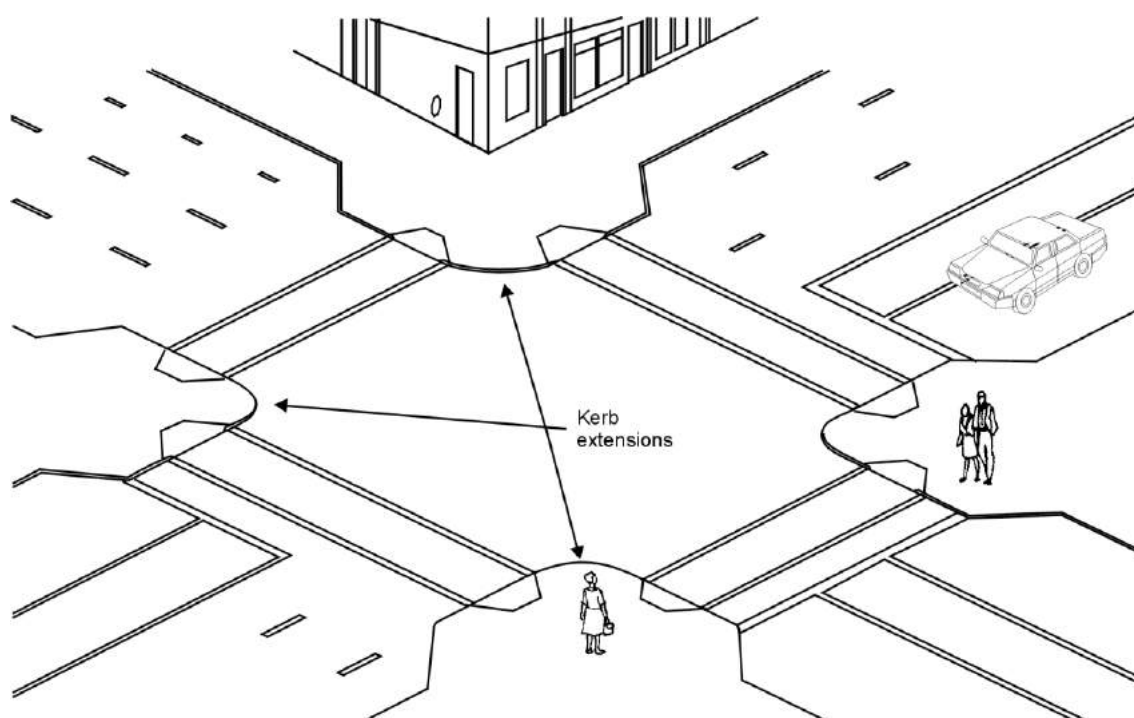


Figure 3.8: Example of kerb extensions

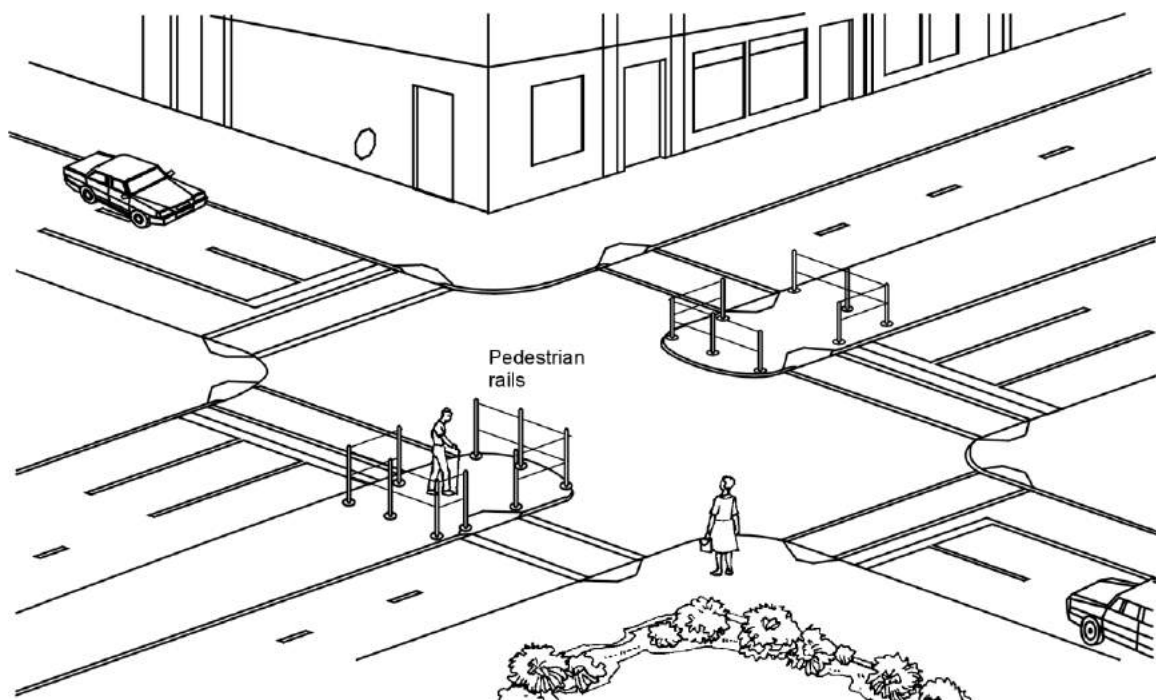


Figure 3.9: Staggered pedestrian crossings at road junctions

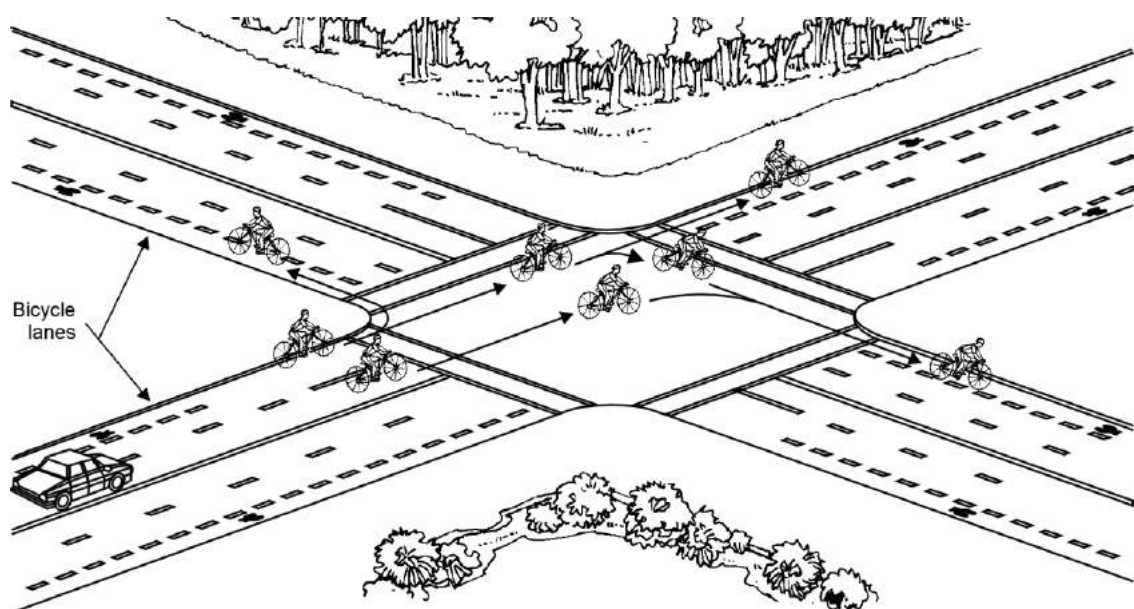


Figure 3.10: Bicycle turning movements at road junctions

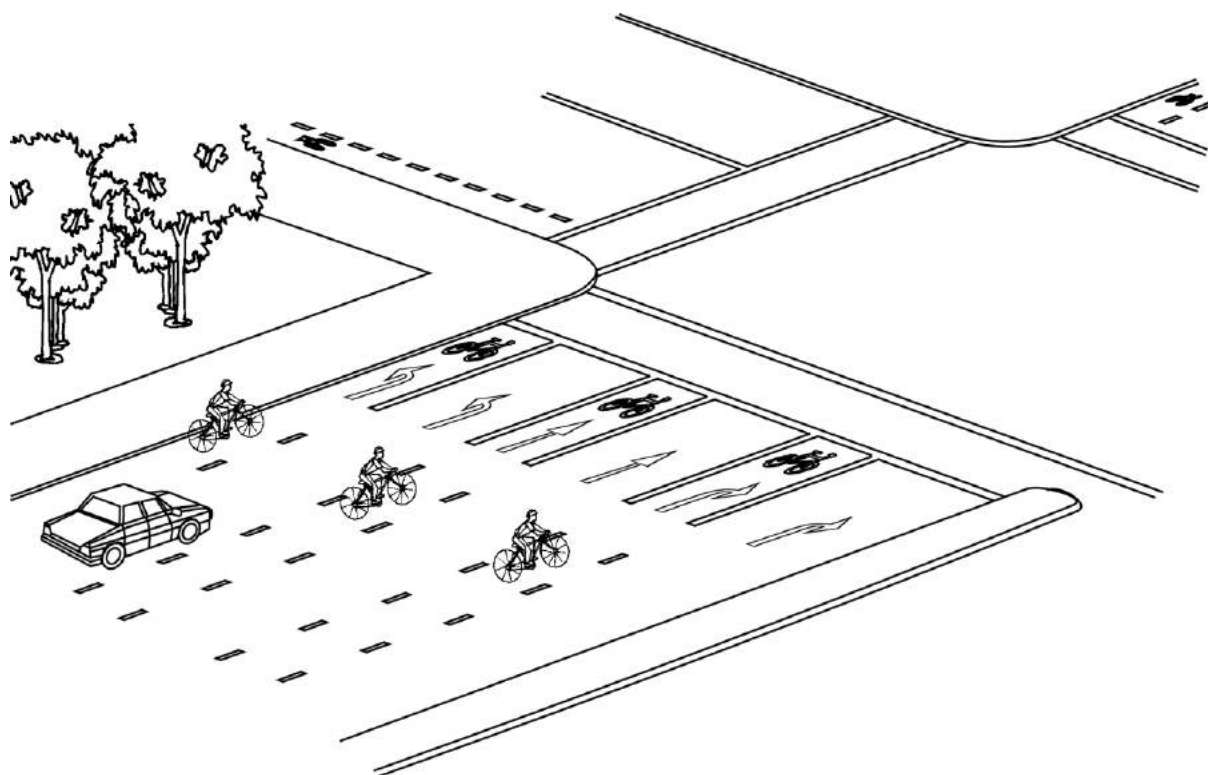


Figure 3.11: Bicycle left-turn and right-turn movements at road junctions

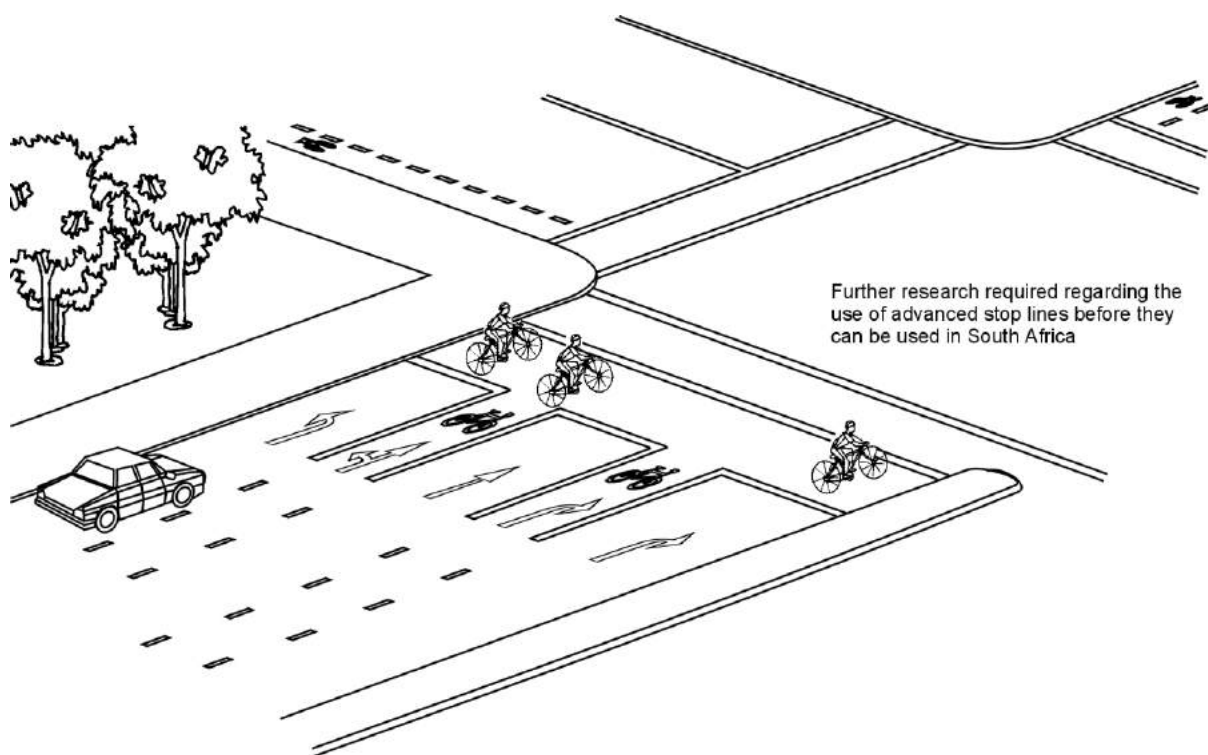


Figure 3.12: Advance stop line for bicycles

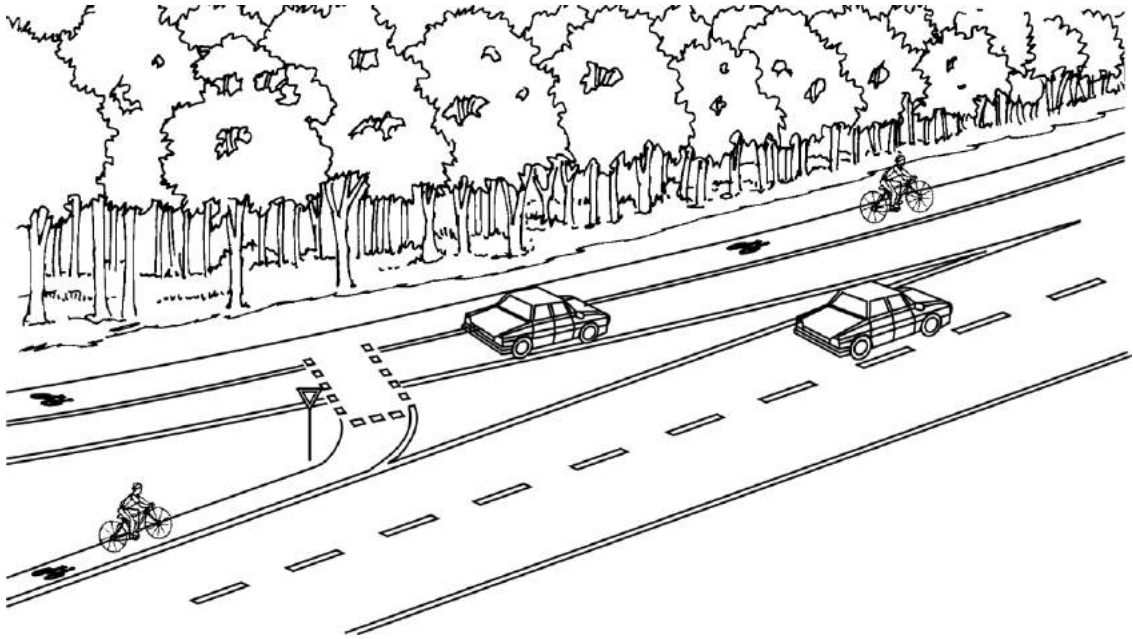


Figure 3.13a: Bicycle lanes at entrance ramps

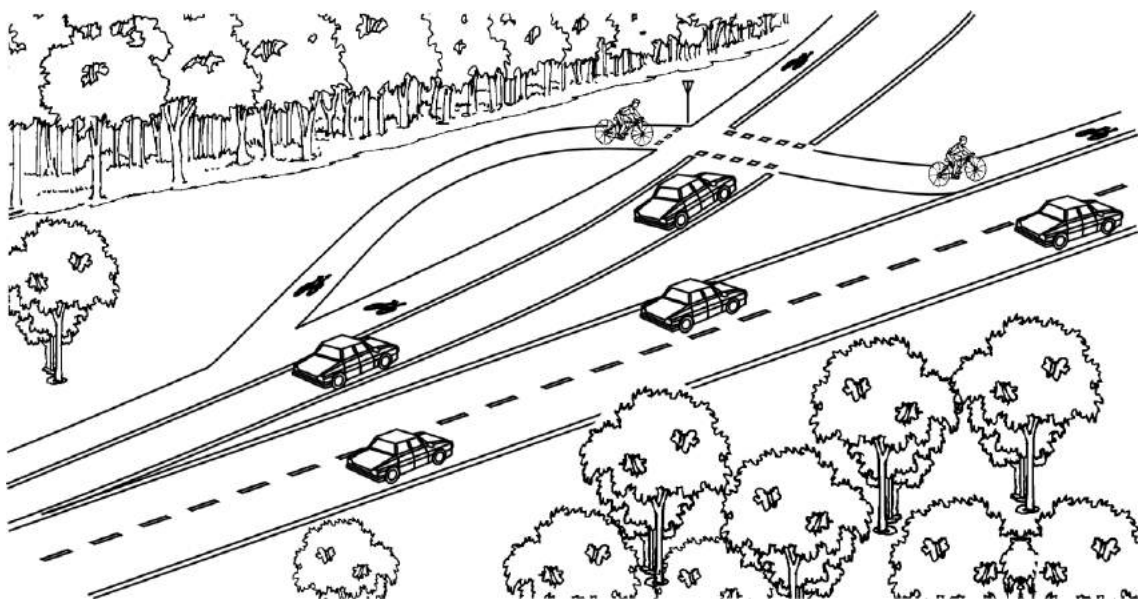


Figure 3.13b: Bicycle lanes at exit ramps

B. Pedestrian and bicycle crossings

4. Pedestrian and bicycle signals

4.1. INTRODUCTION

Traffic signals may be installed and operated in accordance to the requirements of the National Road Traffic Regulations and the Road Traffic Signs Manual. Volume 3 of the manual provides detailed information on various aspects related to traffic signals. The design of traffic signals should not be attempted without a thorough knowledge of the regulations and the signal design manual.

It is not the intention to duplicate the material given in the Road Traffic Signs Manual in this chapter. A summary of the requirements as related to pedestrians and cyclists is given, with the purpose of highlighting some of the important aspects relevant to pedestrians and cyclists.

4.2. APPROVAL OF TRAFFIC SIGNALS

A number of quotations from the National Road Traffic Regulations are given in this chapter. These quotations, however, are from amendments that have been proposed to the regulations and which have not yet been promulgated. The contents of this chapter may have to change depending on the final regulations that will be published.

Due to the complexity of traffic signal systems, decisions concerning the design, installation, and operation of traffic signals, should only be undertaken by professionals with a high level of skill and knowledge of the subject.

According to the National Road Traffic Regulations (2000), “a responsible registered professional engineer or registered professional technologist (engineering) of the road authority concerned SHALL approve every traffic signal installation at a signalised junction or pedestrian or pedal cyclist crossing, and sign a declaration containing the following:

- a) scaled drawing of the layout of the junction or crossing, indicating lane markings and road layout;
- b) number, type and location of traffic signal faces;
- c) pedestrian and pedal cyclist facilities, including pedestrian push buttons;
- d) phasing, time plans and offset settings;
- e) date of implementation; and
- f) name, signature and registration number of the engineer or technologist (engineering) who approved the signal, and date of signature.

The declaration shall be kept by the road authority in control of the traffic signal concerned.

4.3. TRAFFIC SIGNAL WARRANTS

Traffic signals are one of the most common and widely accepted forms of traffic control and affect the daily lives of virtually all road users. Traffic signals can be very effective in improving pedestrian and bicycle flow. However, traffic signals can also cause significant disbenefit and possible danger to all road users when installed inappropriately.

There is unfortunately at times a tendency to use traffic signals indiscriminately in an attempt to solve problems where traffic signals are not appropriate. Traffic signals are often seen as the solution to almost all traffic problems, and pressures are often applied for the installation of unwarranted signals. Contrary to popular belief, however, traffic signals do not always increase safety or reduce delay. In fact, the installation of traffic signals can result in the opposite, namely an increase in delay and a deterioration in traffic safety. Pedestrian and cyclist safety can be severely compromised by the unwarranted installation of a traffic signal.

Warrants for the installation of traffic signals are given in the Road Traffic Signs Manual. The installation of traffic signals for the control of junctions and pedestrian crossings is warranted when the following three conditions are met:

- The traffic signals can meet all the minimum requirements described in the Road Traffic Signs Manual; AND

- No viable and feasible alternative solution is available which, when implemented, would obviate the need for traffic signals; AND
- The traffic signals meet the queue length warrants as described in the manual.

A road authority may use the warrants given in the Road Traffic Signs Manual to justify the installation and removal of signals. However, the fact that a signal is or is not warranted does not oblige the road authority to install or remove the traffic signal.

4.3.1. Minimum requirements for traffic signals

Traffic signals should only be installed when all the minimum requirements described in the Road Traffic Signs Manual can be met, even if an engineering analysis indicates that signalisation is the optimum method of control and that traffic signals would meet the queue length warrants given in the manual.

There are a large number of such minimum requirements, the most important of these are the following:

- Speed limit - the speed limit on any approach to a signalised junction or pedestrian crossing may NOT exceed 80 km/h.
- Visibility requirements - traffic signal faces should be clearly visible and recognisable on an approach to a traffic signal.

4.3.2. Alternatives to traffic signals

The fact that the installation of traffic signals may be warranted in terms of the queue length warrants mentioned above, does not mean that signalisation is the best or optimum solution to a specific problem. Alternative solutions that are viable and feasible and which, when implemented, would result in a situation in which the installation of traffic signals are no longer warranted, may obviate the need for traffic signals. Such alternatives should be thoroughly explored so that the best solution to the problem is found and applied.

Alternatives to traffic signalisation may include, but are not limited to, the following:

- Re-designing the geometry of an existing priority control junction to maximise traffic throughput and provide better safety.
- The provision of a traffic circle or mini-circle that would not only increase the capacity of the junction, but will also significantly improve traffic safety.
- Grade separation, if warranted by high volumes of traffic.
- Introduction of road closures bans on turning movements, provision of one-way systems and other traffic management measures.

The redistribution of traffic on the road network by means of traffic calming, road and street closures and one-way systems is a particularly effective and powerful way of reducing the number of traffic signals required in a network. It may be possible to channel traffic to a smaller number of junctions, or alternatively to junctions that are more suitable for signalisation. Against this, the

dangers of undesirable traffic intrusion or rat running in residential areas should always be recognised and avoided.

4.3.3. The queue length warrant

Traffic signal warrants are used to indicate levels of activity above which signalisation is justified. It would be possible to use economic analysis methods to establish the minimum level of activity required to justify signalisation. However, economic analysis has the problem that it would often indicate that a signal is unjustified, even though there may be chronic congestion during periods with heavy traffic volumes. The problem with traffic signals is that they are often only justified during periods with heavy traffic flow, while serious disbenefits can be incurred when signals are used during off-peak periods. In an economic analysis, the benefit achieved during peak periods can often not outweigh the disbenefit of operating traffic signals for the rest of the day.

One of the main advantages of traffic signals that is not normally taken into account in the economic analysis, is that signals distribute priority amongst more than one stream of traffic, and that one stream of traffic is not experiencing all the benefit of free movement. At a stop or yield controlled junction, the traffic on the stop or yield controlled approaches has no priority, while main road traffic can move freely through the junction. Pedestrians may have some priority, but vehicular traffic does not often comply with the priority rules. A traffic signal would result in a better distribution of benefits, although it could result in an overall disbenefit.

The levels of traffic activity above which signalisation is warranted have been established on the basis of experience over many years. In South Africa, as well as overseas, it has been found that when these levels are exceeded, delays become excessive and unacceptable to users, often resulting in an increase in traffic accidents. The queue length warrant is used in the Road Traffic Signs Manual as the norm for establishing whether the installation (or removal) of traffic signals is warranted. Details of this warrant are given in the manual.

4.4. PEDESTRIAN AND BICYCLE SIGNALS

Pedestrians and cyclists are subject to control by any traffic signal that is intended for vehicular traffic when specific pedestrian and bicycle signals are not provided. The same basic rules that apply to drivers are also applicable to pedestrians and cyclists – they may proceed when signals are green, and they may not cross when signals are red. Traffic, however, is expected to yield to pedestrians that have entered a traffic signal legally.

Specific traffic signals can also be used for the control of pedestrians and cyclists. Such signals, however, may only be operated in conjunction with vehicular traffic signals at midblock crossings and at signalised junctions.

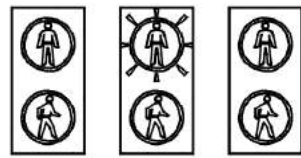
Pedestrian light signals comprise the following:

- a STEADY GREEN MAN LIGHT SIGNAL, followed by:
- a FLASHING RED MAN LIGHT SIGNAL, followed by:
- a STEADY RED MAN LIGHT SIGNAL.

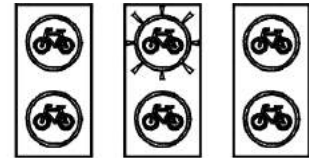
Bicycle or “pedal cyclist” light signals comprise the following:

- a STEADY GREEN PEDAL CYCLIST LIGHT SIGNAL, followed by:
- a FLASHING RED PEDAL CYCLIST LIGHT SIGNAL, followed by:
- a STEADY RED PEDAL CYCLIST LIGHT SIGNAL.

The sequence in which the light signals are displayed is shown in Figure 4.1.



Pedestrian Signal Face S11P



Pedal Cyclist Signal Face S11C

Figure 4.1: Pedestrian and bicycle (pedal cyclist) signal sequence

4.5. CONTROL PRECEDENCE

According to the National Road Traffic Regulations, *the traffic control at a junction or pedestrian or pedal cyclist crossing may include the use of road signs, road markings and road signals and the control precedence SHALL be as follows:*

- a) *A road sign which prohibits or prescribes directional movement of traffic at a junction or pedestrian or pedal cyclist crossing which is controlled by a traffic signal, shall have precedence over any light signal which permits right of way.*
- b) *A light signal that permits right of way shall have precedence over the stop line RTM1;*
- c) *A light signal that has the significance that traffic shall stop, has precedence over any other road traffic sign or another light signal that permits right of way, EXCEPT when such other light signal (permitting right of way) has a higher precedence level. The precedence levels for light signals are as follows, given from the highest to lowest precedence level:*
 - i) *steady or flashing pedestrian and pedal cyclist light signals;*
 - ii) *steady or flashing bus or tram light signals;*
 - iii) *steady or flashing arrow signals, or steady disc signals with traffic signal arrow signs ST1 to ST5; and*
 - iv) *steady disc light signals.*

The above regulation indicates that a pedestrian or bicycle traffic signal has precedence over any other traffic signal.

4.6. OPERATION OF PEDESTRIAN AND BICYCLE SIGNALS

4.6.1. The green pedestrian or bicycle signal

The function of the pedestrian GREEN light signal is to provide a limited initial "step off" or "launching" interval for pedestrians and cyclists. According to the Road Traffic Signs Manual, the green signal may not be displayed for an interval shorter than a minimum of 4 seconds. A longer interval of 5 to 7 seconds, however, is more desirable. Longer intervals may be required when

pedestrian or bicycle volumes are high, but volumes requiring an interval longer than 7 seconds do not occur often. Where vehicular capacity is important, the green interval should not be made longer than necessary.

The green man (and bicycle) signal normally starts at the same time as the vehicular green. The vehicular green light signal, however, may be delayed to allow pedestrians to enter the roadway ahead of vehicles. Care should be taken in using delays longer than 3 seconds as such delays can lead to undesirable behaviour. Such behaviour may include illegal turning manoeuvres by drivers and pedestrians (and cyclists) utilising the delay to cross the junction in the wrong direction.

4.6.2. The flashing red pedestrian or bicycle signal

The function of the flashing red man or pedal cycle signal is to allow pedestrians or cyclists to clear the crossing or junction before the onset of the steady red signal. The green signal must always be followed immediately by a FLASHING RED signal.

Sufficient time must be provided after the green for a pedestrian to walk or pedal cyclist to push his or her bicycle across the roadway to the other side of the road, or up to the median island where such median is provided. The Road Traffic Sign Manual recommends a design walking speed of 1,2 m/s for calculating the clearance time under normal operating conditions. A slower speed of 1,0 m/s may be used for elderly or infirm pedestrians. The pedestrian or cyclist must be able to clear the roadway by the time the parallel vehicular *intergreen* ends (end of the all-red interval).

The flashing red signal should not be displayed for a period longer than the duration of the pedestrian or bicycle clearance time. The flashing signal can, however, be displayed for a shorter period if a steady red signal is displayed for the remainder of the clearance time. The flashing signal should not be displayed for a period shorter than the minimum of the following two values:

- 75% of the clearance time; or
- the clearance time less the parallel vehicular intergreen period.

4.7. THE PELICAN PHASE

At mid-block pedestrian crossings, a “Pelican” phase may be provided to indicate to drivers of vehicles that pedestrians may be clearing the road and have right of way. During the “Pelican” phase, vehicular flashing red signals are displayed at the same time as the flashing red pedestrian signal. Pedestrians may not enter the crossing on the flashing red signal, but they may clear the crossing during the signal. Vehicles, however, may proceed once pedestrians have exercised their right of way and the crossing is clear.

Pedestrians may not enter the crossing during the pelican phase when red man signal is flashing, and the duration of this interval should therefore NOT exceed the time required by pedestrians to clear the crossing.

4.8. PROVISION OF PEDESTRIAN SIGNALS AT JUNCTIONS

Pedestrian signals at junctions have the advantage that safety is improved by restricting the pedestrian movement to a shorter period of time during a signal cycle. It also has the advantage that the capacity of the left-turn vehicular movement is increased.

Pedestrian signals can be considered when exclusive vehicular left- or right-turn phases are provided that conflict with pedestrian movements (alternatively, Pedestrian Prohibited signs R218

may be posted). However, pedestrians do not have right of way when no pedestrian signals are provided and flashing green vehicular signals are displayed.

Pedestrian signals may also be provided on one-way roads where vehicular signals are provided only in the one direction and no signals are available in the other direction.

Pedestrian signals should be considered when large numbers of pedestrians cross the road and pedestrians can impede turning traffic. A capacity analysis can be undertaken to establish whether pedestrian signals would improve the traffic flow.

Pedestrian signals may be considered on an approach when the pedestrian volume crossing the particular approach multiplied by the volume of conflicting turning traffic exceeds 10 000 in any one hour, or 5 000 for each of any four hours of a day.

Pedestrian movements across slipways at junctions may be signalised where warranted by pedestrian queues or delays, or when pedestrians require additional protection due to special conditions such as high vehicle speeds, poor sight distance and pedestrian disabilities.

The non-observance of traffic signals by pedestrians may create capacity problems for turning movements at junctions. This problem can be reduced by providing protected turning phases for vehicles, during which a RED MAN LIGHT SIGNAL is displayed. A pedestrian green signal can be displayed during the main signal phase.

4.9. PEDESTRIAN SCRAMBLE PHASE

The pedestrian scramble phase is also known as an exclusive or serial pedestrian phase. Such a phase allows only pedestrians to walk across the junction while all vehicles receive red light signals and are not allowed to enter the junction from any approach. Provision can also be made for the diagonal crossing of the junction by pedestrians.

The main advantage of the scramble phase is that it can eliminate pedestrian-vehicle conflict, thus improving the level of safety. This, however, will only be achieved if full pedestrian compliance of the light signals can be obtained. In practice, pedestrians may utilise the scramble phase as well as the vehicular phases to cross the junction.

The capacity of turning movements at junctions can be improved by the provision of scramble phases (but only when pedestrians do not violate the light signals). The capacity of straight-through movements, however, is significantly reduced by scramble phases.

Scramble phases can be effectively utilised in pedestrian precincts where vehicular capacity is of less importance. Such phases can create an environment in which priority is given to pedestrians and vehicular traffic flow is of less concern.

4.10. SIGNAL PHASING

Determining the phasing requirements of a traffic signal is an important aspect of establishing traffic signal settings. Specific provision should be made for pedestrians (and cyclists) when establishing traffic signal phases.

Examples of signal phases that can be provided at a traffic signal are shown in Figure 4.2. The following phases are shown in the figure:

- A main phase, which provides for straight-through and permitted left and right-turn movements, and which is signalised by a steady green light signal. A parallel pedestrian or bicycle phase can also be provided.
- Single right-turn phase which provides for a movement to the right, with or without a parallel left-turn phase which provides for a movement to the left. Both phases are signalled by flashing green arrow light signals. A parallel pedestrian or bicycle phase can also be provided, but only on the one side of the road.
- Double right-turn phase which provides for right-turn movements from two approaches, with or without left-turn phases from two adjacent directions. All phases are signalled by flashing left green arrow light signals. No parallel pedestrian or bicycle phase can be provided.

The examples in Figure 4.2 indicate that a pedestrian signal phase can not be provided at the same time as a turning phase. The reason for this is that the flashing green arrow signal used to indicate the turning phases gives priority to vehicular traffic during such phases. In fact, the flashing green arrow signal indicates that the turning driver will encounter no conflicting traffic or pedestrian movements.

4.11. LAYOUT OF PEDESTRIAN AND BICYCLE SIGNALS

Pedestrian and bicycle signal faces may be mounted on the same posts as vehicular signal faces, either parallel or perpendicular to the vehicular faces as shown in Figure 4.3. The following criteria should be used in selecting posts for the mounting of pedestrian signal faces:

- The signals should be in line with the pedestrian crossing, at a position where pedestrians can readily see the signals.

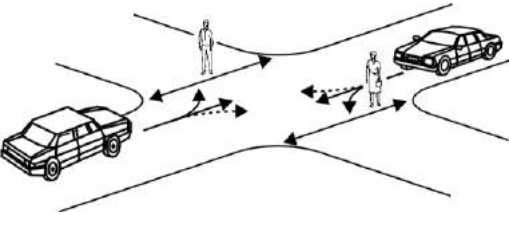
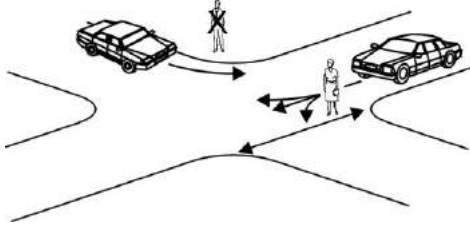
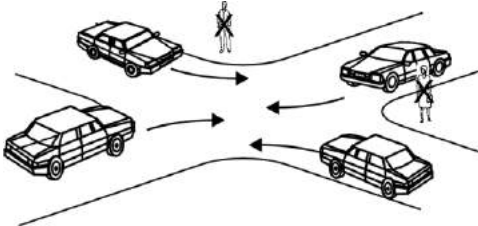
	<p>Main signal phase with pedestrian/pedal cyclist phase.</p> <p>Right-turning movements can either be permitted or prohibited.</p> <p>Pedestrian movements can be allowed during this phase.</p>
	<p>Single right-turn phase with/without left-turn phase</p> <p>Can be provided as either a leading or lagging phase.</p> <p>Lagging phases shall only be provided when no vehicles turning right from the opposite direction can be trapped (such as at T-junctions or on one-way streets).</p> <p>A pedestrian phase can optionally be provided on the one side of the junction only.</p>
	<p>Double right-turn phase with/without left-turn phases</p> <p>Can be provided as either a leading or lagging phase.</p> <p>No vehicles turning right can be trapped, and the phase can be provided as a lagging phase at all types of junctions.</p> <p>No pedestrian movements can be allowed during this phase.</p>

Figure 4.2: Various types of traffic signal phases at a signalised road junction

- The signals should not be located at a position where vehicles stopping at, or slightly beyond, the stop line may obstruct the visibility of the signals. Attention must particularly be given to the possible obstruction of the signal face by buses and heavy vehicles.
- The signal posts should not impede the flow of pedestrian traffic.
- The number of signal posts should be restricted to avoid clutter on the sidewalk and to reduce installation and maintenance costs.

Where no vehicular light signals are provided, consideration can be given to providing a second pedestrian or bicycle signal face as a backup should one of the signals fail.

At signalised mid-block pedestrian or bicycle crossings, type S1 traffic signal faces must be used to control vehicular traffic. There must be at least two S1 traffic signal faces for each approach on the far side of the stop line, as shown in Figure 4.4. A supplementary S1 signal face is also recommended on the near side of the crossing, not further than 3 m from the prolongation of the stop line.

According to the Road Traffic Signs Manual, the S1 signal faces on the far side may be not less than 3 m apart and not more than 20 m apart. Additional overhead mounted S1 signal faces must be provided if the faces are more than 20 m apart (preferably more than 16 m apart). On a divided carriageway road with a median of adequate width, the right-hand S1 signal face must be located on the median island.

The left-hand S1 signal faces should not be located more than 2 m laterally from the edge of the roadway.

4.12. MOUNTING OF PEDESTRIAN AND BICYCLE SIGNALS

Pedestrian and bicycle signal mounting details are shown in Figure 4.5. The signals should preferably be post-mounted. The signals should have a minimum clearance above the sidewalk of not less than 2,1 m. The signal face should be not more than 3,0 m above the level of a point on the road surface nearest to the post, measured to the centre of the lowest (green) light signal.

Where the pedestrian or bicycle signal face is mounted adjacent to a vehicular signal face, the red man or bicycle signal aspect may not be mounted higher than the level of the lowest vehicular green signal aspect. The pedestrian or bicycle signal faces should not be located in a line vertically with any vehicular signal aspect facing the same direction and should be offset to the left or right of such signal aspect.

The pedestrian push button should be mounted approximately 1,1 m above the sidewalk surface. A pedestrian sign should preferably be placed immediately above or below the push button.

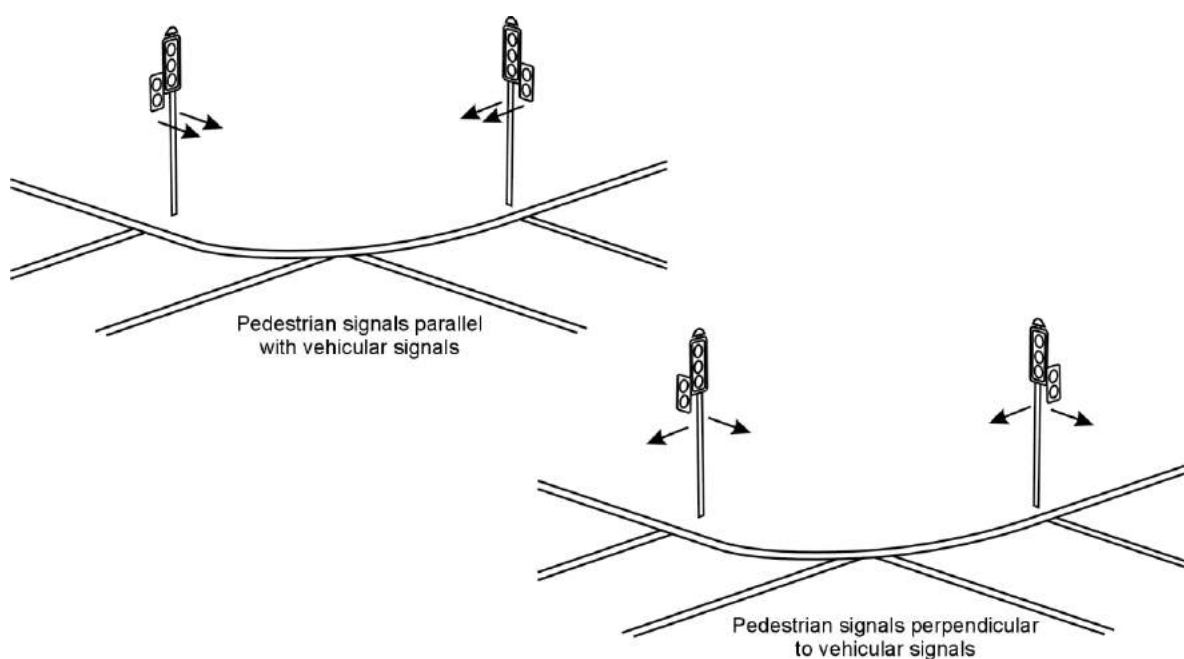


Figure 4.3: Alternative positions for pedestrian signals at signalised junctions

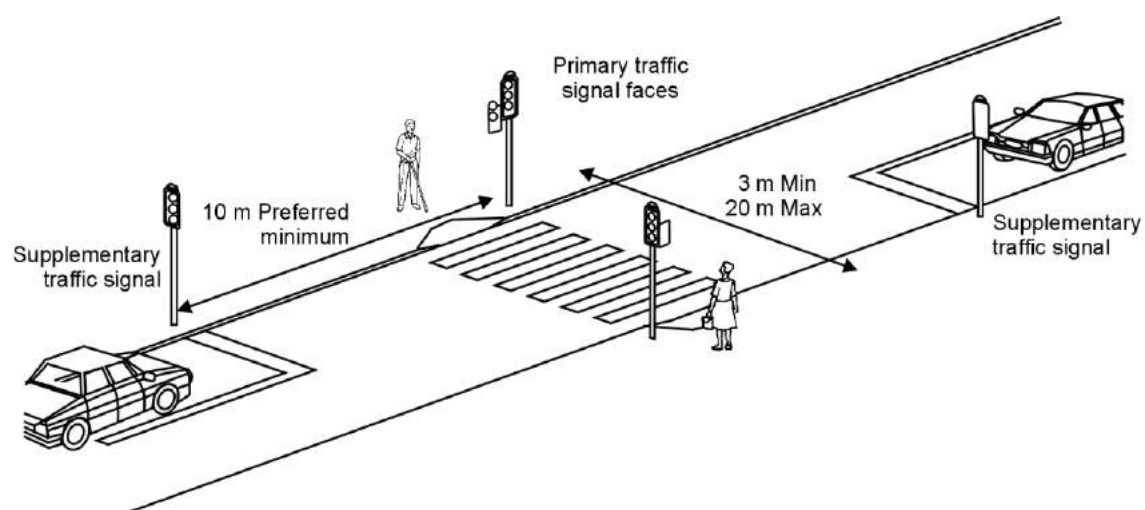


Figure 4.4: Pedestrian traffic signal faces at a mid-block crossing

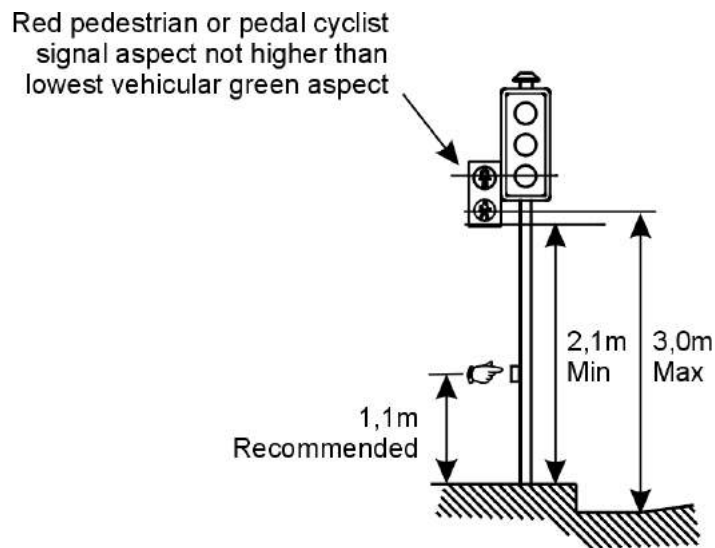


Figure 4.5: Mounting pedestrian signals

4.13. PEDESTRIANS WITH VISUAL IMPAIRMENTS

4.13.1. Problems experienced by pedestrians with visual impairments

Pedestrians with visual impairments are confronted by a host of problems when attempting to cross a street at a signalised junction or pedestrian mid-block crossing. These can be summarised as:

- Knowing when to begin crossing.
- Crossing in the correct direction.
- Using push buttons.

Push buttons present two problems, namely locating the push button and then establishing the direction of movement to which it applies. Visually impaired pedestrians memorise the position of push buttons and the direction to which the buttons apply as they learn a particular route. Push buttons should therefore be located as consistently as possible relative to the position of the crosswalk.

4.13.2. Facilities for pedestrians with visual impairments

The provision of facilities for pedestrians with visual impairments is not a simple matter, and no satisfactory solution has as yet been developed. The following are a number of facilities that have been provided and tested:

- Audible signals.
- Vibrotactile signals.

In addition to the above facilities, a number of special devices have been developed that require highly sophisticated equipment and technology to communicate with or identify visually impaired pedestrians. Many of these are still in an experimental phase and are not available in commercial systems.

4.13.3. Audible signals

Audible signals may be used to indicate to visually impaired pedestrians that the green man light signal is provided (no such signal is required for the flashing red man clearance interval). The signal is sounded for a short duration at the start of the green man light signal.

Although audible signals may, at first glance, appear to be the best available solution, they are not always as useful as they could be. There are a number of problems. The first of these is the problem of noise pollution. For the visually impaired pedestrian, there is also the problem of identifying which crosswalk has the walk signal.

The problem of noise pollution can to some extent be addressed by carefully adjusting the volume of the audible signal. Provision can also be made for automatically adjusting the volume of the signal in response to ambient sound levels.

The problem of identifying which crosswalk has the walk signal can be addressed by using different tones or signals. Standardised tones may be adopted at different junctions and crossings in an area to indicate crosswalk directions. Verbal messages may also be given indicating the name of the street that can be crossed.

Where pedestrians experience problems in locating push buttons, audible locator signals may be considered to assist pedestrians in finding the push buttons. A special tone is required to allow the pedestrian to locate the push button. These signals, however, make the problem of noise pollution even worse since they have to be in continuous operation.

4.3.4. Vibrotactile signals

Vibrotactile devices communicate information to pedestrians through a vibrating surface by touch. These devices address the problem of noise pollution associated with audible signals, but only if they are designed in such a way that the vibrations are not audible.

Vibrotactile signals can be provided in the form of a vibrator attached to a signal post. The vibrator should be continuously vibrating to indicate to the pedestrian that it is in operation and not out of order. Two levels of vibration are used, one to indicate that the green pedestrian signal is being displayed, and the second to indicate the red or flashing red light signal.

The frequency and amplitude of vibration need to be carefully selected to ensure that the pedestrian can differentiate between the two signals. It is also important that the pedestrian does not confuse the vibration with an electrical shock.

The vibrators should be installed on the same posts as the normal pedestrian push buttons. The position of the post can be used to indicate the direction to which the vibrotactile signal applies. Where this is not adequate, a raised arrow may be mounted on the vibrator indicating the direction of the signal.

B. Pedestrian and bicycle crossings

5. Traffic circles (Roundabouts)

5.1. INTRODUCTION

The modern traffic circle requires that vehicles entering from the approaches yield to vehicles within the circulatory roadway. Entries of vehicles to the circle are controlled by a yield type of sign. The central island deflects vehicles from their straight path, thus causing low entry speeds. These characteristics have contributed significantly to the success of the modern roundabout.

The traffic circle also has some advantages for pedestrians and cyclists. Conditions are made safer due to the lower operating speeds while circles can create a positive environment for pedestrians and cyclists. There are, however, some problems at traffic circles that should be addressed when there is a need to accommodate pedestrians and cyclists at such circles

5.2. ACCOMMODATING PEDESTRIANS AT TRAFFIC CIRCLES

Pedestrians typically encounter the following problems at traffic circles:

- The absence of stopped traffic could be an obstacle to pedestrians, particularly the blind and visually impaired pedestrian.
- Traffic at circles often do not yield to pedestrians. Pedestrians with disabilities are particularly vulnerable in such situations. People who are blind or visually impaired are unable to make “eye contact” with drivers – making it impossible to “claim the junction” (Public Rights-of-Way Access Advisory Committee, 2001). Pedestrians with slower than normal mobility may also hesitate when entering the street – which may result in drivers misinterpreting the pedestrian’s intention to cross.

The problem for pedestrians can be reduced by siting the pedestrian crosswalk some distance away from the exit of the circle, as shown in Figures 5.1 and 5.2. Care should, however, be taken not to locate the crossing too far from the exit, pedestrians may not use it. It is therefore generally recommended that pedestrian crossings should be located about 6 m (one vehicle length) from the yield line. This allows pedestrians to cross behind the first motor vehicle stopped at the traffic circle. The provision of a splitter island as shown in Figure 5.2 can also significantly improve crossing conditions. It also serves as a centre refuge island for pedestrians.

The above measure applies to both mini circles and larger circles. The treatments are shown for the two types of circles in Figures 5.1 and 5.2 respectively. The main difference between a mini circle and a large circle is that of size. Due to the small size of mini circles, heavy vehicles are allowed to cross the middle island when turning or even travelling through at the circle. The larger circle usually has sufficient space to allow a heavy vehicle to turn without crossing the island, also a truck apron may be provided on the circle to accommodate very large trucks.

5.3. ACCOMMODATING CYCLISTS AT TRAFFIC CIRCLES

Cyclists can be accommodated at traffic circles (mini circles as well as large circles) by either providing an additional lane inside the circle, as shown in Figure 5.2, or by providing a separate bicycle road around the circle as shown in Figure 5.3. The lane inside the circle can not be marked as an exclusive bicycle lane because this would prohibit traffic to turn across the lane, but it may be marked as a narrow but normal traffic lane.

The design with the separate bicycle road is preferred due to reduced exposure of cyclists to traffic. It may also be necessary to provide a shared pedestrian walkway and bicycle road facility to accommodate pedestrians. The layout shown in Figure 5.3 does not provide for pedestrians.

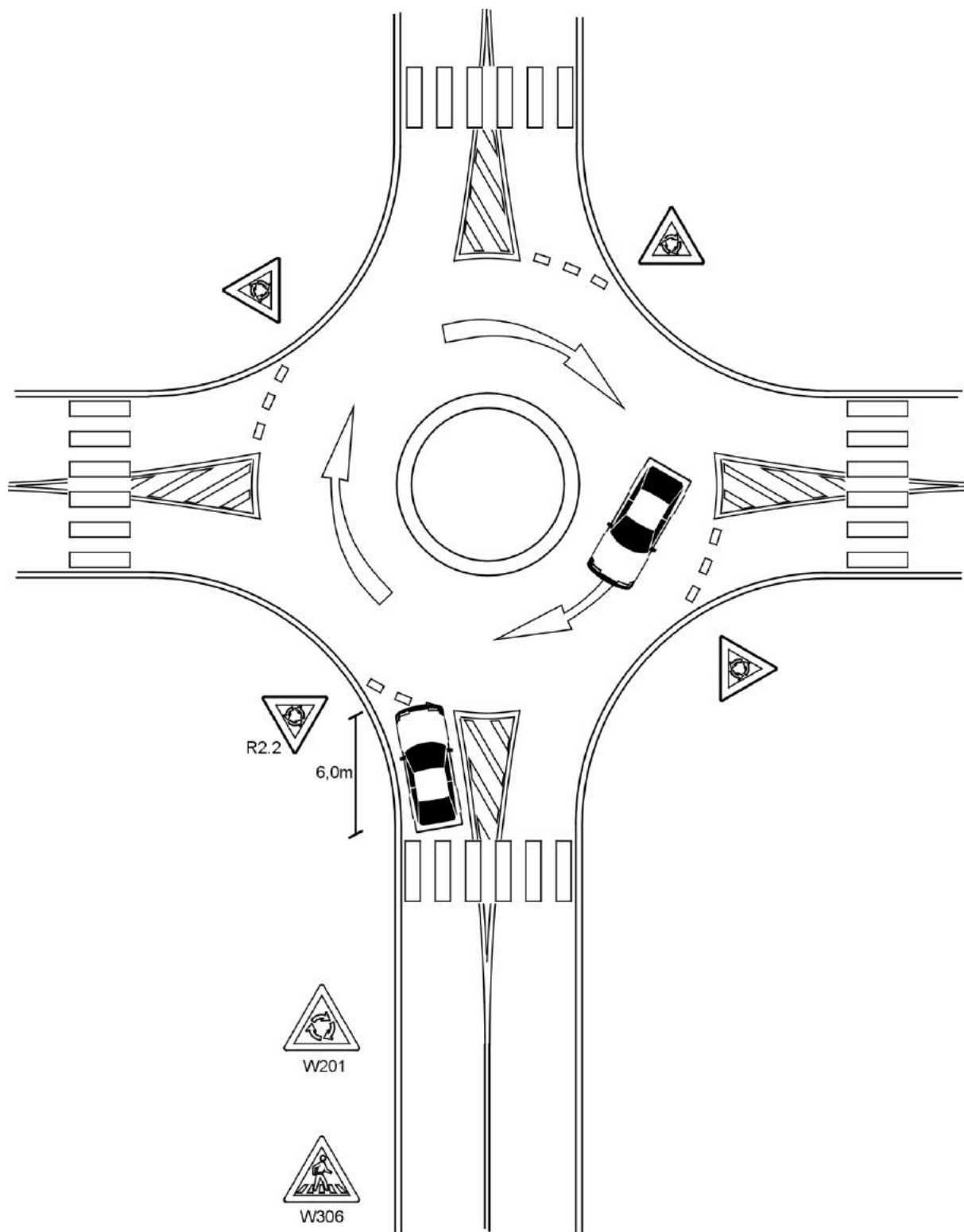


Figure 5.1: Accommodation of pedestrians at mini circles

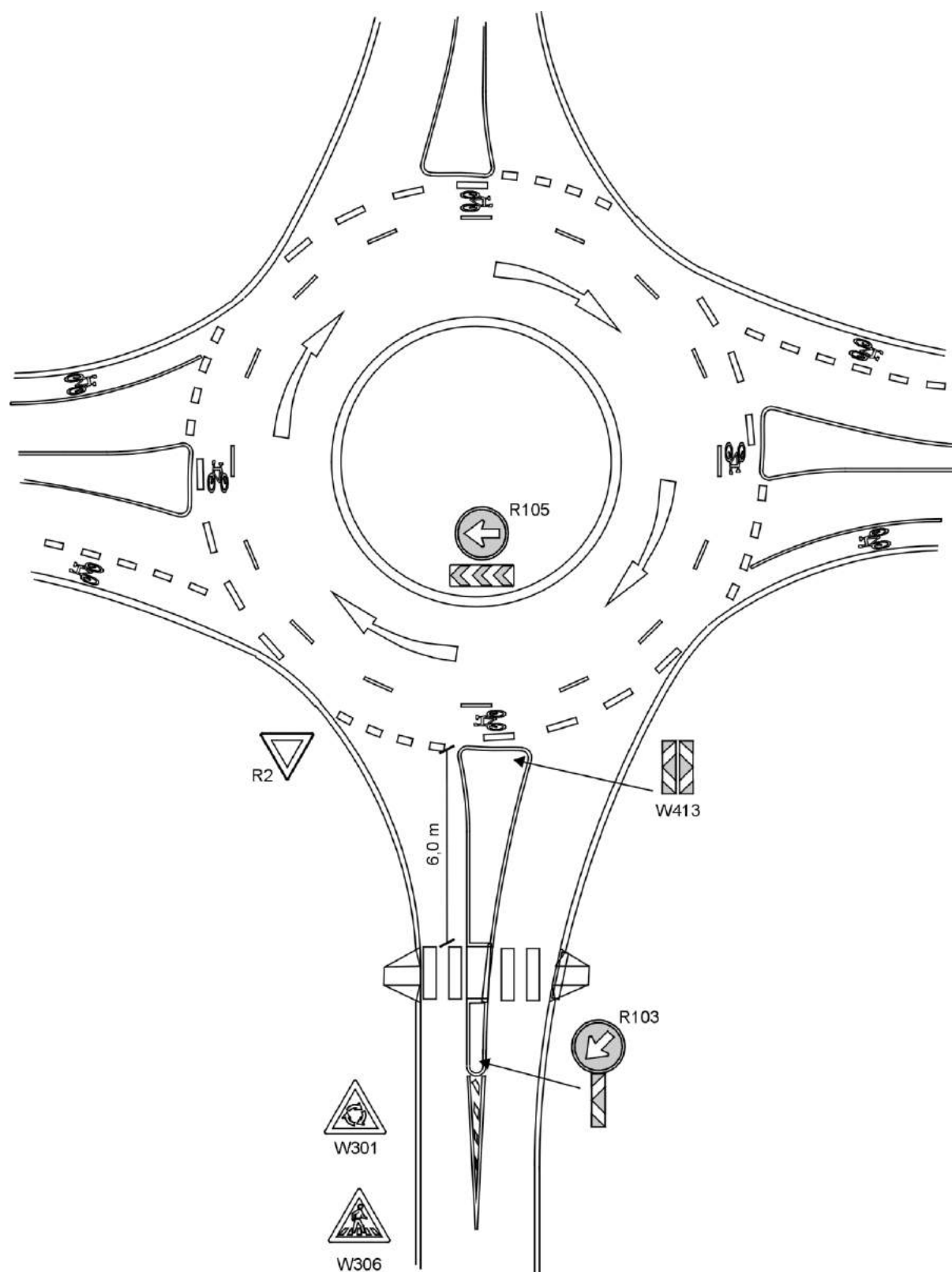


Figure 5.2: Accommodation of pedestrians and cyclists at larger traffic circles

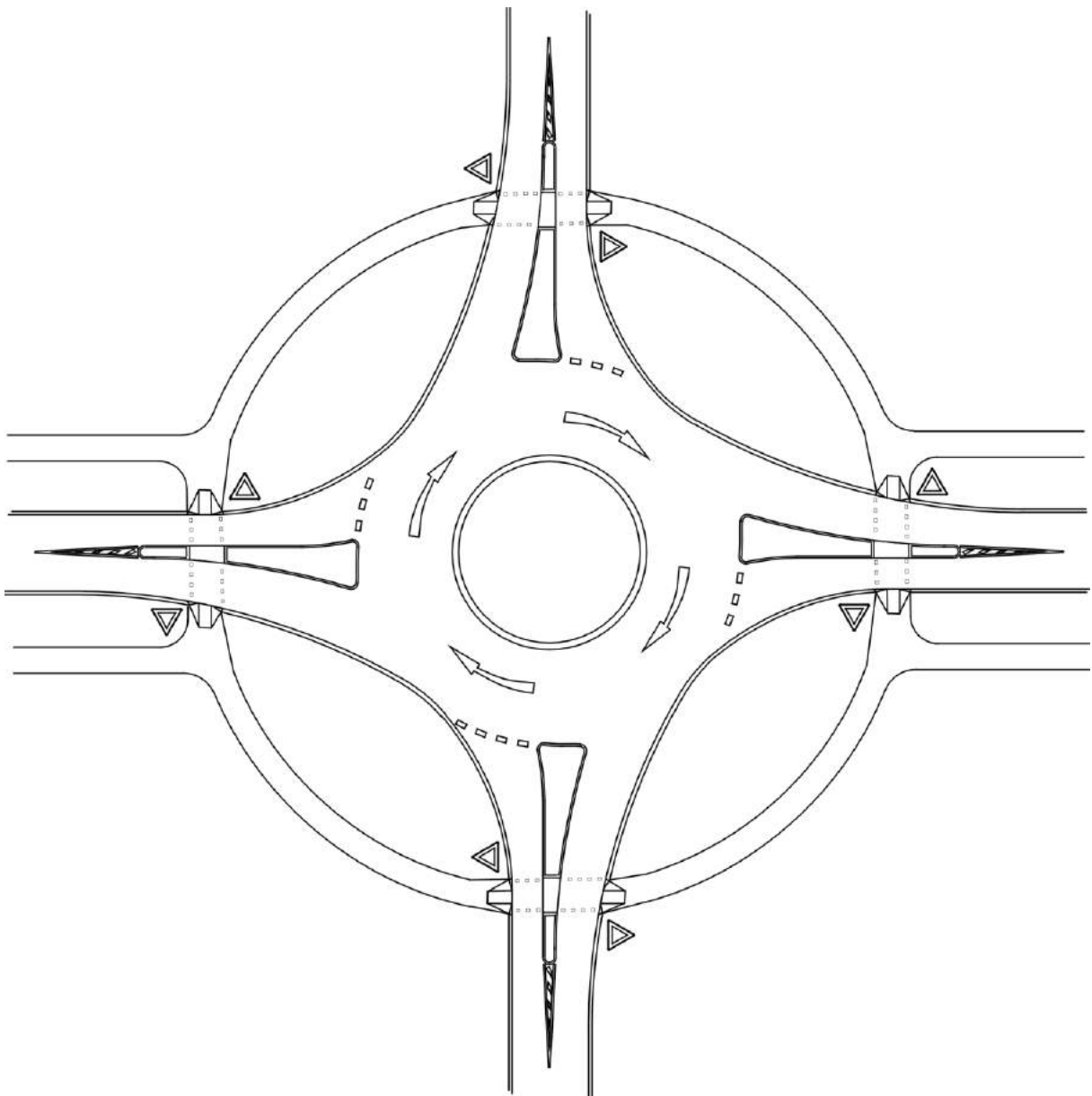


Figure 5.3: Bicycle road at a larger traffic circle (no provision made for pedestrians)

B. Pedestrian and bicycle crossings

6. Grade separated crossings

6.1. INTRODUCTION

Grade-separation by means of bridges and subways is the ideal method of reducing the exposure of pedestrians and cyclists to vehicular traffic. Such crossings, however, are very costly and are often only provided under exceptional circumstances. A further problem is that pedestrians and cyclists tend to avoid crossings that are inconvenient to use and which do not follow the desire lines the pedestrians and cyclists.

6.2. NEED FOR GRADE SEPARATED CROSSINGS

The greatest need for grade separated crossings occur at the following locations:

- Roads on which access control is required, such as freeways and high order roads.

- Locations where large numbers of accidents involving pedestrians and cyclists occur.

Large numbers of accidents are likely to occur at locations where there are high volumes of persons and/or cyclists crossing a road carrying high volumes of vehicular traffic at high speed (such as on freeways).

Grade separated crossings would be the preferred option of addressing safety problems at locations where it is not possible to reduce vehicle speeds, either by posting a lower speed limit or implementing traffic calming measures.

6.3. ATTRIBUTES OF GOOD GRADE SEPARATED CROSSINGS

In planning, designing and construction of grade separated crossings, it is important that the basic needs of pedestrians and cyclists are addressed. These needs are as follows:

- **Security.** A fundamental consideration is making persons feel safe when using the crossing. This is particularly a problem at subways, but also at bridges that are enclosed in a tunnel and in which visibility is restricted. Subways can be successful if they are designed with clear sight lines so that a person using the subway would always be visible to the public.
- **Safety.** The crossing must be designed and built free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Grade separated crossings can be highly effective in improving traffic safety, but only if they are used by pedestrians and cyclists. The crossings serve no purpose when they are avoided by pedestrians and cyclists because they are inconvenient to use.
- **Accessibility.** The crossing should be as accessible as possible to all users, including those with disabilities. A gradual access to the bridge or subway is required, while the facility should be of adequate width.
- **Convenience.** The crossing should be convenient to use. The pedestrian and cyclist desires a fast, direct, continuous, convenient route of access to chosen destinations. Pedestrians and cyclists will not use the bridge or subway if they can more conveniently cross the road or street without using the facility.
- **Comfort.** The crossing should be comfortable to use. Special attention should be given to accesses to the crossings to reduce approach gradients. The ideal grade separated crossing is one in which the pedestrian and bicycle way is on a level gradient.
- **Environment.** Pedestrians and cyclists prefer grade-separated crossings that are attractive to use and which is properly maintained and kept clean.

6.4. SITING CONSIDERATIONS

The most typical settings for grade separated crossings are the following:

- At public transport facilities and other centres generating heavy pedestrian and cyclist traffic
- Between a central business district and a residential area or areas.

- On freeways and other high-speed facilities adjacent to land uses that generate desire lines that cross the freeway.

One of the most important factors promoting the use of grade-separated crossings is their location on a natural direct pedestrian or cyclist route. If the access to the crossing requires pedestrians and cyclists to divert their journey, it prolongs the travelling distance, and lengthens the crossing time, and discourages persons from using the crossing.

6.5. ACCESS REQUIREMENTS

Examples of accesses to grade separated structures are shown in Figures 6.1 and 6.2.

Accesses to bridges and subways should be conveniently laid out. At subways, it is important for persons to see the exit from the entrance. There should also be no nooks or crannies on the accesses (as well as on the bridge and inside the subway) which can make pedestrians and cyclists feel unsafe. Some form of lighting is also desirable in subways.

Ramped access is preferred over stairs. Ramps can be used by cyclists as well as by disabled persons if gradients are flat (preferably not more than 5%). ***The design of the accesses should comply with the requirements for ramps and stairs given elsewhere in this manual.*** This includes the provision of landings at regular intervals on the accesses.

Pedestrians and cyclists should be channelised towards the crossing by means of a sturdy barricade or fence erected on both sides of the crossing. Such fencing should be sufficiently high to prevent pedestrians and cyclists climbing over them.

Handrails with a height of at least 1 m should be provided on the steps or ramps of foot-bridges and subways. The balustrades on the bridges should be higher to deter children from climbing over them.

6.6. BRIDGE AND SUBWAY DIMENSIONS

Minimum dimensions of bridges and subways are given in Table 6.1. The table provides dimensions for exclusive pedestrian bridges and subways as well as shared facilities.

Subways should be as short as possible. There is more daylight in a short subway than a long subway, while pedestrians and cyclists feel safer in a short subway.

The minimum height of 5,2 m for pedestrian bridges is the minimum clearance required for bridges in general in South Africa. According to the National Road Traffic Regulations, the overall height of a double-deck bus is limited to 4,6 metres, and that of any other vehicle to 4,3 metres.

The dimensions given in Table 6.1 are minimum values only. Wider bridges and subways may be required depending on the number of pedestrians and cyclists that will be using them.

6.7. CONSTRUCTION

Bridges and subways may be constructed of a variety of materials. These include concrete, steel and wood. Choosing the appropriate type of structure requires knowledge of conditions at the proposed location. In the selection of the appropriate structure, consideration should be given to cost, constructability, maintenance, aesthetics and physical site constraints.

Pedestrian and Bicycle Facility Guidelines

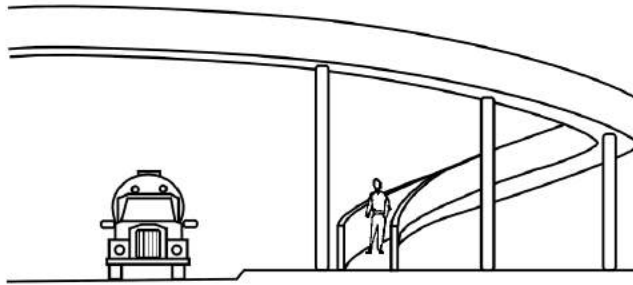
The type of structure will depend on the span length of the structure as well as the available depth for the superstructure.

Pedestrians and cyclists are very sensitive to movement and deflection of bridge structures. The design of the structure should therefore limit the amount of deflection under a live load.

Bridges and subways should have a light colour which provides a greater feeling of safety than dark drab colours. Subways should have a colour scheme in which darker shades provided at the ends of the subway and lighter shades at the middle. Such a scheme contributes toward a greater feeling of security (CROW, 1993).

Table 6.1: Minimum bridge and subway dimensions		
Facility	Width (m)	Height (m)
Pedestrian bridges	2,0	5,2
Pedestrian subways		
Length: 14 m or less	2,1	2,4
Length: 14 m to 24 m	2,4	2,4
Length: More than 24 m	3,0	3,0
Shared pedestrian/bicycle subways		
Pedestrian walkway	2,0	2,5
Cycle way	3,0	2,5
Total	5,0	

Front elevation



Plan view

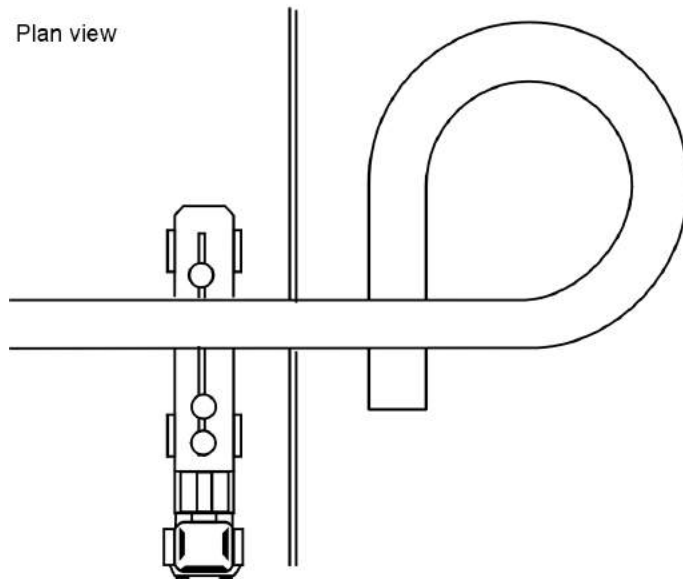


Figure 6.1: Design of an access to a pedestrian/bicycle bridge

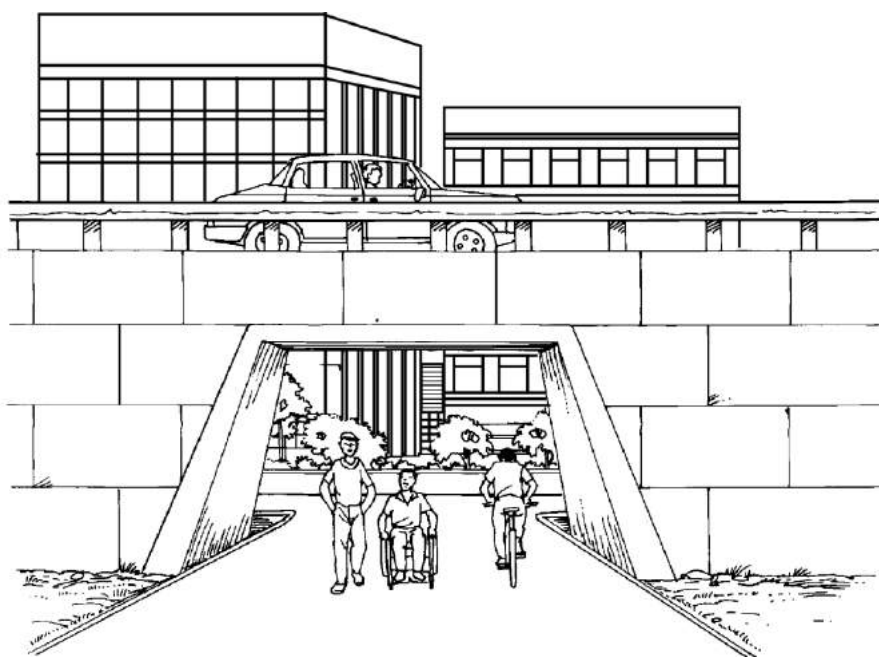


Figure 6.2: Pedestrian and bicycle subway

B. Pedestrian and bicycle crossings

7. Kerb ramps

7.1. INTRODUCTION

Kerb ramps are required wherever a pedestrian or cyclist needs to cross a kerb. The ramps are mainly provided for use by cyclists persons using wheelchairs, and persons pushing such items such as prams, wheelbarrows and others, but can also be useful for persons with mobility impairments.

Kerb ramps should be provided at all road junctions, midblock crossings, medians, islands and any other location where a kerb must be crossed, *without exception*. The ramps should be provided on all newly constructed and improved roads and streets, while programmes should be instituted to retrofit existing roads and streets with such kerb ramps. Where necessary, existing kerb ramps that do not meet requirements should also be improved.

7.2. KERBS

Kerbs are raised edges that are located adjacent to the travelled way and are usually used for:

- Drainage control;
- Delineation of the pavement edge, and
- Reduction in maintenance operations by providing protection for the edge of surfacing.

Kerbs are normally only used in urban areas where vehicle speeds are relatively low. In rural areas, the drainage function is normally accommodated by channels or open drains of various forms. Delineation is then usually by means of an edge line or a contrasting colour on the shoulder.

Kerbs may be barrier, semi-mountable or mountable. Barrier kerbs can only be mounted with considerable difficulty, while semi-mountable kerbs have a relative flat sloping face and are mountable under emergency conditions. Mountable kerbs have a flat sloping face and can be crossed easily by vehicles.

Barrier kerbs are primarily used to prevent parking on the sidewalk at road junctions and other locations and also to control access to properties. The disadvantage of the barrier kerb is that when it is struck by a vehicle travelling at high speed, it can result in loss of control and damage to the vehicle. The barrier kerb should therefore only be used on lower speed roads (less than about 80 km/h).

7.3. KERB RAMP DESIGN

The recommended design of the kerb ramp is shown in Figures 7.1a and 7.1b. The kerb ramp consists of the following components:

a) Ramp

The preferred width of the ramp is 1,5 m, but this may be reduced to 1,2 m where inadequate space is available. The gradient on the ramp should not exceed 1:12 (8,3%). Where this is not feasible, the gradient can be increased to 1:10 (10%), or even to 1:6 (16%) if necessary (U.S. Architectural and Transportation Barriers Compliance Board, 1999).

A gradual transition should be provided between the ramp and the roadway to ensure smooth wheelchair operations. ***All connections should be flush (within reasonable construction tolerances), and no “lips” should be provided.*** When the front wheels of a wheelchair hit such a lip, the wheels could swivel sideways, which could bring the wheelchair to an abrupt and dangerous stop.

An abrupt change in gradients can also cause problems for persons in wheelchairs, as illustrated in Figure 7.2. The algebraic difference between the ramp gradient and that of the road surface should therefore be restricted to a maximum of 11%. Where this maximum is exceeded, a level surface of 600 mm wide can be provided.

b) Flared sides

The flared sides of the ramp provides for a transition between the ramp and the adjacent pavement. To avoid a tripping hazard, the slope of the flared side *relative to the plane of the sidewalk* should not exceed a maximum of 1:10 (10%).

The flared sides are not required when the edges of the ramp are protected by other structures or barriers as indicated in Figure 7.3.

c) Landing

The landing at the top of the kerb ramp is an important component of the ramp. It provides an unobstructed area that can be used for purposes such as a queuing space for pedestrians. It also provide an area for wheelchairs to change direction after completing an ascent, rather than during the rise, and to avoid travelling across the compound slope of the flare sides, as shown in Figure 7.4. The landings also provide a level area that allows persons to bypass the kerb ramps entirely.

The landing should be at least 1,2 m but preferably 1,5 m wide. The landing should be relatively flat and the cross fall on the landing should not exceed a maximum of 1:50 (2%).

The kerb ramp should be orientated perpendicular to the kerb. Skew ramps can cause problems for persons using wheelchairs as illustrated in Figure 7.5. Persons in wheelchairs must “square off” when approaching a change in slope to ensure that all wheels of the chair remain on the ground at the same time. A skewed approach could leave one caster of the ground, thus compromising balance and control. A further problem is that most persons using wheelchairs will take a run at an up-ramp to take advantage of forward momentum. A skew ramp will require a turn when ascending, which is a more difficult and taxing manoeuvre (U.S. Architectural and Transportation Barriers Compliance Board, 1999).

7.4. KERB RAMP LAYOUT AT JUNCTIONS

The typical layout of pedestrian kerb ramps at road junctions is shown in Figures 7.6a and 7.6b. Two ramps should preferably be provided on each corner, one in each direction. A single ramp can be provided if limited space does not allow for two ramps as recommended. The single ramp design, however, is undesirable due to the following reasons:

- The single ramp aligns the pedestrian into the wrong direction of travel. This may lead visually impaired persons inadvertently into the junction area and into the path of moving vehicles.
- Persons in wheelchairs must make a turn to use the ramp. The loss of momentum due to the turn requires the persons to exert more effort.
- At traffic signals, the single ramp precludes the use of two widely spaced, easy to distinguish pedestrian push buttons. This is particularly important for visually impaired persons.

7.5. DETECTABLE WARNINGS

A detectable warning surface should be provided on the kerb ramp as shown in Figure 7.7. The purpose of this surface is to alert pedestrians who are blind or visually impaired to the presence of hazards in the line of travel (Public Rights-of-Way Access Advisory Committee, 2001). Note that the purpose of this surface is NOT to increase resistance against skidding by persons or wheelchairs (even though the ramp is mostly provided for use by persons using wheelchairs).

The design of the detectable warning surface shown in Figure 7.7 is aimed at achieving a high level of detectability by pedestrians. ***The shape and size of the studs or small domes are aimed at ensuring a high level of detection through the shoes.*** The spacing and square alignment of the domes allow persons in wheelchairs to avoid the domes.

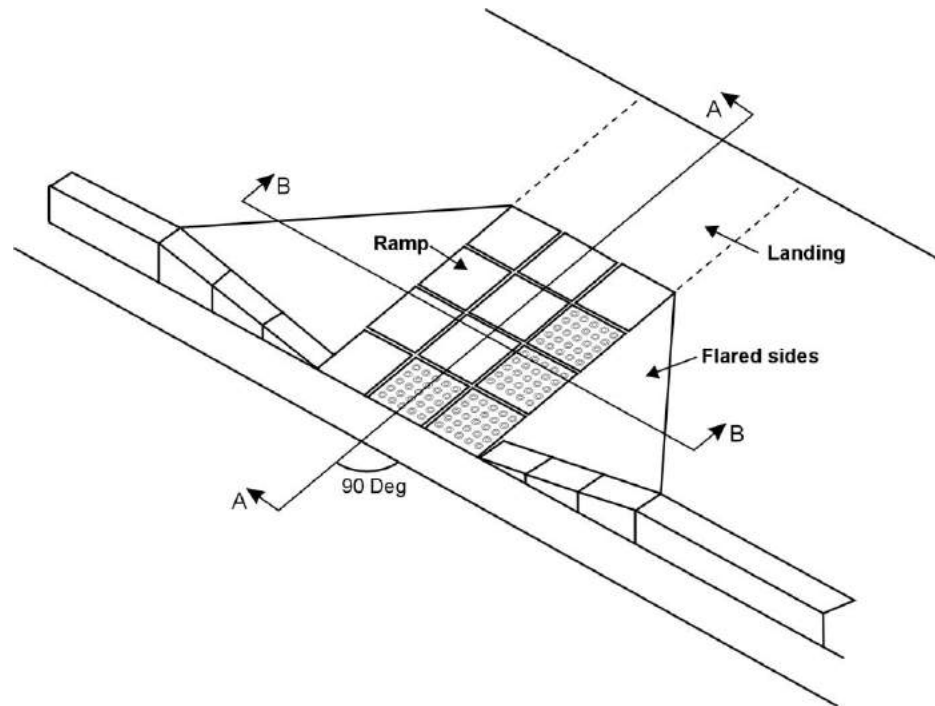
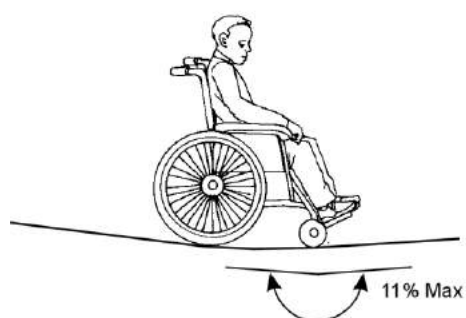
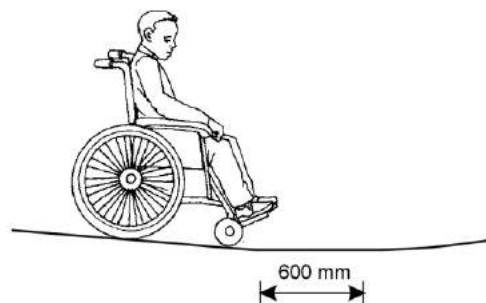


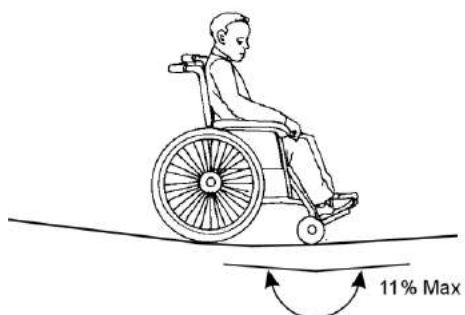
Figure 7.1a: Kerb ramp - Isometric view



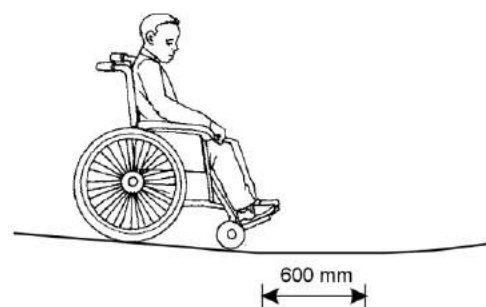
Algebraic difference in gradients not to exceed 11%



Provide 600mm level strip if algebraic difference exceeds 11%



Algebraic difference in gradients no to exceed 11%



Provide 600mm level strip if algebraic difference exceeds 11%

Figure 7.2: Maximum algebraic difference to accommodate wheelchairs

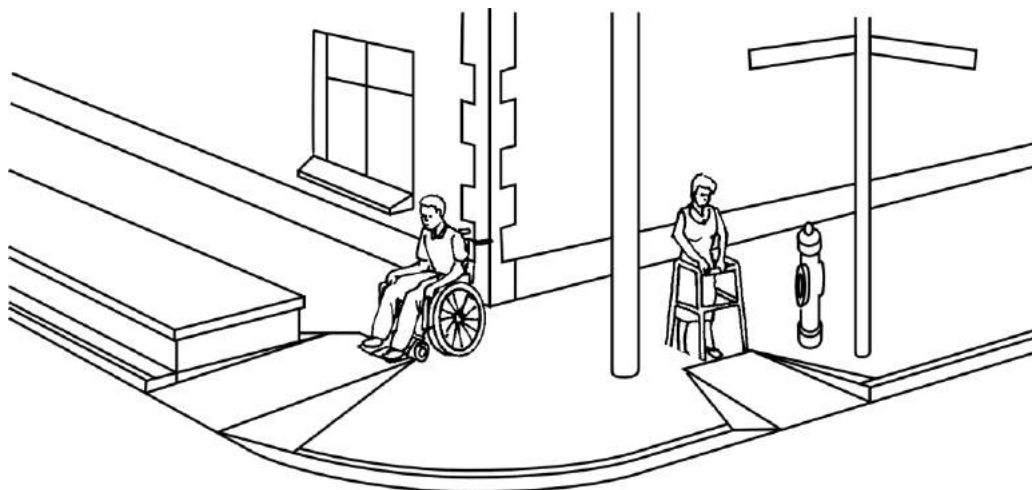


Figure 7.3: Flared sides not required when protected by other structures on the sidewalk

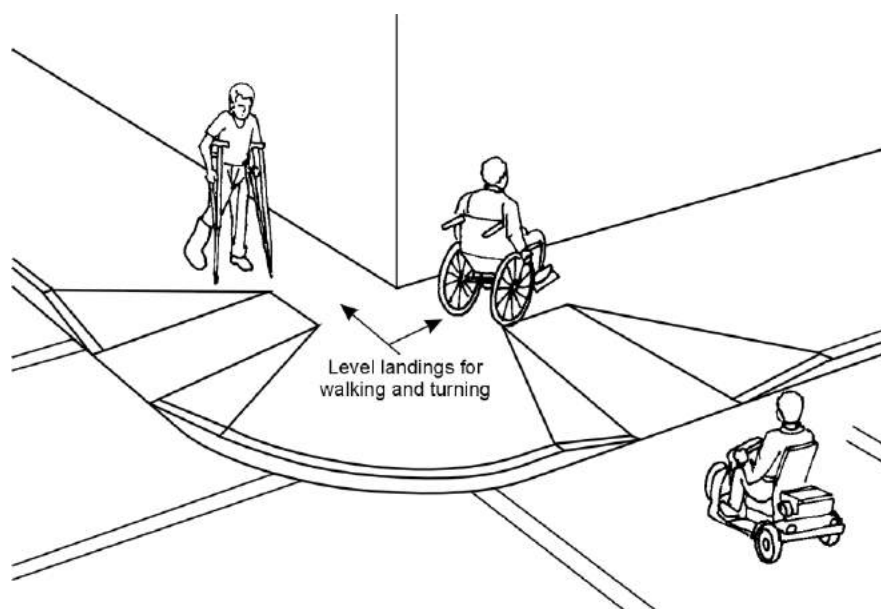


Figure 7.4: The need for a landing at a kerb ramp

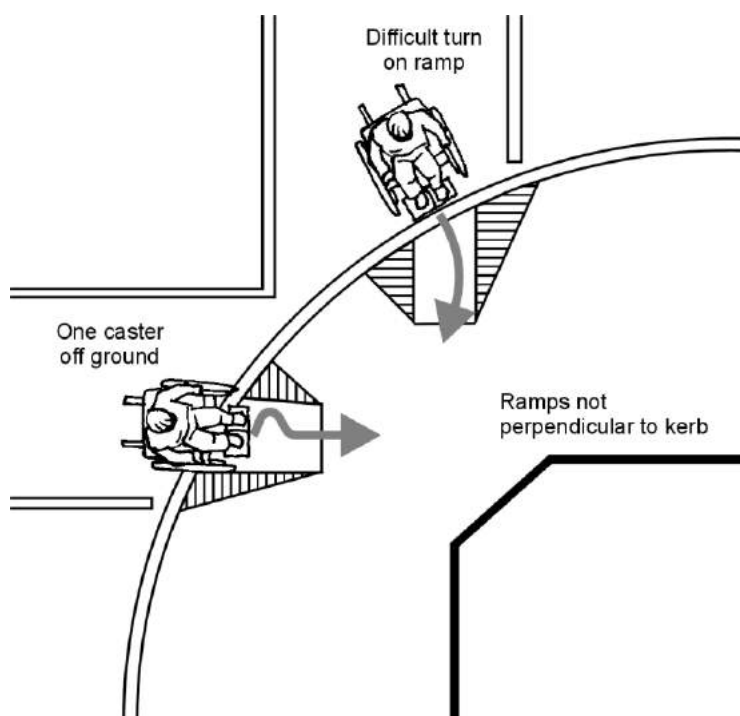


Figure 7.5: Problems with kerb ramps that are not perpendicular to the kerb

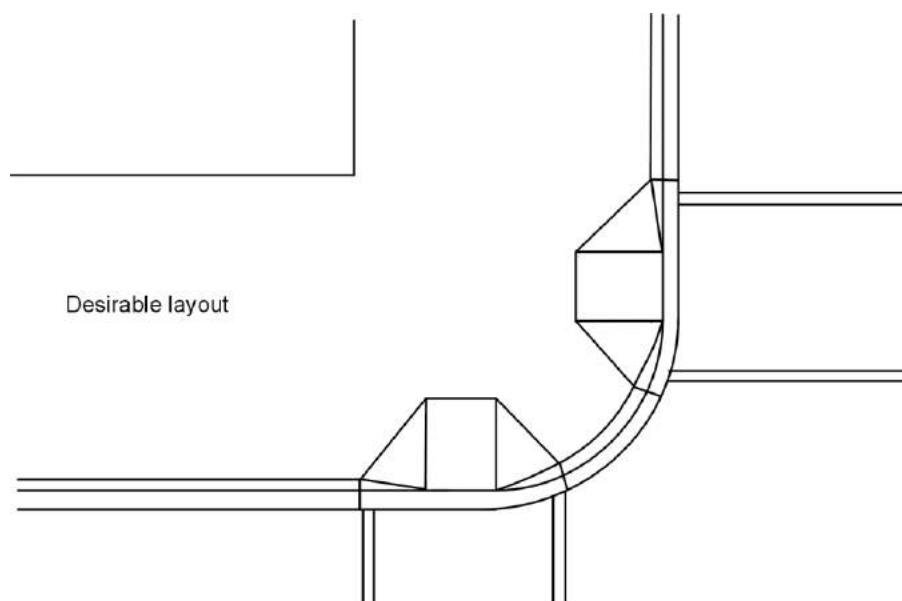


Figure 7.6a: Double pedestrian kerb ramp at junction corner

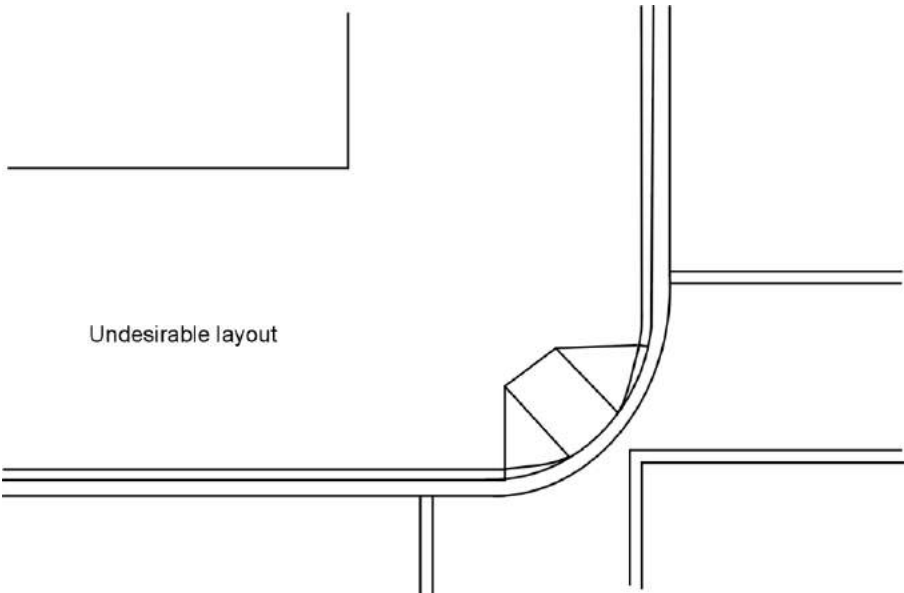
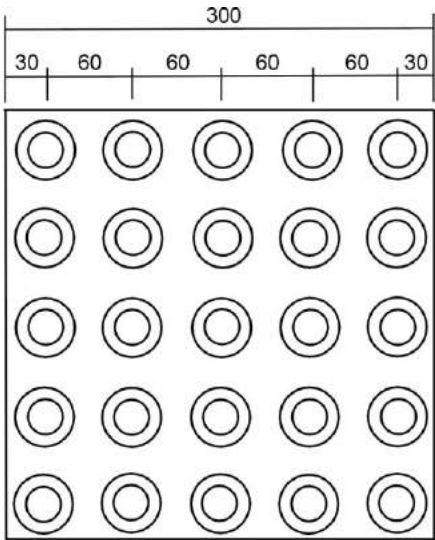
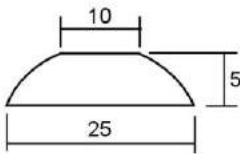


Figure 7.6b: Single pedestrian kerb ramp at junction corner (undesirable design)



Dome spacing

Note: It is the top diameter of the dome that is important in ensuring detection through shoes



Dome section

Figure 7.7: Pedestrian ramp detectable warning

B. Pedestrian and bicycle crossings

8. Pedestrian and cyclist refuge

8.1. INTRODUCTION

Pedestrian and cyclist refuge can be provided by means of protected areas on a road or in a road junction. These areas are normally protected by means of constructed islands, but other forms of protection may also be used.

Refuge islands can be highly beneficial to pedestrians and cyclists to safely cross wide roads one section at a time. The refuge island will allow relatively large volumes of pedestrians and cyclists to cross a wide road carrying relatively large volumes of traffic. ***It is one of the most effective and safest facilities that can be provided for use by pedestrians and cyclists.***

The provision of pedestrian refuge islands at strategic places can also be of great assistance to the elderly, the young and handicapped people to cross roads more safely. Refuge islands can be placed at junctions or at pedestrian crossings across multilane roads. On multilane arterials, refuge islands should be provided as a standard feature, especially in areas where large numbers of pedestrians occur

8.2. DESIGN OF REFUGE ISLANDS

An example of a refuge island is shown in Figure 8.1. The following are a number of recommendations with regard to the design of the islands:

- Refuge islands should preferably be constructed with kerbs, but may also be painted. Mountable kerbs should be used, except if there is a need to prevent parking on an island.
- The width of the walkway should be a minimum of 1,5 m, but preferably not less than 2 m.
- The width of the refuge island or median should not be less than 2 m, but preferably not less than 3 m, to accommodate pedestrians, persons in wheelchairs and cyclists. Wider widths may be required where large volumes of pedestrians must be accommodated.
- ***The thoroughfare area of the refuge island must be flush with the road surface, but with sufficient gradient to accommodate drainage.*** The gradient of the thoroughfare should not exceed a maximum of 1:20 (5%), while the cross fall should not exceed a maximum of 1:50 (2%).
- The sides of the thoroughfare should be sloped over a 0,5 m width as shown in Figure 8.1.
- The length of the refuge island should not be less than 6,0 m, but preferably longer. This is required to ensure that the island has a good visibility target value for the motorist.

Pedestrian refuge islands should preferably be illuminated at night. Refuges can usually be illuminated by street lighting but, where necessary, supplementary floodlighting can be provided. Road signs used at pedestrian refuge islands must always be made of high intensity retroreflective materials.

8.3. REFUGE ISLANDS AT MIDBLOCK PEDESTRIAN CROSSINGS

The provision of a refuge island at a midblock pedestrian crossings on multi-lane roads

- simplifies the road crossing task considerably, and
- encourages more pedestrians to use the crossing.

An example of the use of a refuge island at a midblock pedestrian crossing is shown in Figure 8.2. The figure shows the road signs and road marks that should be provided.

Of particular importance, is the hatched painted islands that must be placed in advance of the kerbed refuge island. The painted islands must be designed in accordance to the Road Traffic Signs Manual. The following aspects are important:

- The taper rate of a hatched painted island placed in advance of a kerbed island is dictated by the operating speed of traffic.

- Road studs should be provided on the island with the purpose of delineating the road.

The following road signs are provided on the refuge island:

- For two-way roads, the KEEP LEFT sign (R103) should be displayed on the nose of the island as shown in Figures 8.1 and 8.2. A danger plate W401 should be mounted beneath the keep left sign.
- Where refuge islands are provided on one-way roads, two danger plates W401 and W402 should be provided on the nose of the island next to each other.

8.4. REFUGE ISLANDS AT JUNCTIONS

Refuge islands can be installed at junctions to provide safer crossing opportunity. Such islands are normally provided at signal controlled junctions, but can also be beneficial at priority control junctions where pedestrians and cyclists find it difficult to cross the road.

The refuge islands can be provided at the following locations at a junction:

- On the median to allow the crossing of a road in two stages. At signal controlled junctions, the provision of such refuge islands can assist signal timings by reducing the amount of green time that must be allocated to pedestrians.
- At junction corners where it is necessary to accommodate the turning paths of large vehicles by means of slipways.

The median refuge island can be introduced at a junction in a similar way as for midblock crossings (refer to Figure 8.2). Normally, however, the refuge island would be provided as part of the median as shown in Figure 8.3.

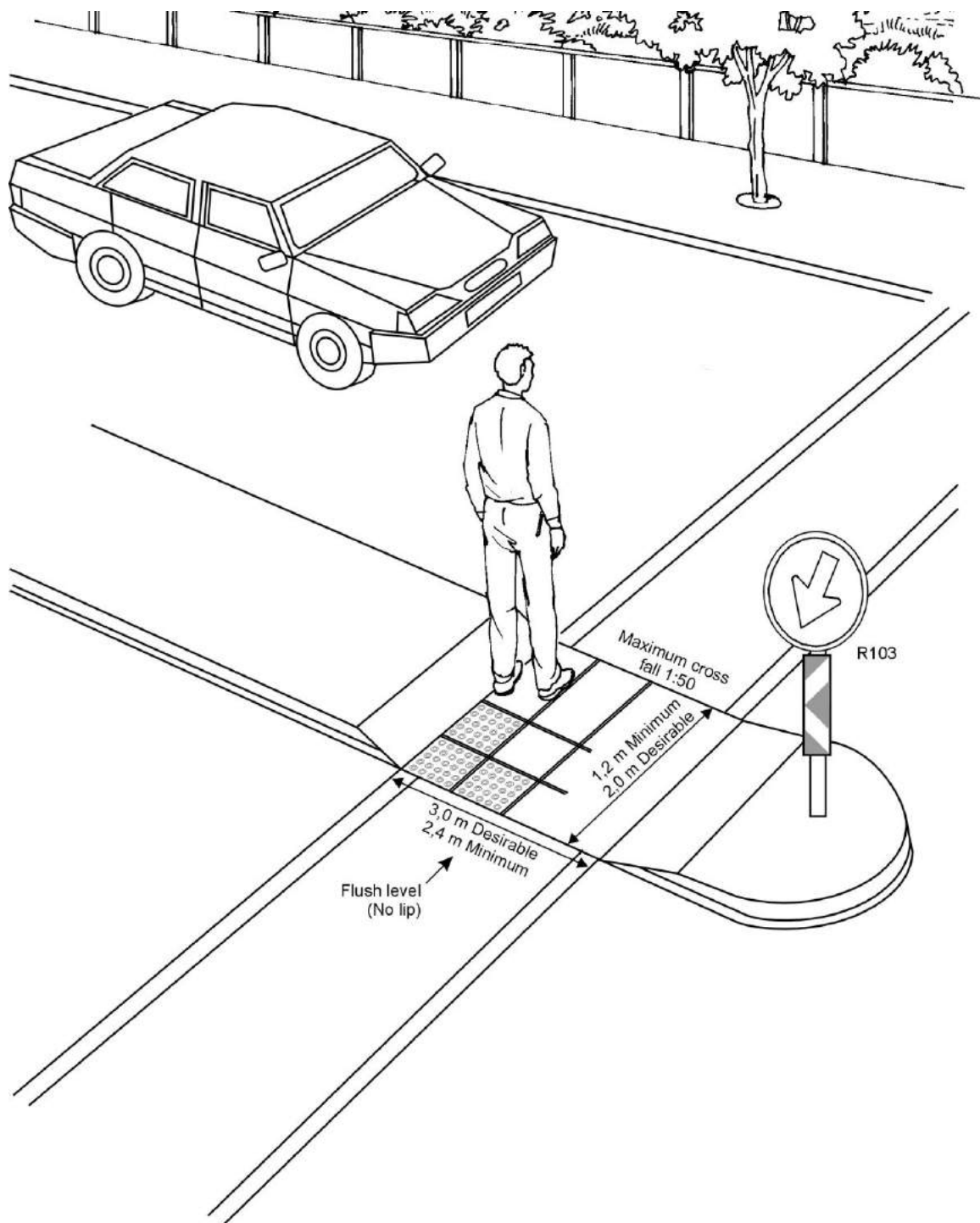


Figure 8.1: Construction details of a refuge island

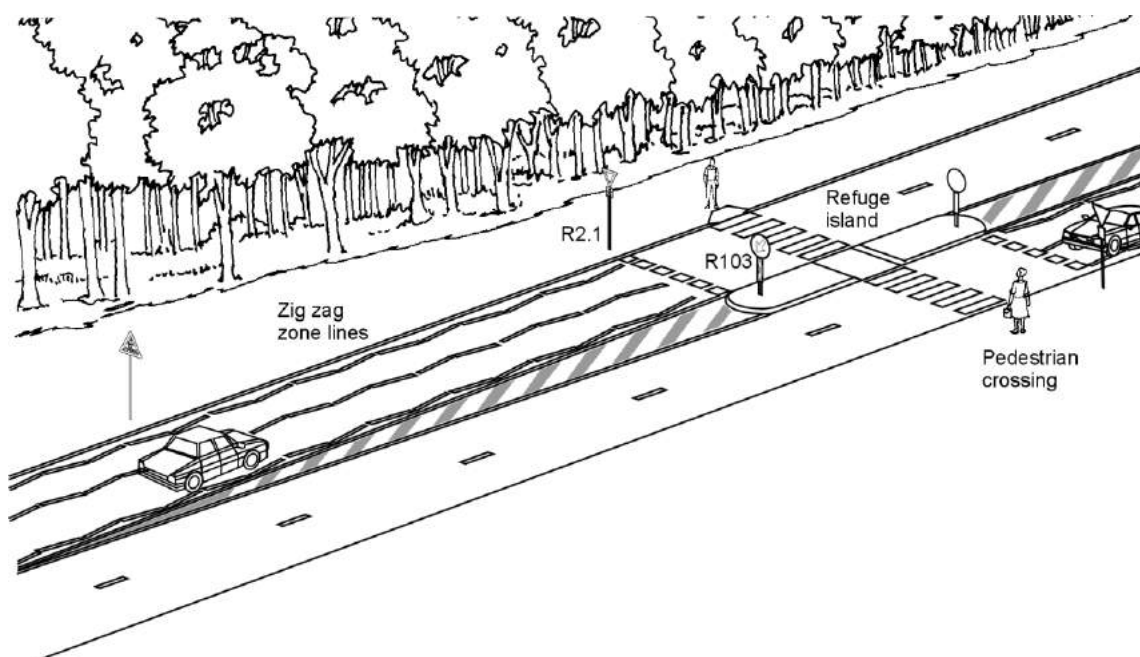


Figure 8.2: Layout of a refuge island at a pedestrian crossing

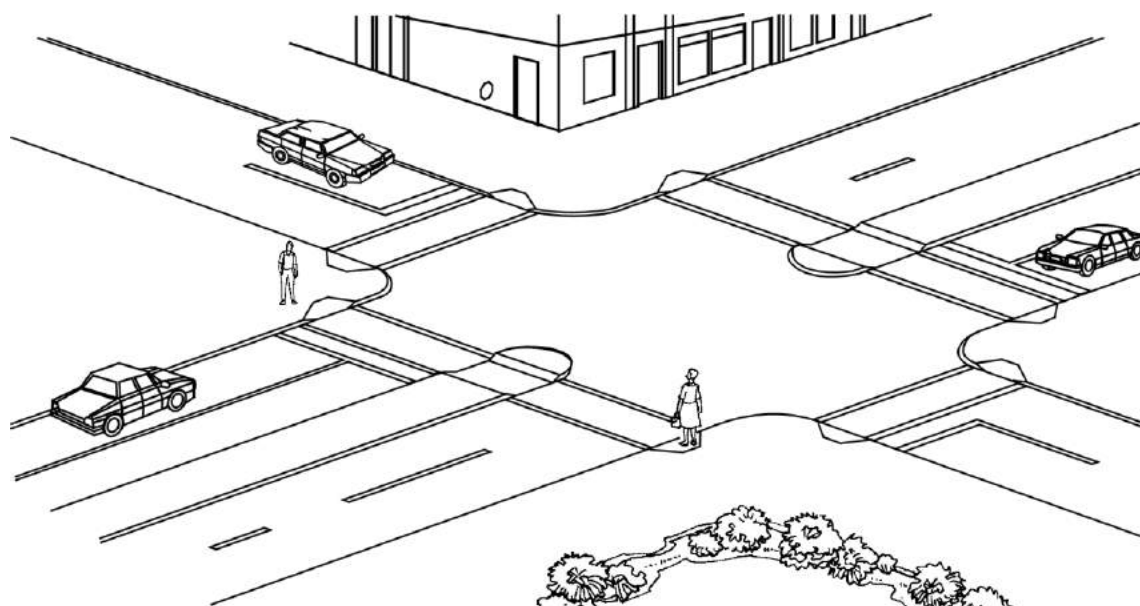


Figure 8.3: Median refuge island provided at road junctions

PART C

PEDESTRIAN AND BICYCLE

WAYS

C. Pedestrian and bicycle ways

1. Introduction

1.1. TYPES OF PEDESTRIAN AND BICYCLE WAYS

Pedestrian and bicycle ways can be provided in various forms and types. The ways can be provided on the roadway pavement, or as separate walk and cycle ways. Pedestrian and bicycle ways can also be shared, although this is not normally recommended. The types of pedestrian and bicycle ways are as follows:

a) Pedestrian ways (footpaths)

- i) **Sidewalks**, provided parallel to a street or road within the road reserve.
- ii) **Walkways**, which are independently aligned and not typically provided in the road reserve.

b) Bicycle ways

- i) **Bicycle lanes (Class III cycle way)**, that are specifically marked on the roadway pavement. When the lanes are not specifically marked and a road or street is shared with other traffic, the bicycle way is designated as a **Class IV cycle way**.
- ii) **Bicycle roads (Classes I and II cycle ways)**, which are provided for the exclusive use of cyclists. Bicycle roads can further be subdivided as follows:
 - Bicycle roads within the road reserve, provided parallel to a street or road (Class II cycle way).

- Bicycle roads which are independently aligned and not typically provided in the road reserve (Class I cycle way).

The different types of pedestrian and bicycle ways are shown in Figure 1.1. Each of the different types is discussed in greater detail in subsequent chapters of this manual.

1.2. NATIONAL ROAD TRAFFIC REGULATIONS APPLICABLE TO PEDESTRIAN WAYS

According to the National Road Traffic Regulations (2000), pedestrians have the following duties when walking along a road:

316. (1) Whenever a sidewalk or footpath abuts on the roadway of a public road, a pedestrian shall not walk on such roadway except for the purpose of crossing from one side of such roadway to the other or for some other sufficient reason.

(2) A pedestrian on a public road which has no sidewalk or footpath abutting on the roadway, shall walk as near as is practicable to the edge of the roadway on his or her right-hand side so as to face oncoming traffic on such roadway, except where the presence of pedestrians on the roadway is prohibited by a prescribed road traffic sign.

According to the South African National Road Traffic Act (Act No. 93 of 1996), a sidewalk is that area or the road verge intended for the exclusive use of pedestrians. Cyclists or other traffic are therefore not allowed to use sidewalks for travel, *unless specifically signed for such purpose.*

1.3. NATIONAL ROAD TRAFFIC REGULATIONS APPLICABLE TO BICYCLE WAYS

The National Road Traffic Act (Act No. 93 of 1996) includes a bicycle in its definition of a motor vehicle, and bicycle roadways can therefore be provided in the same way as roads for motor vehicles. According to the act, a "motor vehicle" means any self-propelled vehicle and includes a) a trailer; and b) a vehicle having pedals and an engine or an electric motor as an integral part thereof or attached thereto and which is designed or adapted to be propelled by means of such pedals, engine or motor, or both such pedals and engine or motor.

The regulations have specific rules for cyclists:

311. (1) No person shall ride a pedal cycle on a public road unless he or she is seated astride on the saddle of such pedal cycle.

(2) Persons riding pedal cycles on a public road shall ride in single file except in the course of overtaking another pedal cycle, and two or more persons riding pedal cycles shall not overtake another vehicle at the same time.

(3) No person riding or seated on a pedal cycle on a public road shall take hold of any other vehicle in motion.

(4) No person riding a pedal cycle on a public road shall deliberately cause such pedal cycle to swerve from side to side.

(5) No person riding a pedal cycle on a public road shall carry thereon any person, animal or object which obstructs his or her view or which prevents him or her from exercising complete control over the movements of such pedal cycle.

(6) A person riding a pedal cycle on a public road shall do so with at least one hand on the handlebars of such pedal cycle.

Pedestrian and Bicycle Facility Guidelines

(7) Whenever a portion of a public road has been set aside for use by persons riding pedal cycles, no person shall ride a pedal cycle on any other portion of such road.

(8) A person riding a pedal cycle on a public road or a portion of a public road set aside for use by persons riding pedal cycles, shall do so in such manner that all the wheels of such pedal cycle are in contact with the surface of the road at all times.

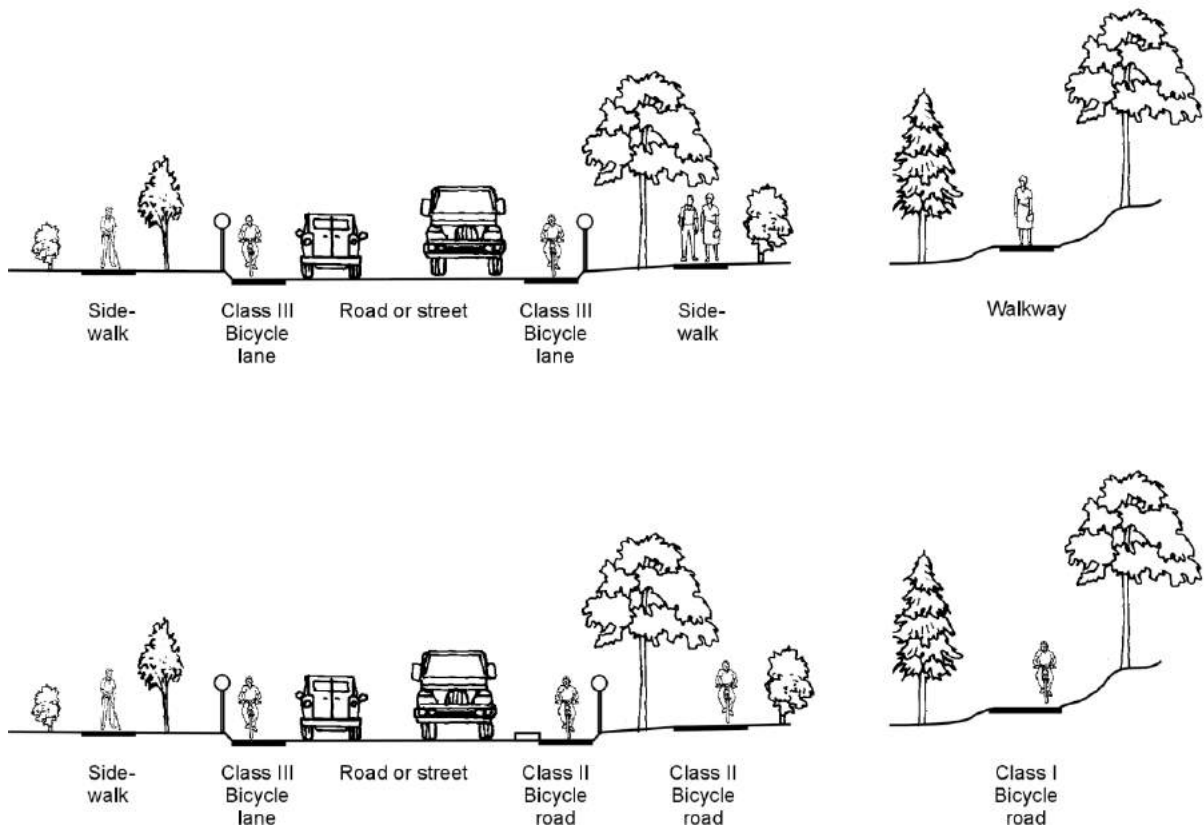


Figure 1.1: Types of pedestrian and bicycle ways

C. Pedestrian and bicycle ways

2. Networks

2.1. INTRODUCTION

The quality of walking and cycling as modes of transport depends on whether entire routes are available. If only parts of the walking and cycling network are provided, the uncompleted or non-available parts could be a decisive deterrent to walking and cycling. A few dangerous or impassable sections make the entire trip unattractive, with the result that walking and cycling trips will not be made.

It is therefore of vital importance that a coherent network of pedestrian and bicycle facilities be available. A network is coherent when most origins and destinations are connected, and a large proportion of the distances travelled is on through routes. It is important that authorities should develop a master plan of such facilities for their areas.

All roads and streets provided in an urban network (and also some rural roads), should be considered potential pedestrian and bicycle routes, unless they are specifically designed to provide vehicle mobility (the higher classes of roads). It is therefore important that facilities should be provided on all roads and streets that have the potential of attracting large volumes of pedestrians and cyclists.

2.2. ATTRIBUTES OF GOOD NETWORK DESIGN

A good network design is one in which the basic needs of pedestrians and cyclists have been addressed. These needs are as follows:

- **Security.** The pedestrian and cyclist environment should make persons feel secure and safe. Movement links should not be provided in secluded or deserted areas where there is a high security risk. Back yards and small alleyways should be avoided where possible.
- **Traffic safety.** Traffic safety is an important consideration because of the vulnerability of pedestrians and cyclists. Pedestrian and cyclist exposure to vehicular traffic (and each other) should be minimised. Street crossings, in particular, should be minimised or eliminated where possible.
- **Accessibility.** The movement network should be as accessible as possible to all users, including those with disabilities.
- **Convenience.** The network should be convenient to use. The pedestrian and cyclist desire fast, direct, continuous, convenient routes between their origins and destinations.
- **Comfort.** The network should be comfortable to use. Where possible, steep topography should be avoided.
- **Environment.** Pedestrians and cyclists prefer environments that are attractive to use. Pedestrian and bicycle routes should therefore be located in attractive environments (natural or built).
- **Economy.** The network should be economical and affordable. Improvements should be designed to achieve the maximum benefit for their cost. This, however, also includes reduced reliance on more expensive modes of transportation.

2.3. EXPOSURE TO TRAFFIC

One of the most important needs of pedestrians and cyclists is that of traffic safety. The danger of accidents is reduced when pedestrian and cyclist exposure to vehicular traffic is minimised.

Exposure to traffic can be reduced by separating pedestrians, cyclists and traffic. The ideal is to provide separate pathways for pedestrians, cyclists and traffic. Where this is not possible, steps such as those described below should be taken to at least minimise such exposure.

Pedestrians and cyclists are at their most vulnerable when crossing traffic streams. Network designs should therefore attempt to minimise the number of such crossings.

Pedestrians and cyclists should also not be exposed to wide arterials carrying large volumes of traffic. The concept of human scale implies two or four traffic lanes – no more. Roads with five or more lanes are hard to cross and unpleasant to walk or cycle along.

2.4. NETWORK CONNECTIVITY

A pedestrian and bicycle network should be designed to provide a high level of connectivity between origins and destinations, and to overcome barriers to walking and cycling. The ideal is to provide a complete system of interconnected pedestrian and bicycle ways that connects all important locations in the network. These locations should include all major centres that are likely to be visited by pedestrians and cyclists.

Connectivity for pedestrians and cyclists can be achieved when an “open” road network is provided in contrast to the “closed” system. Examples of these two types of networks are shown in Figure 2.1.

The main difference between the open and closed types of networks is that the open network allows traffic movement in as many directions as possible, while such movements are restricted in the closed network. The open network allows traffic to disperse to a myriad of local streets, which is in contrast with the closed system which focuses traffic onto a restricted number of high order roads and discourages traffic from using low order streets.

Both open and closed systems have advantages and disadvantages. The open network encourages community access and provides greater accessibility to pedestrians and cyclists. The closed system, on the other hand, has the advantage that extraneous through traffic is discouraged from using the local street system. This is particularly important in residential areas where it is necessary to preserve the residential quality of the areas, and to protect the safety of residents by reducing conflicts between pedestrians and vehicles.

An example of a system which combines the advantages of both the open and closed road networks is shown in Figure 2.2. In this system, linkages are provided for the exclusive use of pedestrians and cyclists. Community access is encouraged while the residential quality of the area is ensured by restricting vehicular access.

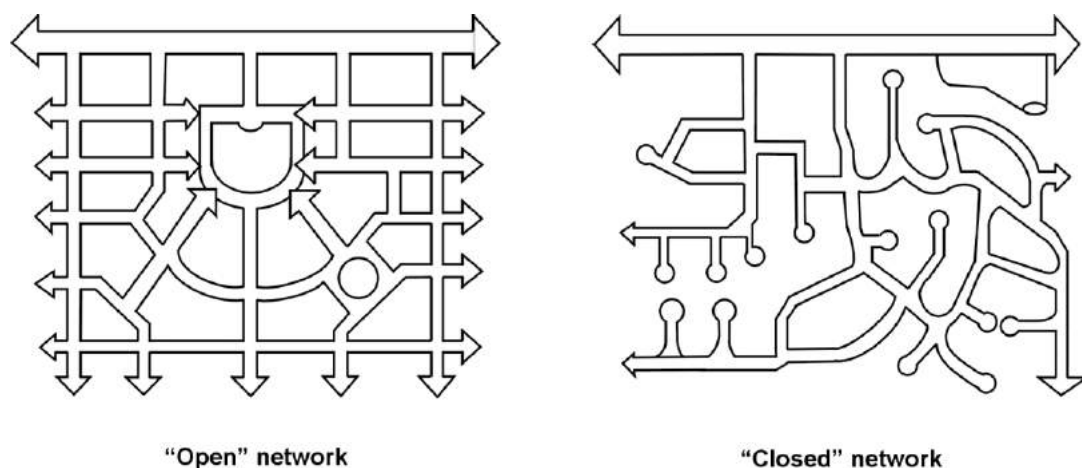


Figure 2.1: Open and close networks

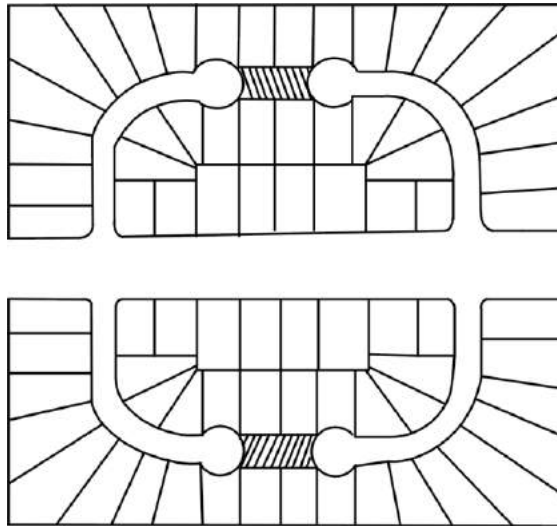


Figure 2.2: A “compromise” network with pedestrian/bicycle linkages

C. Pedestrian and bicycle ways

3. Sidewalks and walkways

3.1. INTRODUCTION

Pedestrian sidewalks are walkways that are parallel to a street or road within the road reserve width. Sidewalks typically have paved surfaces separated from the roadway by linear planting strips.

According to the South African National Road Traffic Act (Act No. 93 of 1996), a "sidewalk" means that portion of a verge intended for the exclusive use of pedestrians. This means that no vehicles, including bicycles, may use the sidewalk for travel.

Walkways are pedestrian ways that are independently aligned and not typically located parallel to streets or within road reserves. These pathways are often found in open spaces in a neighbourhood and in parks. Walkways can serve as pedestrian connections, to shorten walking trips in places where street blocks are large. Walkways may also be provided in place of a standard sidewalk where it is difficult to provide sidewalks due to factors such as steep terrain and other right-of-way constraints.

The design of both sidewalks and walkways is discussed in this chapter. There is very little difference in the design requirements for sidewalks and walkways, and they can be designed to the same standards.

3.2. THE NEED FOR SIDEWALKS AND WALKWAYS

The sidewalk and walkway is one of the most important facilities that can be provided for pedestrians (together with pedestrian crossings, kerb ramps and refuge islands). Sidewalks are often associated with significant reductions in pedestrian accidents and the improvement of mobility for pedestrians (Ogden, 1994). Sidewalks can also contribute significantly to the character of a neighbourhood, as shown in Figure 3.1.

Sidewalks (and walkways) should therefore be part of every street and road, except those on which pedestrians are not allowed or which are not used by pedestrians. In urban areas, particularly, sidewalks should be installed even if pedestrian traffic may be light (Otak, 1997).

In areas where sidewalks and walkways have not been provided, programmes should be put in place to gradually construct sidewalks and walkways. Even in areas where there are budget restrictions, some funds should be made available for sidewalk and walkway construction, even if such funds are limited. Each authority should strive to rectify as many streets and roads as possible with available funds.

Priority can be given to streets and roads on which sidewalks are most urgently required, but the intention should be, in urban areas, to provide a sidewalk on every street used by pedestrians.

Even in rural areas, sidewalks should be provided on roads used by significant number of pedestrians.

3.3. SIDEWALKS ON BOTH SIDES VERSUS ONE SIDE OF A ROAD

It is generally desirable to provide sidewalks on both sides of streets used by pedestrians. Pedestrians are encouraged to walk on the side of the street facing vehicular traffic.

A sidewalk on one side of the street may be adequate when there are low volumes of pedestrians, or as an interim phase in the provision of sidewalks on streets where previously no sidewalks were provided.

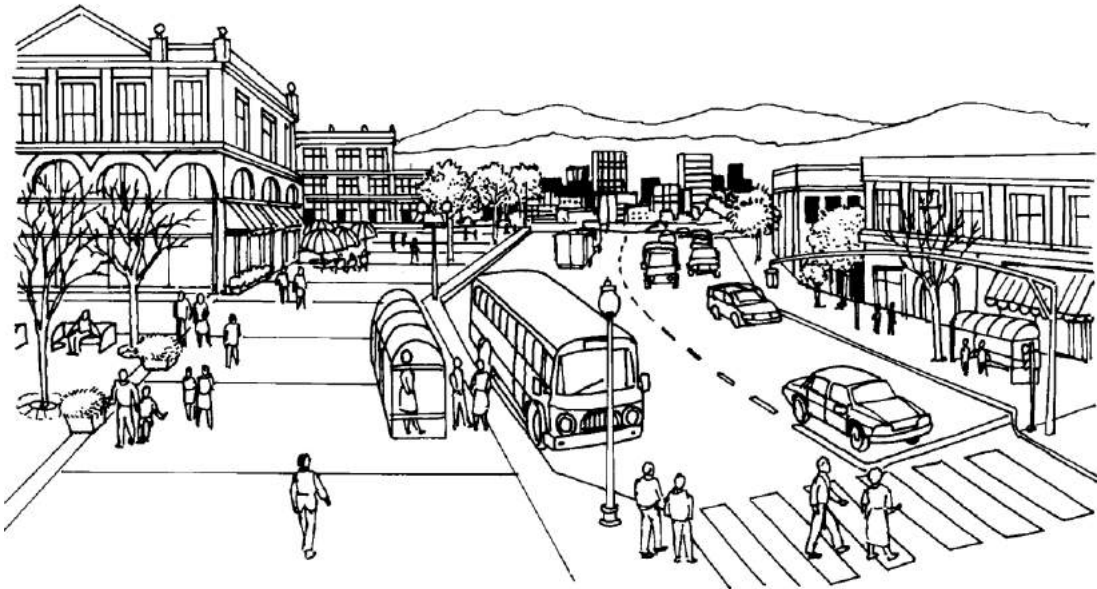


Figure 3.1: Sidewalks can contribute significantly to the character of a neighbourhood

33.4. THE USE OF SHOULDERS AS SIDEWALKS

Road shoulders are used to provide:

- A recovery area for errant vehicles.
- A refuge for stopped or disabled vehicles.
- An area out of the travel lanes for emergency and maintenance vehicles.
- Lateral support of the roadway structure.
- A travel way for use by pedestrians and cyclists.

According to the National Road Traffic Regulations, driving on the shoulder of a road is prohibited except on two-lane roads while being overtaken by other vehicles and then only during daylight hours, provided this can be done without endangering the vehicle, other vehicles, pedestrians or property and if persons and vehicles on the road are clearly discernible.

The above indicates that shoulder along roads in rural areas can serve as walkways. This, however, would only be acceptable where pedestrian volumes are limited. The shoulders may be paved or unpaved, but it is unlikely that pedestrians would use unpaved shoulders as footpaths. Paved shoulders should also be well delineated with a painted edge line to discourage drivers from straying onto the shoulder.

Shoulders that are heavily relied upon by pedestrians will not function adequately if there is a large volume of cyclists. Under such circumstances, separate bicycle lanes or roads are recommended.

Shoulders used for walking should preferably be at least 1,5 m wide (Otak, 1997). Wider shoulders of 3 m and wider, however, are preferred to providing greater separation distance between pedestrians and traffic.

3.5. ATTRIBUTES OF GOOD SIDEWALKS AND WALKWAYS

In planning, designing and construction of sidewalks and walkways, it is important that the basic needs of pedestrians are addressed. These needs are as follows:

- **Security.** A fundamental consideration is making persons feel secure when using the sidewalk or walkway. Sidewalks and walkways should not be located in areas that are deserted or secluded, or where there are hiding places for criminals and vandals.
- **Safety.** The sidewalk or walkway must be designed and built free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Traffic safety is an important consideration because of the vulnerability of pedestrians. Pedestrians should be protected from traffic.
- **Accessibility.** The sidewalk or walkway should be as accessible as possible to all users, including those with disabilities.
- **Convenience.** The sidewalk or walkway should be convenient to use. The pedestrian desires a fast, direct, continuous, convenient route of access to chosen destinations.
- **Comfort.** The sidewalk or walkway should be comfortable to use. Gradients should not be too steep while the sidewalks or walkways should be paved with a suitable material. The sidewalk or walkway should have adequate width and a buffer should be available between the sidewalk and the roadway.
- **Environment.** Pedestrians prefer sidewalks and walkways that are attractive to use. Care should be taken in providing sidewalks and walkways that encourage walking.
- **Economy.** Sidewalks should be economical and provide the maximum benefit for their cost.

3.6. MINIMUM SIDEWALK AND WALKWAY WIDTH

Recommended minimum sidewalk and walkway widths are given in Table 3.1. Wider widths are required to provide greater capacity in areas with high pedestrian volumes, such as central business areas.

Many sidewalks have been constructed to a width of 1,2 m. This width is not adequate for two pedestrians to walk side-by-side, or to allow one person to pass another. A minimum width of 1,5 m is required for these purposes, although 1,8 m would be more desirable (as shown in Figure 3.2).

The following sidewalk and walkway widths are adequate for persons with disabilities (Public Rights-of-Way Access Advisory Committee, 2001):

- 1,5 m Width is desirable under normal operations. This width allows two wheelchairs to pass and a wheelchair to make a U-turn.
- 1,8 m Width is more desirable in areas with relatively high volumes of persons with disabilities.
- 1,2 m Width can be accepted over short distances where inadequate space is available, or across a driveway where it is difficult to maintain the desirable cross fall on the sidewalk and walkway.

Table 3.1: Minimum sidewalk and walkway width	
Description	Minimum width (m)
Sidewalks/walkways with buffer strip	
Minimum width	1,5
Desirable width	1,8
Buffer strip width	0,6
Sidewalks/walkways without buffer strip	1,8
Sidewalks in Business Centres	2,5 – 3,5m

3.7. PROTRUDING OBJECTS AND OBSTRUCTIONS

Protruding objects are potentially hazardous, and can cause bodily harm to persons, particularly to persons that have visual impairments.

A vertical clearance interval of 2,1 m should be provided below all elements that overhang a sidewalk or walkway, such as awnings, banners, tree branches, and road signs (as shown in Figure 3.2).

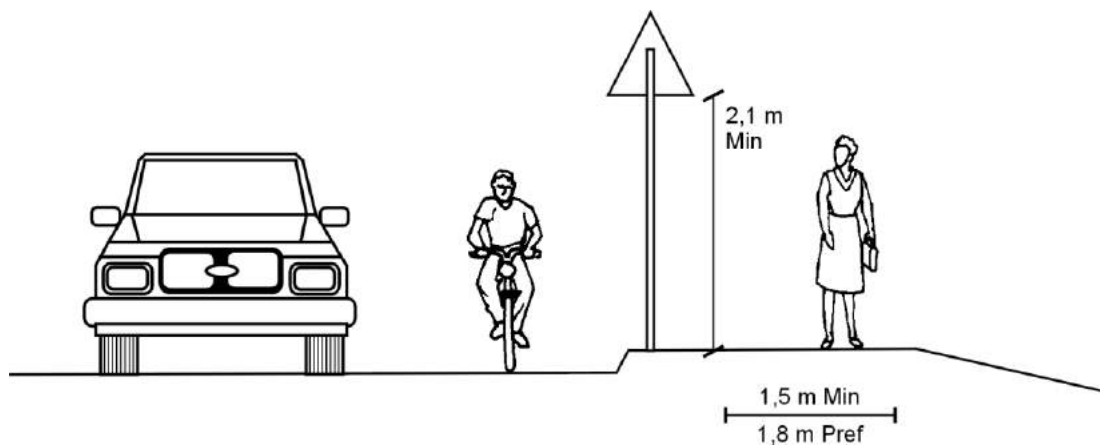


Figure 3.2: Sidewalk width and vertical clearance

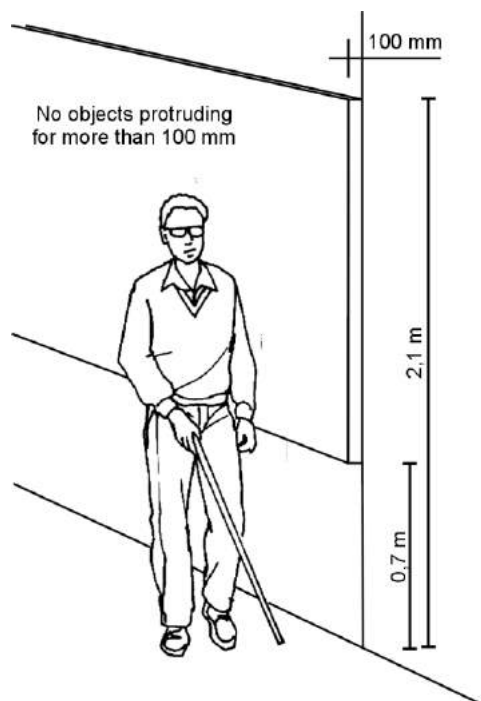


Figure 3.3: Protruding objects

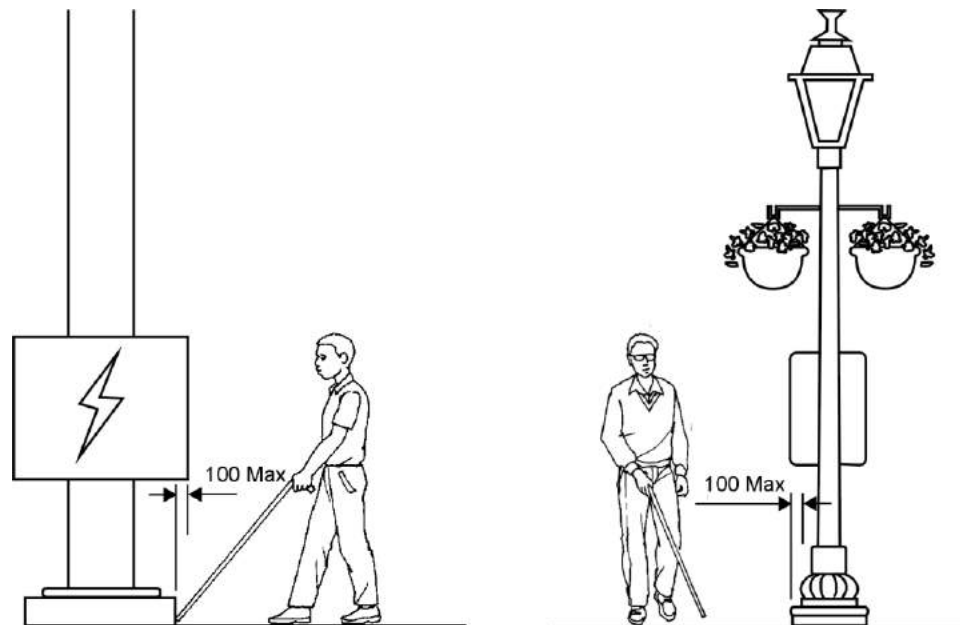


Figure 3.4: Post-mounted objects

To accommodate blind persons using a cane for guidance, it is recommended that no object (except handrails) should protrude more than 100mm horizontally into the sidewalk or walkway space if such object is located between 0,7 m and 2,1 m from the pavement surface, as indicated in Figure 3.3. These requirements are also applicable to posts or pylons on the road surface, as indicated in Figure 3.4.

Typical cane techniques do not locate protruding objects extending into the travel path above a height of about 0,7m. The techniques employed by blind persons are as follows:

- The touch technique, where the cane is arced from side-to-side and touches the ground at points outside both shoulders.
- The constant contact technique, where the cane is slid from side-to-side in a path extending just beyond both shoulders.
- The diagonal technique, where the cane is held in a stationary position diagonally across the body with the tip just above the ground at a point outside one shoulder and the handle extended to a point outside the other shoulder.

3.8. PEDESTRIAN LEVELS OF SERVICE

The minimum sidewalk and walkway widths given in the previous section are appropriate when pedestrian volumes are low. Wider sidewalks and walkways are required when pedestrian volumes are high.

Although wider sidewalks and walkways are desirable to accommodate higher pedestrian volumes, care should be taken to provide excessively wide paths – expansive pavement and empty-looking walkways may seem uninviting to pedestrians (Otak, 1997).

The sidewalk and walkways widths to accommodate higher pedestrian volumes can be established using the Highway Capacity Manual (TRB 2000). This manual gives a detailed procedure for establishing a level of service for pedestrian walkways as a function of various parameters, including sidewalk and walkway width. The following service levels are acceptable for sidewalks and walkways (South African Roads Board, 1992):

- Level B for residential areas.
- Level C for general conditions in city centres or high usage areas.
- Levels D and E for local or temporary circumstances where severe peaking occur.

A very important element of sidewalks is the provision of adequate queuing space at junctions, particularly signalised junctions. The Highway Capacity Manual also provides procedures for establishing the level of services for such queuing spaces. Where insufficient queuing space is available, measures such as the following can be considered to widen the queuing areas:

- Relocate or consolidate street furniture to keep obstructions to an absolute minimum.
- Create a “hawker or vending restricted area” at junction corners.
- Provide kerb extensions to increase queuing area.
- Setback buildings at corners or provide road reserve corner splays to widen sidewalks.

3.9. SEPARATION (BUFFER)

Sidewalks should be separated from the adjacent roadway by a buffer strip as shown in Figures 3.5a and 3.5b. This buffer strip can be a planting strip or a landscaped area in which elements such as street trees, signal and utility poles, road signs, street lights, hydrants, parking meters, grates and other street furniture can be provided.

The buffer strip has a number of important advantages (Otak, 1997):

- It provides a greater level of safety and comfort to users of the sidewalk.
- It provides a buffer against vehicular noise.
- It provides a buffer against water splash from passing vehicles – which is of great practical benefit to pedestrians.
- It increases the aesthetic appeal of the sidewalk and improves the pedestrian environment.
- If wide enough, it can be planted with larger trees that will provide shade and wind protection.
- It provides a visual guide to pedestrians, particularly for those that have visual impairments.

The buffer strip has the disadvantage that it requires maintenance when vehicles park or stop on the verge of the road. This is particularly a problem when no provision has been made for parking,

or where no facilities have been provided for buses or mini-buses. In such cases, the buffer strip is quickly eroded by vehicles, resulting in an uneven surface between the road and the sidewalk. This problem is best addressed by providing specific parking and stopping facilities for vehicles. Where this is not possible, a barrier kerb can be provided to prevent vehicles stopping on the side of a road.

The following minimum widths of the buffer strip are recommended:

- 0.6 m Minimum where inadequate road reserve is available (Public Rights-of-Way Access Advisory Committee, 2001). The 0,6 m minimum is also required where on-street parking is provided as indicated in Figure 3.6.
- 1,2 – 1,5 m Preferred minimum where road reserve is available (Otak, 1997; Zegeer, Seiderman, et al, 2002).
- 1.5 m Minimum when trees are to be planted between the sidewalk and the roadway.
- 3.0 m Desirable minimum where space is available (South African Roads Board, 1992).

The safest location for a sidewalk in both urban and rural areas in terms of traffic accidents is at the edge of the road reserve. In rural areas, however, this location is not popular with pedestrians because of two reasons. The first is due to security concerns and the second is that such a sidewalk often follows all the variations in the natural ground level, which does not make for comfortable walking in rolling or mountainous terrain. Under such circumstances, it may be necessary to locate the sidewalk nearer to the roadway as shown in Figure 3.7.

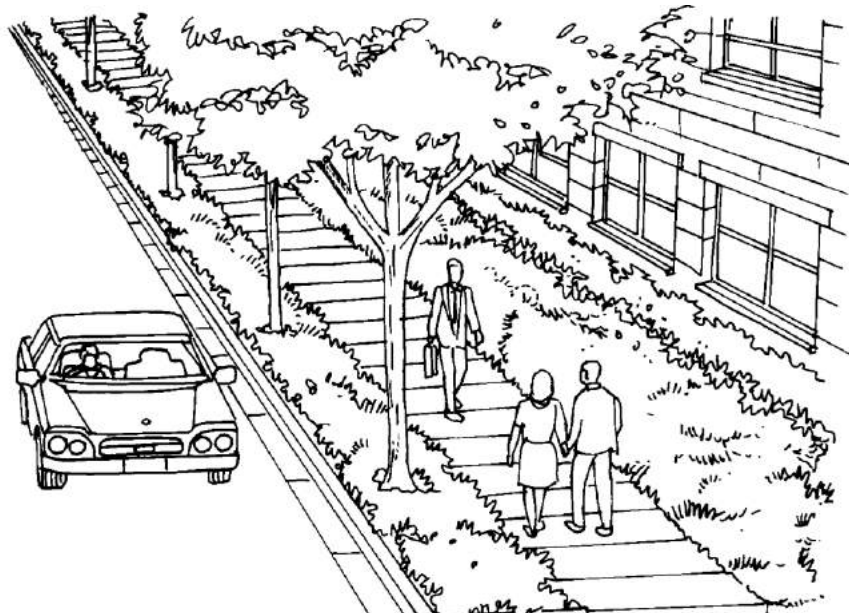


Figure3.5a: Buffer strip in a residential area

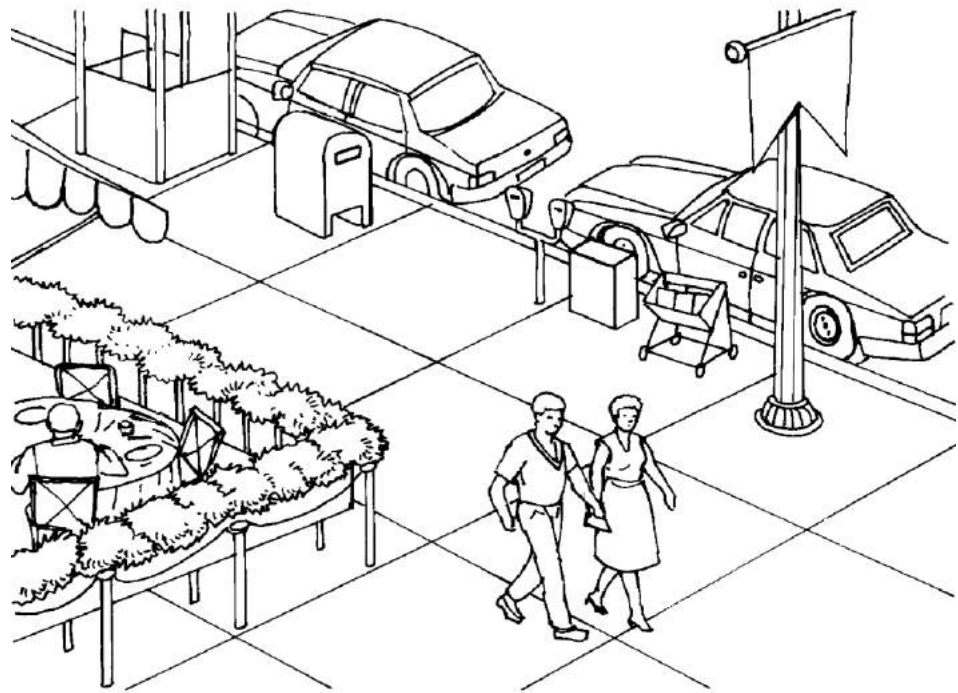


Figure3.5b: Buffer strip in a commercial district

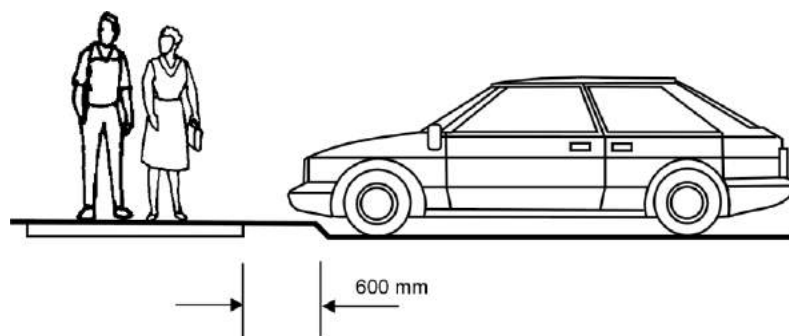


FIGURE 3.6: Accommodation of parking overhang

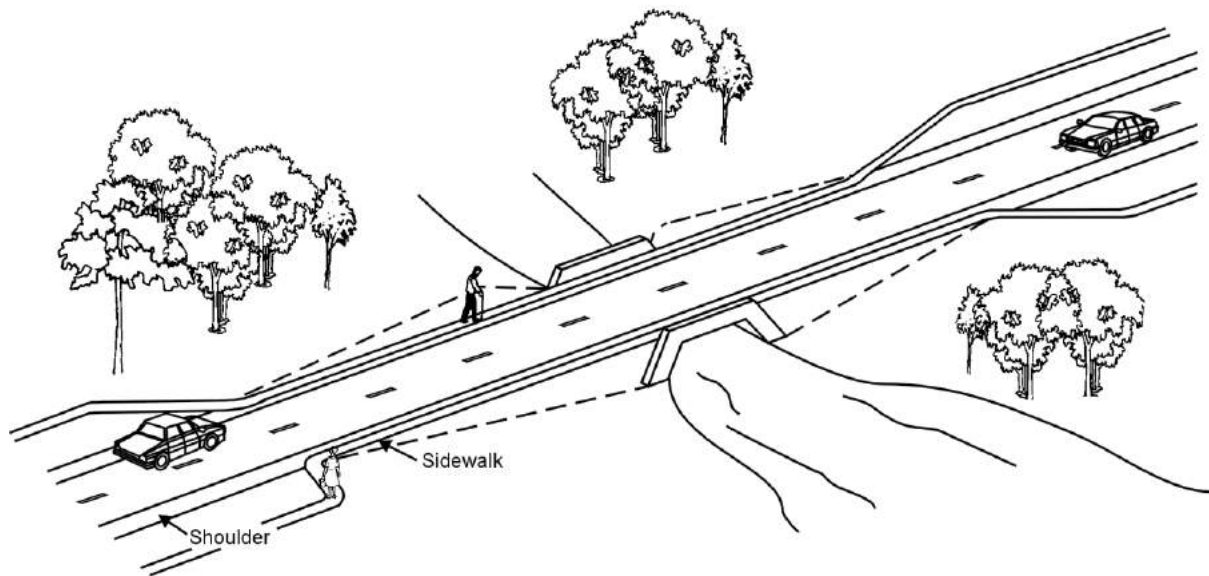


Figure 3.7, Reduction of buffer strip in rural areas to accommodate cuts and fills

3.10. SIDEWALK AND WALKWAY CROSS FALL

It is recommended that sidewalks and walkways should be designed for a maximum cross fall of 2% (1:50). Such cross fall facilitates positive drainage to the adjacent planting buffer, and accommodates persons with disabilities.

Excessive cross fall is a major barrier to travel along sidewalks and walkways for persons who use wheelchairs, crutches, braces or who have lower-limb prosthesis or any person who have gait, balance or stamina impairments (U.S. Architectural and Transportation Barriers Compliance Board, 1999). Energy that might otherwise be used for forward travel must be expended to resist the perpendicular force of a cross fall. This impedes forward progress on an uphill gradient, and could compromise control and balance in downhill travel and on turns. The problems are illustrated in Figure 3.8.

Excessive cross slopes often occur on driveway or alleyway aprons. This problem can be addressed by constructing aprons as shown in Figure 3.9. The apron in the figure consists of three parts - the apron on the roadway side, the sidewalk, and the apron on the property side. The two outer aprons can be constructed with a steeper gradient to accommodate the flatter cross fall on the sidewalk.

3.11. SIDEWALK AND WALKWAY GRADIENT

Recommended standards for sidewalk and walkway gradients to accommodate persons with disabilities are given in Table 3.2. The maximum gradient on the sidewalk and walkway is 5%, unless the adjacent roadway gradient is steeper and there is no alternative alignment for the walkway.

Abrupt changes in the level of a sidewalk or walkway can create surface bumps that make passage difficult for pedestrians, particularly those with disabilities. It is therefore recommended that pavement levels should not change by more than 6 mm over a distance of 0.6m.

Table 3.2: Gradient requirements for persons with disabilities	
Description	Maximum
Gradient of sidewalk or walkway	
Road gradient less than 5%	Max 5%
Road gradient more than 5%	Road gradient
Transition sections (e.g. kerb ramps)	8,3% (1:12)
Public Rights-of-Way Access Advisory Committee (2001)	

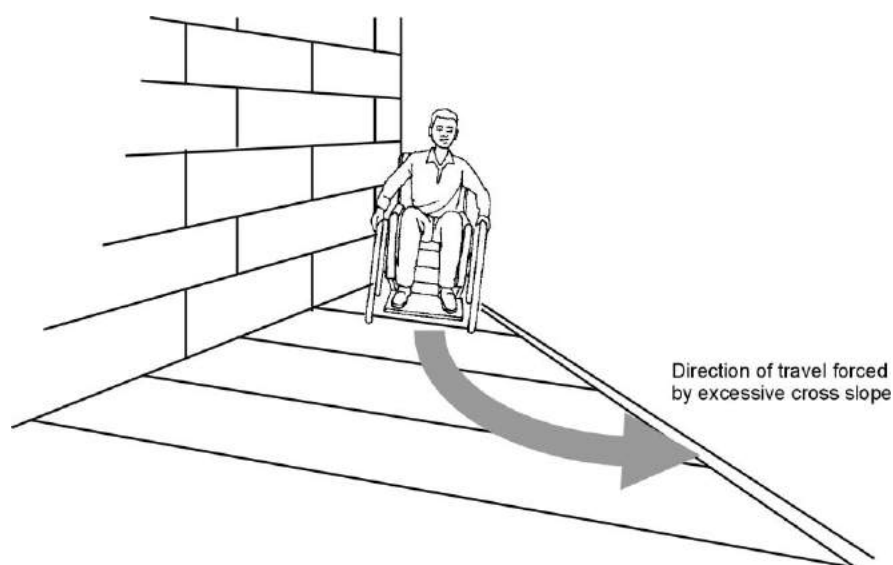


Figure 3.8: Effect of excessive cross slope on wheelchair operations

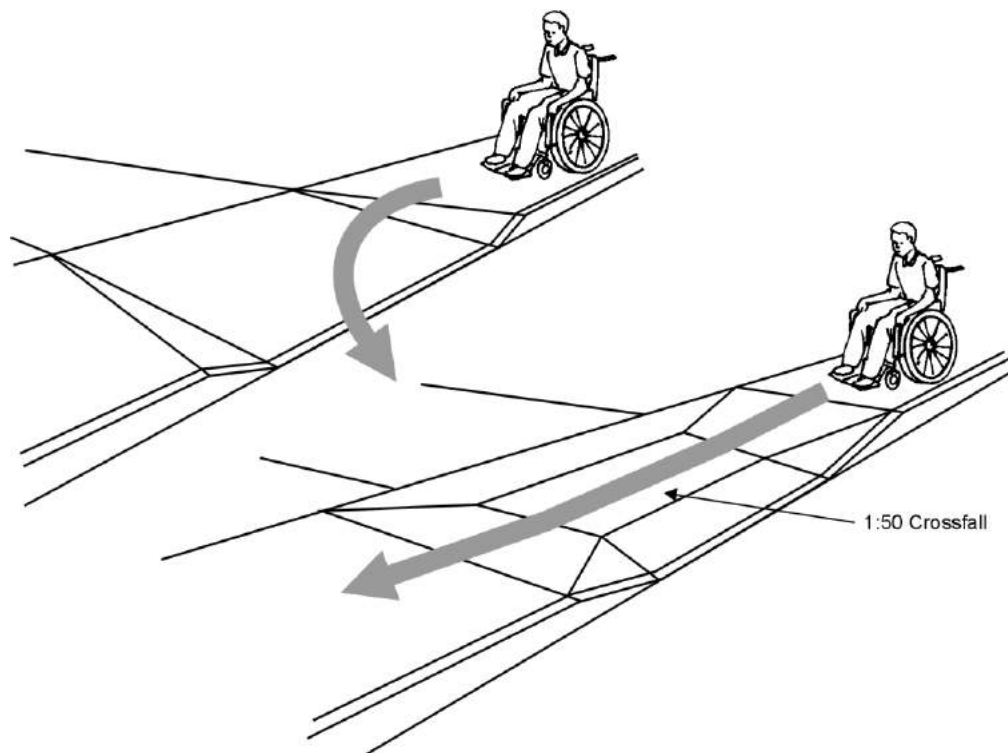


Figure 3.9: Maintaining maximum cross fall across a driveway

3.12. SIDEWALK AND WALKWAY PAVEMENTS

In general, sidewalks and walkways should be paved with a hard-surface material. The surface should meet the following criteria:

- Stable and firm.
- Slip resistance.
- Good level of drainage. The sidewalk and walkway should be kept free of puddles and water accumulation that could become slippery.
- Relatively free of irregularities.
- Free of obstructions.

Irregularities could result in people tripping and falling. For persons with disabilities, irregularities such as those shown in Figure 3.10, can cause the following problems:

- For persons in wheelchairs, irregularities in the pavement surface may cause jerks in the persons body that could be painful and result in muscle spasms.
- For persons with crutches, irregularities may cause problems in the placement of the crutches.
- For blind persons using canes, a sufficiently large irregularity may catch the tip of the cane, which could be potentially dangerous to such persons.

Sidewalks and walkways in urban areas are typically constructed with concrete, which provides a smooth, long lasting and durable finish that is easy to construct and maintain.

Asphalt can be used as an alternative to concrete, but it generally has a shorter life. Asphalt sidewalks and walkways are more susceptible to deterioration by vegetation and requires more frequent maintenance (Otak, 1997). In areas where the sidewalk or walkway is aligned adjacent to shallow-rooted trees, root damage to the pavement can more readily occur.

The use of decorative material such as bricks or cobblestones can improve the aesthetic quality of the sidewalk or walkway, but they may cause hardship for persons with disabilities. The pavements are also more difficult to maintain over the long term.

Creative alternatives that may be considered for pavements include coloured concrete (stamped to look like brick), or a concrete pavement with a brick trim which preserves the decorative quality of brick, but which is an easier surface to negotiate (Public Rights-of-Way Access Advisory Committee, 2001).

In rural areas, alternative surfacing, such as compacted crushed rock or unpaved compacted earth may be acceptable for certain sidewalks and walkways. Such surfaces, however, are not typically accessible to persons using wheelchairs unless very smooth and well compacted.

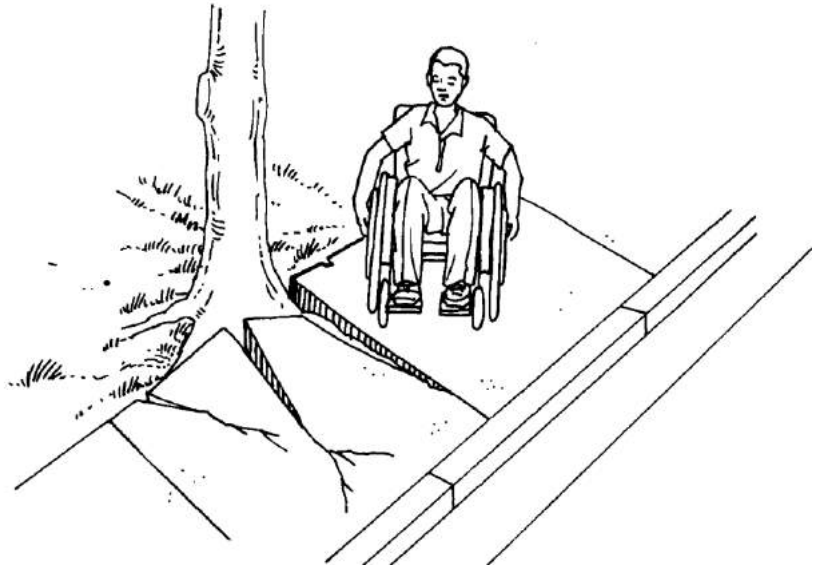


Figure 3.10: Pavement irregularities

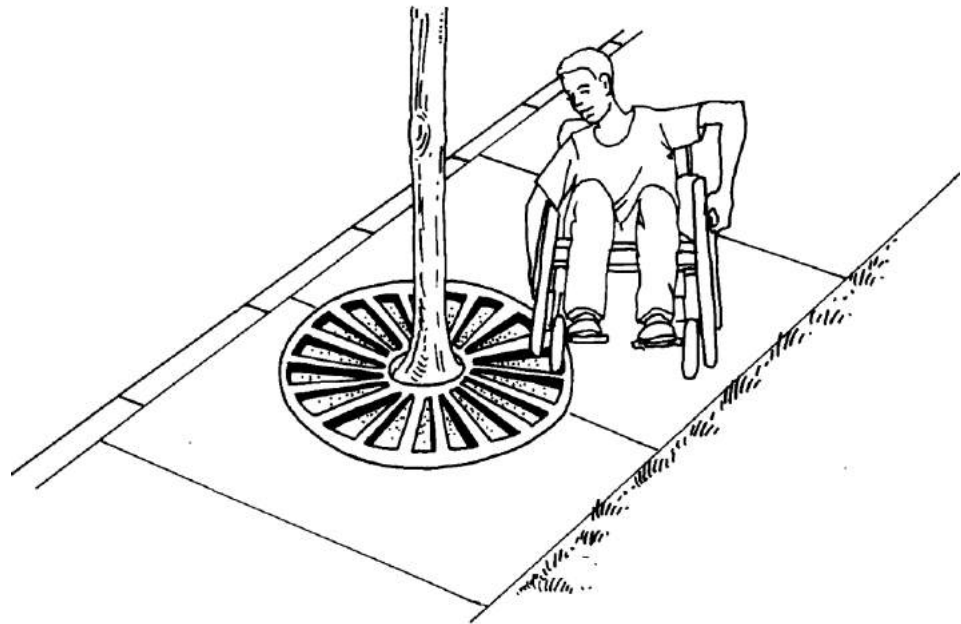


Figure 3.11: Gratings with wide openings

3.13. GRATINGS AND OTHER COVERS

Gratings and other covers that have openings greater than 12 mm in size should not be placed on a sidewalk or walkway. Such gratings and covers can be dangerous to pedestrians -, particularly to persons with disabilities.

Grating openings can capture the end of a crutch or cane, or even the small front wheels of a wheelchair, which could result in a person tripping and even falling (see Figure 3.11). When wet, grids can also become slippery, which can further lead to hazardous conditions. Drainage grates and inlets are therefore best located outside the sidewalk or walkway.

3.14. SIDEWALK AND WALKWAY EDGES

Sidewalks and walkways should preferably have well defined edges in order to provide directional orientation. This is particularly important for persons with visual impairments that use such edges as both visual and tactile boundaries (by means of walking canes) for direction.

Steep drop offs on sidewalks and walkways are potentially hazardous, particularly for persons with disabilities. A level area of a minimum 1,2 m wide is recommended for the sides of the sidewalk or walkway.

Where steep drop offs occur along sidewalks, edge protection should be provided by means of handrails or other measures. Protection should be considered where there is a steep slope of a vertical drop adjacent to the sidewalk.

3.15. HANDRAILS

Handrails on sidewalks and walkways should be considered where (Otak, 1997):

- A vertical drop or more than 0,8m with a side slope steeper than 1:2 occurs within 1,2m from the edge of the sidewalk or walkway.
- A vertical drop or more than 1,8m with a side slope steeper than 1:3 occurs within 1,2m from the edge of the sidewalk or walkway.

The recommended height for railings adjacent to sidewalks and walkways to provide protection from vertical drops is 1,0 m. Railings should be designed with no opening large enough to allow a passage of a 100 mm diameter sphere.

3.16. SIDEWALKS AND WALKWAYS ACROSS BRIDGES

Sidewalks and walkways should be continued across any bridge located on a road or street. Where it is likely that sidewalks will be provided on a road in future, space should be provided in the bridge design for pedestrians.

The minimum width of the footway on a bridge structure should be 1,2 m. It is, however, preferable to continue the width of the sidewalk or walkway across the bridge.

Examples of sidewalks across bridges are shown in Figures 3.12a and 3.12b. In Figure 3.12a, the sidewalk has been integrated into the design of the bridge, while Figure 3.12b shows an example of a sidewalk that has been added to an existing bridge.

Care must be taken that the approach sidewalks to a bridge provide safe and relatively direct access to the footway on the bridge. This may require the erection of barriers to channelise pedestrians onto the bridge.

A flush roadway shoulder should never terminate in a sidewalk on a bridge. Where such installations exist and their removal is not economically justifiable, the ends of the sidewalk should be protected by a guardrail.

3.17. SHARED-USE SIDEWALKS AND WALKWAYS

According to the South African National Road Traffic Act (Act No. 93 of 1996), a sidewalk is that area or the road verge intended for the exclusive use of pedestrians. Cyclists or other traffic are therefore not allowed to use sidewalks for travel, *unless sidewalks are specifically signed for such purpose*.

The shared use of specifically sidewalks by pedestrians and cyclists should not generally be allowed due to the following reasons (Oregon Department of Transport, 1995; Otak, 1997):

- Conflict between pedestrians and cyclists. Pedestrian movement is often unpredictable, especially those of children. Pedestrians cannot also always predict the path that will be followed by an oncoming cyclist.
- Conflict between cyclists and vehicles pulling out of driveways and intersections. Sight distance along sidewalks is often restricted at driveways and at intersections.

- Sight distance on sidewalks and walkways may be restricted due to obstructions such as plants, landscaping, signs, etc.

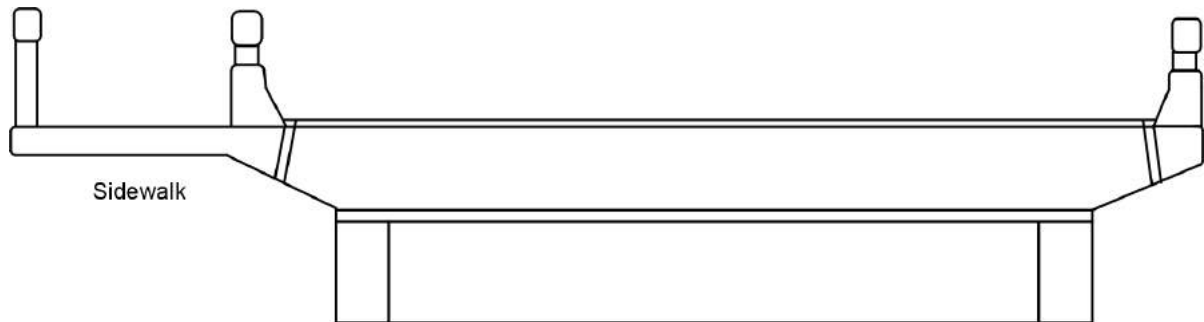


Figure 3.12a, Sidewalk integrated with bridge design

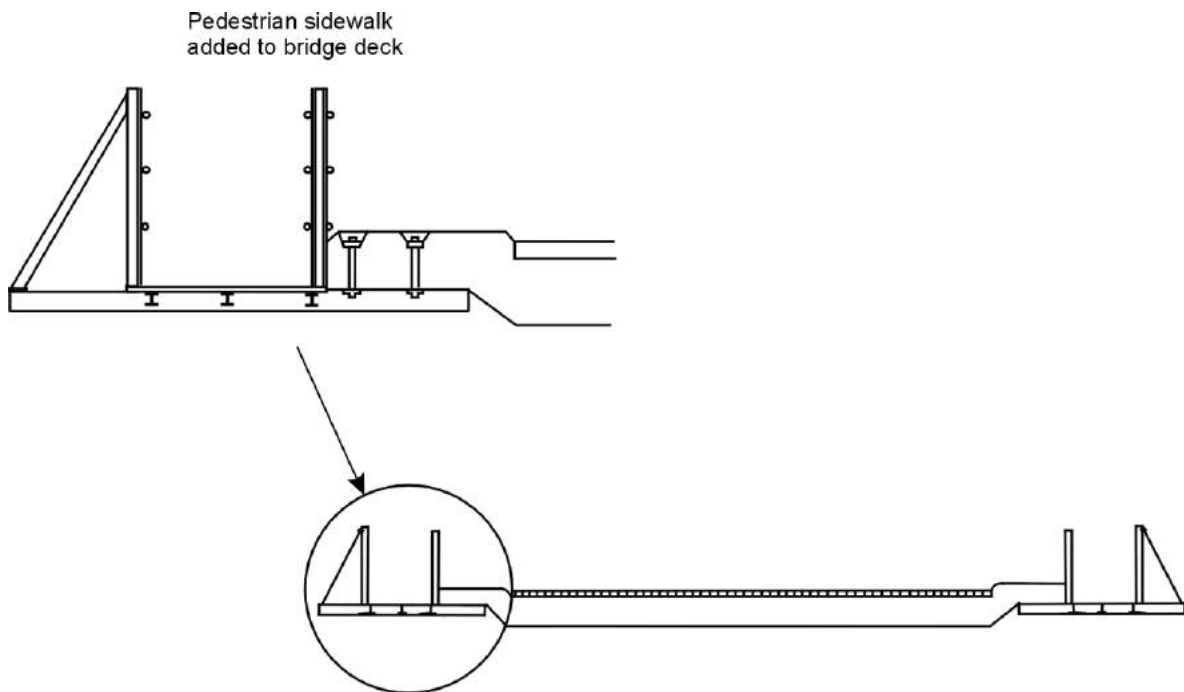


Figure 3.12b: Pedestrian sidewalk added to an existing bridge deck

Walkways can be used by both pedestrians and cyclists, but such design is also not desirable because of the potential for conflicts. Children are particularly at risk on shared-used walkways because their movements tend to be unpredictable, both as a pedestrian and a cyclist. Children may change direction unexpectedly in front of another person, which could result in accidents.

When walkways must be shared by pedestrians and cyclists, they should preferably be designed at higher standard than normal walkways. Particular attention should be given to the following (Otak, 1997):

- Provision of a wide pavement that can provide adequate separation between pedestrians and cyclists, as shown in Figure 3.13. The pavement should be preferably 3,7 m wide or 3,0 m minimum. Shoulders 0,6m wide should also be provided on both sides as stopping and resting areas and to provide for passing.
- Avoidance of view obstructions on the side of the trail. Vegetation should be controlled and cleared where necessary to provide sufficient sight distance.

3.18. SEGREGATED SHARED-USE WALKWAYS

Segregated shared-used walkways where segregated paths are provided for pedestrians and cyclists. Pedestrians and cyclist utilise separate but parallel paths. The division between the paths may be a physical separator or a single continuous white channelisation line. The two paths can also be of different colour. Such segregated walkways are preferred over walkways in which no segregation is provided.

According to the Road Traffic Signs Manual, Signs R113 and R115 may be used to indicate that a shared-use walkway is a segregated one. Painted symbols depicting a pedestrian and a cyclist should be applied to the surface of the roadway to indicate which portions each should use, as shown in Figure 3.14.

The correct handed versions of the cyclists and pedestrians only signs should be used for shared-use facilities. The signs should be displayed at the beginning of the walkway, and repeated at regular intervals along to the path to indicate to other traffic that it is a pedestrian and cyclist only facility.

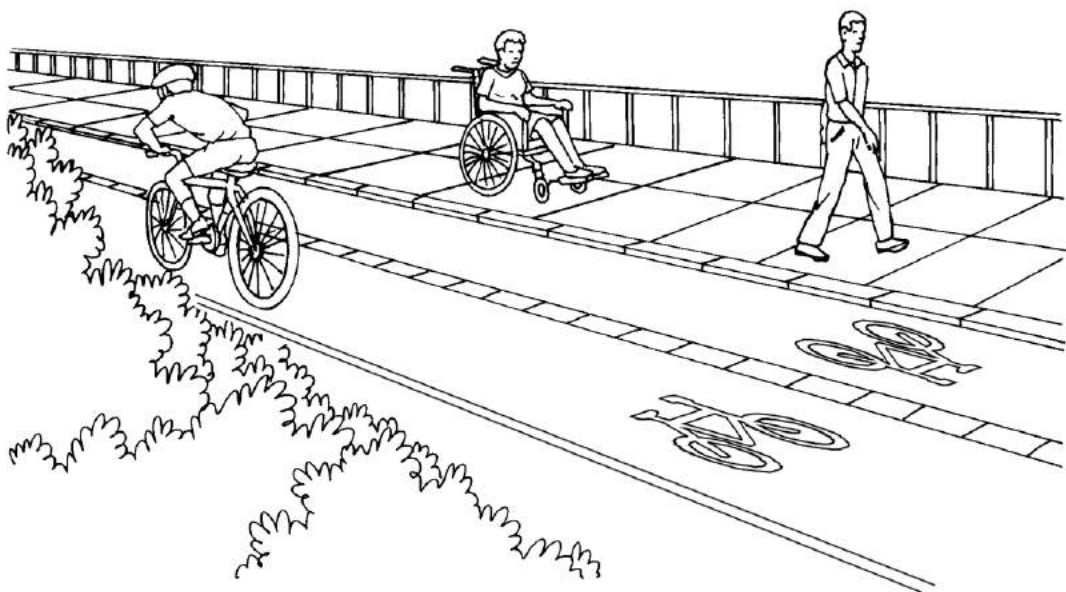


Figure 3.13: Shared-used walkways

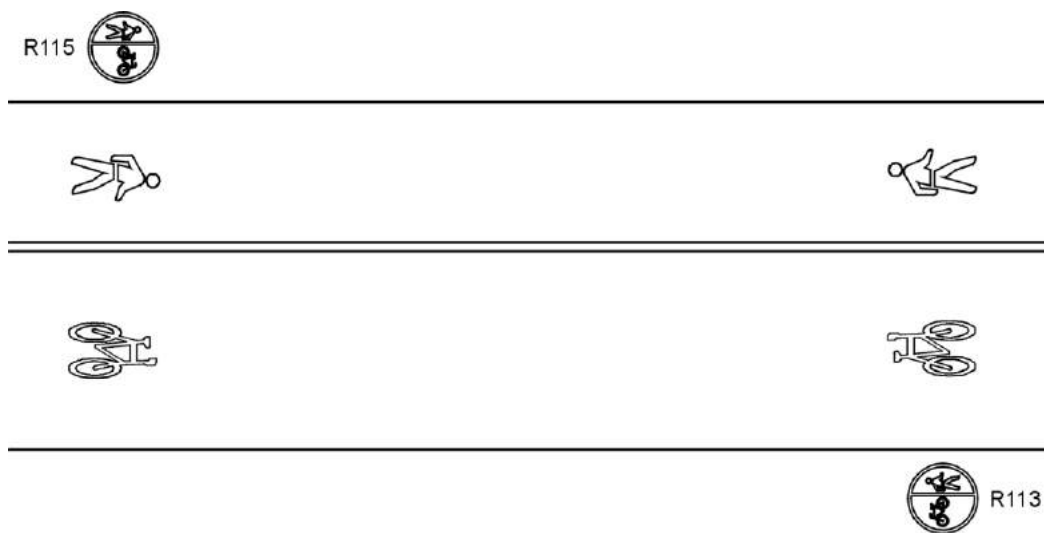


Figure 3.14: Road signs and marks on segregated shared walkway facilities

3.19. PRIORITISING SIDEWALKS

A method is described below which may be used for the prioritising of sidewalks. The method has the advantage that, although it can utilise traffic data, it can be used with a minimum amount of traffic information.

A point rating system is used in the method. The method assumes that the cost of providing sidewalks does not vary significantly from location to location. The method calculates an index that provides an indication of the potential economic benefits of a sidewalk. The potential economic benefits are assumed to accrue mostly from a potential reduction in number of accidents, which is assumed to be related to the following factors:

- Volume of pedestrians
- The level of experience and disability of pedestrians
- Volume of vehicular traffic
- Vehicular speed
- Level of exposure to vehicular traffic
- Provision of street lighting

According to the point rating system, priority should be given to a location that has the highest priority index. The index for a particular improvement is calculated by means of the following formula:

$$P_i = F_p \times (1 + P_x \times F_x) \times F_t \times F_v \times F_e \times F_l$$

in which:

- P_i Priority index for a particular improvement (numbered i).
- F_p Factor for pedestrian volume.
- P_x Proportion of users with special needs.

F_x	Factor for users with special needs.
F_t	Factor for traffic volume.
F_v	Factor for vehicular speed.
F_e	Factor for level of exposure.
F_l	Factor for road lighting.

3.19.1. Factor F_p : Pedestrian and/or bicycle volume

Provision is made for the average number of persons that are expected to use the sidewalk per day (24 hours). Where daily traffic counts are available, the factor can be calculated using the counts, as follows:

$$F_p = \text{Average daily count (24 hours)} / 1000$$

Where counts are not available, the factor can be established from a qualitative evaluation of the volume. The following table may be used for this purpose:

Factor for pedestrian count	
Number of pedestrians per day	Factor
Locations where very few persons will use the facility	0.1
Locations where some (few) persons will use the facility.	0.3
Locations where higher volumes of persons will use the facility	0.5
Locations where high volumes of persons will use the facility.	1.0
Locations where very large volumes of persons will use the facility	5.0

3.19.2. Factors P_x and P_x : Persons with special needs

Persons with special needs include those that are inexperienced, such as children, as well as persons that require special assistance, such as persons with disabilities and the elderly. Two factors are required to account for these persons:

- P_x : The average proportion of persons with special needs. This proportion can be obtained from counts or can be estimated.
- F_x : A factor which accounts for persons with special needs, allocated in accordance to the following table.

Factor for persons with special needs	
Group	Factor
Older children (secondary schools)	1.0
Elderly persons	3.0
Young children (primary schools)	5.0
Persons with severe disabilities	7.0

3.19.3. Factor F_t : Traffic volume

Provision is made for the average number of vehicles travelling along the road per day and which are in conflict with pedestrians or cyclists (AADT). Where traffic counts are available, the factor can be calculated by means of the following formula:

$$F_t = \text{Average daily vehicular count (24 hours)} / 1000$$

Where counts are not available, the factor can be established from a qualitative evaluation of the traffic volume. The following table may be used for this purpose:

Factor for traffic volume	
Number of vehicles per day	Factor
Roads with very few vehicles, typically very low order roads	0.1
Roads with some vehicles, typically serving residential areas	0.5
Roads with higher volumes of traffic, typically residential collectors	5.0
Roads with high volumes of traffic, typically minor arterials	10.0
Roads with very high volumes of traffic, typically major arterials	25.0

3.19.4. Factor F_v : Vehicle speed

Vehicle speed is an important factor in accidents involving pedestrians and cyclists. The factor for vehicle speed can be calculated using the following formula:

$$F_v = (\text{Average traffic speed}/100)^4$$

Where speed measurements are not available, the average speed can be estimated. The speed limit may also be used on roads where vehicles keep the speed limit.

3.19.5. Factor F_e : Exposure to traffic

Exposure to traffic is an important factor in traffic accidents. Greater priority should be given to locations where pedestrians have to walk near or on the roadway. Factors for exposure are given in the following table.

Factor for level of exposure to traffic	
Level of exposure	Factor
Pedestrians walk on unpaved footpaths adjacent to road	1.0
Pedestrians walk on road shoulder wider than 2 m.	1.0
Pedestrians walk on road shoulder between 1 and 2 m wide.	2.0
Pedestrians share road with vehicles.	5.0

3.19.6. Factor F_1 : Road lighting

There is a greater need for improving pedestrian and cyclist facilities at locations where no or poor lighting is provided. The factor to account for road lighting is given in the following table.

Factor for road lighting	
Available road lighting	Factor
Adequate road lighting	1.0
Poor road lighting	1.2
No road lighting provided	2.0

C. Pedestrian and bicycle ways

4. Ramps and stairs

4.1. INTRODUCTION

Pedestrian and particularly bicycle routes with ramps and stairs should be avoided where possible. Ramps are preferred over stairways, but walk- and bicycle ways with flat gradients are generally preferred.

4.2. RAMPS

A ramp is a short walkway with a steep gradient. Walkway gradients should preferably not exceed a maximum of 1:20 (5%). If the grade must exceed this maximum, a ramp can be provided over a short length of the walkway (U.S. Architectural & Transportation Barriers Compliance Board, 1998).

According to the National Building Regulations (SABS, 1900; Freeman, 1985), the maximum gradient on a ramp is 1:12 (8,3%). Where this gradient is not feasible, a gradient of 1:10 (10%) can be accepted, but the rise of the ramp should then be restricted to a maximum of 400 mm.

The National Building Regulations (SABS, 1900; Freeman, 1985) requires that a landing must be provided every 1,5 m of vertical rise. At a gradient of 1:12, this is equivalent to a maximum ramp

length of 18 m. A maximum length of 9 m, however, is preferred to accommodate persons with disabilities (U.S. Architectural & Transportation Barriers Compliance Board, 1998).

The minimum trafficable surface on a ramp or landing may not be less than 1,1 m wide according to the National Building Regulations. A wider width of 1,5 m, however, is generally preferable.

The landing may not be shorter than 1,2 m according to the National Building Regulations. A longer length of 1,5 m would, however, generally be preferred. According to the Regulations, when a landing must be provided at entrance doors to any building, the minimum length of the landing is 2,0 m if the doors opens towards the ramp, and 1,8 m if it opens away from the ramp.

4.3. STAIRS

Stairs are efficient for those able to negotiate them. Ramps have the disadvantage that they require a long length to traverse a small vertical height. Stairs, however, have the disadvantage that they cannot be used by disabled persons and they pose a danger of people falling or tripping.

Stairs should preferably only be provided when an alternative ramped route is available for use by disabled persons.

According to the National Building Regulations (SABS, 1900; Freeman, 1985), stairs must meet the following minimum requirements:

- The rise of any step may not exceed 200 mm.
- The width of the tread may not be less than 250 mm.
- The variation in the above dimensions along a flight of stairs may not exceed 6 mm.
- The balustrade may not be less than 1 m high

Preferred dimensions for stairs, however, are shown in Figure 4.1. Stair treads should preferably not be less than 280 mm wide, while the preferred maximum height is 185 mm. (U.S. Architectural & Transportation Barriers Compliance Board, 1998; Otak, 1997). Risers should however not be less than 110 mm high (Otak, 1997).

The following are a number of important considerations when designing stair treads and risers (Otak, 1997; Untermann, 1984):

- Public stairs should not be constructed narrower than 1,5 m.
- There should not be fewer than three treads to avoid the hazard of one or two steps not being seen. The top step may be flush with the continuing pavement, but should match other treads in finish and material. A change in material is required to provide a visual warning to pedestrians.
- Stair nosing should be chamfered or have rounded corners to reduce the possibility of tripping.
- Bevelled shadow lines should be provided which helps to create a visual distinction between steps, as shown in Figure 4.1.

- Stairs should also be provided with a slip proof, high visual contrast strip on the leading edges of the stairs, as indicated in Figure 4.1. The strips should be provided over the full width of the stairs and be at least 50 mm wide.
- Treads should be pitched downgrade at a 2 percent slope for drainage.

Landings on stairs should be provided at regular and frequent intervals on stairs to provide resting areas for pedestrians and to break up the visual expanse of the stairway. Design requirements for landings are shown in Figure 4.2. The height between landings should not exceed a maximum of about 4,0 m (Otak, 1997) to minimise fatigue. A lower height of about 1,5 m, however, is desirable to allow a clear view of the next landing.

Landings should be long enough to allow minimum of three strides on the landing. A 1,5 m landing is a typical minimum length.

4..4. ACCOMMODATING BICYCLES ON STAIRS

Bicycle ramps can be provided immediately adjacent to a stairs as shown in Figure 4.3. The design allows the cyclist to walk up or down the stairs while pushing the bicycle on the ramp.

A ramp should be provide on both sides of the stairs to allow simultaneous ascend and descent of bicycles. A groove should be provided in the ramp to assist with the steering of the bicycle.

The angle of the ramp should not be steeper than 1:2 (50%), which means that the treads should be about twice as wide as the rise.

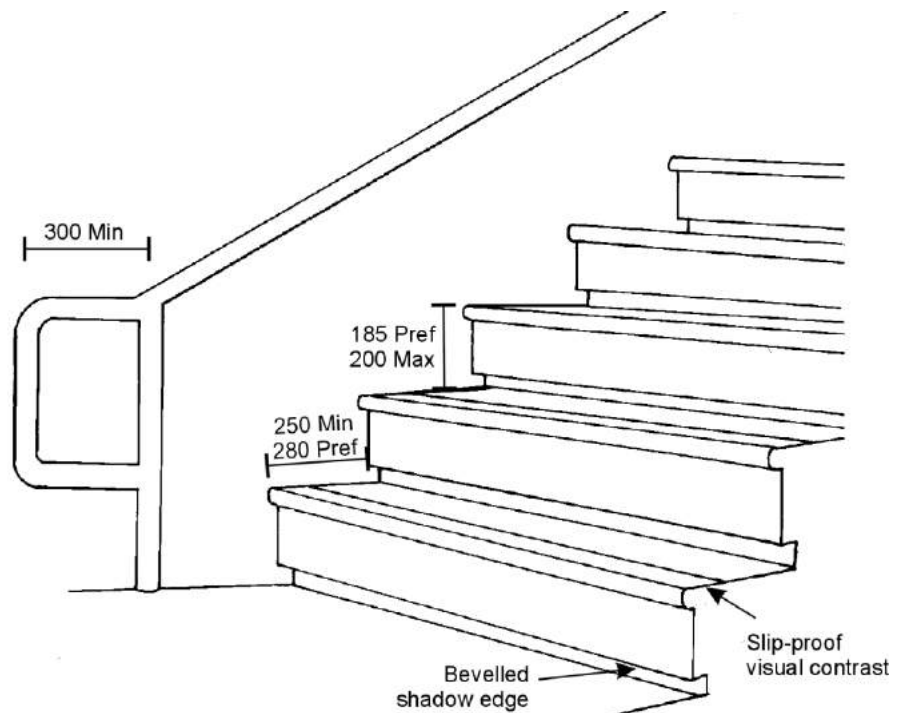


Figure 4.1: Stair dimensions and slip-proof visual contrast

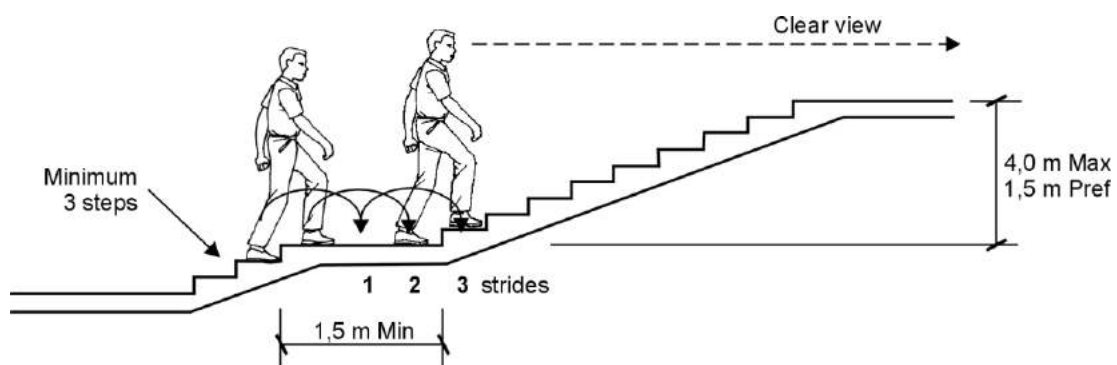


Figure 4.2: Landing placement for stairs

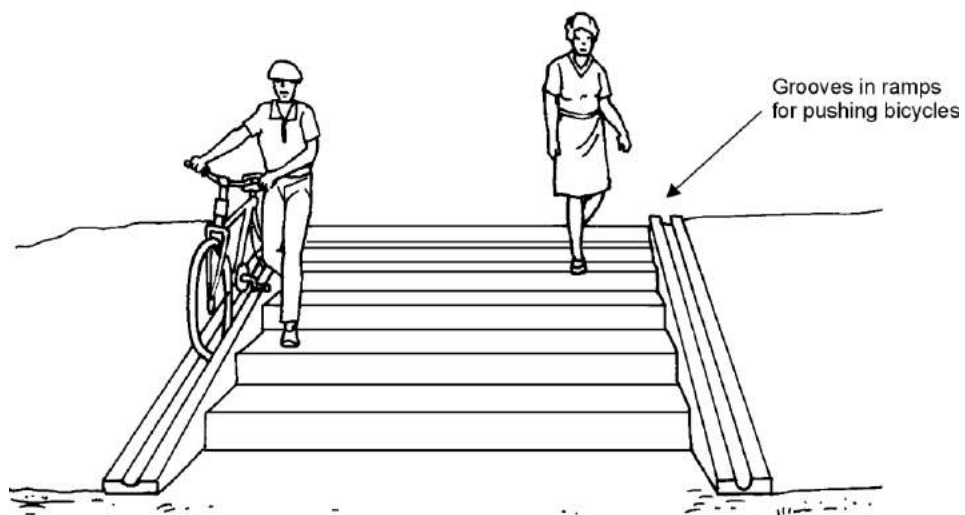


Figure 4.3: Bicycle ramp adjacent to stairs

C. Pedestrian and bicycle ways

5. Bicycle lanes

5.1. INTRODUCTION

Bicycle lanes (Class III bicycle ways) are cycle paths established within the carriageway of roads by marking specific lines of demarcation between areas reserved for bicycles and lanes to be occupied by motor vehicles.

The bicycle lane is an important facility that can be provided for cyclists. Bicycle lanes can significantly improve mobility and road safety for cyclists.

Bicycle lanes should be considered wherever there are significant numbers of cyclists. In urban areas, particularly, consideration should be given to the use of bicycle lanes on a greater scale. In areas where bicycle facilities have not been provided, programmes should be put in place to encourage cycling and gradually provide such facilities.

5.2. THE SHARING OF LANES BY CYCLISTS AND TRAFFIC

Bicycle lanes do not necessarily have to be marked on a road, and traffic lanes can be shared by traffic and cyclists. Such sharing should, however, be restricted to roads and streets carrying low

volumes of traffic at low speeds (maximum 50 km/h, but preferably not more than 40 km/h). With higher speeds and traffic volumes, shared lanes become less attractive for bicycle use.

Where cyclists must share lanes with traffic, wider outside lanes should be provided to minimise conflicts between cyclist and motor vehicles. The minimum width of such shared outside lanes should be 4,2 m (excluding kerb and gutter) on roads on which no parking is provided. On roads carrying higher volumes of traffic or on which speeds are higher, a wider lane of 4,5 to 5,5 m should preferably be used. Care must be taken in providing wider lanes as drivers may start utilising such lanes as two lanes of traffic.

5.3. ROAD SHOULDERS AS BICYCLE LANES

Road shoulders can be effectively utilised for cycling when speeds are low and there are relatively low volumes of cyclists and traffic. Such shoulders should be paved – it is unlikely that unpaved shoulders will be used by cyclists.

The minimum paved width of a shoulder suitable for cycling is 1,8 m. Narrow shoulders of 1,2 m can be used on low speed roads carrying low volumes of traffic. Wider shoulders of at least 3 m wide, however, are preferable. Wider shoulders are particularly required on steep grades and where a kerb or guardrail is provided.

Shoulders that are less than 1 m wide are not considered suitable for cycling.

5.4. MARKED BICYCLE LANES

Bicycle lanes have proven their value to all road users. Among their benefits in creating a smooth, efficient and safe sharing of roads are the following:

- Improved bicycle safety.
- Establishing the correct riding position for bicyclists.
- Sending a message to drivers that cyclists have a right to the roadway.
- Permitting bicyclists to pass queues of vehicles.
- Permitting motorists to pass bicyclists.

There are many secondary benefits of bike lanes as well:

- Providing added border width to the road.
- Enhancing highway drainage and reduce vehicle hydroplaning.
- Increasing turn radii at junctions.

Cycling on high speed roads can be dangerous, and bicycle lanes should therefore not be provided on roads with a speed limit of higher than 80 km/h. Lower speed limits of 70 or 60 km/h, however, are preferred.

5.5. MINIMUM BICYCLE LANE WIDTHS

When providing bicycle lanes, it is particularly important that the lanes should not be too narrow, and that the available lane width should be free of all obstructions (including drainage structures).

Recommended minimum bicycle lane widths are shown in Figure 5.1 and are as follows:

- A minimum width of 1,2 m is recommended on roads where parking is prohibited and where a paved shoulder or a kerb and gutter is provided. The 1,2 m width excludes the width of the shoulder or gutter.
- A minimum width of 1,5 m is recommended on roads where unpaved shoulders are provided, or where there is a drop-off between the roadway and the shoulder.
- Bicycle lanes adjacent to on-street parking are generally not recommended because of the danger of car doors being opened in front of oncoming cyclists. Where such bicycle lanes are provided, the width should be increased to a minimum of 1,8 m.
- A minimum width of 1,5 m should be provided at junctions, although a width of 1,8 m would be preferred. The wider width is required to accommodate two cyclists who stop side-by-side at the junction. The width of bicycle lanes at a junction should not be wider than 2 m to prevent vehicles using them.

5.6. AERODYNAMIC FORCES ON CYCLISTS

Aerodynamic forces from vehicles are an important safety concern to cyclists. A separation distance should therefore be provided on roads where vehicles travel at high speeds.

Figure 5.2 shows the critical speeds and distances at which cyclists are endangered by aerodynamic forces. No separation distance is required when speeds are below 60 km/h (typically on many urban streets). Separation distances are required on roads with higher speeds. For a heavy motor vehicle speed of 100 km/h, the separation distance between the cyclist and the motor vehicle should be 1,9 m as shown in Figure 5.2.

5.7. ONE-WAY VS TWO-WAY BICYCLE LANES

Bicycle lanes are normally provided as one-way bicycle lanes. Two-way bicycle lanes should normally not be provided since they tend to promote bicycle travel against the flow of vehicular traffic (Oregon Department of Transport, 1995; Otak, 1997).

Two-way bicycle lanes, however, can be provided on **one-way roads** under the following conditions:

- The bicycle lane nearest to the vehicular traffic must travel in the same direction as the vehicular traffic.
- Adequate provision has been made for the bicycle lanes at junctions.
- No driveways are located on the side of the road on which the bicycle lanes are provided.
- No parking is provided adjacent to the bicycle lanes.

5.8. BICYCLE LANE SIGNS AND MARKS

Required bicycle lane signs and marks are shown in Figure 5.3. The following signs and marks must be provided:

Pedestrian and Bicycle Facility Guidelines

- The CYCLE LANE RESERVATION regulatory sign R304.
- EXCLUSIVE USE LANE LINE marking RM9 used with SYMBOL marking RM17.11.

In addition to the above road signs and marks, bicycle lanes can be pigmented to another colour. Such pigmentation assists in marking the bicycle lanes, and has the added advantage that it gives the effect that the overall roadway width has been decreased, which may result in drivers reducing speeds. Such treatments would be desirable on roads where speed studies indicate that drivers exceed the speed limit.

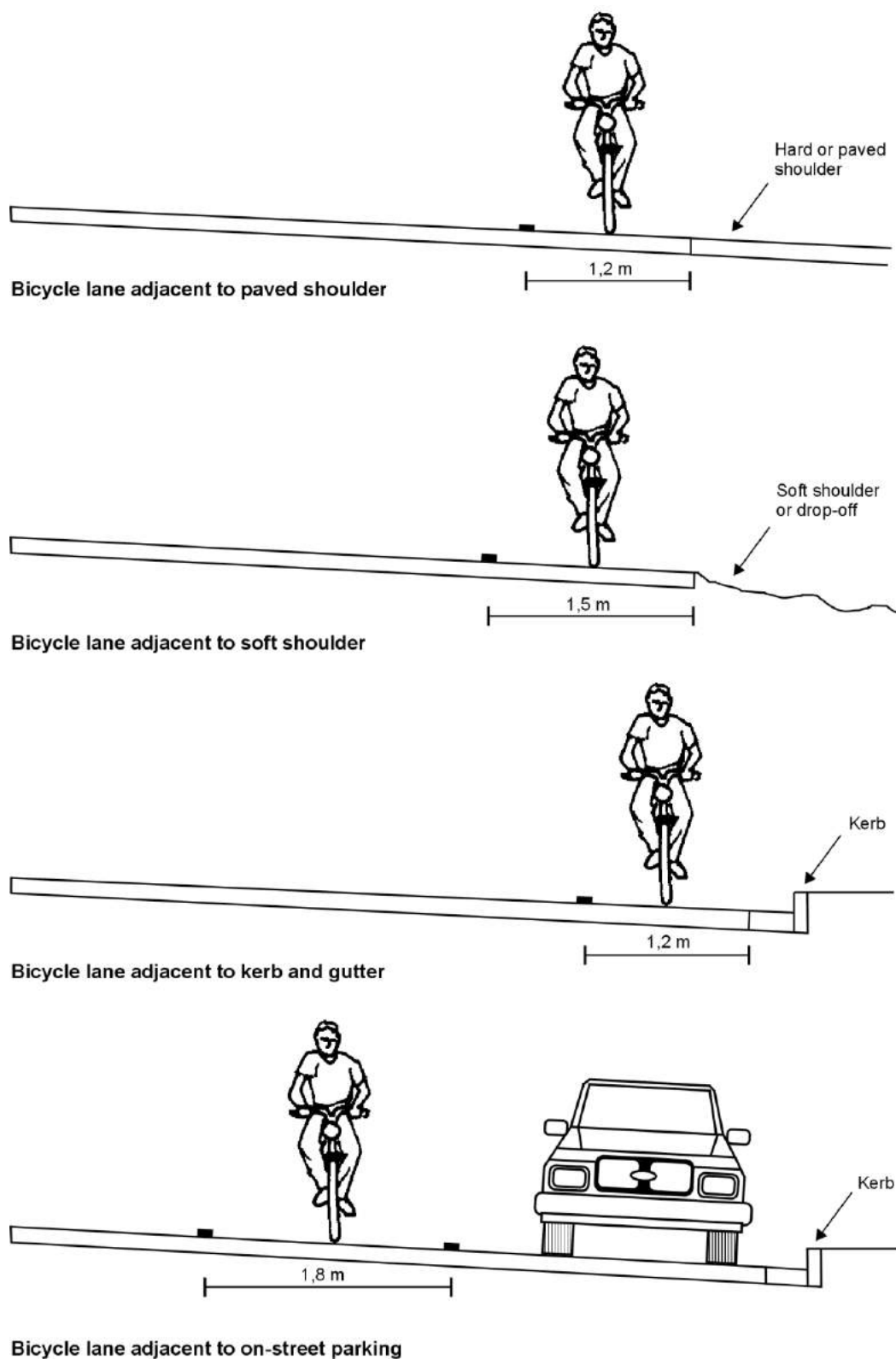


Figure 5.1: Minimum bicycle lane widths (one-way lanes)

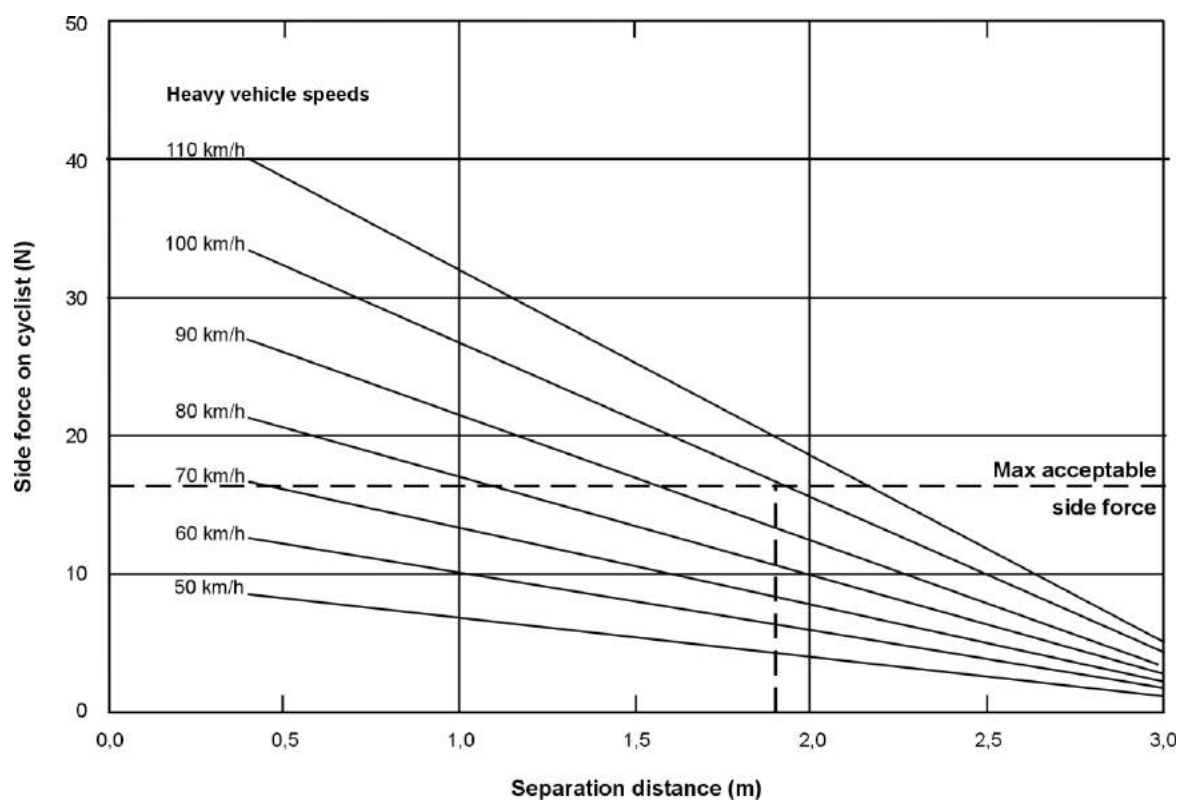


Figure 5.2: Separation distance to account for aerodynamic forces

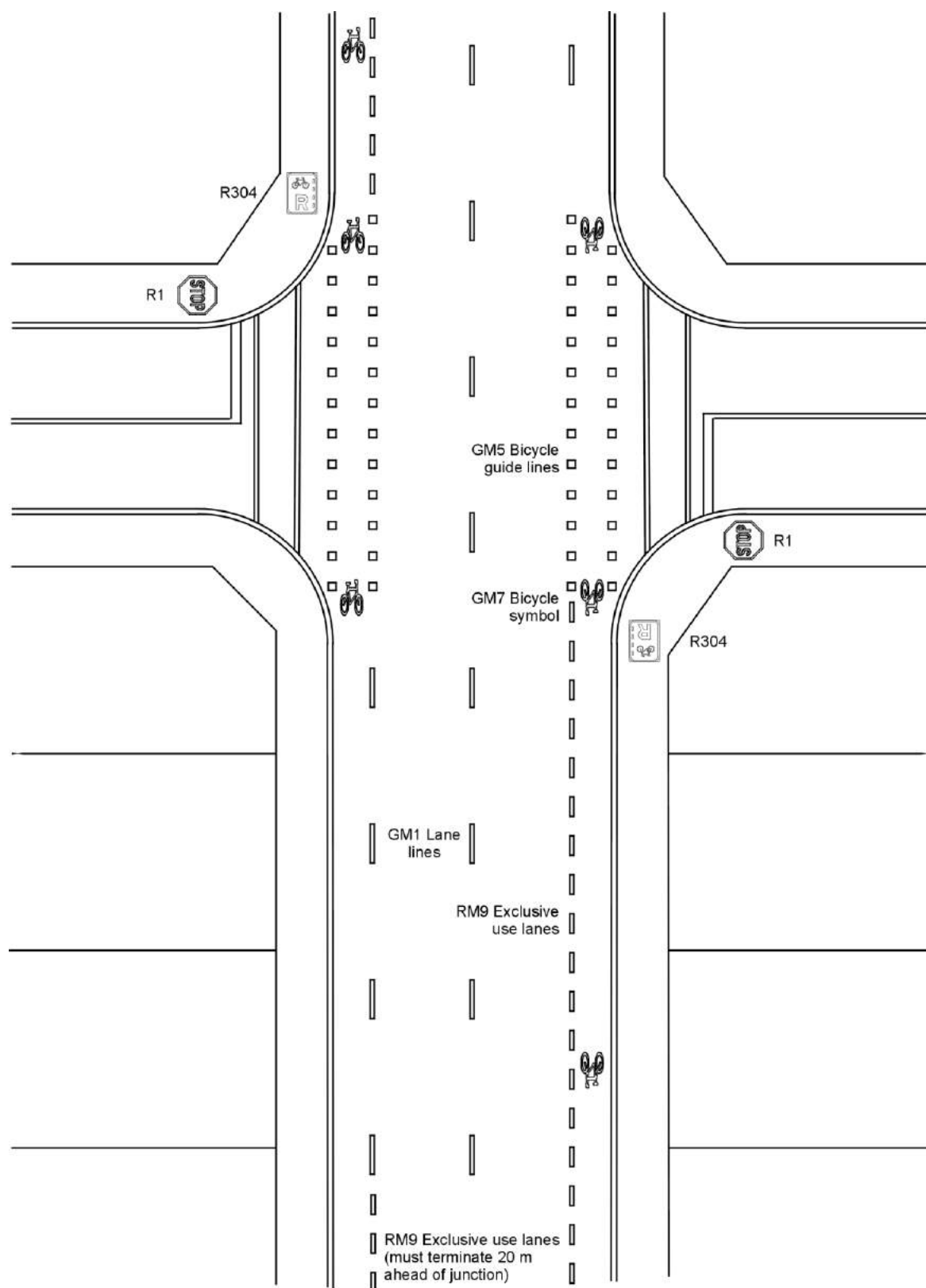


Figure 5.3: Bicycle lane signs and marks

C. Pedestrian and bicycle ways

6. Bicycle roads

6.1. INTRODUCTION

Bicycle roads (Class I and II bicycle ways) are provided for the exclusive use of cyclists. These roads can be considered as the most desirable type of facility. It offers a pleasing environmental experience for the cyclist and reduces conflicts with traffic as well as pedestrians.

Cycle roads may be shared with pedestrians. Such shared use, however, is generally not recommended, except where segregated facilities are provided.

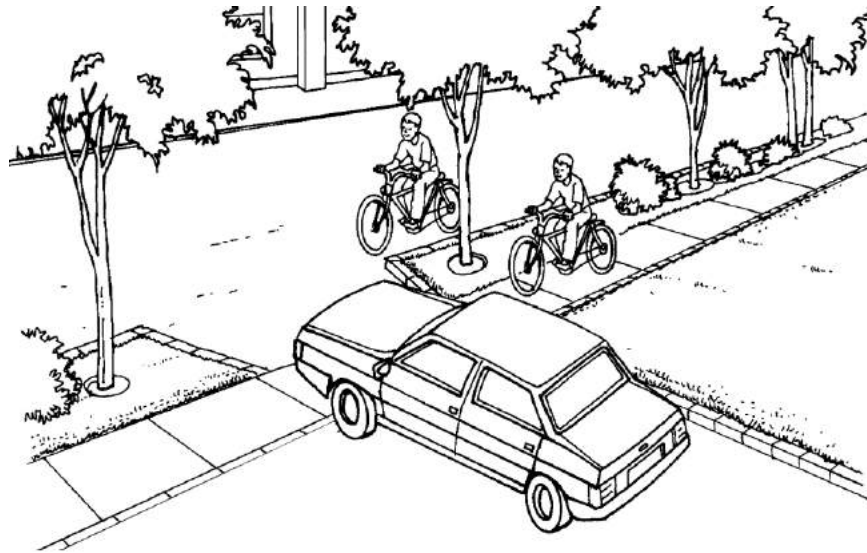


Figure 6.1: Conflicts at driveways

6.2. BICYCLE ROADS ADJACENT TO ROADWAYS

Bicycle roads can be constructed within road reserves adjacent to roadways. A physical buffer strip is provided between the bicycle road and the roadway.

Care must be taken in providing bicycle roads adjacent roadways due to the following issues:

- Cyclists tend to enter junctions at high speed, sometimes without regard to other traffic. This is particularly a problem when insufficient visibility and sight distance is available at a junction.
- On roads where driveways are provided to adjacent properties, a separate bicycle road can lead to conflicts between cyclists and vehicles using driveways, as shown in Figure 6.1. The design of a separate bicycle road should make it clear to motorists that cyclists have priority and that drivers should be on a lookout for them. Sufficient sight distance must also be available at each driveway.
- Conflicts with pedestrians, even if separate facilities are provided. At junctions, it is often difficult to resolve such conflicts.
- Traffic rules, such as obligations to yield, are unclear along the bicycle roads, and at junctions and driveways, creating confusion and risk between cyclists, pedestrians and traffic.

Bicycle roads tend to be used bi-directionally which compound all of the problems noted above.

6.3. THE NEED FOR BICYCLE ROADS

The bicycle road is an important facility that can be provided for cyclists. Bicycle roads can significantly improve mobility for cyclists, and can improve road safety.

The cost of providing bicycle roads is high, and the provision of such roads can therefore only be considered when they would be economically justified. Such roads would be justified when they would be regularly used by high volumes of cyclists, and when there are severe conflicts on existing roads.

The main advantages of bicycle roads are that cyclists are protected from conflicts with traffic, and that a more pleasant environment is provided to cyclists (CROW, 1993). The disadvantages include their costs and space requirements.

6.4. ATTRIBUTES OF GOOD BICYCLE ROADS

In planning, designing and construction of bicycle roads, it is important that the basic needs of cyclists are addressed. These needs are as follows:

- **Security.** A fundamental consideration is making persons feel secure when using the bicycle roads. The bicycle roads should not be located through areas that are secluded or deserted, and there should not be hiding places for criminals and vandals.
- **Safety.** The bicycle roads be designed and built free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Traffic safety is an important consideration because of the vulnerability of cyclists.
- **Accessibility.** The facility should be as accessible as possible to all cyclists.
- **Convenience.** The bicycle roads should be convenient to use. Cyclists desire a fast, direct, continuous, convenient route of access to chosen destinations.
- **Comfort.** The bicycle roads should be comfortable to use. Gradients should not be too steep, while a pavement of adequate construction should be provided.
- **Environment.** Cyclists prefer environments that are attractive. Great care should be taken in providing an environment that encourages cycling as a mode of transport.
- **Economy.** Bicycle roads should be economical. The roads should be designed to achieve the maximum benefit for their cost.

6.5. MINIMUM BICYCLE ROAD WIDTHS

Bicycle roads can be provided as one- or two-way roads. It is, however, highly unlikely that one-way roads would not be used as two-way roads, and such roads are therefore not recommended.

The minimum recommended bicycle road width for **two-way** operations is shown in Table 6.1 and Figure 6.2. The desirable minimum width should be used where sufficient funds and land is available. The absolute minimum width should only be used when conditions are very restrictive. Wider widths should also be used when high bicycle volumes are expected.

Bicycle paths should be widened around curves to compensate for cyclists leaning to the inside of the turn and the greater difficulty in negotiating turns. Recommended curve widening for different design speeds are shown in Figure 6.3.

Table 6.1: Recommended minimum bicycle road widths (two-way)	
Desirable minimum	3,5m
Acceptable minimum	3,0m
Absolute minimum	2,5 m
Horizontal clearance	0,5 m

6.6. VERTICAL ALIGNMENT

The vertical alignment of a bicycle road normally consists of straight tangents and parabolic vertical curves. The elements that require particular attention are the maximum gradient on the bicycle road and the design of the vertical curve.

6.6.1. Maximum gradient

Steep gradients require the expenditure of a significant amount of energy by cyclists and should be avoided as far as possible. Where steep gradients are required due to topographical or other limitations, the lengths of such gradients should be limited.

As a general guide, the maximum grade on a bicycle road should not exceed 4 to 5%. Grades less than 3% can be of unrestricted length while steeper grades should be restricted in length.

Height differences along a bicycle road should preferably not exceed a maximum of 5,0 m (CROW, 1993). After this, it is recommended to introduce a horizontal section on the road with a length of about 25 m before a next gradient is introduced. Such a design would provide a “resting” period for cyclists at regular intervals along the bicycle road.

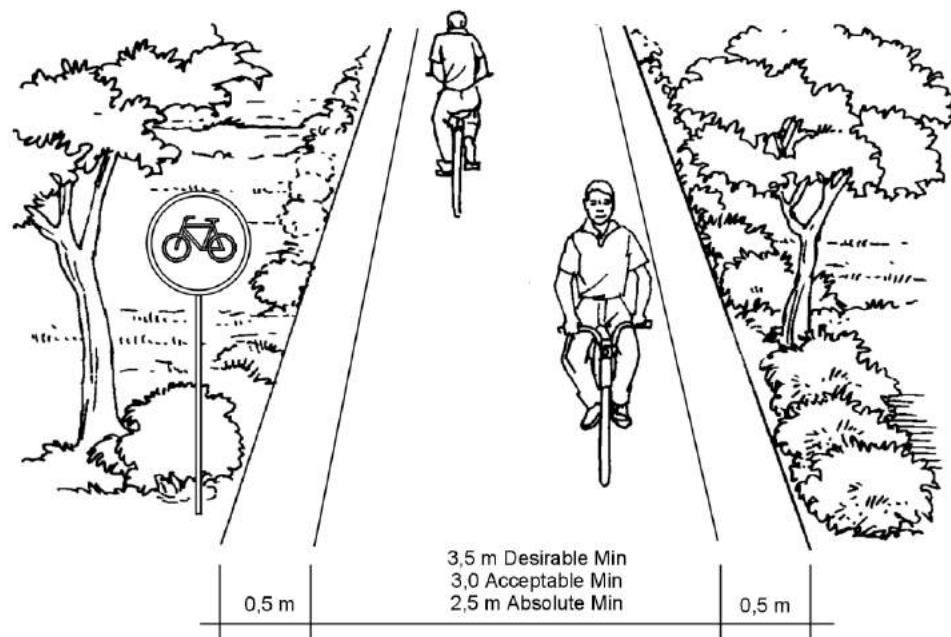


Figure 6.2: Minimum bicycle path width

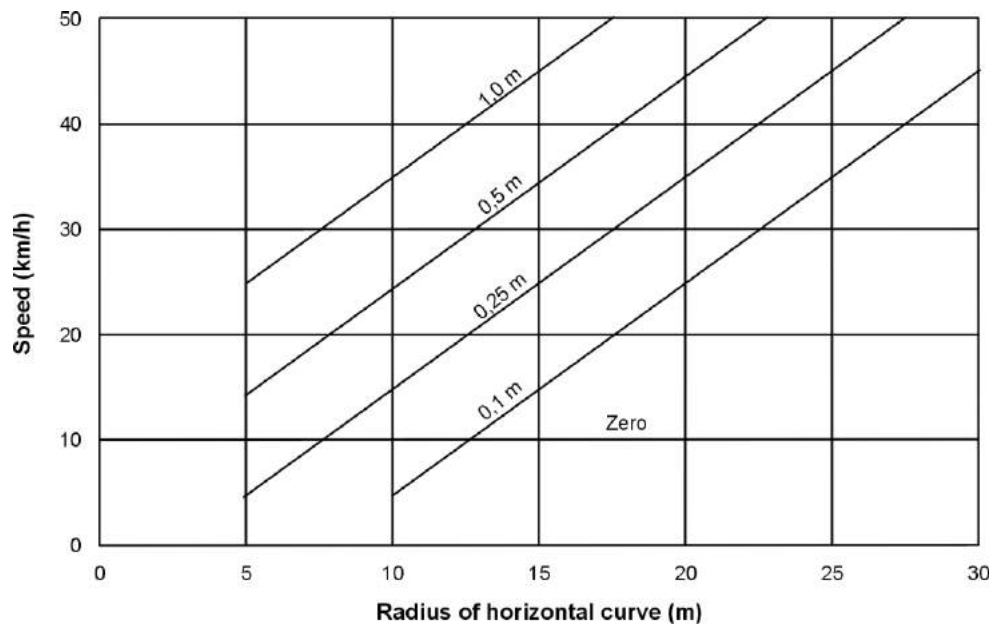


Figure 6.3: Bicycle path widening around curves

6.6.2. Vertical crest curves

Vertical crest curves should be designed to provide adequate sight distance. Provision should, at a minimum, be made for stopping sight distance, but is preferable to provide for decision sight distance where possible.

The minimum length of a crest vertical curve required to provide a particular sight distance is given in Figure 6.4. This figure was established for an eye height of a cyclist of 1,4 m and an object height of zero.

6.7. HORIZONTAL ALIGNMENT

The horizontal alignment of a bicycle road normally consists of straight tangents and circular curves (and sometimes transitional curves). The horizontal curve requires particular attention in the design of a bicycle road. A horizontal curve should have a sufficient radius of curvature to prevent sideways skidding and to provide adequate sight distance.

6.7.1. Sideways skidding

The minimum design radius of curvature required to prevent sideways skidding is given by the following formula:

$$R = (V/3,6)^2 / (9,8 \times (e+f))$$

in which

R = Minimum radius of curvature (m)

V = Design speed (km/h)

e = Superelevation rate (m/m)

f = Coefficient of friction (m/m)

Superelevation is normally not provided on bicycle paths and a 2% cross fall is normally continued through the curve. The coefficient of friction depends on speed, surface type, roughness and condition of pavement as well as type and condition of tires.

The recommended minimum radii of curvature for paved bicycle paths can be selected from Table 6.2 (Minnesota Department of Transportation, 1996):

Table 6.2: Turning radii to prevent sideways skidding		
Design speed (km/h)	Friction factor f	Minimum radius R (m)
20	0.30	15
30	0.28	30
40	0.25	55
50	0.22	100

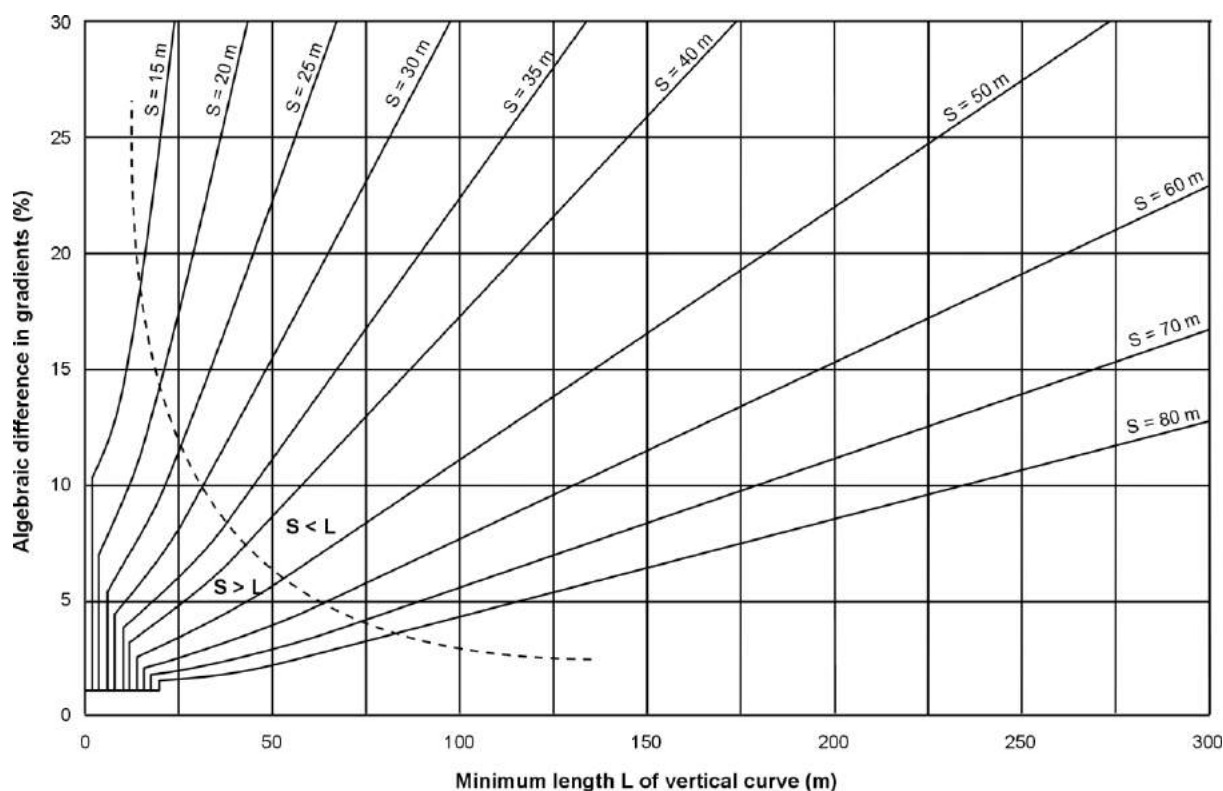


Figure 6.4: Vertical curvature to provide sight distance

6.7.2. Sight distance

Sufficient sight distance is required on curves to provide the cyclist with the opportunity to see hazards and react accordingly. Provision should, at a minimum, be made for stopping sight distance, but is preferable to provide for decision sight distance where possible.

The radius of curvature required to provide adequate sight distance around a curve is given in Figure 6.5. The lateral clearance should be one that would most likely be maintained along the bicycle road.

Pedestrian and Bicycle Facility Guidelines

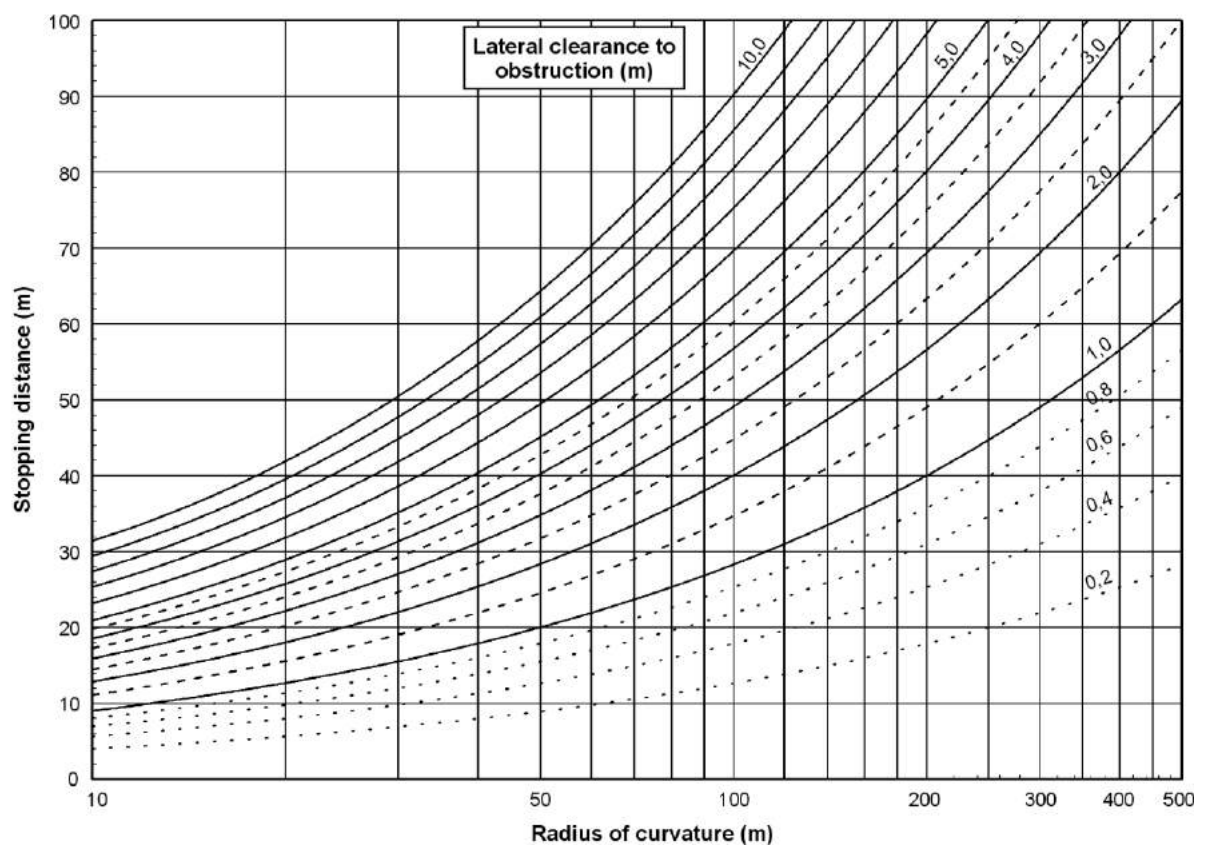
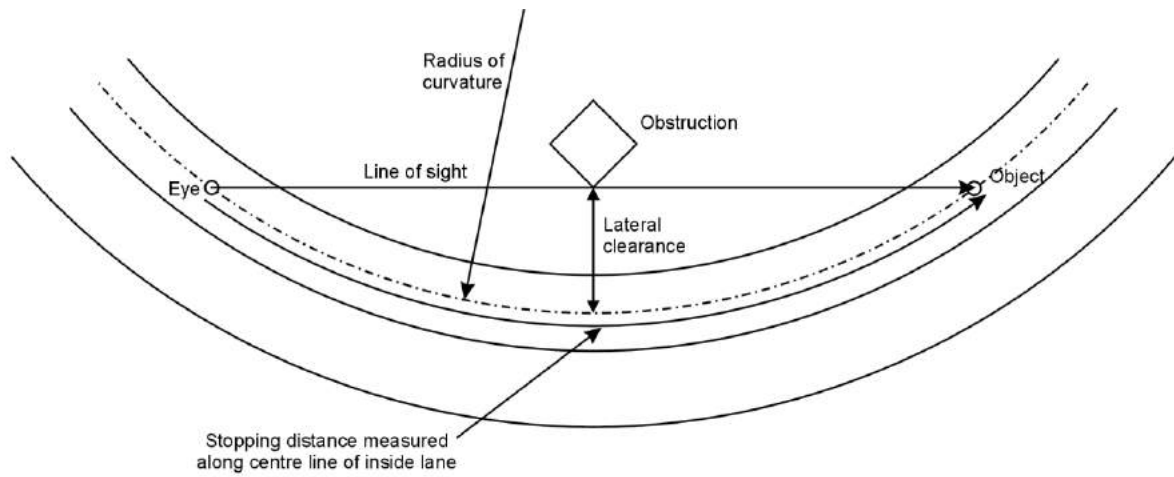


Figure 6.5: Horizontal curvature to provide sight distance

6.8. LANDSCAPE INTEGRATION

Creating a pleasant cycling experience is a worthwhile objective when planning and designing bicycle roads. Particular attention should be given to landscape integration and scenic values. The location of the bicycle road, its alignment, profile and construction should be in harmony with the setting.

Bicycle roads should be integrated with landform by following contours and slopes which is the least damaging to the landscape. The amount of earthworks required to construct the road should be a minimum and large cuttings and embankments should be avoided where possible.

6.9. CONSTRUCTION OF BICYCLE PATHS

Bicycles have narrow tyres inflated to high pressures and have no suspension system to speak of. Wheels and tires on bicycles are also much narrower than other roadway vehicles. A smooth surface is therefore desirable for bicycles to be used effectively, comfortably and safely. Of particular concern are:

- Uneven expansion and paving joints.
- Concrete pathways where considerable upheaval has taken place,
- Potholes and uneven patching on road surfaces to be used by the cyclist.
- Loose gravel or crushed aggregate that could induce skidding.
- Pavement drop-offs.
- Utilities such as manhole covers and drainage grates.

Various materials that may be used for the construction of bicycle paths are shown in Figure 6.6. Pavements could consist of premixed asphalt, a 6 mm chip-and-spray seal, a slurry seal, concrete or interlocking concrete blocks or bricks. The interlocking concrete blocks, however, are often not preferred by cyclists because of low riding quality. A dense graded surface of stabilised soil or gravel may also be acceptable for recreational cycle paths, even if riding quality is poor.

The establishment of a suitable foundation for a bicycle path is essential. It is not necessary to provide a heavy foundation for bicycle roads, but it is particularly important to remove all vegetation, topsoil and other soils which are considered unsuitable over the width of the path. (Minnesota Department of Transportation, 1996).

Tree roots can badly damage the surface of a bicycle road, as shown in Figure 6.7. Due to condensation forming on the underside of the pavement (particularly with asphalt), a climate arises which is conducive to root growth (CROW, 1993). Various methods can be used to prevent such root growth, but the preferred method is to only allow species of trees whose roots will not damage the bicycle road.

PREMIX



15 mm Premix
100 mm Crusher run base

CHIP AND SPRAY



6 mm Chip and spray
100 mm Crusher run base

CONCRETE



100 mm Concrete
100 mm Gravel base (if required)

BLOCK OR BRICK PAVING



Blocks or bricks
50 mm River or similar sand
100 mm Gravel base (if required)

STABILIZED GRAVEL



100 mm Gravel stabilised with
lime or bitumen emulsion

Figure 6.6: Various materials that may be used for the construction of bicycle paths

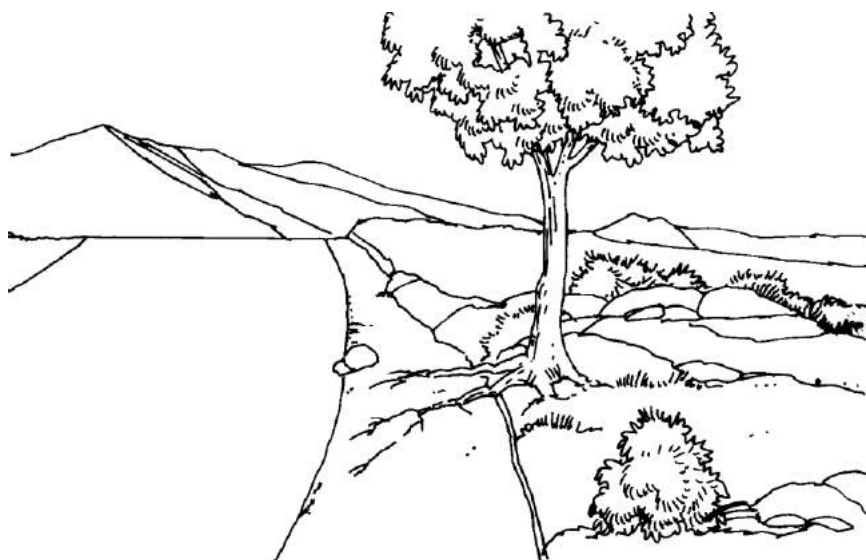


Figure 6.7: Danger of root damages to pavements

C. Pedestrian and bicycle ways

7. Construction sites

7.1. INTRODUCTION

Road works at road construction sites can pose unexpected problems for pedestrians and cyclists. For persons with disabilities, such work can severely limit or even totally preclude travel through the area. Provisions should be made for safe and clearly delineated paths through a construction zone.

7.2. GENERAL CONSIDERATIONS

There are a number of basic considerations in planning for pedestrians and cyclists at construction sites:

- Persons should not be led into conflicts with work site vehicles, equipment, and operations.
- Persons should not be led into conflicts with vehicles moving through or around the construction site.
- Persons should be provided with a safe, convenient path that replicates as nearly as practical the most desirable characteristics of the existing travel ways.

Pedestrian and bicycle traffic should where possible be separated from both construction site activity and vehicular traffic.

7.3. ROAD TRAFFIC SIGNS AND MARKINGS AT CONSTRUCTION SITES

A series of road signs have been developed to cater for pedestrians at road construction sites and should be used whenever the appropriate situation arises.

According to the Road Traffic Signs Manual, it is an important aspect of the safety arrangements of roadworks sites that specific accommodation should be made for pedestrians. According to the manual, it is too common an occurrence that pedestrians are left to their own devices and expected to walk within reduced spaces, sometimes totally without protection.

The manual states that ***any authority or contractor not making provision for pedestrians could, in the event of an accident, find themselves facing serious litigation.***

The temporary signing of roadworks in urban areas is commonly influenced by the following factors:

- Limited space to accommodate road signs and traffic.
- High traffic and pedestrian volumes.
- The need to maintain access to many properties.

Factors which commonly mitigate against the effectiveness of temporary road signs in urban areas, and which must be recognised and taken into account, include:

- Availability of street lighting.
- Obstruction of signs by trees, street furniture and large vehicles.
- Limited sight distance.

7.4. BARRICADES

Extensive use should be made of barricades when there is a danger of injury at road works, especially when the work involves excavations and trenches. Barricades must be strong enough to prevent people from falling into excavations in the work area.

An example of a low cost temporary barricade is shown in Figure 7.1. The barricade should have solid bottom and top rails. The top rail should be mounted at a height of between 900 and 1 050 mm with diagonal stripes. The barricade support should not protrude more than 100 mm beyond the toe rail. Barricades supported by “feet”, such as inverted T supports, may create a tripping hazard if they extend too far into the walkway.

Multi-coloured plastic tape, preferably with red-and-white or black-and-yellow stripes, can be used to mark off the work area. The tape makes the work area more conspicuous for people with impaired vision, but is of little use to blind people. Marking tape is not a substitute for a barricade.

7.5. SIDEWALK DIVERSIONS

A typical arrangement for the accommodation of pedestrians due to temporary, and localised, excavation of the sidewalk is shown in Figure 7.2. The signs given in the figure is typical only, and is not intended to be a definitive inventory.

The arrangement in Figure 7.2 provides for a situation such as an isolated excavation with no other roadworks, such as a local repair to a water main, sewer, electrical cable or other underground service.

Where more than one excavation occur within a larger site, the signs provided within the advance warning area may be modified according to specific site requirements.

More details regarding road signs and markings required at construction work zones are given in the Road Traffic Signs Manual.

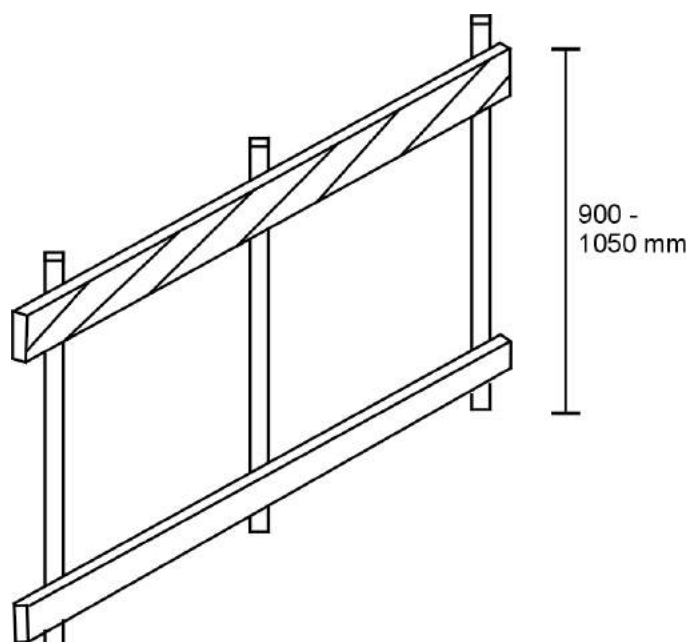


Figure 7.1: Example of a low cost temporary barricade

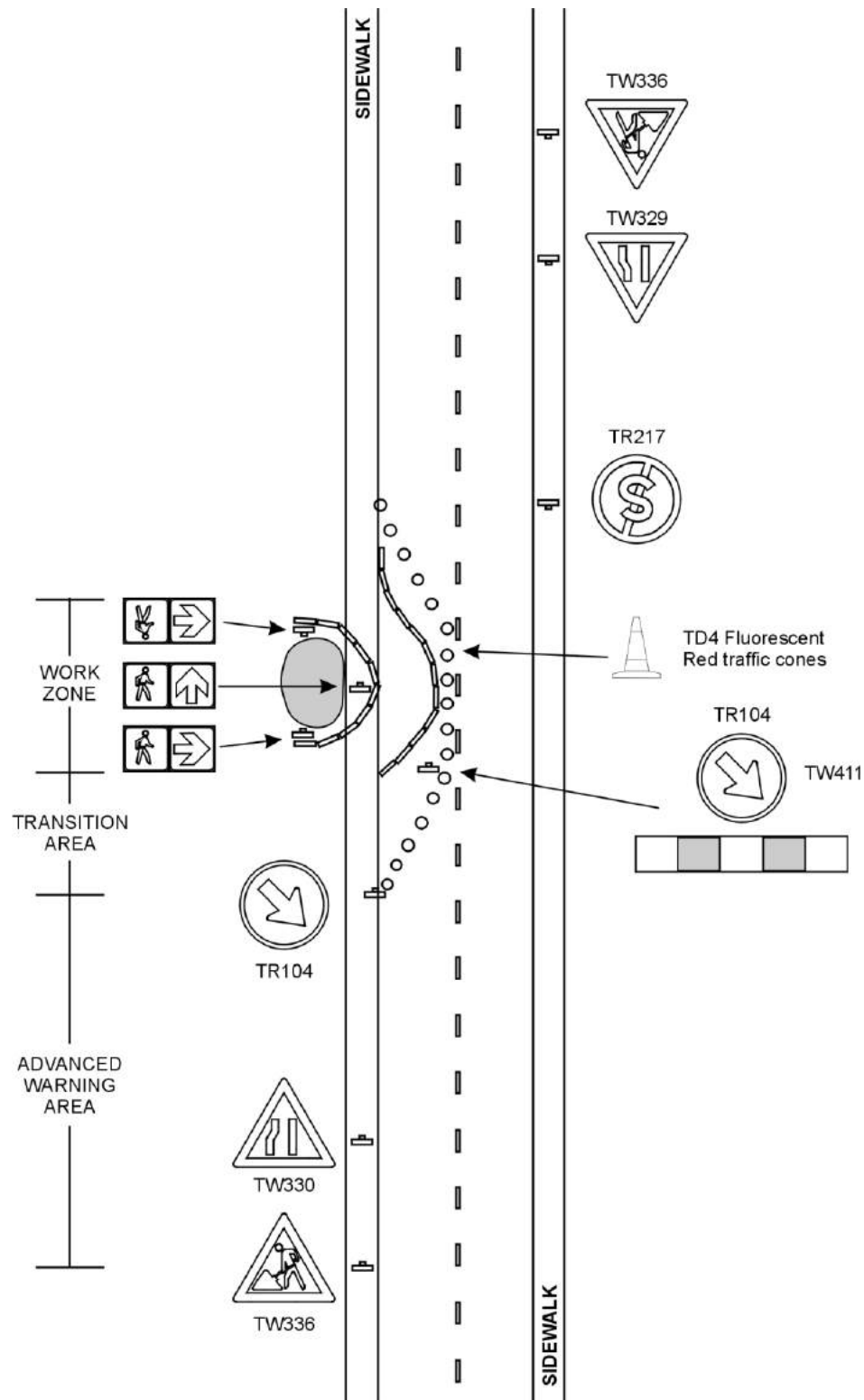


Figure 7.2: Deviation of sidewalk

PART D

PEDESTRIAN AND BICYCLE AMENITIES AND SUPPORT

D. Pedestrian and bicycle amenities and support

1. Bicycle parking and storage

1.1. INTRODUCTION

Little attention is generally given to bicycle parking when bicycle facilities are planned. The problem of securing a bicycle from theft, however, is shared by all cyclists and proper bicycle storage is thus a pre-requisite to any bicycle trip.

The following facets of design should be considered when providing for bicycle parking and storage:

- Location – convenience of parking relative to destination.
- Storage facility - degree of security and safety from vandalism and theft as well as weather protection (sun and rain).

1.2. LOCATION OF BICYCLE PARKING FACILITIES

Parking facilities for bicycles should be located as near to the destination of a cyclist as possible. The access to the facilities should be easy and appropriate walkways to the facilities should be provided. The parking facility should always be sited in a very visible area, and preferably within clear view of the main entrance to the destination. This allows cycle parking facilities to be easily found (and used) by visitors.

In selecting a location for bicycle parking and storage, it is particularly important that the security of the cyclist as well as stored bicycles should be taken into account. The parking facility should not be place in an area where it is difficult to detect vandalism and theft. Cycle parking that has been hidden away in a little-used location provides the perfect environment for thieves to work unnoticed, and must be avoided.

1.3. STORAGE FACILITIES

The most important requirement of a bicycle storage facility is that it must provide security against theft and vandalism. It is, however, also important to provide shelter to protect the bicycle against the elements. Lighting is also required when the facility is used at night.

Various types of storage facilities are shown in Figures 1.1 to 1.3. The bicycle racks shown in the figures can be used when a light to medium level of security is adequate. Storage lockers may be required if a high level of security is required.

Bicycle lockers are rather expensive compared to bicycle racks, and are not often provided. Bicycle racks can provide an acceptable level of security, but the racks should be designed with care.

1.4. DIMENSIONS OF PARKING FACILITIES

Each bicycle parking space should be easily accessible. Cyclists should be able to securely lock their bicycles without undue inconvenience and their bicycles should be reasonably safeguarded from intentional or accidental damage. Adequate space should be provided for the bicycle itself as well as access by the cyclist to the bicycle.

Bicycle storage spaces should be at least 1,8 m long and 0,6 m wide. An overhead clearance of 2,1 m should be provided for persons to stand and walk.

An aisle of at least 1,5 m wide should be provided between rows of bicycle storage facilities.

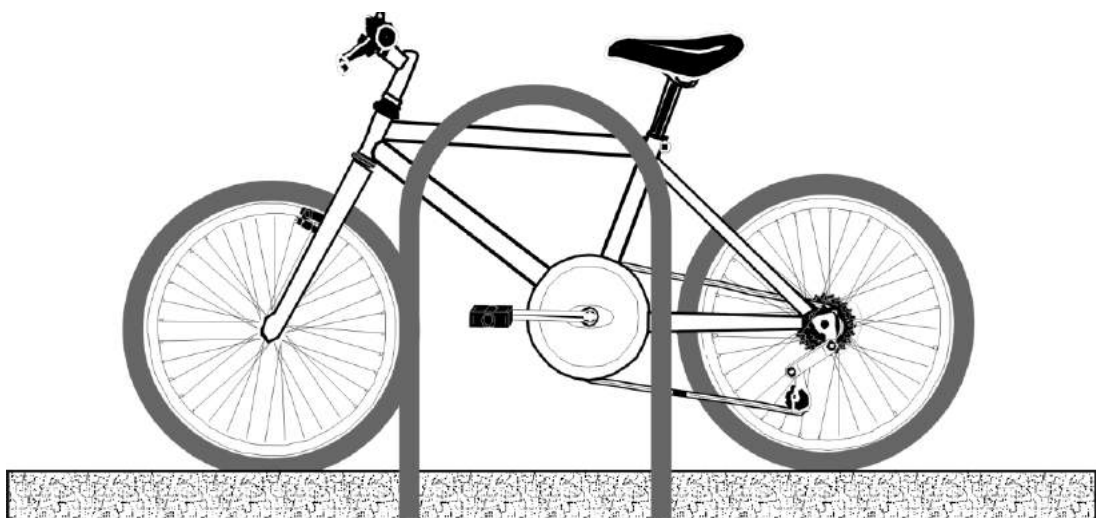


Figure 1.1: Bicycle rack providing light security

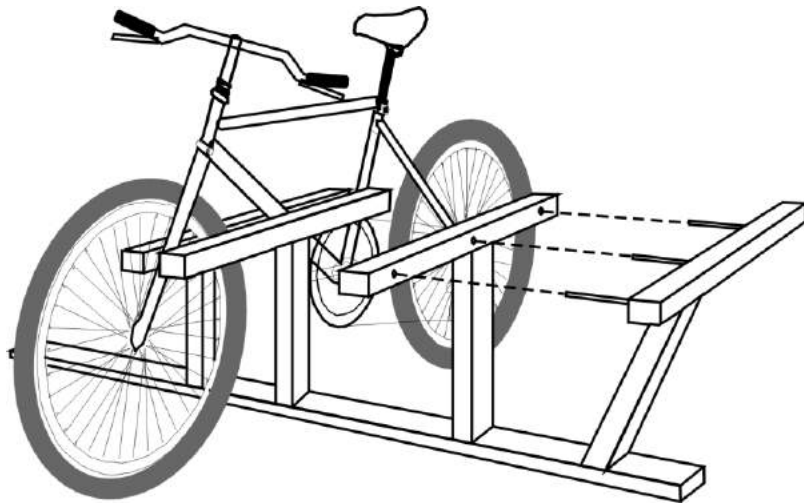


Figure 1.2: Bicycle rack providing light security

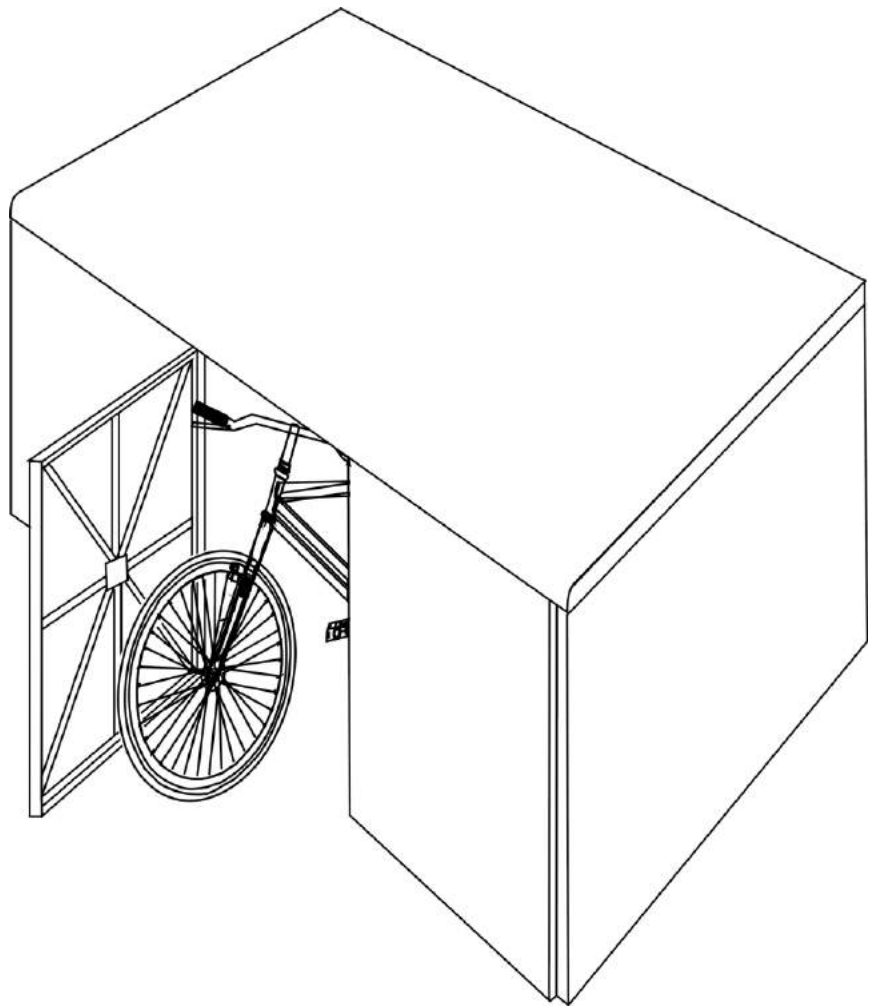


Figure 1.3: Bicycle locker providing a high level of security

D. Pedestrian and bicycle amenities and support

2. Lighting facilities

2.1. INTRODUCTION

Lighting of the road and street system increases pedestrian and cyclist security, safety and comfort and provides a pleasant environment. Lighting should therefore preferably be provided at all facilities used by pedestrians and cyclists.

The provision of lighting is particularly essential at the locations where security may be a problem. These locations include pedestrian and bicycle bridges and subways as well as at bicycle parking areas. Lighting has to be provided at night but some facilities may also require illumination during the day (such as subways).

2.2. SABS STANDARDS

In South Africa, the provision of lighting at pedestrian and bicycle facilities must comply with the following South African Bureau of Standards specifications:

- SABS 098: Part I-1990, Code of practice for public lighting, Part I: The lighting of public thoroughfares.
- SABS 098: Part II-1973, Code of practice for public lighting, Part II: The lighting of certain specific areas of streets and highways.

2.3. VISIBILITY NEEDS

Lighting at pedestrian and bicycle facilities should address the following requirements:

- Drivers should be able to see other road users. The lighting should clearly show the actual positions of such users, as well as the direction and speed of movement.
- Pedestrians and cyclists should be able to anticipate the intentions of other pedestrians and cyclists in time to any action necessary, particularly when security is an issue.

The South African Bureau of Standards specifications describes methods of lighting which address the above requirements. The methods also have the desirable effect that an attractive environment is created by special lighting and shading effects.

2.4. PROVISION OF LIGHTING AT MIDBLOCK CROSSINGS

A pedestrian traversing a street at night presents a very demanding visual task to motorists, and every effort should be made to reveal pedestrians at a safe distance.

When a single luminaire is used to light a pedestrian crossing facility, it should be so positioned that the bright patch it produces covers the greater part of the crossing. This, however, leaves a dark background against which it is difficult to see the pedestrian or cyclist, as shown in Figure 2.1.

The above problem can be addressed by providing a supplementary luminaire further away and on the other side of the carriageway. This will provide a bright background against which the pedestrian or cyclist can be seen. An example of such lighting is shown in Figure 2.2.

Where a midblock crossing is provided on a road on which luminaires have been provided on both sides of the road, the midblock crossing should preferably be positioned midway between consecutive luminaires position on opposite sides of the road.

2.5. LIGHTING CONSIDERATIONS AT JUNCTIONS

Preferred locations of luminaires to accommodate pedestrian crossings at junctions are shown in Figure 2.3. The luminaires are positioned over the exit sides of the junctions to provide a bright background against which pedestrians (as well as traffic) can be seen.

At junctions, luminaires should not be positioned over the centre of the junction since it would cause a bright strip at the entrance to the junction, which could obscure the junction and any pedestrian crossing situated at the exit from the junction.

2.6. AESTHETICS OF LUMINAIRES

A lighting installation must not only be efficient by night, but should also be aesthetically appealing by day. There are no simple or universal rules for aesthetic lighting since each city or town has its own character.

Examples of attractive luminaires and supports are shown in Figure 2.4.

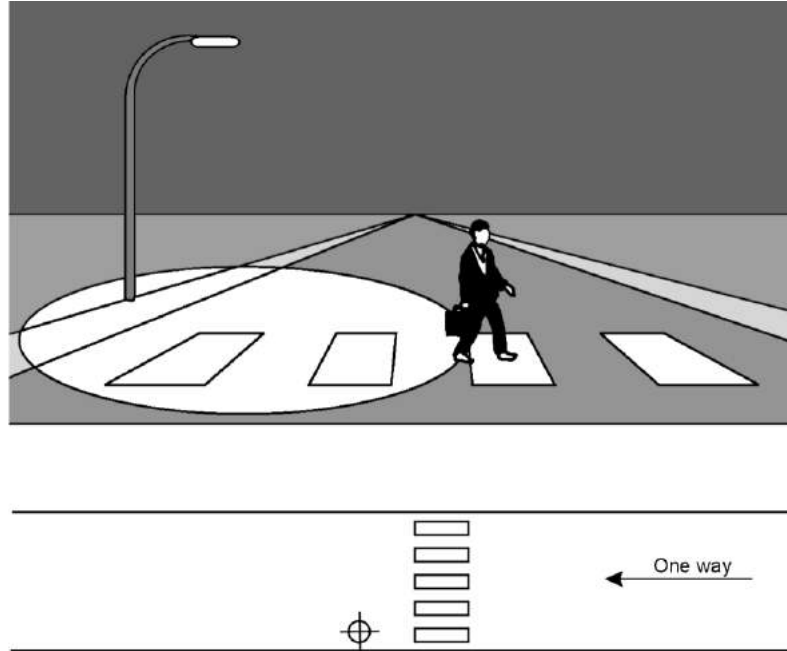


Figure 2.1: Use of a single luminaire to provide lighting on a pedestrian and cyclist facility

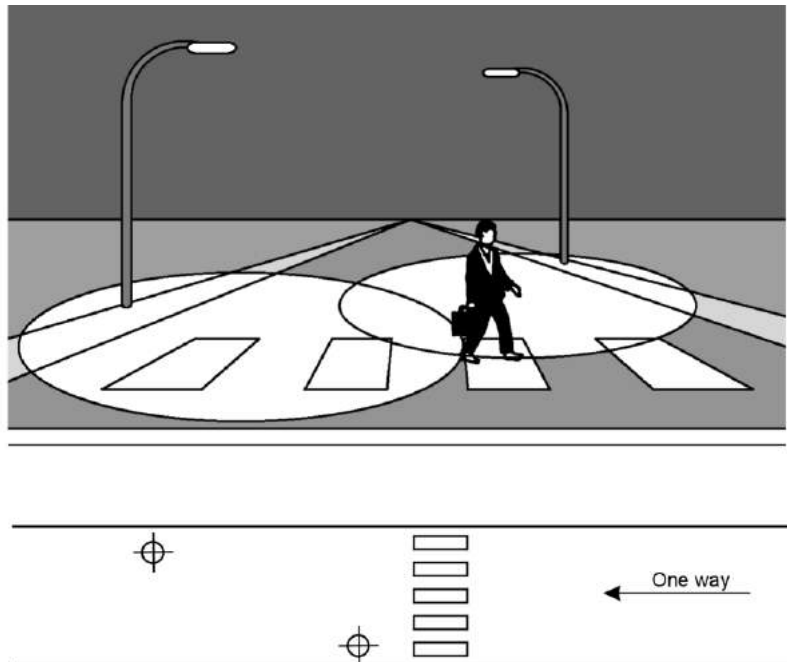


Figure 2.2: Use of two luminaires to provide lighting on a pedestrian and cyclist facility

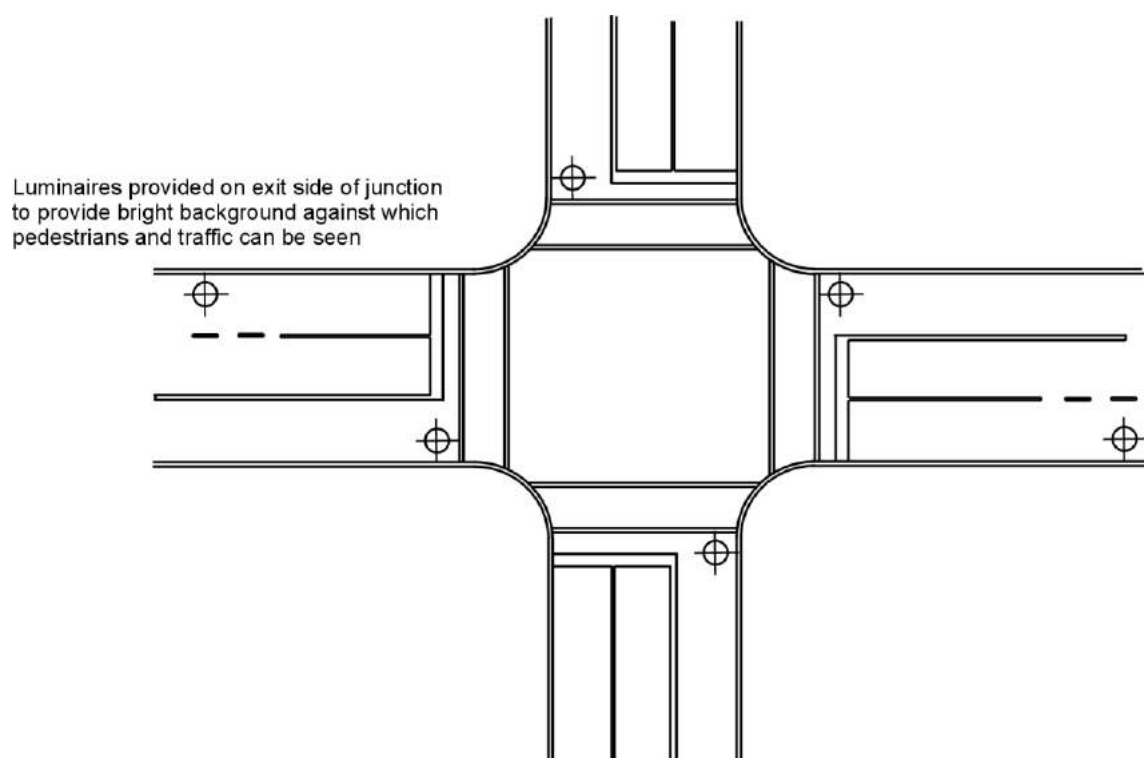


Figure 2.3: Provision of lighting at junctions

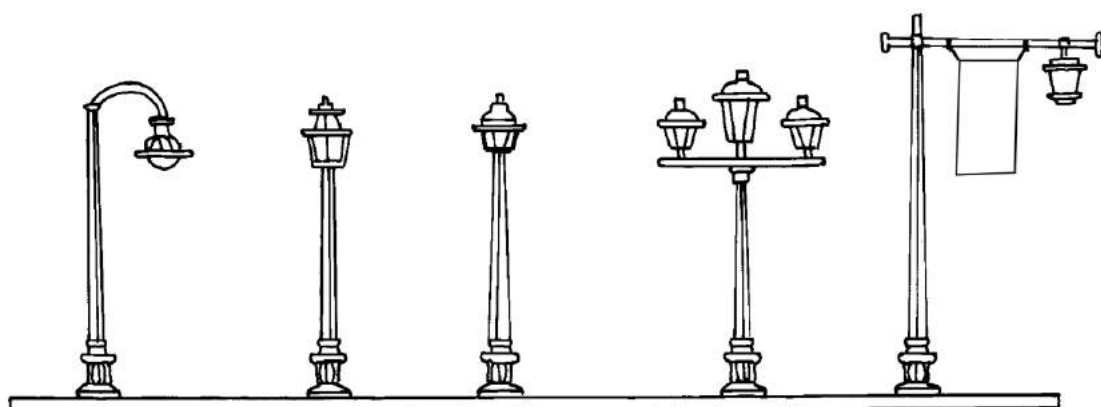


Figure 2.4: Attractive forms of streetlights

D. Pedestrian and bicycle amenities and support

3. Safety barriers

3.1. INTRODUCTION

Safety barriers are provided to protect pedestrians and cyclists against traffic accidents. Such barriers can be used at locations where there is a high incident of traffic accidents and where there is a need to protect pedestrians and cyclists against traffic.

Information on barrier systems is given in the South African Road Safety Manual (National Department of Transport, 1999). The intention is not to repeat all the information given in this manual, but to summarise information which is particularly important to pedestrian and bicycle safety.

A problem with many barrier systems is that they have been designed primarily to enhance the safety of vehicle occupants in the event of an accident, and they are less suitable for protecting pedestrians and cyclists from out-of control vehicles. Many barrier systems provide cushioning against accidents by deforming, which could be fatal for persons using a facility adjacent to such a barrier.

3.2. ATTRIBUTES OF GOOD SAFETY BARRIERS

The attributes of a good pedestrian or cyclist safety barrier include the following (Somers, 2000):

- **Strength**, sufficient to stop a vehicle in direct or oblique impact.
- **Energy attenuation and deformation** characteristics, to sufficiently cushion occupants of an impacting vehicle, while limiting the deformation or displacement of the barrier.
- **Height**, sufficient to resist vehicle overriding and breaching;
- **Positioning** at roadside, to provide an adequate frontage of protection.
- **Profile**, to limit penetration of the crash-barrier system into the passenger compartment of the impacting vehicle.
- **Permeability** to pedestrian (and cyclist) traffic, to allow necessary movement of pedestrians. In particular, the barrier system should not force pedestrians and cyclists onto an unsafe route.
- **Physical features**, such as sharp or pointed ends, edges or corners that could hurt pedestrians and cyclists or damage vehicles.
- **Ease of inspection**, to allow confirmation of a satisfactory maintenance status.

3.3. BARRIER SYSTEMS

Barrier systems can be classified as being either impact attenuation devices or longitudinal barriers. The purpose of the impact attenuation device is to decelerate a vehicle to a stop, while a longitudinal traffic barrier is used to redirect a vehicle parallel to the roadway.

For pedestrians and cyclists, any rigid system such as a large tree or a concrete wall provides the ideal form of protection. Such barriers, however, would not be safe for the occupants of vehicles, and may require the installation of energy-absorbing barriers to minimise risks to vehicle occupants.

The following are a number of safety barriers that can be used to protect pedestrians:

a) Concrete wall

A rigid concrete wall is one of the most effective longitudinal traffic barriers where pedestrian walk adjacent to a road. Such a wall not only serves to protect pedestrians against traffic accidents, but can also be used to prevent pedestrians from crossing the road at undesirable locations. The disadvantage of concrete walls is that they are expensive to install.

b) W-shaped guardrail

The W-shaped metal guardrail is often used in South Africa not only to protect vehicles, but often also to protect pedestrians (and sometimes cyclists). The guardrail can be effective as a safety barrier, but it can also create additional danger when improperly installed. The main problems with guardrail involve the end treatments. An exposed guardrail can easily penetrate a vehicle and is highly dangerous to vehicle occupants, while a ramped end treatment can result in vehicle vaulting or rollovers, which could be dangerous to pedestrians.

A problem with a guardrail installed between a sidewalk and a roadway, is that pedestrians often attempt to climb across the guardrail to cross the road. This creates the danger that a pedestrian may trip and fall in front of an oncoming vehicle. A guardrail installation does not provide sufficient deterrent for pedestrians to cross a road.

c) Bollards

Bollards with high strength can provide a measure of protection for pedestrians. Such bollards are not very safe for the occupants of motor vehicle, but they have the advantage that they do not pose an obstacle to pedestrian travel. Bollards can therefore be relatively effective at junction corners.

d) Concrete kerb

A concrete barrier or semi-mountable kerb is sometimes regarded as a form of safety barrier for pedestrians in that they prevent vehicles from making too sharp turns at junction corners. A problem with such kerbs is that they may result in vehicle vaulting or rollovers that could be dangerous to pedestrians, particularly on high-speed roads. Such kerbs are therefore more suitable on low speed roads as typically found in urban areas.

D. Pedestrian and bicycle amenities and support

4. Barricades and fences

4.1. INTRODUCTION

Pedestrian and bicycle barricades and fences are used to prevent undesirable and unsafe pedestrian and cyclist movements, either across or along a road or street.

Barricades and fences are particularly required on roads that are carrying relatively large volumes of traffic at relatively high speeds, and where high volumes of pedestrians and cyclist attempt to enter the roads, either to cross the roads or to walk along the roads. Such roads would typically be freeways, but barricades and fences may be required on other types of high-speed roads. The problems typically occur adjacent to developments and settlements that generate or attract high volumes of pedestrians.

4.2. REQUIREMENTS FOR BARRICADES AND FENCING

The type of barricades and fencing required at a particular location depends on a number of factors. In some instance, a light fence would be effective, while in other instances a heavy concrete wall could be required to stop pedestrians. In general, a barricade and fence should meet the following requirements to be effective:

- The barricade or fence should be of sufficient height to prevent persons from climbing over it. A height of 2,4 m would usually be sufficient for this purpose.
- The barricade or fence should not have footholds that could assist a person from climbing over it. A person, for example, can easily scale a wire fence. A barricade or fence consisting only of vertical components is more effective in this regard.
- The barricade and fence should be able to withstand vandals and thieves. A wire fence can easily be breached or removed from a road. A concrete barricade and fence is usually more effective in this regard.

A concrete or brick wall is the most effective barricade or fence that can be used to prevent pedestrians from entering or crossing a road. A further advantage of such a wall is that it can serve to reduce traffic noise for persons living adjacent to the road.

4.3. CONSTRUCTION OF BARRICADES AND FENCING

Barricades and fencing can be constructed in various ways using a variety of different types of materials. The following are examples of types of barricades and fences.

- **Chain fences.** Chain fences can be used to delineate an area, but are not very useful for preventing pedestrians from crossing or entering a road.
- **Tubular steel rails.** Tubular steel rails are more effective than chain fences, but would again not be very effective in preventing pedestrians from climbing across the barricade.
- **Wire fences of various types and shapes.** Wire fences can be effective under certain circumstances, but have the disadvantage that they can easily be breached, and they are also often targeted by thieves.
- **Concrete palisades.** Concrete palisades can be effective as a pedestrian barricade or fence when they are of sufficient heights and constructed of vertical components. They should, however, be of sufficient strength to prevent breaching by persons determined to cross the road.
- **Brick or concrete walls.** A brick and concrete wall is perhaps the most effective form of pedestrian barricade or fence, but only if of a solid construction. Walls consisting of light concrete panels would not be effective for this purpose.

D. Pedestrian and bicycle amenities and support

5. Traffic calming

5.1. INTRODUCTION

Traffic calming measures are often aimed at making an area (such as a residential area) safer for pedestrians and cyclists, and particularly for children. Traffic calming, however, do not have to be restricted to residential areas only, but can also be applied at any location where there is a high concentration of pedestrians and cyclists.

Residential areas are particularly vulnerable to problems caused by traffic and the public is becoming less tolerant regarding the general disturbance caused by traffic on residential streets. Many residents see and treat the road reserves outside their dwellings as an extension of their residential environment, more suitable to uses other than vehicular travel. Examples of such uses include walking, cycling, children's play, meeting neighbours and even social events such as street parties. These activities require that less priority should be given to traffic needs, and more attention given to the needs of residents. Traffic calming has become an important objective in many existing residential areas, locally and throughout the world.

5.2. TRAFFIC CALMING PRINCIPLES

Traffic calming is aimed at addressing two specific types of problems experienced on roads and streets, traffic intrusion and speeding. Different types of treatment are required to address these problems, and it is important that the problem should correctly be identified before the appropriate treatment is selected.

5.2.1. Traffic intrusion

Many streets and roads in urban areas are experiencing ever-increasing volumes of traffic on roads due to the growth of urban areas, but often also caused by an inadequate major road network that is not capable of handling traffic. The result of this is traffic taking short cuts through residential areas, resulting in the problem called “traffic intrusion”.

Traffic intrusion resulting in high volumes of traffic on roads, is often associated with a poor quality of life. In a study of the impact of traffic on liveability, Appleyard (1981) found that people living on streets with high volumes of traffic had fewer friends, acquaintances, level of pride, sense of ownership and a sense of place. Increased traffic causes people to retreat into buildings and their homes, abandoning the public space. Often this results in a deteriorating environment in which vandalism and criminal activity may increase, and people who were neighbours now merely live in adjoining houses and buildings.

Traffic can be discouraged from intruding and travelling through an area by making it less convenient for drivers to travel through the area than around the area. This can be achieved by increasing both travel time and distance through the area that must be protected. In many cases, both travel time and distance must be increased to be effective. Increasing travel time alone is often not sufficiently effective to divert through traffic, and it is also necessary to increase travel distance. Most traffic calming measures, however, are aimed at increasing travel time while travel distance is unaffected. Travel distance can usually only be increased through the judicial closure of roads.

5.2.2. Speeding

Speeding is a problem that is often experienced on residential streets. Many of the older residential areas have been designed in a grid pattern, resulting in long straight streets that is an open invitation for drivers to speed.

Traffic calming can be very effective at addressing speeding problems. Most of the measures, however, are only effective at a point along the road or street, and measures must often be repeated to be effective over a long stretch of road. Drivers often become irritated when they perceive that there is an excessive number of calming measures.

5.3. TRAFFIC CALMING MEASURES

A large variety of traffic calming measures are available that can be used in urban areas (refer to Figure 5.1). The intention here is not to provide a comprehensive list of available measures. The measures described below are those that most often used in South Africa, and which have been found to be effective in either reducing traffic intrusion or in speeding.

5.3.1. Speed humps

The speed hump is perhaps the most widely implemented traffic calming measure. It has a relatively low cost, and is very effective in reducing speed at a point along the road.

A well designed speed hump allow vehicles to travel at the intended speed (usually 30 km/h) with minimal discomfort, but driving over the hump at higher speeds will cause severe discomfort and even risk of damaging the vehicle.

The most effective height of the speed hump from a control standpoint is between 50 and 100 mm (Minnesota Department of Transportation, 1996).

5.3.2. Raised crosswalks

The raised crosswalk is a speed hump which is wider than a normal speed hump, and which is marked as a pedestrian crossing. The advantage of the raised crosswalk is that it reduces speed at the point where pedestrians need to cross.

The raised crosswalk has the advantage that the driver can see a clear goal with the measure, whereas a speed hump may be perceived as a nuisance with little purpose.

5.3.3. Mini and traffic circles

There are many types of traffic circles. The larger traffic circles function primarily to improve traffic flow through a junction, although speeds are reduced. The smaller circles are primarily used to control speeds, but can also be used to improve traffic flow through junctions. The smaller or mini circles are often used in traffic calming schemes.

The mini circle can be very effective in reducing speeds when it is designed and constructed correctly (many mini circles in South Africa have not been constructed to appropriate standards). Speed reduction is achieved by diverting traffic around the circle island. Care should be taken in designing the island to achieve desirable speeds. At mini circle, the aim is often to reduce speeds to about 25 km/h through the circle.

A disadvantage of the mini circle is that it can improve traffic flow through junctions, particularly for right-turn movements. This is not very conducive in reducing through traffic in an area, and may also cause a redistribution of traffic to streets that previously did not experience traffic problems. Mini circles should therefore only be considered in areas where traffic intrusion is not a problem, or in combination with other measures aimed at addressing traffic intrusion problems. The mini circle will often only increase the traffic intrusion problem.

Mountable kerbs at the perimeter of the circle island are recommended to provide the ability for large vehicles, particularly buses, to drive over the island when turning at the circle. The turning space may otherwise be too small to accommodate the larger vehicles.

5.3.4. Chicanes

Chicanes utilise traffic islands on a road to force traffic to travel in a serpentine pattern, thereby reducing speeds. These chicanes are installed at midblock locations between junctions and can be very effective in reducing speeds. The chicane is the one speed calming measure that can be considered on higher speed roads.

The chicane has the disadvantage that it requires a relatively long length of road to implement. This is not only costly, but may result in driveways being located within the chicane. Although it is possible to accommodate driveways in the design of a chicane, it is not always the most desirable solution.

Chicanes may pose a danger to bicycle traffic due to the manoeuvres undertaken by vehicles travelling through the chicanes. A separate bicycle path should therefore be provided that bypass the chicanes.

5.3.5. Chokers

Chokers are calming measures aimed at reducing the capacity of a road. Such chokers only allow a limited volume of traffic to use a road and therefore physically control the maximum traffic throughput. Other traffic is forced to divert to other roads.

Although chokers can reduce traffic throughput, they can not divert all traffic. Some traffic will still be able to use a road. Chokers are therefore only effective during peak hours and only when the peak-hour traffic volume exceeds the capacity of the choker. During off-peak periods, the chokers are less effective since traffic demand is then typically be lower than the capacity of the choker.

Chokers are not always effective in reducing speeds, and they may have to be combined with another measure such as a speed hump if speed calming is also required.

Chokers may also pose a danger to bicycle traffic due to limited space available for vehicular traffic. Consideration should therefore be given to the provision of a separate bicycle path that bypasses the choker.

5.3.6. Road closure

The closure of a road is a sure and effective method of preventing traffic intrusion. Road closure is the most extreme technique for deterring traffic short of banning all traffic from the road or street.

Roads can be closed in the middle or at the end of a block at a junction. An alternative method is to close intersections diagonally (partial closures).

The disadvantage of these designs is that travel distances can be significantly increased for residents in the area. A more serious disadvantage, however, is that the road closures could divert traffic to other roads that previously did not experience traffic intrusion problems. Residents living on such negatively affected streets will often not agree to such diversions.

A further problem with road closures is the need to provide a turning area at a road closure. Road reserves are usually wide enough to allow passenger cars to turn, but are seldom wide enough to accommodate turning heavy vehicles. Road closures are therefore not always possible or an ideal solution.

The diagonal diverter is a barrier placed diagonally across a junction to, in effect, convert the junction into two unconnected streets, each making a sharp turn. The primary purpose of the diverter is to break up short-cut routes through an area. A system of diagonal diverters can be very effective in reducing traffic intrusion on a particular route, but traffic would probably be distributed to other roads in an area.

Provision should be made to allow bicycles entry at road closures. Care should, however, be taken in the designing the bicycle paths through such closures since drivers may not expect bicycles to enter a road or street at such locations.

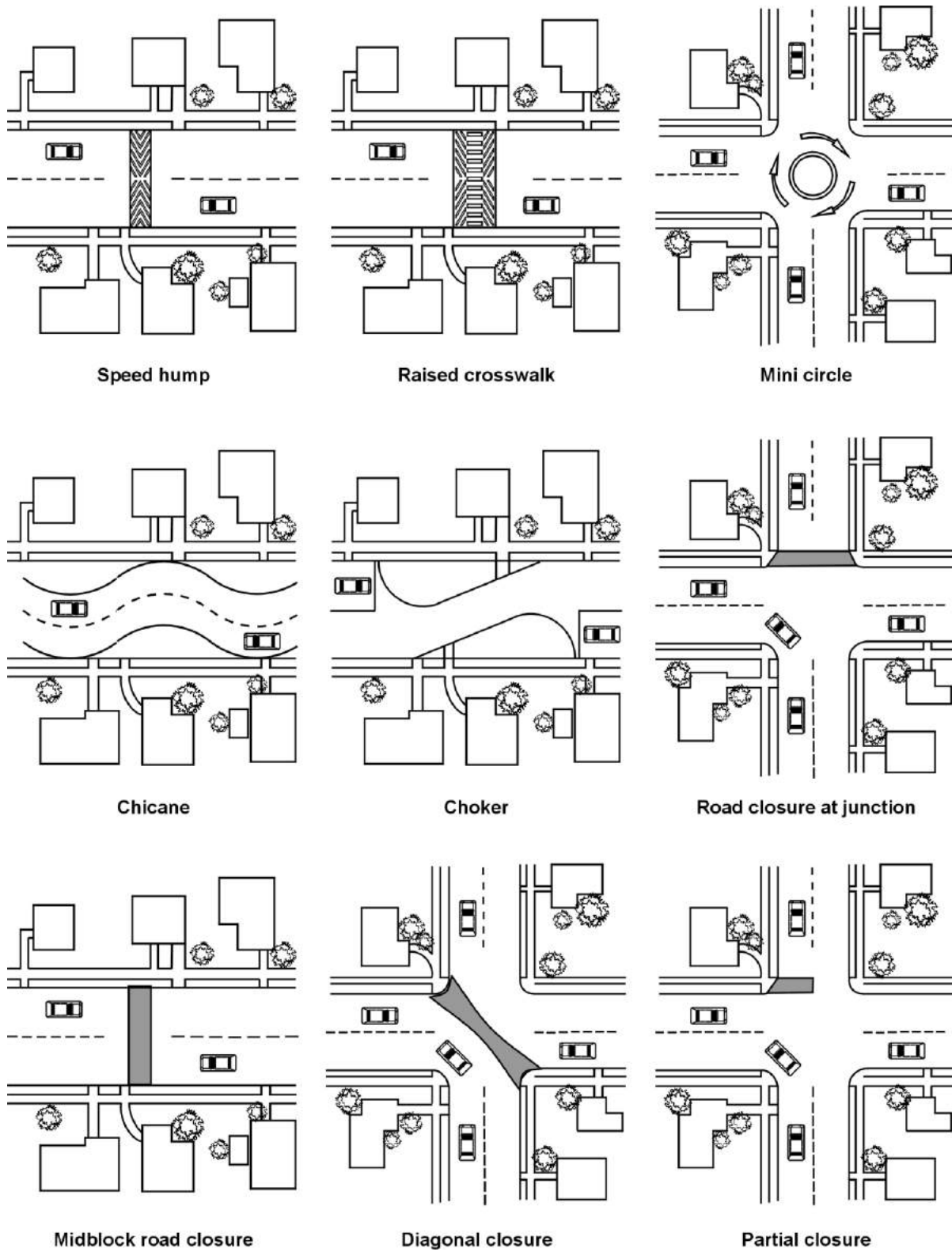


Figure 5.1: Traffic calming measures

D. Pedestrian and bicycle amenities and support

6. Speed limits

6.1. INTRODUCTION

Excessive speed is a frequent contributing factor in the number as well as severity of accidents, particularly accidents involving pedestrians and cyclists. The severity of accidents increases exponentially with speeds due to the increase of kinetic energy with high speeds. Accidents are also more difficult to avoid at high speeds because of the longer distance travelled during reaction time, the longer distance required to stop and the greater difficulty of controlling a vehicle at high speed. High-speed puts greater strain on tyres and brakes which increases the risk of a tyre burst or brake failure. High speed also makes it difficult for other road users (other drivers, pedestrians and cyclists) to estimate distances when entering or crossing a road.

In addressing speed problems it is important to recognise that it is not necessarily high speed that kills, but speed that is excessive for circumstances. No speed can be defined as "safe" since even a very low speed may be unsafe under particular circumstances. Stationary vehicles or vehicles that are slowing to turn on a high-speed road, for example, could be particularly dangerous. A high variation in speeds also increases the frequency of vehicles overtaking, which, in turn, increases the risk of accidents. Speed variance could be as important a factor in accidents than high speed as such.

6.2. SETTING OF SPEED LIMITS

General speed limits for urban streets and rural roads are prescribed in the National Road Traffic Act and Regulations. These general limits, however, cannot accommodate all possible conditions that may occur on roads. Provision has therefore been made in the act and regulations to allow the posting of lower, and in the case of urban streets, higher speed zone limits on particular roads and streets.

A procedure for establishing speed limits has been developed by the South African Department of Transport (1996). A detailed procedure is given for the setting of speed limits and information is given on sizes and the positioning of speed limit signs. This procedure stresses that speed limits should be established by persons who are qualified to do so.

It is not the intention to repeat all the information contained in this procedure in this chapter, but to highlight some important aspects, particularly those applicable to pedestrians and cyclists. The presence of pedestrians on a street and road is recognised by the procedure as one of the most important factors in establishing speed limits.

6.3. LAW ENFORCEMENT AND SPEED LIMITS

Although the procedure is aimed at establishing speed limits, it clearly recognises that posting a speed limit will not automatically mean that speeds will reduce and road safety improve. Unless law is enforcement is applied, drivers will continue to ignore the speed limit and it would have little affect on road safety.

There is little sense in simply posting a speed limit that is ignored by most drivers and therefore serves no purpose and solves no problem. In such cases, it is important that other solutions (other than a lower speed limit) should be considered to address a particular safety problem.

6.4. PEDESTRIANS AND SPEED LIMITS

The procedure for setting speed limits is to a great extent based on the 85th percentile speed of traffic. There are many advantages in this approach, one of which it often results in reasonable speed limits. The procedure, however, recognises that the use of 85th percentile speed has certain limitations, one of which that it only accounts for the perception of vehicle drivers, and not for other road users such as pedestrians (and cyclists).

The procedure recommends speed limits for various situations and conditions. The following speed limits are recommended when pedestrians are present on a road or street:

- An 80 km/h speed limit is used when few pedestrians use a road. Public transport termini typically occur at isolated locations on such roads.
- A 70 km/h speed limit is used when higher volumes of pedestrians can gain access to a road. Public transport termini occur regularly on the road or street.
- A 60 km/h speed limit is used when relatively high volumes of pedestrians can gain access to a road.

The procedure recognises that lower speed limits are required to accommodate pedestrians. It is, however, unlikely that such speed limits would be successful in reducing speeds. Traffic calming

Pedestrian and Bicycle Facility Guidelines

measures are recommended when lower speeds are required to accommodate pedestrians and cyclists.

PART E

PEDESTRIAN AND BICYCLE PLACES

E. Pedestrian and bicycle places

1. Introduction

1.1. BACKGROUND

Pedestrian and bicycle places are those areas in which special attention should be given to the needs of these two groups of road users. These areas would obviously include all urban areas and some portions of rural areas, but the emphasis is on addressing the needs of pedestrians and cyclists (sometimes even to the detriment of vehicular traffic).

It is important that the needs of pedestrians and cyclists should be addressed from the first initial planning of an urban area. Land-use and urban planning should be undertaken with due consideration of all transportation needs, including walking and cycling.

1.2. TYPES OF PEDESTRIAN AND BICYCLE PLACES

Particularly important pedestrian and bicycle places include the following:

- Urban areas
- Rural Areas
- Disadvantaged communities (relying largely on walking and cycling)
- Schools and other educational institutions.
- Public transport stops and termini.
- Development sites and pedestrian malls.

Information on the provision, planning and design of pedestrian and bicycle facilities at these places are included in this part of the manual.

E. Pedestrian and bicycle places

2. Urban areas

2.1. INTRODUCTION

Walking and cycling are particularly important modes of transport in urban areas because of the very large concentrations of people living in such areas. Of particular importance to pedestrians and cyclists is the development of the “compact city” in which travel distances are reduced through measures such as densification and mixed land-use development.

2.2. THE COMPACT CITY

The “compact city” is a planning model that strives to minimise the effects of urban sprawl by controlling the extent of the horizontal expansion of urban areas. The aim of the compact city is to reduce to inefficiencies and inconvenience associated with low-density urban development.

Many towns and cities in South Africa have developed with low-density residential and other developments around a central core of higher density economic activity. Most of the residential areas are almost exclusively devoted to the provision of housing only, comprising of detached dwelling units. The low-density residential development has contributed to an increase in vehicular travel demand and, in the more affluent areas, a preference for travel by private vehicles, which has led to high levels of congestion.

A shift to walking, cycling and public transport together with densification and mixed land-use development can address many of these problems. By bringing higher density homes, job, shops and recreational amenities closer together, walking and cycling would become easier, public transport services would become more viable, and dependence on private transport would be reduced.

Generally, higher densities support higher levels of public transport and a greater range of social and economic opportunities and facilities. Higher densities can assist in reducing walking distances, which is especially important to the poor sectors of society. The viability of public transportation can also be improved if such densification is orientated to public transportation corridors.

Mixed land uses allow access to a range of activities within easy walking distance. A blend of residential and non-residential land uses place trip attractions within walking distance of people's homes. This can contribute to a reduction in the need for vehicular travel, particularly when the developments occur at higher densities, and an appropriate land use mix is used. Inappropriate land use mixes may lead to dispersed development, which could affect transport efficiency (particularly that of public transport).

2.3. URBAN TYPOLOGY

Urban areas can develop in a variety of forms and shapes. The urban typology is often defined by the vehicular road network. Roads do not only provide shape to land, but in the case of freeways and other high order roads, are also often dividers of land because continuity of movement across these roads is often curtailed. This applies particularly to pedestrian as well as bicycle traffic.

The divisive nature of the high order road system inevitably leads to the creation of inward looking urban "cells" as shown in Figure 2.1. The size of these cells can vary from relatively small neighbourhoods, to relatively large urban districts. It is difficult to integrate different cells from the point of view of reinforcing economic activity and sharing of social facilities.

The high order roads on the edges of the cells are often access controlled. Due to the high speeds encountered on these roads together with high volumes of traffic, pedestrians and cyclists would find it dangerous to use these roads. Developments along these roads should therefore be restricted to those that would not require direct access to such roads, or that would not generate high levels of pedestrians and cyclists. The type of developments most suitable for these locations are those that are mainly dependent on vehicular traffic. Typical examples of such developments are distribution centres, high technology centres, industrial parks, corporate head-offices, etc.

The divisive effect of mobility roads can to some extent be addressed by building vehicular and pedestrian bridges or subways across the roads. The cost of such bridges, however, is high and can only be justified when they will be used by sufficiently large volumes of traffic. Where bridges are planned, it is preferable to construct the mobility roads at a level lower than the surrounding land. The bridges can then be provided near to ground level, which allows for greater integration of the bridges with the surrounding environment. Such bridges will also be more readily be used by pedestrians and cyclists.

2.4. RESIDENTIAL AREAS

The provision of pedestrian and bicycle facilities in residential areas are particularly important for various reasons. Not only are such facilities safer, but they can also contribute to a neighbourhood's "sense of community". Such a community spirit is often impossible in the motor-orientated society when there is little chance for people to get to know each other.

Pedestrian and bicycle facilities in residential areas are more likely to be used when they are located near to activity centres such as schools, shops, community centres, sport fields, public transport stops, etc. The provision of pedestrian facilities near to schools and public transport stops are particularly important, the first because children are involved, and the second to encourage the use of public transport.

Facilities should not be provided in secluded areas for security reasons. Long walkways through secluded parks may be attractive from an environmental point of view, but will not be used by pedestrians if there is a security danger along in such areas.

Many developing communities have a lack of transport facilities of all types. This is expounded by a lack of proper planning of township layout, which often makes it difficult to provide such facilities once the community has settled. Due to the lack of transport facilities, many people settle adjacent to existing main roads and, in many cases, even along freeways. Such main roads are then used to provide direct access to the settlement, or must be crossed to reach destinations on the other side of a road.

2.5. COMMERCIAL AREAS

High volumes of pedestrians often occur in commercial areas, and conflict between pedestrians and vehicular traffic is a major problem. Although the principle of diverting traffic around such areas has been advocated for many years, numerous areas still exist where traffic crosses these commercial areas. Changing an existing situation is often very costly and not easy to implement.

The following measures are effective in improving the pedestrian environment in commercial areas:

- Diverting vehicular traffic around an area on roads or streets that are less used by pedestrians.
- Provision of sufficient pedestrian crossings and the use of pedestrian refuge island to facilitate such crossings.
- Provision of wide sidewalks, and preferably alleyways where pedestrians can be separated from vehicular traffic.

2.6. INDUSTRIAL AREAS

Industrial areas are often characterised by large volumes of pedestrians travelling to and from work. Facilities for pedestrians, however, are often inadequate, both for crossing and walking adjacent to roads, particularly at or in the vicinity of public transport stops, termini and stations.

In industrial areas, it is very important that pedestrian desire lines should be studied to ensure that pedestrian facilities are provided where they are the most urgently required. The following are particularly important:

- Adequate pedestrian crossings, either at midblock locations or at road junctions.
- Sidewalks of sufficient width, and even exclusive pedestrian walkways leading to public transport facilities.
- Locating public transport facilities near to destinations to ensure shortest possible walking distances.

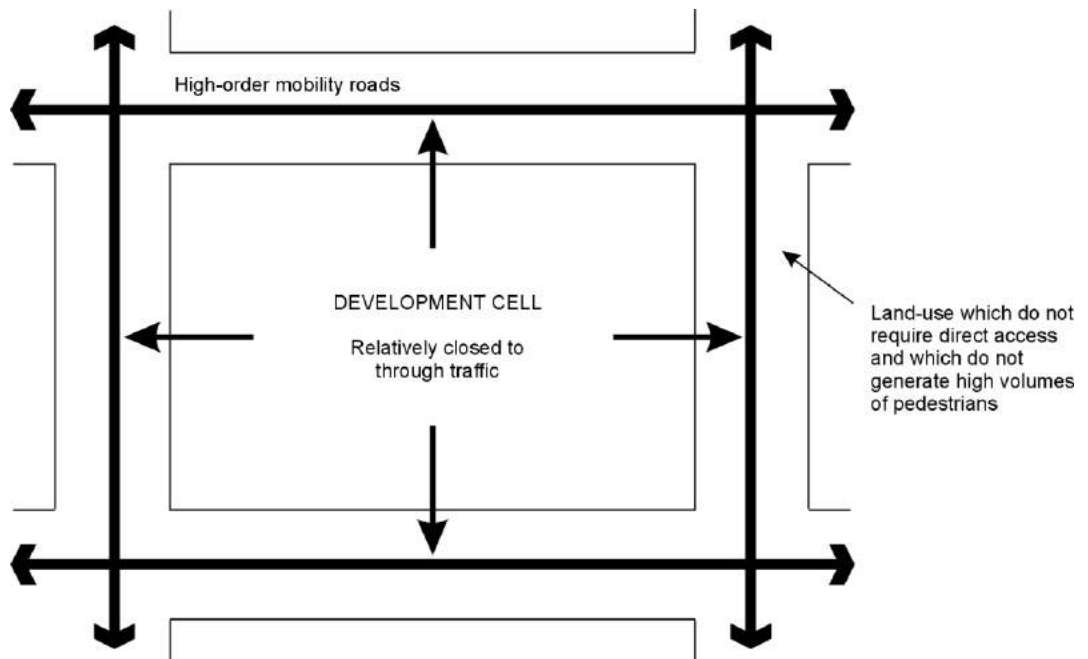


Figure 2.1: Development “cells” created by a high-order road system

E. Pedestrian and bicycle places

3. Rural areas

3.1. INTRODUCTION

Most pedestrian and cycling activities occur in urban areas where there is larger population of people living. Urban areas would probably benefit most from improved pedestrian and bicycle transportation facilities. This, however, does not mean that no pedestrians and cyclists use rural roads. There are densely populated parts in rural areas that can generate significant numbers of pedestrians and cycling. Some pedestrians and cyclists can also be found in less densely populated areas.

Many of the guidelines given in this manual are applicable to both urban and rural areas. Where there are specific differences, these have been highlighted in relevant sections of the manual.

3.2. SUSTAINABLE RURAL DEVELOPMENT

Sustainable rural development is a national priority in South Africa. The South African President in 2001 announced the Integrated Sustainable Rural Development Strategy, of which the following are some of the important elements:

- The vision of the strategy is to attain socially cohesive and stable rural communities with viable sustainable economies and access to social amenities.

- The strategy is anchored in the generation of local economic development which is targeted through nodal development.
- The continued delivery of basic infrastructure and services will create the lead mechanism for opening economic access in target local economies.
- The focus of the strategy is centred on a concept of integrated and co-ordinated action, as a means to achieve maximum impact.

The provision of pedestrian and bicycle facilities can assist in speeding up service delivery in rural areas. Poverty levels in rural areas are high, and most people in such areas have to walk for various purposes. These purposes include activities such as the collection of firewood and water. The walking distances involved are often very long, and people can spend a considerable amount of time walking.

3.3. SAFETY PROBLEMS ON RURAL ROADS

Research conducted on pedestrian casualties on rural roads (Ribbens, 1989), showed that special attention should be given to pedestrians (to cross roads and to walk alongside roads) at the following areas:

- Close proximity to towns.
- Densely populated rural areas (informal and formal).
- Mining areas.
- Rural industries.
- Agricultural depots.
- Major roads at irrigation schemes and extensive agricultural areas.

A problem in rural areas is that very often little provision is made for pedestrians and cyclists. These groups must share rural roads with vehicles that can sometime travel at very high speeds. On many roads, this problem is somewhat mitigated by the provision of paved shoulders that can be used by pedestrians and cyclists, but on many roads, only gravel shoulders are available. Narrow road bridges, cuttings and fills often also create problems for pedestrians.

A further important problem in rural areas is travel at night. No or very little lighting is provided, and drivers are often blinded by the lights of other vehicles. Speeds also tend to be high at night, sometimes even higher than during the day. There is also probably a greater tendency for intoxication at night amongst all road users. All these factors contribute to a situation that is very dangerous for pedestrians and cyclists on many rural roads.

3.4. PEDESTRIAN CROSSINGS IN RURAL AREAS

The provision of pedestrian crossings on roads with high operating speeds presents a major problem for which solutions are not readily available. Yield controlled pedestrian crossings are undesirable on such roads because pedestrians are not able to judge vehicle speeds or stopping distances for faster traffic. Traffic signals, according to the Road Traffic Signs Manual, may not be installed on roads with a speed limit higher than 80 km/h. In South Africa where speed limits of 100 and 120 km/h are typically used on rural roads, it would often not be possible to provide pedestrian crossings on rural roads.

Pedestrians can be accommodated on high-speed roads by providing grade-separated structures. Such structures, however, are expensive and are often difficult to justify economically. Under such circumstances, the only solution is to reduce vehicle operating speeds to not more than 80 km/h. Speed limits can be posted, but are unlikely to be successful. Traffic calming measures can be introduced but care should be taken to introduce measures that do not create additional danger on a road. Speed humps, for example, have the problem that their visibility can be poor, particularly at

night on unlit rural roads. When the speed humps are not properly maintained, or sufficient warning is not given, they may be dangerous and could lead to serious accidents.

A more suitable measure for calming traffic on high-speed roads is the traffic chicane. Chicanes utilise traffic islands on a road to force traffic to travel in a serpentine pattern, thereby reducing speeds. The advantage of the chicane is that it can be designed to allow travel at higher speed than those normally associated with other traffic calming measures. This may be more acceptable in a rural setting where pedestrian volumes are normally not as high as in urban areas.

3.5. PEDESTRIAN SIDEWALKS AND WALKWAYS IN RURAL AREAS

Pedestrian sidewalks and walkways can be utilised very successfully in rural areas near to large pedestrian generators such as schools. Shoulders can serve as walkways on rural roads, but this is normally only acceptable when pedestrian volumes are limited, and when there are also not many cyclists using the road. Under these circumstances, a sidewalk or walkway adjacent to the road should be provided.

To ensure that sidewalks or walkways are used for the purpose intended, they should have all-weather surfaces, otherwise pedestrians would continue to walk on the roadway. Sidewalks should also not be provided too far from the roadway where they would be perceived as a security risk. Special protection should be given to pedestrians on road bridges, especially narrow bridges, and on the approaches to these bridges.

Shoulders are often used as walkways on roads in rural areas. This is acceptable where pedestrian volumes are limited, or where speeds are relatively low. The shoulders may be paved or unpaved, but it is unlikely that pedestrians would use unpaved shoulders as footpaths. The paved shoulders should preferably be at least 1,5 m wide, but wider shoulders of 3 m and wider are preferred to providing greater separation distance between pedestrians and traffic.

3.6. BICYCLES IN RURAL AREAS

Road shoulders can be used to accommodate cyclists in rural roads, when traffic volumes and speeds are relatively low. When a road is used by large volumes of cyclists as well as traffic, particularly when operating speeds are high, a separate bicycle road may be justified. Such bicycle road should be paved, otherwise cyclists may continue to use the roadway.

Bicycle lanes are not normally suitable on rural roads, particularly where the speed limit is higher than 80 km/h. On such roads there is a high likelihood that vehicles may stray onto the bicycle lane, which could create dangerous conditions for cyclists.

E. Pedestrian and bicycle places

4. Disadvantaged communities

4.1. INTRODUCTION

Most of the disadvantaged communities in urban and rural areas lack adequate pedestrian and bicycle infrastructure alongside roads and to cross roads safely. These communities, however, are characterised by large volumes of pedestrians walking adjacent and on roads. Vehicle ownership is typically low and most people have to rely on walking as their basic mode of transport.

This chapter focuses on guidelines that could assist traffic engineers to upgrade pedestrian facilities in these disadvantaged communities. This upgrading should go hand in hand with the national imperatives to provide adequate infrastructure in these disadvantaged areas such as Integrated Development Planning (IDP), Shova Kalula (Pedal Easy), Poverty Alleviation and the Integrated Sustainable Rural Development Strategy (ISRDS). The ISRDS also targets townships for improved service delivery.

4.2. TYPICAL ROAD SAFETY PROBLEMS IN DISADVANTAGES COMMUNITIES

Road safety problems occur in informal settlements as well as in formalised townships. Informal settlements, however, typically experience greater safety problems due to the lack of infrastructure and particularly pedestrian facilities, and also because such settlements often occur adjacent to

major roads due to the need for access to transport. In some cases, the settlements occur so near to the roads that encroachment of informal housing has occurred onto road reserves.

Although transportation facilities have been provided in some townships, many of these facilities have not been properly maintained or neglected due to limited budgets. This also applies to pedestrian facilities such as sidewalks and pedestrian crossings. In many townships pedestrian facilities are completely lacking.

Various common problems are experienced in informal settlements as well as townships which have a negatively impact on road safety. These include the presence of hawkers and even small businesses in the road reserve blocking pedestrian sidewalks. A further problem is the lack of drainage, or poorly maintained drainage, which force pedestrians onto the roadway. Street lighting facilities either do not exist or are sometimes poorly maintained.

Road authorities should consider developing pedestrian and bicycle master plans for townships as part of the Integrated Development Planning (IDP) process and the Integrated Sustainable Rural Development Strategy (ISRDS). Such master plans should be based on pedestrian desire lines and major land uses that generates pedestrian traffic in the community.

4.3. PEDESTRIANS ON FREEWAYS AND MAJOR ROUTES

The problem of pedestrians on freeways and major routes adjacent to informal settlements and townships exists in many parts of the country and requires special attention. Many traffic accidents involving pedestrians occur on such roads. Some of the measures that can be implemented to address this problem include the following:

- The provision of warning signs to alert drivers of the presence of pedestrians on the road and the reduction of the speed limit at the settlement. Such reduction, however, is unlikely to be successful unless the speed limit is enforced. Furthermore, the presence of pedestrians on a freeway or major road should not be seen as acceptable practice, and other measures are more desirable.
- The provision of grade separated pedestrian facilities (bridges or subways) where large numbers of pedestrians cross the road.
- The channelisation of pedestrians to specific crossing points is also a measure that can be considered. Various examples exist where brick and concrete walls have been provided to prevent pedestrians from crossing or entering the major road or freeway.
- The routing of public transport into the informal settlements or townships to avoid the picking up of people on the freeway or major road.

4.4. LACK OF PEDESTRIAN FACILITIES

The lack of pedestrian facilities in informal settlements and in many townships is often a cause for many road safety problems. The most important facilities required in such areas include the following:

- An internal network of pedestrian sidewalks and walkways should be provided based on pedestrian desire lines and major land uses generating pedestrian traffic in the area such as schools, sports fields, commercial centres, etc.

- Pedestrian crossings are required at locations where the internal network of pedestrian walkways crosses major roads.
- Land uses such schools and other pedestrian generators should be located away from major roads, or in such a way that major roads do not need to be crossed. If this is not possible, provision should be made for grade separation and the channelisation of pedestrians to these crossing points.
- Roads should be designed in such a way that speeds would be limited. Where this is not possible, traffic calming measures should be included in the upgrading of settlements to safeguard pedestrians.

4.5. ENCROACHMENTS BLOCKING PEDESTRIAN WALKWAYS

In many informal settlements and townships, road reserves are utilised for a multitude of purposes that impact negatively on pedestrian safety. Some examples include:

- Hawkers selling their goods adjacent to roads, blocking pedestrian sidewalks.
- Small businesses operating on the sidewalk such as car maintenance, telephone booths, etc.
- Shacks/houses built up to the edge of the road.
- Minibus taxis using the sidewalk as bus stops or ranking areas.
- Obstacles put on the walkway area such as boulders to protect properties against traffic.

Measures such as the following can be considered to ensure clear pedestrian sidewalks next to roads:

- The relocation of hawkers and small businesses to designated areas, preferably near to public transport facilities
- The installation of barriers and fences such as brick walls to prevent the encroachment of shacks onto the road reserve
- The provision of barrier kerbs to prevent vehicles stopping on the sidewalks.

The lack of drainage systems or blocked road drains also often force pedestrians to walk on the roadway. Regular maintenance of such drainage systems would improve the plight of pedestrians walking alongside roads especially during inclement weather conditions.

E. Pedestrian and bicycle places

5. Pedestrians and cyclists at schools

5.1. INTRODUCTION

The potentially for severe, and often fatal, consequences of an accident involving a child often raises high emotions in communities. The safety of children at schools should therefore be a major concern to all parties involved, including parents, the school, the general community, law enforcement and the road authority.

The identification of problems and implementation of improvements to safety problems require a co-operative effort among all parties to ensure maximum success. Parties should work together to develop improvement programmes that provide better and safer opportunities for children to walk or cycle to school

There are two key components of an improvement programme that ensure safer conditions for school children:

- Effective operation plans and safety programmes, consisting of supervisory control elements and education for school trip safety.

- Adequate level of physical facilities at and near to the school

5.2. THE ACCIDENT RISK OF SCHOOL CHILDREN

Children tend to be exposed to more traffic accidents for various reasons. Children, as pedestrians, have certain limitations that increase their vulnerability to accidents. Children are not simply “short adults”, and require additional consideration. The following are some of the important differences between children and adult pedestrians:

- One of the most problematic characteristics of child pedestrians is that their movements are less predictable than adults are. Young children tend to dart into traffic and to dash across the street.
- Children are shorter than adults, with a typical eye height of about 1 meter above ground. Their field of vision is therefore different from those of adults. Due to their small stature, children are sometimes not noticed by fast moving or inattentive drivers.
- Young children lack the visual acuity and peripheral vision to judge speeds of oncoming traffic and adequacy of gaps in the flow of traffic. When accepting gaps, most children only consider how far the vehicles is and do not take the speed of the vehicles into consideration.
- Children are less able to determine the direction of sounds.
- Children have less experience as pedestrians, and may not be fully aware of dangerous conditions.
- Children do not drive, and therefore lack the understanding of what a driver's intentions might be at a junction or crossing point.
- Children have shorter attention spans and may grow impatient at crossings.

Most drivers are not aware of the above limitations, and overestimate a child's ability to deal with traffic, particularly when they walk alongside or cross a street. It is for these reasons that particular attention must be given to addressing safety issues at schools.

5.3. CAUSES OF ACCIDENTS AT SCHOOLS

Road traffic safety problems in school precincts culminate from three primary reasons, namely:

- Modal mix. School traffic is characterised by a high concentration mix of most road user modes, i.e. pedestrians, cyclists, cars and busses. This high concentration modal-mix results in many traffic conflicts.
- Inexperienced road users. School children, being young and inexperienced, are ill equipped to deal with the complex traffic movements and high concentrations of vehicles during peak periods at schools.
- High intensity traffic peaks. Practically all inter-modal interaction in the vicinity of schools takes place within a relatively short peak period.

Typical problems that are encountered at schools include the following:

- High traffic speeds ill-suited for schools. Illegal turning movements and actions at school access points i.e. U-turns, double parking etc.
- Lack of pedestrian and cyclist facilities adjacent or en-route to schools. Inappropriate control devices and measures. Uncoordinated and unplanned parking/drop-off movements. Vehicles parking too close to intersections and obscuring sight distances.
- Unsafe home-based school pedestrian and cyclist trip routes. Pedestrians having to cross major roads.

5.4. RESPONSIBILITIES FOR SCHOOL SAFETY

Pedestrian safety for school children is not just the responsibility of the school. Everyone in the community has a critical role (Savage, Brix, et al 1996):

- **Drivers** perhaps have the greatest responsibility for school pedestrian safety. Pedestrians have the right-of-way at crossings and drivers should allow them to use the road, particularly when they are children. Drivers should also be aware of the typical problems experienced with the child pedestrian.
- **Students** have the personal responsibility for their own safety. The child must understand and follow instructions given to him or her regarding road safety.
- **Parents** have the best opportunity to identify and correct poor pedestrian behaviour of a child. The child's attitude toward road safety rules will be greatly influenced by the attitudes of the parents.
- **Schools** have the responsibility of addressing the road safety needs of their students. The schools should play an active part in the training of the students, and the provision of scholar patrols.
- **Local authorities** have responsibilities for the design, installation and maintenance of pedestrian and bicycle facilities, as well as law enforcement.

5.5. SCHOOL SAFETY MANAGEMENT

Schools should implement management procedures on a local level for addressing traffic safety issues. A committee should be established who would be responsible for the traffic safety. Committee members may represent parents, teachers, traffic police, local authority and even children.

The committee should institute programmes aimed at:

- Providing scholars (as well as parents) with a proper knowledge of traffic safety and available pedestrian and bicycle facilities at and near to the school.
- Establish safe pedestrian and bicycle facilities at the school, including drop-off and parking areas for parents.
- Establish a "Safe Route to School" programme aimed at:

- Identifying safest routes to the school together with possible deficiencies of such routes as well as hazardous locations that need improvement.
- Establish the required crossing facilities where routes cross the roads and streets.

A safe school route is not a totally risk-free walking or cycling environment – it is unlikely that a route will ever be completely free from exposure to all potential risks or injury, small or great. Even a child walking or cycling in the most protected environment experiences some risk of being injured.

5.6. SCHOOL SITE SELECTION

Schools have traditionally been one of the focal points of the community, serving a variety of functions, such as meeting and voting. Siting a school so it can be easily reached from all directions and providing a sufficient level of pedestrian and cycling facilities further assist in establishing the school as a strong community centre.

Schools should be located in the centre of the community neighbourhood so that it can be accessed from all sides. Streets leading to the school should have sidewalks and bicycle facilities and all the elements required to address pedestrian and cyclist needs.

Generally, schools should NOT be located on or near the high order road system carrying high volumes of traffic at high speeds. Such roads should also NOT dissect the neighbourhood serving the school. In particular, a school should not be located on one side of such a high order road, while the service area is located on the other side of the road.

5.7. SCHOOL SITE DESIGN

The school site and surrounding areas should be planned and designed to invite pedestrian and bicycle travel, while ensuring a high level of pedestrian safety. Schools should ideally be centred in a community and paths provided that the school can be accessed from all sides.

The following are a number of elements of good school site design:

- School buildings should be accessible to pedestrians from all sides with entries and exits.
- Trails and pathways provide direct and continuous links between the school site and the surrounding neighbourhood.
- Public transport drop-off zones should be separated from private vehicle drop-off zones to minimise conflict.
- Vehicles and pedestrians are separated and provided with their own designated areas for travelling.
- Strategically located, well-delineated crossing opportunities are provided, including midblock crossings and crossings at controlled junctions.
- Pedestrians are clearly directed to specific crossing points and pedestrian accesses by directional signs, fencing and other elements.
- Traffic calming devices are installed with the purpose of reducing speeds.

- Sight distance obstructions are removed so that there is clear visibility of pedestrians throughout the area.

5.8. SCHOLAR CROSSINGS

The scholar crossing at a school is an efficient and safe method to assist scholars in crossing roads. A description of the composition and functioning of scholar patrols is contained in a scholar patrol manual issued by the Directorate Traffic Safety of the Department of Transport (National Road Safety Council, 1988).

According to the Road Traffic Signs Manual, there are two options for pedestrian crossings operated by scholar patrols, as illustrated in Figures 5.1 and 5.2:

- At a permanent crossing where the scholar patrol stop sign R1 over-ride the R2.1 signs whilst the scholar patrol is in operation.
- At a location where guide line markings have been provided and the scholar patrol stop sign does not overrides any other sign.

The scholar patrol has advantages beyond that of controlling traffic. Such patrols offer a way of extending traffic safety education directly to students. The patrol members should preferably be selected from older students. Qualities such as leadership and reliability are important in selecting students for the patrols

5.9. DROP-OFF AREAS AND PUBLIC TRANSPORT STOPS

One of the biggest safety hazards around schools is the dropping off and picking up of children. To address this problem, there should be a clearly marked area where parents can drop off and pick up children. Provision must also be made for various modes of transport.

Bus and mini-bus stops need to be adequately designed to provided sufficient waiting area away from the roadway for the number of children using the stop. The design of the stops should be in accordance to recommendations given elsewhere in this manual.

Examples of drop-off areas and public transport stops are shown in Figure 5.3.

5.10. SIGHT DISTANCE AND VISIBILITY

Children are smaller than adults are, and more difficult for motorists to see at crossings. Crossings should therefore be provided with an unobstructed visual field for both the pedestrian and the driver of a vehicle.

The following are examples of obstructions that can reduce visibility and which should be removed (or replaced by less obstructive elements where appropriate):

- Street furniture, such as poles, bus shelters, refuse bins, etc.
- Landscaping and plants, including shrubs and trees.
- Parked vehicles (even momentarily).

5.11. TRAFFIC CALMING AT SCHOOLS

Traffic calming measures are used to slow vehicles and reduce non-local through-traffic. These measures can be particularly effective at and near schools to create a safer and more comfortable environment for pedestrians and cyclists.

Traffic calming measures are preferred over lower speed limits. Lower speed limits are only effective if they are consistently enforced, and unless a continuous law enforcement programme can be implemented, preference should be given to traffic calming.

Traffic calming measures are discussed in greater detail elsewhere in the manual. The following are examples of measures that can be used at schools:

- Refuge islands at crossings.
- Raised pedestrian crossings and speed humps.
- Mini-circles.

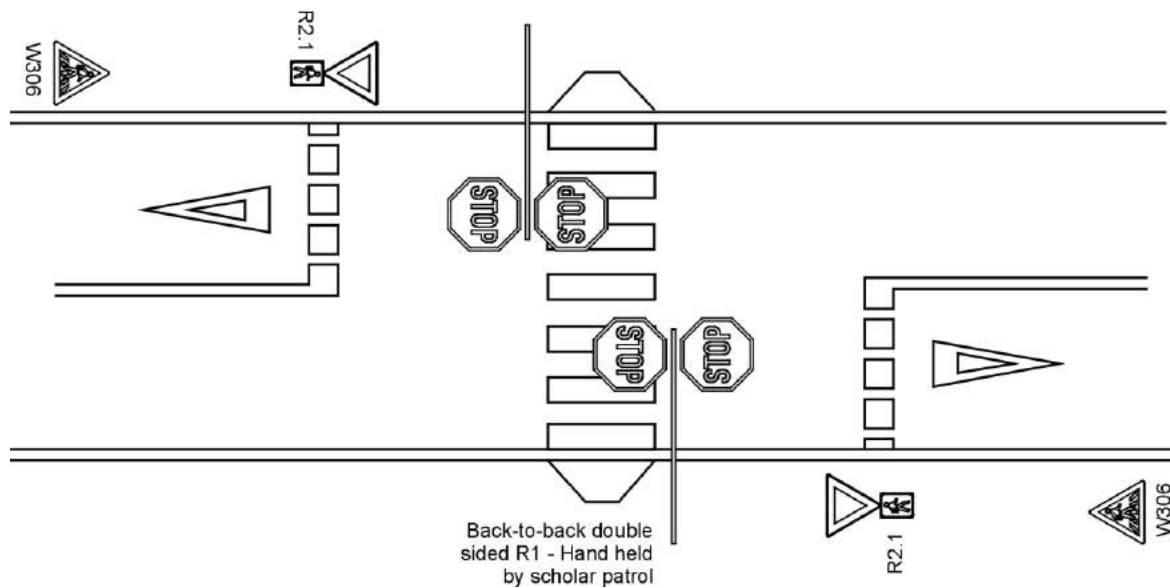


Figure 5.1: Stop over-riding yield option

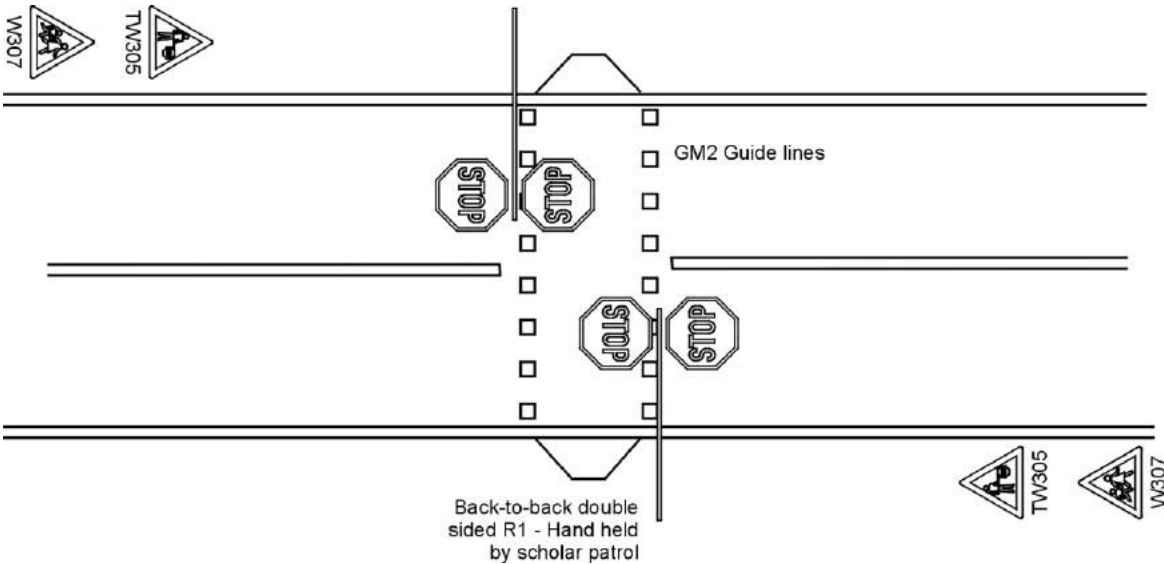


Figure 5.2: Part time operation option

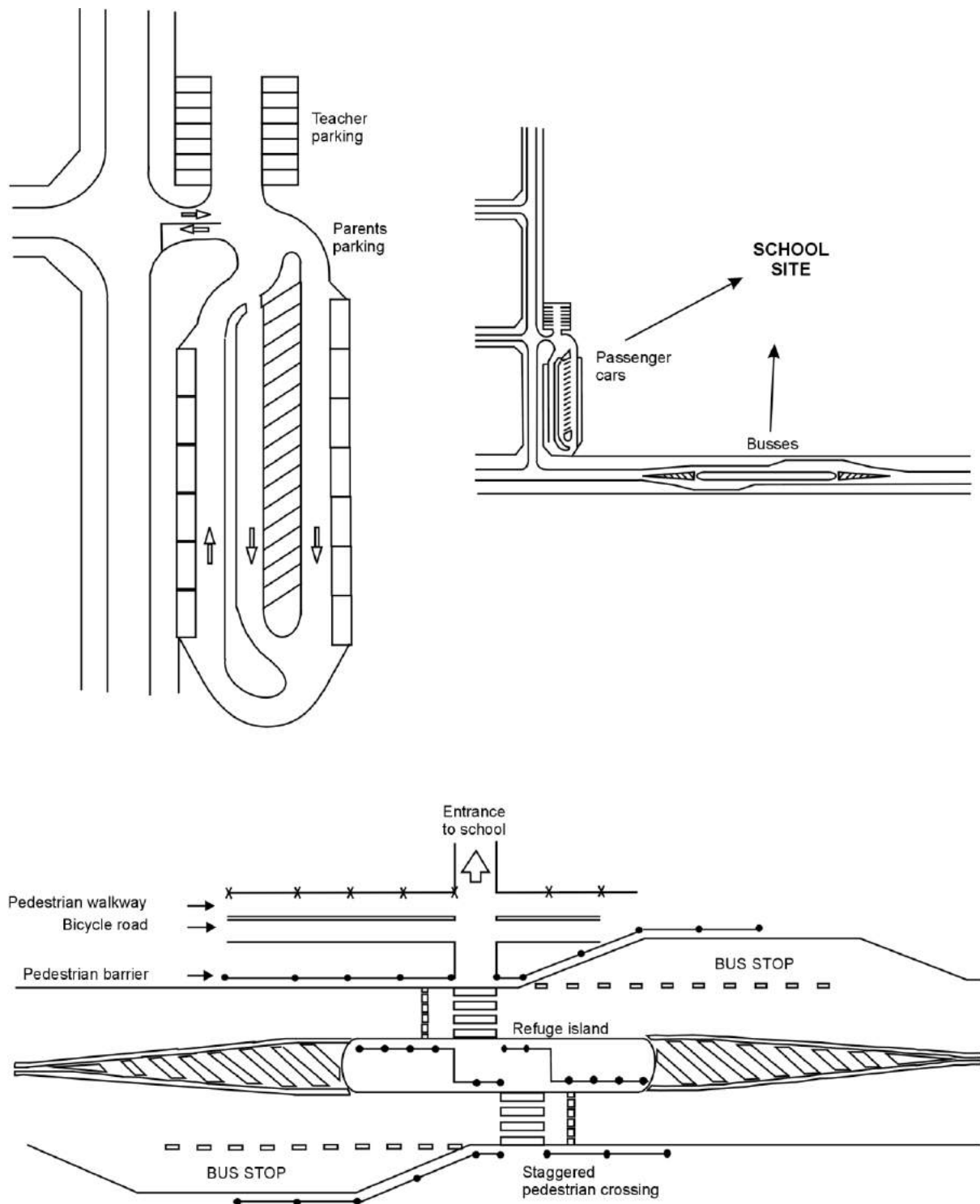


Figure 5.3: Planning of pedestrian facilities at schools in conjunction with other traffic modes

E. Pedestrian and bicycle places

6. Public transport facilities

6.1. INTRODUCTION

The success of public transport as a mode of transportation is highly dependent on pedestrian (and bicycle) access. People with disabilities, in particular, often rely on public transport as their primary source of transportation, and public transport facilities need to be designed to meet their needs. High priority should therefore be given to providing pedestrian (and cycling) facilities at and near to bus and mini-bus stops and termini.

The focus of this chapter is on the provision of pedestrian facilities required at and near to bus and mini-bus stops and termini, rather than the design of the facility itself. Other guidelines and manuals must be consulted for such purpose.

6.2. BUS AND MINI-BUS STOPS

At bus and mini-bus stops, it is important that all pedestrian facilities should be provided, including a waiting area, sidewalks and crossing facilities. The following are a number of important design guidelines regarding pedestrian facilities at bus and mini-bus stops.

- The waiting area should be provided as shown in Figure 6.1. The width of the waiting area should not be less than 1,5 m and its length not shorter than 2,7 m (Otak, 1997).
- It may be desirable to provide a continuous strip of pavement along the entire length of the bus and mini-bus stop, rather than to try and predict where a bus or mini-bus will stop. In such cases, the pavement should preferably be at least 2,4 m wide (Otak, 1997).
- Particular attention is required to ensure that the pavement surface is not slippery, particularly adjacent to the roadway where passengers embark and disembark buses and mini-buses.
- Open sight lines should be maintained between the bus operator and persons waiting at the bus stop.
- Provide shelters and covered structures where feasible to protect passenger waiting areas from wind and rain. The shelters should be well lit and constructed in such a way that views out of or into the shelter are not obstructed (refer to Figure 6.2).
- Sidewalks and walkways should be provided that lead to stops. The sidewalks near the stops should preferably not less than 1,8 m wide, which would enable two adults to walk comfortably side by side (Otak, 1997).

Pedestrian crossing facilities are often required near or adjacent to bus and mini-bus stops. The road signs and marks required to accommodate such facilities are prescribed by the Road Traffic Signs Manual, and are shown in Figures 6.3 and 6.4.

Pedestrian accidents at bus stops often occur because of pedestrians stepping out from behind the bus and moving directly into the path of an oncoming vehicle. This problem can be addressed by providing space for the bus to move well clear of the travelled way. A painted or constructed island can then be provided between the bus lay-by and the roadway which can accommodate pedestrians. Alternatively, barriers can be provided at the bus stop to prevent crossing of the road in the immediate vicinity of the bus stop, as shown in Figure 6.4.

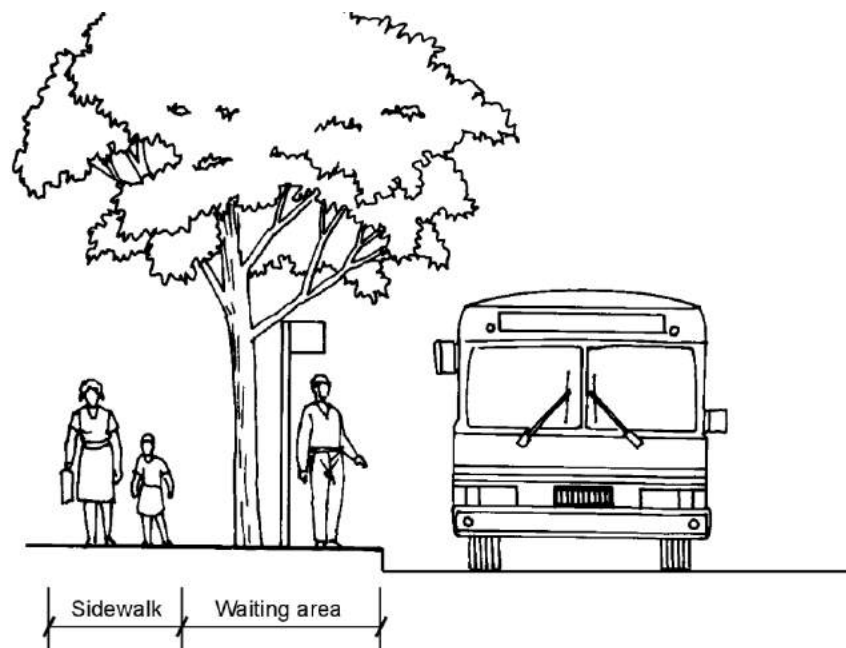


Figure 6.1: Sidewalks and waiting area at bus and mini-bus stops

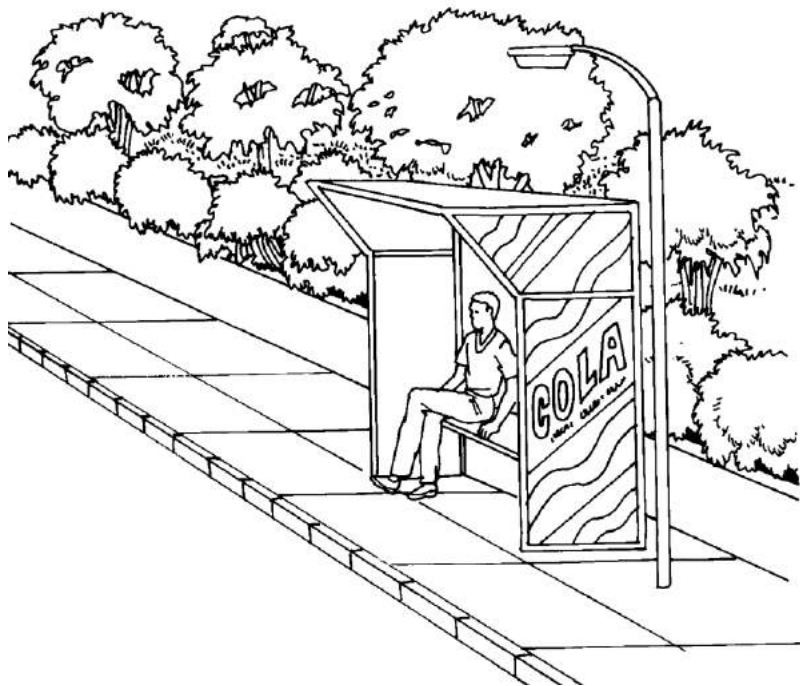


Figure 6.2: Bus shelter

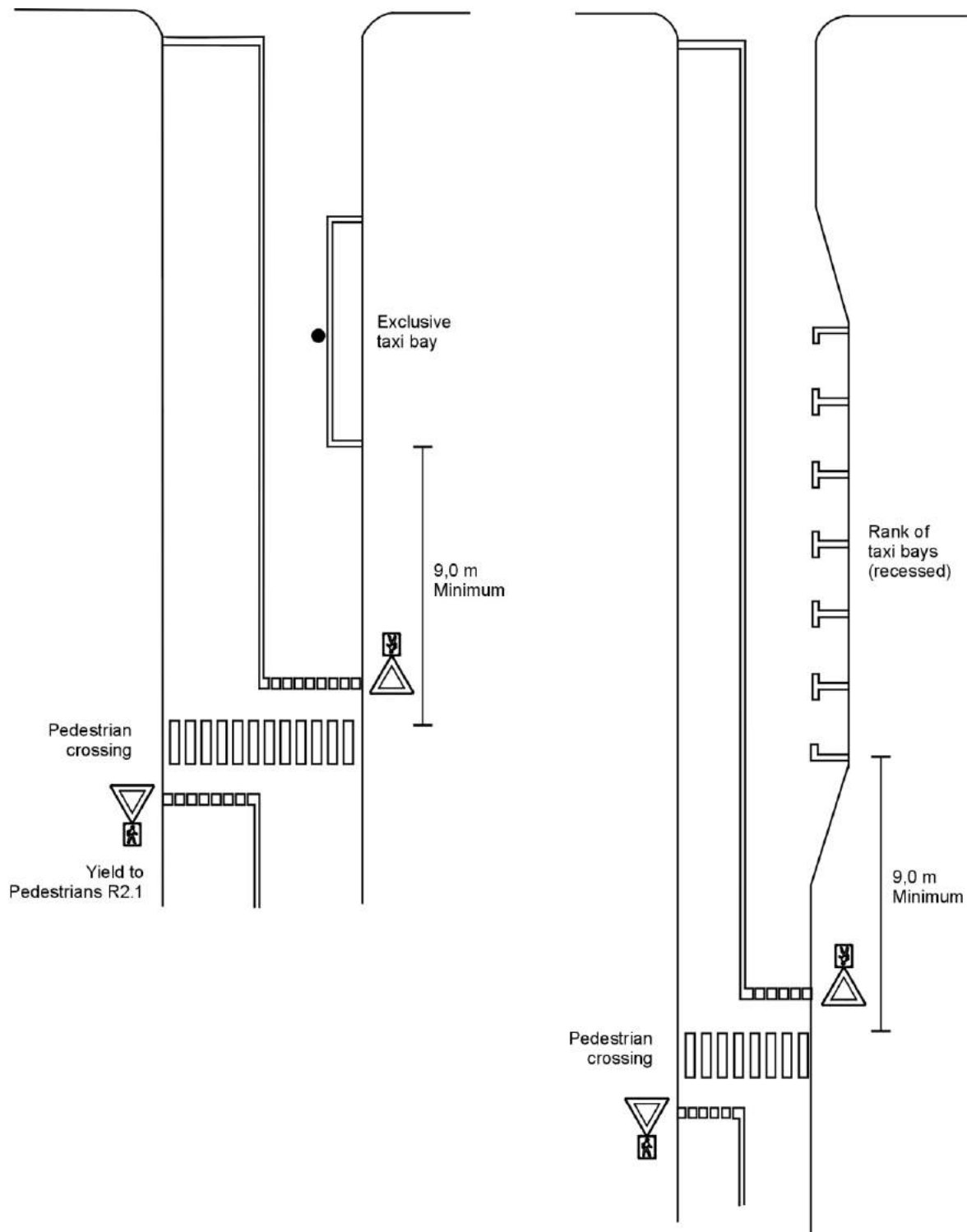


Figure 6.3: Pedestrian crossings in relation to public transport stops

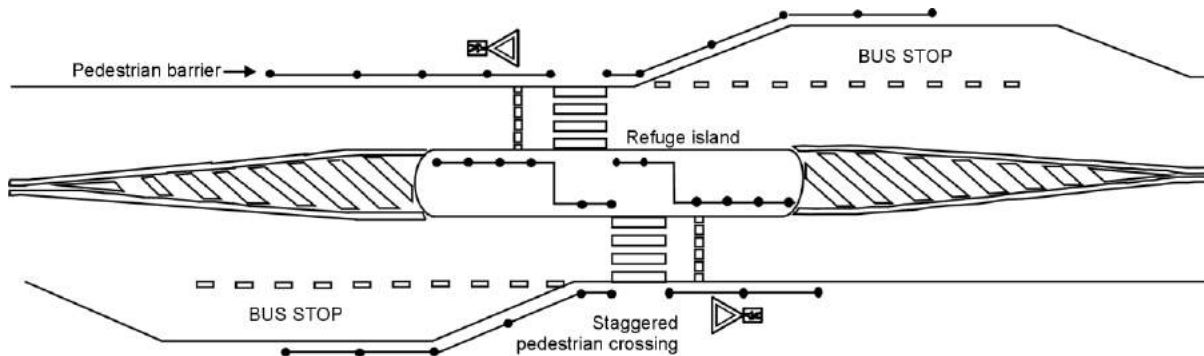


Figure 6.4: Pedestrian crossings on a busy road with bus stops

6.3. PUBLIC TRANSPORT TERMINI AND STATIONS

Very high concentrations of pedestrians are often found in the location of public transport facilities such as railway stations, bus termini and mini-bus ranks. Such concentrations typically occur in the early morning and late afternoon peak periods. Many accidents occur at these locations due to factors such as pedestrians running across the road to catch a bus or train.

At public transport termini and stations, it is important that sufficient and proper pedestrian facilities must be provided. Due to the large volumes of pedestrians using these facilities, it is not sufficient to provide minimum designs. Wider than minimum sidewalks are typically required, while pedestrian crossings must be provided where needed. Particular attention should also be given to the provision of pedestrian refuge islands.

In the planning of pedestrian facilities at public transport termini and stations, it is imperative that pedestrian desire lines need to be studied in order to determine the need of commuters. Such desire lines can be established by means of pedestrian counts or by techniques such as aerial photographs. An example of a desire line study is shown in Figure 6.5.

Public transport facilities are usually characterised by tidal flows of pedestrians in high peaks of short duration, particularly at railway stations. This has definite implications for traffic engineering practice, particular in terms of the widths of sidewalks as well as traffic signal timing.

The following are number of considerations that could contribute to enhancing pedestrian safety at public transport termini and stations (Department of Transport, 1990):

- One-way vehicular movements are generally safer.
- All vehicle movements should be in a forward direction of travel. The only exception will be the holding area where reversing in and out of the standard parking bays may be permitted.
- Passengers should have clearly defined queuing areas. Walkways should preferably be raised by kerbs and clearly separated from vehicle movements.

- Conflicts between pedestrians and vehicles should be minimised through the location of pedestrian islands and paths in accordance with the natural flow of pedestrians, which is normally the shortest path. The best way is to try to design the layout to have the minimum conflict points.
- All pedestrian islands used inside the terminal should be at least 2 m wide and must be raised by a non-mountable kerb to enforce vehicle movement around it to increase safety.
- An over-riding factor in layout design, is the provision of adequate sight distance between vehicles and pedestrians.
- Particular attention must be given to the location of the pedestrian exit and entrance in relation to the bus exit and entrance. As a general rule, it is preferable for pedestrian paths to cross departing vehicles rather than entering vehicles, as the latter are usually travelling faster.

Figure 6.6 shows an example of a public transport terminus at which provision was made for pedestrian crossings. These crossings have been provided to accommodate the most likely points where pedestrians will cross a road or street.

6.4. LOCATION OF PUBLIC TRANSPORT FACILITIES

Public transport facilities should be located so as to minimise pedestrian walking distances. Pedestrian destinations should be identified and if possible, facilities should be provided within a 5 minute walk (400 m to 500 m) of the highest employment concentrations in the area.

Long walking trips create dissatisfaction and have an adverse effect on walking as a mode of transport. Long trips mean that:

- More roads have to be crossed
- Sidewalks become congested, creating unpleasant and crowded conditions,
- Opportunities are created for mini-buses and buses to make unsafe stops at unsuitable places

Public transport facilities will not be used if they are located far from destinations. There are many examples of termini and ranks in South Africa that are either not used or that are under-utilised. Such facilities serve no purpose and are detrimental to the image of public transport in the country.

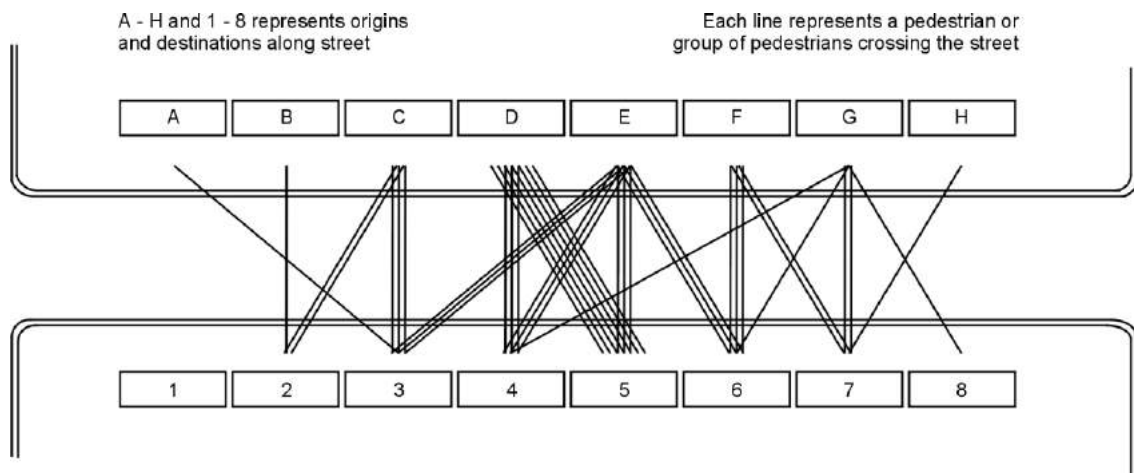


Figure 6.5: Desire line study

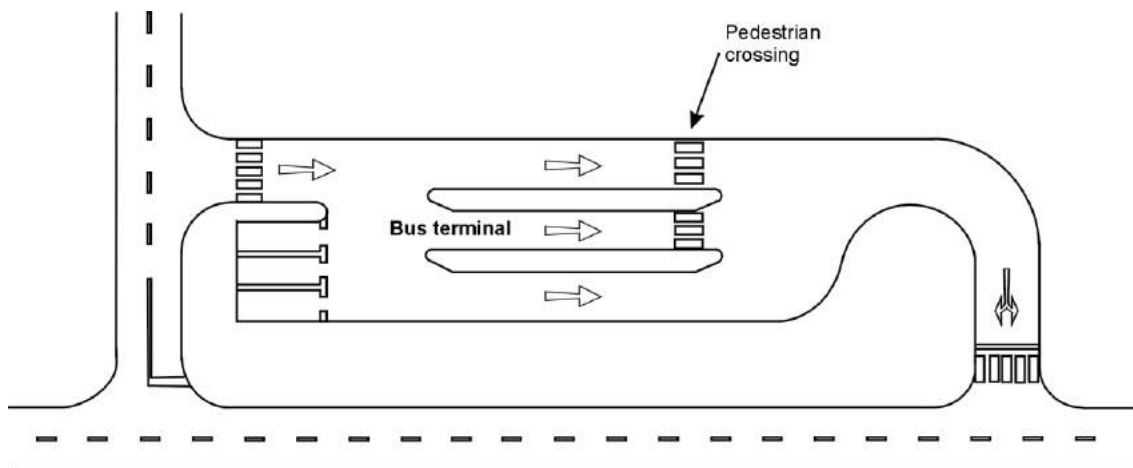


Figure 6.6: Pedestrian crossings at a public transport terminal (Road Traffic Signs Manual)

E. Pedestrian and bicycle places

7. Development sites

7.1. INTRODUCTION

The integration of pedestrians and cyclists in commercial, business, office and other developments can improve the character of the community and are beneficial to all types of social and economic activities.

Many developments in South Africa currently fail in even starting to address the needs of pedestrians and cyclists. In many instances, this is due to economic pressures and a lack of concern for the end users of a development. It is therefore important that local authorities should have requirements for the accommodation of pedestrians and cyclists at development sites. Such requirements should cover the provision of all types of pedestrian and bicycle facilities, including sidewalks and walkways, bicycle paths and crossings.

7.2. SITE PLANNING PROCESS

The first step in providing for pedestrians and cyclists, is for design professionals to be more conscious of pedestrian and cyclist needs at the onset of the planning and design process, rather than as an afterthought.

A sketch planning process can be followed when designing for pedestrians and cyclists. Such a process would first establish likely pedestrian and cyclist desire lines. The origins and destinations are located on a map and connected by the straight lines. Walk and cycling routes should be located as near as possible to the straight desire lines.

The planning and design process should be focussed on finding all possible impediments to walking and cycling at the site. All potential conflict areas should be identified and measures introduced to address likely problems.

7.3. GENERAL REQUIREMENTS

Development sites should provide facilities that specifically address the needs of pedestrians and cyclists. These needs are as follows:

- **Security.** A fundamental consideration is making persons feel safe when using the facilities. Facilities will remain unused when there is a high security risk in an area.
- **Safety.** All facilities must be designed and built free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Traffic safety is an important consideration because of the vulnerability of pedestrians and cyclists. The exposure of pedestrian and cyclists to traffic (and each other) should be minimised. In particular, the number of times people must cross traffic should be reduced to a minimum.
- **Accessibility.** The facilities should be accessible to all users, including those with disabilities.
- **Convenience.** The facilities should be convenient to use. Pedestrians and cyclists desire fast, direct, continuous, convenient routes to chosen destinations. Walking distances should be as short and direct as possible. Where this is not possible, resting places should be provided along the walkways.
- **Comfort.** The facilities should be comfortable to use. Gradients should be restricted, while good pavement surfaces should be provided.
- **Environment.** Pedestrians and cyclists prefer crossings that are attractive to use.

7.4. WALK AND CYCLE WAYS

The walk and cycle way is an important element of a site development. It is therefore essential that sufficient attention be given to the layout and design of a network of such walk and cycle ways. The following are a number of important considerations:

- Meandering walk and cycle ways may look nice on a plan, but are not the most efficient way of walking or cycling from one place to another. The walk and cycle ways should follow the most direct route where possible.
- All walkways should be accessible to persons with disabilities.
- Covered walkways and shelters should be considered when persons have to walk long distances.

- All walk and cycle ways should be well illuminated.

7.5. ON-SITE CIRCULATION

One of the main concerns in the design of on-site circulation, is the separation of conflicts between pedestrians, cyclists and vehicles. The following design strategies can minimise such conflicts:

- Clearly define walk and cycle ways. Such ways should preferably be constructed with kerbs and landscaping.
- Walkways should lead directly to building entrances. Small plazas should be created at the entrance to buildings that draw pedestrians to the building.
- Minimise the number of pedestrian and bicycle crossings.
- Where crossings are required, consider using raised crossings to discourage high speeds.
- Provide separate accesses to parking areas for pedestrians and cyclists.
- Provide one-way traffic flow in parking areas to minimise pedestrian confusion and conflicts.
- Avoid locating pedestrian and bicycle facilities near to freight delivery zones. Trucks backing up are often in conflict with pedestrians.

E. Pedestrians and bicycle places

8. Pedestrian malls

8.1. INTRODUCTION

Pedestrian malls are shopping precincts that are restricted for the exclusive (full or partial) use of pedestrians. Such malls provide important opportunities for increasing pedestrian travel.

An example of a pedestrian mall is shown in Figure 8.1. Various types of pedestrian malls are described in Table 8.1.

For pedestrian malls to be successful, they must provide a viable and attractive alternative to large shopping malls. This is often difficult because shopping malls provide a variety of facilities, such as sheltered shopping areas, parking provision, separation between pedestrians and vehicles, etc. In order to succeed, it is important that similar facilities be provided at pedestrian malls.

Table 8.1: Types of pedestrian malls	
Classification	Description
Modified Street	One block of a conventional street is closed to vehicular traffic for the exclusive use of pedestrians.
Transit Mall	The street is closed to all traffic except buses and emergency services (and sometimes bicycles, delivery and refuse collection vehicles). Transit vehicles operate on a narrow right-of-way within the mall space.
Plaza or Interrupted Malls	Several blocks of a retail street are exclusively designated for pedestrian use, with cross streets left open to vehicular traffic.
Continuous or Exclusive Mall	A multiblock area, which may include more than one street, is exclusively designated for pedestrians, with the exception of emergency, maintenance and delivery vehicles.
Displaced Sidewalk Grid	A pedestrian walkway is developed away from the regular sidewalk grid through alleys, arcades, and/or lobbies within buildings.
Multi-level Mall	The multi-level mall – one or more levels built above and below grade – is an integral part of in-town renewal projects or commercial developments.

8.2. ADVANTAGES AND DISADVANTAGES OF PEDESTRIAN MALLS

Pedestrian malls have several advantages, including the following:

- It is an ideal method to provide for safe and free-flow movement of pedestrians.
- Enhancement of the aesthetic and social environment.
- Greater pedestrian accessibility to businesses and retail activities.
- A potential improvement in business and economic activities.
- Possible unification of business and residential activities.

Possible disadvantages of pedestrian malls include the following:

- High cost of implementation.
- Rerouting of traffic to other streets.
- Possibility of economic activities reducing.
- Possible disruption of public transport facilities.
- Potential security and policing problems.
- Pedestrian-vehicle conflicts at entrances and at cross streets in a mall.

8.3. PEDESTRIAN SAFETY REQUIREMENTS

One of the important advantages of pedestrian malls is the improved level of safety provided by such malls. The effectiveness and safety of a pedestrian mall can be improved by:

- Pedestrian malls should be planned in conjunction with the street system and parking areas to ensure traffic safety.
- Pedestrian malls should preferably not be intersected by main roads or streets. The potential for accidents is increased by such layouts, even if pedestrian crossings are provided over the streets.

- Pedestrian mall entrances should provide a transition zone from the traffic free environment to the vehicular traffic area. Humans tend to adjust slowly, and the rapid transition between environments could lead to safety problems. One possible solution is to provide a parking area as a buffer between the mall and the street. Another design solution would be to channelise pedestrian movements to desired pedestrian crossings.

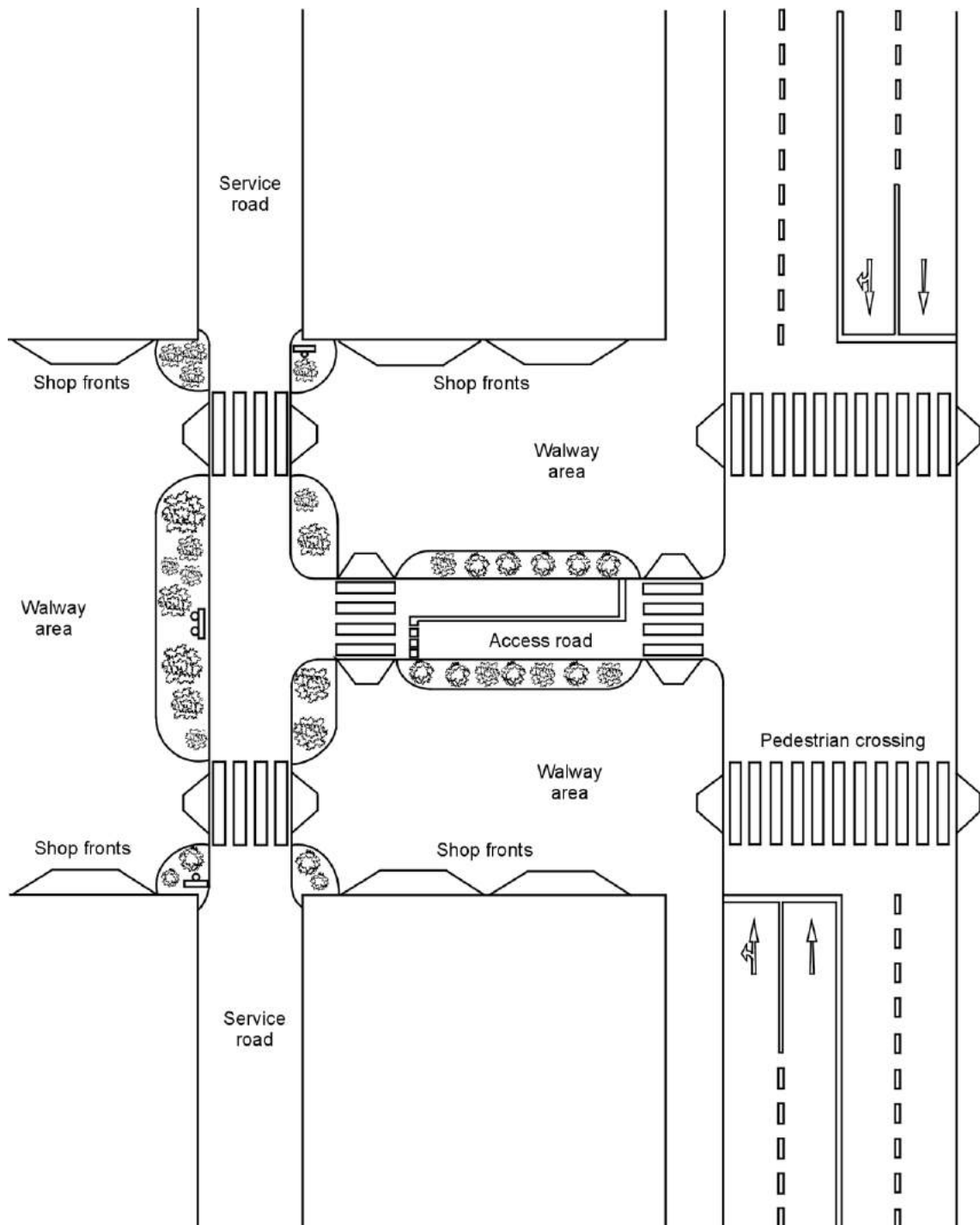


Figure 8.1: Example of a pedestrian precinct

PART F

PEDESTRIAN AND BICYCLE PLANNING

F. Pedestrian and bicycle planning

1. Introduction

1.1. BACKGROUND

A well-planned and designed pedestrian and bicycle facility is of benefit to society. It is costly to plan, design and build a facility that is little used, or is inadequate because of poor planning and design. Inadequately planned facilities discourage walking and cycling, and waste money and resources. The lack of proper planning could be a major contributing factor in hazardous locations, particularly on high speed rural roads.

Good planning does more than provide a facility for persons who already walk or cycle – it also encourages more people to walk and cycle.

The need of pedestrians and cyclists should be considered in all transportation projects, and also from the inception of the projects. Pedestrian and bicycle facilities will probably be inadequate if they are considered add-on features.

1.2. INTEGRATED DEVELOPMENT PLANNING IN SOUTH AFRICA

Integrated development planning is one of the essential tools for local government in South African (South African Department of Provincial and Local Government, 2000). The purpose of such planning is to develop strategic development plans for a five-year period in an area. Such planning is prescribed by the Municipal Systems Act of 2000, and the Integrated Development Plan (IDP) has legal status.

One of the core components of the IDP is the *spatial development framework* for an area. The Municipal Systems Act require local governments to prepare spatial plans showing desired patterns of land use, directions of growth, urban edges, and special areas. A normative approach to spatial planning is required to ensure that the problems and challenges are addressed in such a way as to promote the creation of liveable, integrated cities, towns and rural areas.

In South Africa, it is particularly important that pedestrian and bicycle considerations be comprehensively integrated in the planning process. Effective pedestrian and bicycle-orientated land-use and transportation systems planning can have significant benefits for the country. Integrated development plans should include clear goals regarding pedestrian and cyclist needs and objectives. Priority should be given to the provision of pedestrian and bicycle facilities. Particular attention should be given to the needs of children near to schools.

1.3. TRANSPORTATION PLANNING IN SOUTH AFRICA

The South African Department of Transport has enacted various acts and policies that have particular significance for integrated development planning. These acts and policies are aimed at improving the efficiency transportation efficiency, creating better functioning cities, towns and rural areas and the realisation of the economic and social role of transport.

The following are a number of key objectives of the governments policy as related to pedestrians:

- The use of public transport should be promoted over private car travel, with the goal of achieving a ratio of 80:20 between public transport and private car usage.
- Accessibility and mobility should be improved, and walking distances should be restricted to less than about one kilometre in urban areas.
- Ensure that the transport needs of the country's disable population are taken into account when new infrastructure is planned and designed.

F. Pedestrian and bicycle planning

2. The planning process

2.1. INTRODUCTION

The basic steps in the pedestrian and bicycle planning process are as follows.

- Involve interested and affected groups (including the public).
- Develop goals and objectives.
- Inventorise the existing environment.
- Undertake traffic studies, determine existing and potential pedestrian and bicycle traffic demand and identify hazardous locations in the road network.
- Develop alternative plans and evaluate. Undertake benefit/cost analysis.
- Implement and monitor.

2.2. INVOLVE INTERESTED AND AFFECTED GROUPS

The first step in the planning process is to identify and involve groups of people who are interested and would be affected by improvements to pedestrian and bicycle facilities. The exact groups to involve will vary by area and the type of facilities being considered, but would typically include the following:

- The local authority, its officials, consultants and political leaders.
- Bicycling, hiking and other user groups who may have an interest in the planning and design of pedestrian and bicycle facilities. Individuals from these groups can help identifying issues and opportunities related to specific projects.
- General public, neighbourhood groups, educational institutions, schools, businesses, developers, etc. The public participation process represents an important component of any planning effort. This group should be involved early and throughout the planning process to ensure that potential concerns are identified early in the planning process.

An excellent method of involving the community in the planning process is by taking community members on bus tours through a study area. During such tours, problems affecting pedestrians and cyclists can be more readily identified.

2.3. DEVELOP GOALS, OBJECTIVES AND CRITERIA

The planning process is guided by a value structure, which is typically conceived as a three tiered hierarchy that includes goals, objectives and criteria. This is an important step in problem solution.

Goals are broad, abstract statements that reflect the views, perceptions and aspirations of the community, e.g. to promote walking and bicycle usage amongst school children. Objectives are specific measurable statements that, if achieved, are steps towards the relevant goal. The objectives should attempt to define and describe the conditions that are to be aimed for.

Criteria are means of measuring the attainment of objectives. For example, for the goal of promoting walking and cycling, one of the objectives may be the reduction in pedestrian and bicycle accidents. The degree of attainment of this objective can be judged by criteria such as the number of accidents involving pedestrians and cyclist per annum.

Only after statements of goals and objectives have been prepared and agreed upon by all interested parties can the solution or alternative solutions be completely developed.

2.4. INVENTORISE EXISTING ENVIRONMENT

An essential step of the planning process is to obtain an inventory of the existing environment. It is not possible to plan new facilities unless information is available on existing facilities.

The information should preferably be presented on maps of the area. The preferred scale of such maps is 1:10 000, although a scale of 1:25 000 may also be used when an area is too large. An example of an inventory map is shown in Figure 2.1.

An inventory is required of all existing physical components that may affect pedestrian and bicycle travel. This includes information on:

Pedestrian and Bicycle Facility Guidelines

- Existing land use, particularly those land uses that generate or attract large volumes of pedestrians and cyclists. It is particularly important to identify land uses such as the following:
 - Schools and other educational centres.
 - Commercial centres (shops and other).
 - Business and industrial centres.
 - Recreational centres such as sport fields.
 - Informal trade areas (hawkers and other).
- Roads and streets that may be used by pedestrians and cyclists, as well as those which should not be used. Information should be collected on items such as the following:
 - Functional road classification.
 - Junction layout and control.
 - Locations with poor sight distance.
 - Traffic calming measures.
 - Street lighting (light intensity measurements may be required).
- Public transport facilities available in an area, including stops and termini.
- Existing pedestrian and bicycle facilities, their location, type and condition. Important facilities include sidewalks, bicycle roads and pedestrian crossings.
- Possible barriers and constraints to walking and bicycle use such as the following:
 - Topographic and geographic conditions, e.g. major streams, steep slopes in excess of 5% grade, etc.
 - Climatic conditions, e.g. areas of high temperatures, or where strong winds or rain prevail for long periods throughout the year
 - Land use developments restricting through movement by pedestrians and bicycles
 - High volume roads, freeways and rail lines, particularly those with limited points of safe crossing.
- Opportunities for accommodating walking and cycling such as the following:
 - Roads and streets that may be used, particularly those with wide road reserves.
 - Parks and other open spaces.
 - Abandoned buildings and other structures that may be transformed for use by pedestrians and cyclists.

It is important to note that the mere existence of an opportunity does not necessarily justify a facility at such a location.

2.5. TRAFFIC STUDIES AND HAZARDOUS LOCATIONS

The estimation of traffic demand and the identification of hazardous locations are important components for the planning process. Pedestrian and bicycle facilities should be provided where there would be demand for such facilities, while priority should be given to improving the most hazardous locations.

The following traffic studies would normally be undertaken:

- Traffic demand studies:

- Traffic counts, typically undertaken during weekday morning and afternoon peak hours. Such counts would include all modes of transport, including pedestrian and bicycle traffic.
- Estimation of future pedestrian and bicycle traffic demand using demand estimation models.
- Identification of hazardous locations:
 - Vehicle speed surveys on roads used by pedestrians and cyclists. These surveys are normally undertaken during off-peak periods and under free-flow conditions.
 - Accident data collection and analysis.
 - Traffic conflict studies aimed at identifying safety problems.
 - Road safety audits and assessments.

More information on traffic demand studies and the identification of hazardous locations are given in following chapters.

2.6. PLAN DEVELOPMENT AND EVALUATION

Once the traffic demand has been estimated and hazardous locations identified, specific proposals for improvements can be made. Various alternative plans are usually developed which have to be evaluated in order to decide on preferred options.

To evaluate different alternatives, criteria should be defined which can be used to measure the benefit of each alternative. These criteria would reflect the need of pedestrians and cyclists, but also accommodate greater societal needs. Criteria may include the following:

- **Cost** of constructing, maintaining and operating pedestrian and bicycle facilities. A benefit/cost analysis should be undertaken.
- **Security.** A fundamental consideration is making persons feel safe when using a facility.
- **Safety.** Facilities must be free of safety hazards, including slippery surfaces and protruding obstacles.
- **Traffic safety.** Traffic safety is a most important consideration because of the vulnerability of pedestrians and cyclists.
- **Accessibility.** The facility should be as accessible as possible to all users, including those with disabilities.
- **Convenience.** The facility should be convenient to use. The pedestrian and cyclist desire a fast, direct and continuous route to chosen destinations.
- **Comfort.** The facility should be comfortable and easy to use. Gradients should not be too steep and pavements should be surfaced.
- **Environment.** Pedestrians and cyclists prefer crossings that are attractive to use. Care should be taken in providing facilities that encourages walking and cycling.

A very simple method in ranking the various alternatives can be adopted. For example, numerical ratings (e.g. from 1 to 5) can be assigned to the performance of each alternative under each criterion. A further refinement is to assign a relative weighting to each criterion. Ratings can then be added for all criteria to yield a weighted average ranking of each alternative.

A special effort should be made to inform the public of the alternative schemes. Full consultation with the public regarding most desirable improvements is required from the earliest stage of the planning process.

2.7. BENEFIT/COST ANALYSIS

A benefit/cost analysis should be undertaken of each proposed improvement, taking into account the cost of the improvement and the benefit in terms of expected savings in accident and other costs over a period of time.

The expected saving in accident costs can be determined by estimating the possible reduction in number of accidents for each proposed improvement. Standard accident cost rates can be used to establish the potential saving in accident costs.

2.8. IMPLEMENTATION AND MONITORING

After the final selection of the preferred alternative, the final plan can be developed, as shown in Figure 2.2. Attention can then be directed to the construction of facilities. In this regard, specific attention should be given to the aspect of quality. Poor construction can easily result in facilities not being used by pedestrians and cyclists.

A specific monitoring process should also be worked out at this stage to monitor and evaluate factors such as changes in traffic patterns after implementation and possible problems which may occur as a result of implemented changes.

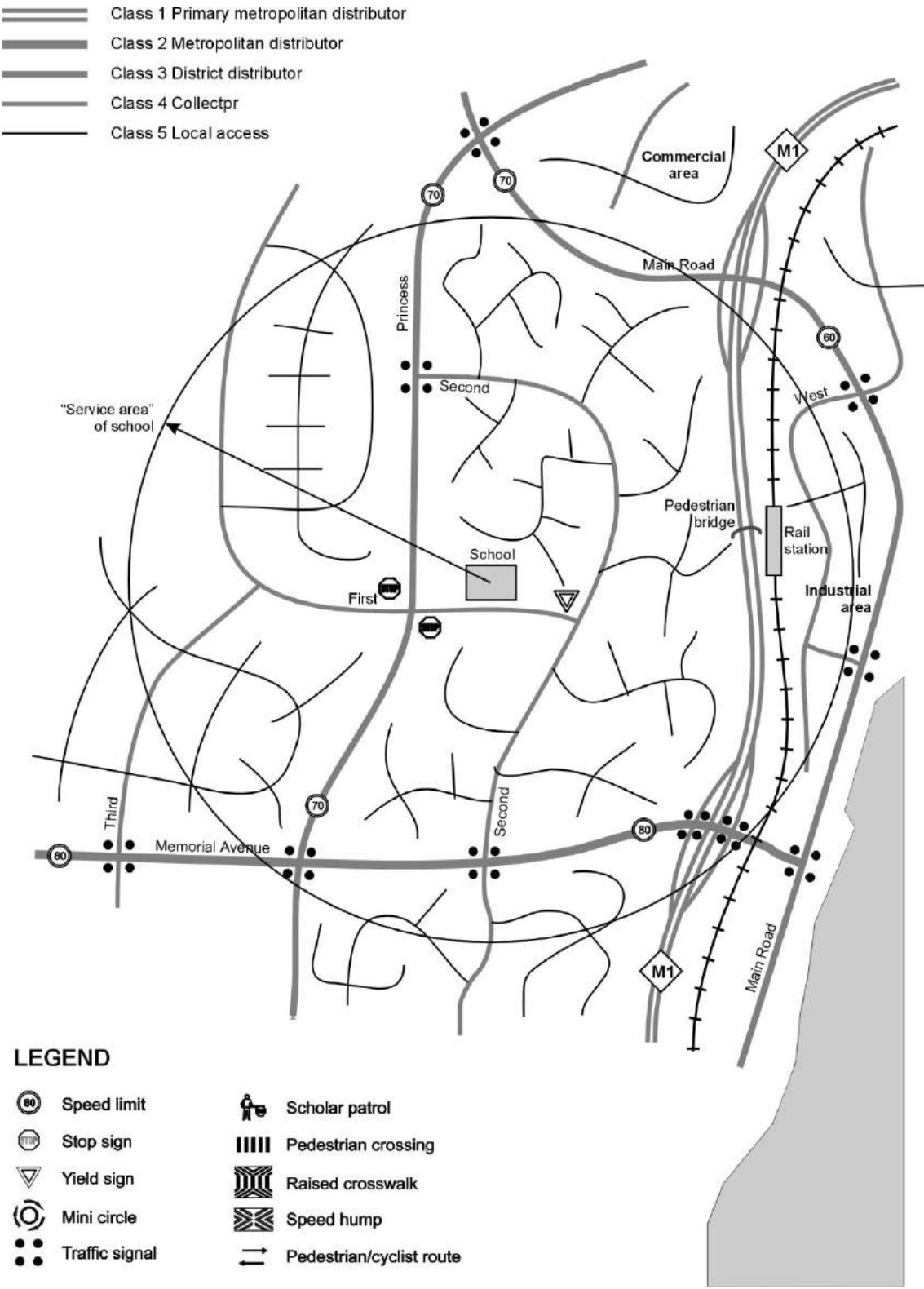


Figure 2.1: Example inventory map

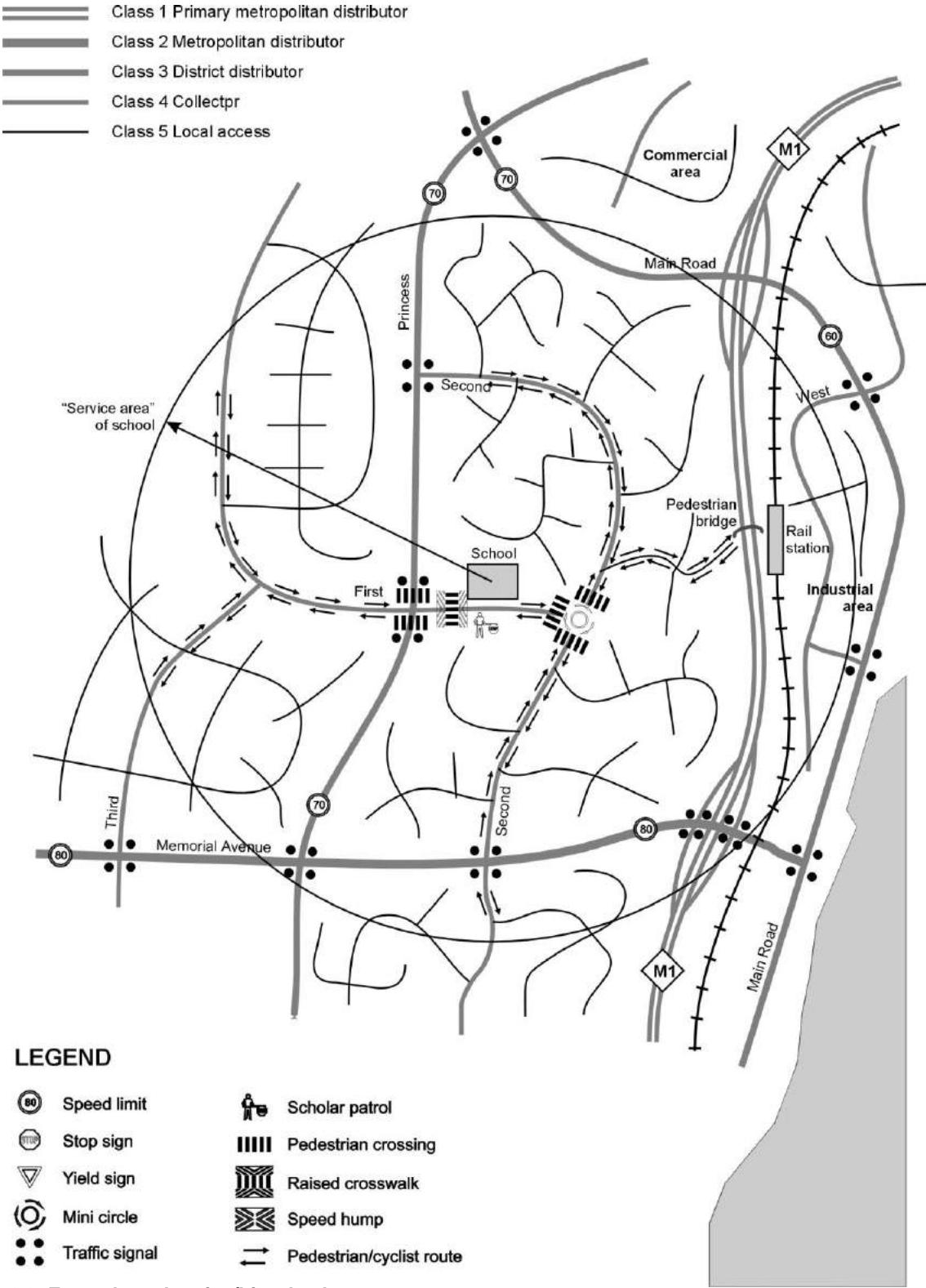


Figure 2.2: Example pedestrian/bicycle plan

F. Pedestrian and bicycle planning

3. Demand estimation

3.1. INTRODUCTION

The estimation of demand for a pedestrian or bicycle facility is a crucial component of the planning process. There is probably nothing that can hurt pedestrian and bicycle planning more than the implementation of a facility which is not used or does not meet the intended objectives.

Travel demand needs to be estimated for the current (or base) as well as a future design years. Current travel demand can simply be obtained from pedestrian and bicycle counts, but future travel demand must be estimated by means of some travel demand model.

The estimation of future travel demand requires a high level of professional expertise and is a highly specialised field of study. It is therefore not the intention to describe methods that are available for such estimation, although an overview of the methods will be given. Even undertaking pedestrian and bicycle counts is not a simple exercise. A relatively simple method for establishing desire lines, however, is described which can be used to provide an indication of travel demand.

3.2. FUTURE DEMAND ESTIMATION METHODS

Future travel demand for vehicular modes of travel is often estimated by means of the “four-step” demand estimation process. According to this method, a study area is first subdivided into traffic zones, and the following four steps are then followed:

- The number of trips generated by, and attracted to each zone is estimated (normally for all modes of travel). The total number trips generated in all zones should be equal to the total number of trips attracted by all zones. If not, either the trip generation or attraction must be adjusted.
- The trips generated in each origin zone are distributed to other destination zones in relation to the trip attraction of the destination zone as well as the travel time or distance.
- Trips are split between different modes of travel, such as private and public transport.
- Trips are assigned to specific elements of the transportation system.

The above method can theoretically be used for estimating pedestrian and bicycle demand, but is not often used for this purpose. The cost of developing a traffic demand model can be very high, with the result that demand models are often restricted to vehicular traffic only. Simplified models are then used for estimating pedestrian and bicycle demand which may not be as accurate, but which is better than having no model available.

3.3. SKETCH PLANNING METHODS

Sketch planning methods are simplified methods for the estimation of future pedestrian and bicycle demand. Various forms of sketch planning methods are available, some simpler but less accurate than others.

The following sketch plan method is a relative simple method for estimating future demand, but it requires a significant amount of judgement by a professional team. The method uses current pedestrian and bicycle counts on which future projections of growth are superimposed.

The first step in the sketch planning method is to identify the major existing as well as future trip origins and destinations. Examples of such origins and destinations are:

- Residential areas.
- Educational facilities such as schools, colleges and universities.
- Major parks (especially if provision is made for cycling in these parks), sport fields and other recreational facilities.
- High-activity commercial establishments, such as neighbourhood or regional shopping centres, and centres of employment.
- Public transport facilities and parking areas.
- Any other points of attraction to pedestrians and cyclists.

The second step in the process is the identification of the “service areas” for each of the origins and destinations. These service areas are defined by the maximum distances people are prepared to walk or cycle. Long trips will be made by other modes of transport, in which case the destination would be a parking lot or a public transport facility. A service area can be identified around each major origin and destination.

The above information on origins, destinations and service areas can then be combined and used to establish desire lines between the origins and destinations. Travel demand along each of the

desire lines can be estimated based on pedestrian and bicycle counts to which growth factors are applied.

The next step in the process consists of identifying possible routes for use by pedestrians and cyclists. In establishing such routes, information on barriers to, and opportunities for walking and cycling should be used. Typical barriers include steep terrain, rivers, major roads, buildings, etc. Opportunities for travel may include available land such as parks and low order streets.

Traffic demand along each desire line is then assigned to the identified routes of travel which approximately follows the direction of the desire line. This process may require some judgement, particularly where alternative routes are available.

The routes carrying significant volumes of pedestrians and cyclists are then identified as pedestrian and cyclist corridors. The demand is established for each corridor, or sections of a corridor.

3.4. PEDESTRIAN AND BICYCLE COUNTS

Pedestrian and bicycle counts are often undertaken manually. Although significant developments have occurred in the field of automatic traffic counts, equipment is still not readily available for the counting of pedestrians and bicycles.

Manual counts can be taken by using simple tally sheets, or by means of tally counters. Counts are typically collected in 15-minute intervals and recorded on count forms. The counts can further be processed manually by means of a computer spreadsheet program or specialised computer software.

Due to the sampling nature of most manual counts, it is important that counts should not be undertaken when exceptional events occur. The identification of “normal” and “exceptional” days is an important consideration when pedestrians and cyclists are counted. Normal days occur most often during the year, and volumes are more constant and show fewer fluctuations than on exceptional days.

The possibility of large counting errors can be reduced if pedestrians and cyclists are counted on normal days when volumes are relatively stable, unaffected by events such as inclement weather, and schools holidays. All public and school holidays are considered to be exceptional days.

Exceptional days may be either unpredictable or predictable. The unpredictable days are days that cannot be predetermined and are typically caused by inclement weather. Predictable exceptional days are that can be predetermined and are known in advance, such as school and other holidays. Unpredictable exceptional days typically occur less often than predictable days.

Predictable exceptional days include public and school holidays, as well as other days which may be influenced by such holidays. A single public holiday in a week can affect pedestrian and bicycle travel patterns during all the other days of the week, while a school holiday may affect patterns for the full duration of the holiday as well as periods before and after the holiday.

3.5. ORIGIN-DESTINATION STUDIES

Pedestrian and bicycle counts on routes that serve multiple origins and destinations reveal little about the origin and destination of trips. Specific surveys are required to obtain such information. Various methods can be used for such purpose, one of which is the house-to-house survey. An alternative (or supplementary) method is by means of roadside surveys.

Surveys of travel demand should attempt to gather the following information:

Pedestrian and Bicycle Facility Guidelines

- *Who* – Demographic information should be collected on age, gender, residence location, employment and income level.
- *Where*– Origins and destinations of trips, including travel by other modes.
- *When* – Time, day of the week and date of trips undertaken, including condition such as weather, day or night, etc.
- *Why* – Purpose of the trip (for which reason was a trip undertaken).

F. Pedestrian and bicycle planning

4. Hazardous pedestrian and bicycle locations

4.1. INTRODUCTION

An important step in the process of improving pedestrian and bicycle safety is to identify locations or areas where accident problems exist and where infrastructure improvements will be most beneficial.

One of the most successful short-term solutions to a road safety problem is to identify the most hazardous sections of the road network and to eliminate these hazards either while the road network is being upgraded or by improving specific individual sites identified as hazardous.

4.2. STRATEGIES FOR IMPROVING HAZARDOUS LOCATIONS

There are four basic strategies for accident reduction through the use of counter measures. These are:

- Single site - the treatment of specific types of accident at a single location.
- Route action plans - the application of known remedies along a route with a high accident rate.
- Area action plans - the applications of various treatments over a wide area of a town or city, i.e. traffic management and traffic calming.
- Mass action plans - the application of a known remedy to different locations with a common accident problem.

The first three strategies differ in terms of the size of the geographical area over which various types of accident reduction treatments are applied. The mass action plan involves the application of one specific treatment at various locations.

The single site strategy is most probably be the most cost-effective method since specific locations with high accident rates are targeted. Such specific treatments are most likely to have the greatest impact on accident numbers.

4.3. ACCIDENT DATA

The identification of hazardous locations rely on the availability of data describing accidents and their locations to identify where accidents occur and what are the common features that contribute to them. Accident data and the use of collision diagrams are key analysis tools for identifying hazardous locations.

Pedestrian and bicycle accident data should be collected over a relatively long period. Accident rates tend to fluctuate substantially from year to year, and to obtain a statistically reliable sample, it is necessary to collect accident data over as long a period as possible. However, where there are rapid changes in the environment, such as new roads being built, or where there are high levels of growth in traffic. The accident data collected over a too long a period would not be representative of current conditions.

The following periods for collecting accident data are therefore recommended:

- 2 Years in areas where there is relatively rapid change in the environment.
- 3 Years in areas where there is a relatively moderate change in the environment.
- 5 Years in areas where the environment is relatively stable.

Locations for which accident data are required should be identified, and each location should be pinpointed as accurately as possible. For this purpose, use should be made of information such as road and street names, addresses, route numbers, kilometre markers and other landmarks.

The accident data should be collected for each location in a format as indicated in Figure 4.1. The following statistics are shown in the figure:

- Type of accident (pedestrian, bicycle, single vehicle, rear-end, etc).

- Severity of accidents. The following severity classification is used:
 - Fatal accidents are accidents involving death as a direct result of the accident.
 - Serious accidents are those in which people were seriously injured. Serious injuries include fractures, concussions, severe cuts and lacerations, shock necessitating medical treatment and any other injuries necessitating hospitalisation.
 - Slight accidents are those in which people were slightly injured. Slight injuries include cuts and bruises, sprains and slight shock not requiring hospital treatment.
 - Damage only accidents in which there is no personal injury but damage to property only.
- Day of the week and time of the day during which accidents occurred.
- The probable causes of the collision should be established if possible, e.g. alcohol involvement of driver and pedestrian.

4.4. EQUIVALENT ACCIDENT NUMBER

The equivalent accident number (EAN) is the weighted number of accidents per annum at a particular location. The following weighting is recommended for the calculation of the EAN:

Fatal accidents	12
Injury accidents	3
Slight and damage only accidents	1

The EAN of each location is calculated by multiplying the above accidents with the number of accidents in each category, and dividing the total number by the number of years over which accident data were collected.

4.5. ACCIDENT RATE

Accident rate is the average number of accidents divided by some number indicating the level of exposure to accidents. Such level of exposure can simply be the vehicle-kilometres along a road, or the total number of vehicles entering a junction, or it can be much more complex number such as the number of conflicting movements that may occur at a site (Ogden, 1994).

The establishment of accident rates requires counts of traffic as well as pedestrians and cyclists. Such counts, however, may be available for a few locations, but are seldom available for all locations. Unless a significant exercise is undertaken to obtain the required counts, it is seldom possible to establish accident rates on a network wide scale. It may, however, be possible to establish accident rates at particular locations.

4.6. IDENTIFICATION OF HAZARDOUS LOCATIONS

Once accident data have been collected, the most hazardous locations should be identified.

There are various methods for the identification of hazardous locations (Ogden, 1994). These are usually based on the number of accidents (the accident frequency) or the accident rate, although other measures may be used such as potential accident reduction.

The problem with using number of accidents as a criterion for the identification of hazardous locations is that high accident frequencies often occur at locations where traffic volumes are high, while there could be a very dangerous situation at a site with low traffic volumes, but with a high accident rate.

Using accident rate as the criterion for identifying hazardous locations, however, has the disadvantage that the potential benefit of reducing a large number of accidents at a site with a low accident rate, but high traffic volume, can be missed.

Because of the above considerations, the selection of locations for further investigation should preferably be based on a consideration of both accident rate as well as number of accidents. The most dangerous locations would be those at which the accident rate as well as the number of accidents are the highest.

The estimation of accident rate requires additional traffic data which is often not available, and many accident studies are therefore based on number of accidents alone. In such cases, it is desirable to classify sites according to the size and type of facility, as well as the amount of traffic at a site. Such a classification, for example, could be a two-lane road with a high volume of vehicular and pedestrian traffic. An average number of accidents can be determined for each such classification, and the ratio of number of accidents to average number of accidents can be determined for each class of site. Sites with the highest accident ratios are then identified as being the most hazardous.

4.7. HAZARDOUS LOCATION INVESTIGATION

Locations that have been identified as hazardous should be visited and various studies undertaken to obtain additional information. Site visits are an essential part of the investigation process. The following information should be collected during the site visit:

- Information on the layout of the existing facility.
- Design elements that are substandard and which could contribute to accidents involving pedestrians and bicycles.
- Counts of traffic conflicts and infringements of road regulations.
- Various classified traffic counts as well as measurements of the 85th percentile speeds.

The above information is used to identify possible causes of accidents and to establish which remedial measures would be beneficial.

4.8. TRAFFIC CONFLICTS

Accident data can not always provide an indication of why accidents occur at a location. One of the problems with accident data is that sample sizes are often small and that several years of data must be collected before conclusions can be made. A further problem is that the quality of accident data could be poor, either because accidents are poorly reported, or because of problems with the capturing of accident data.

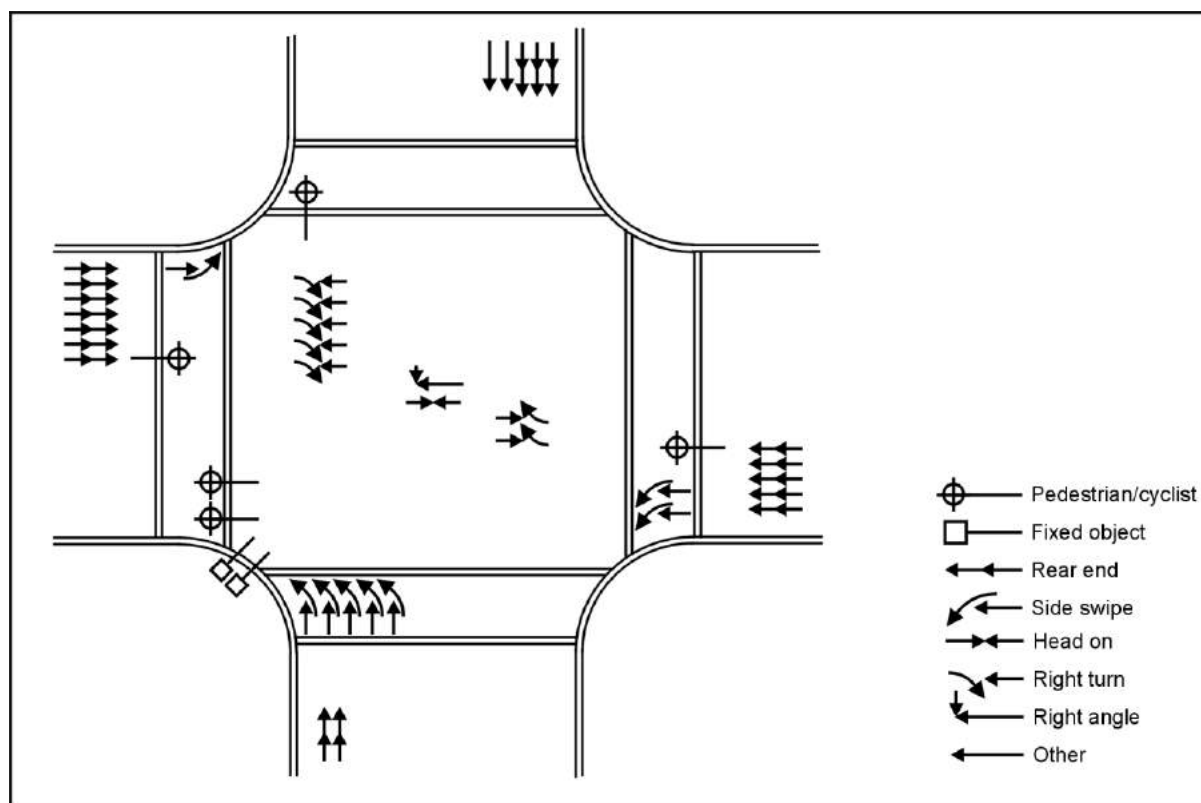
The Traffic Conflict Study technique is a method according to which potential accidents and causes of accidents can be identified without the use of accident data. A traffic conflict is an undesired event in the traffic stream, such as a near-accident or a violation of a traffic rule. A few hours or days of observations would often reveal undesirable driver, pedestrian and cyclist behaviour which could lead to traffic accidents.

4.9. IMPROVEMENTS OF HAZARDOUS LOCATIONS

Once all information has been collected for a hazardous location, possible remedial measures that can address the problems should be identified. Where pedestrians and cyclists are involved, improvements to the following could be considered:

- Sight distances
- Road signs and traffic signals.
- Midblock crossings and road junctions.
- Sidewalks, walkways, bicycle lanes or bicycle roads.
- Traffic calming measures and speed limits.
- Street lighting.

A preliminary design should be made of each improvement and the cost of each improvement established. Benefit-cost analysis can then be undertaken to establish whether the improvement would be cost-effective.



ACCIDENT DATA	TYPE OF COLLISION								Total
	Pedestrian & cyclist	Fixed object	Rear end	Side swipe	Head on	Right turn	Right angled	Other	
DEGREE:									
Fatal	3				1	2			6
Serious injury	1	1				1	1		4
Slight injury	1	1	2	1		3			8
Damage only			15	7		1		2	25
DAY:									
Weekdays	1	1	13	5		7		2	29
Saturdays	3	1	3	2	1		1		11
Sundays	1		1	1					3
TIME:									
00:00–06:00		1					1		2
06:00–09:00			5	3	1	6		2	17
09:00–12:00			1						1
12:00–03:00			2	1					3
03:00–06:00			7	4					12
06:00–09:00	2		2			1			4
09:00–12:00	3	1							4
TOTAL	5	2	17	8	1	7	1	2	43

Figure 4.1: Example of a collision diagram

F. Pedestrian and bicycle planning

5. Pedestrian and bicycle safety audits

5.1. INTRODUCTION

Pedestrian and bicycle safety audits are undertaken to ensure that pedestrians and cyclists are considered comprehensively in the provision of transportation, and that the safety of pedestrians and bicycles are given the required attention.

Pedestrian and bicycle safety audits should not only be undertaken for specific pedestrian and bicycle projects, but in all projects involving improvements to the transportation system. The audits can be integrated with the normal road safety audit, or audits can specifically be undertaken to ensure that the needs of pedestrians and bicycles were adequately addressed. It is, however, important that such audits do not duplicate any work carried out as part of a standard safety audit.

There is an urgent need for authorities in South Africa to undertake pedestrian and bicycle audits. This need stems from the inadequate attention that is often given to the safety of pedestrians and cyclists. An audit of transportation projects would ensure that problems affecting pedestrians and cyclists can be addressed before projects are implemented. By making a special audit of safety, the awareness of safety issues is increased, which will ensure that safety is given due consideration.

5.2. ROAD SAFETY AUDITS IN SOUTH AFRICA

The South African Road Safety Manual was developed by the National Department of Transport (1999) for the evaluation of traffic safety on the road network. One of the topics covered by the manual, is the road safety audit.

The manual defines a road safety audit as the *formal examination of a future or existing road or traffic project or any project where interaction with road users takes place, in which an independent, qualified examination team reports on the accident potential and safety performance of the project.*

A road safety audit can be undertaken at various stages of a project, starting from the preliminary planning stage up to a stage after which the road has been placed in operation.

The South African manual specifically recognises pedestrians and cyclists as user groups, and states that *no road safety audit can be carried out without due cognisance of the needs of each specific road user.*

5.3. THE ROAD SAFETY AUDIT TEAM

Road safety audits should be undertaken independent of the project design team to ensure that those who are unbiased and those who may have a different perspective are reviewing the project.

The road safety audit team should have experience in road safety engineering principles and practices, accident investigation and prevention, traffic engineering and road design. Additionally, members with experience in enforcement, maintenance, and human factors can be added to the team when required.

Where pedestrians and cyclists are involved, it is imperative that the audit team has substantial experience in the needs of these users. Audit checklists are provided for these users, but these should only serve as to remind the audit team members of aspects that should be evaluated. The team should already have the experience dealing with all issues, and should not learn as they undertake the audit.

5.4. ROAD SAFETY AUDIT CHECKLISTS

The South African Road Safety Manual provides various checklists for the undertaking of road safety audits. The checklists are comprehensive, covering a range of aspects, including those related to pedestrians and cyclists. The aim of these checklists is to identify possible safety problems for pedestrians and cyclists and to ensure that measures to eliminate or reduce the problems are considered fully.

The checklists cover questions such as the following:

- Are there any pedestrian desire lines crossing a project, requiring that provision should be made for pedestrians?

Pedestrian and Bicycle Facility Guidelines

- Was consideration given to the need of cyclists?
- Will the project cause the division of existing communities, or separation of communities from basic commodities like water, firewood or retail facilities?
- Are pedestrians guided or prevented from crossing the road at dangerous locations?
- Is there a need for pedestrian refuge islands and are they wide enough to ensure safety?
- Is there a need for pedestrian crossings? Are pedestrian crossings provided along desire lines?
- Has sufficient measures been provided to ensure that pedestrians do not walk on the highway?
- Is provision made for paved footpaths where there are pedestrian generators in the adjacent land uses?
- Is there a need for bicycle lanes, or can shared pedestrian-cycle facilities be provided?
- Is the expected operational speed appropriate for the pedestrian facilities that are provided?
- Is there a need for the special provision of facilities for vulnerable road users such as children and the elderly?
- Was special consideration given to the provision of adequate sight distances at pedestrian crossings? Is the sight distance adequate for both day and night operations?
- Are pedestrians considered in the traffic signal phasing?

A disadvantage of the checklists is that they may be used as a substitute for thinking and could result in a simple scanning and ticking of checkboxes. However, their advantage is that they act as a prompt to ensure that no item is forgotten. Another advantage of the checklist is that the designer knows what the design is going to be audited against. The designer is then likely to undertake a self-audit before the real audit, leading to an increase in awareness and emphasis on safety issues.

5.5. PEDESTRIAN AND BICYCLE REVIEWS

In addition to road safety audits, road authorities may also elect to undertake a review of transportation facilities to establish the degree to which other than road safety needs of pedestrians and cyclists have been accommodated. Pedestrians and cyclists will not use a facility if all of their needs have not adequately been addressed.

A review would address each of the following needs of pedestrians and cyclists:

- **Security.** This is one of the most fundamental needs of pedestrians and cyclists. The review should carefully evaluate the level of security provided to pedestrians and cyclists.
- **Safety.** The degree to which pedestrian and bicycle facilities are free of safety hazards, including slippery surfaces and protruding obstacles.
- **Accessibility.** Accommodation of all users with special needs, including those with disabilities.

Pedestrian and Bicycle Facility Guidelines

- **Convenience.** The provision of fast, direct, continuous, convenient route of access to chosen destinations.
- **Comfortable.** The provision of flat gradients and smooth pavements.
- **Environment.** The attractiveness of the environment to pedestrians and cyclists.

APPENDICES

Appendix A

Pedestrian and bicycle road signs and markings

A.1. INTRODUCTION

In South Africa, the provision and installation of road traffic signs and markings are regulated and controlled by the National Road Traffic Act (Act No. 93 of 1996), the National Road Traffic Regulations (2000) and the various volumes of the SADC and South African Road Traffic Signs Manual. The different road signs and road markings are described in detail in these documents, and the intention is not to repeat these details in this manual. An overview of the most relevant and important aspects will be given, but the above documents should be consulted when detailed information is required.

A.2. BASIC SYMBOLS AND ROAD SIGNS

There are a number of basic symbols and road signs that are use for pedestrians and cyclists. These are as follows:

- The basic symbols that are used in road signs and markings, shown in Figure A.1.
- The basic regulatory signs that may be used for pedestrians and cyclists, shown in Figure A.2.
- The basic warning signs that may be used for pedestrians and cyclists, shown in Figure A.3.
- The basic guidance signs that may be used for pedestrians and cyclists, shown in Figure A.4.
- The basic information signs that may be used for pedestrians and cyclists, shown in Figure A.5.

- A number of combination signs that may be used for pedestrians and cyclists, shown in Figure A.6.
- The basic road markings that may be used for pedestrians and cyclists, shown in Figure A.7.

A.3. SIGN PLACEMENT

Road traffic signs should be placed at positions where:

- They are needed and where they would be visible.
- They would not obstruct pedestrians and cyclists.
- Where they would not create a significant hazard to road users.

Regulatory signs should be placed at, or as close as possible to the point on the road from which their message is to apply. Some regulatory signs have specific conditions relating to their location, which should also be taken into account.

Warning signs should be placed in advance of the hazard to which they refer. Hazard marker warning signs, on the other hand, should be placed near to the hazard.

SYMBOL	DESCRIPTION	USED ON CLASS OF SIGN
	Pedestrian	Regulatory/Warning Direction
	Children	Warning
	Disabled person	Regulatory/Direction
	Woonerf precinct	Regulatory
	Scholar patrol	Warning
	Hitch-hiker	Regulatory
	Cyclist	Regulatory/Warning Direction

Figure A.1: Pedestrian, cyclist and other symbols

CONTROL SIGNS



COMMAND SIGNS



PROHIBITION SIGNS



RESERVATION SIGNS



COMPREHENSIVE SIGNS



SYMBOLIC MESSAGE SIGNS



DERESTRICTION SIGNS



Figure A.2: Pedestrian and cyclist regulatory signs



Figure A.3: Pedestrian and cyclist warning signs

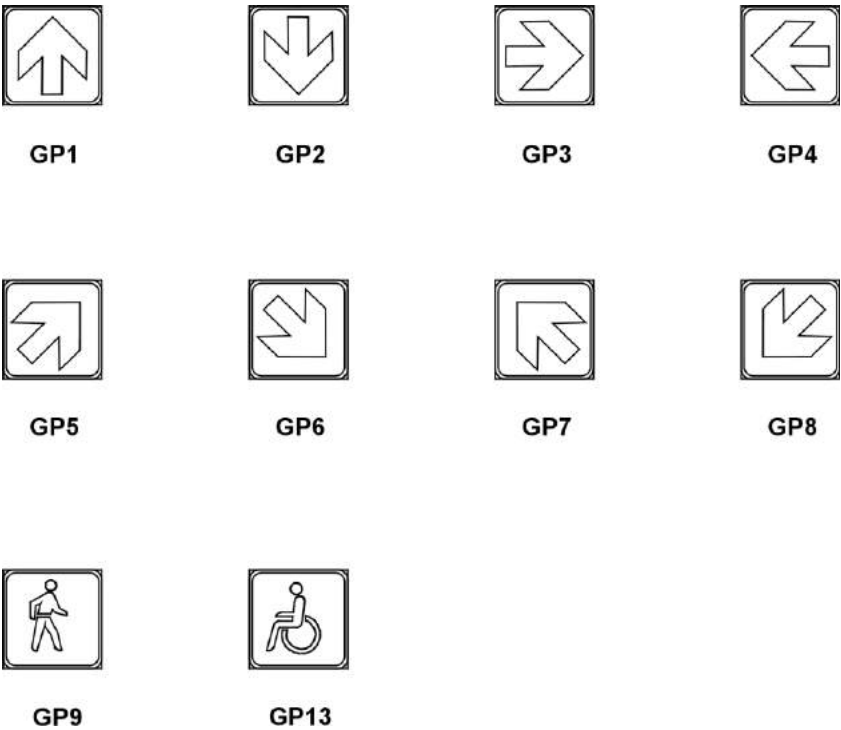


Figure A.4: Pedestrian and cyclist guidance signs

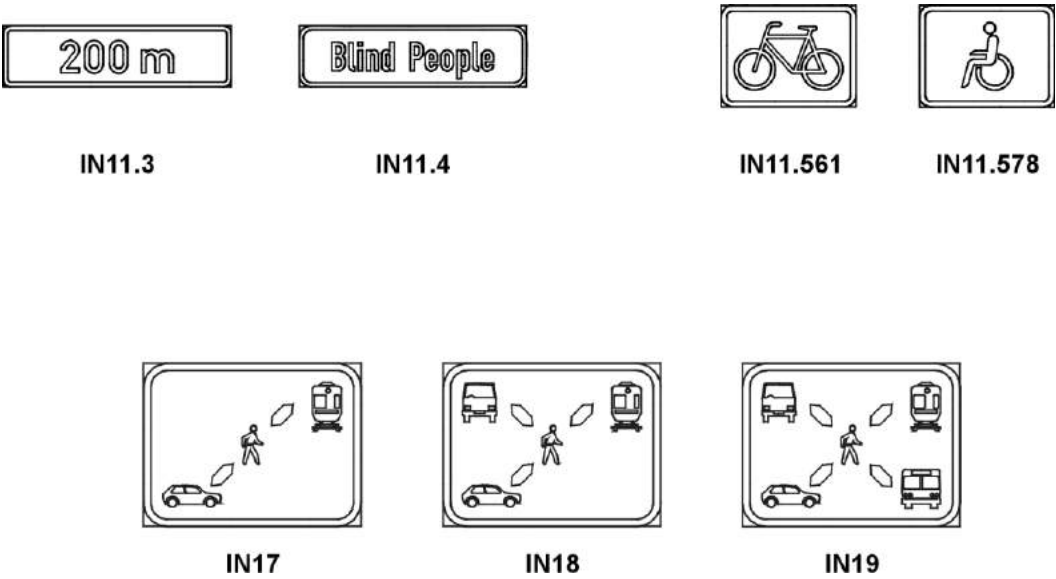


Figure A.5: Pedestrian and cyclist information signs



Figure A.6: Examples of combination signs

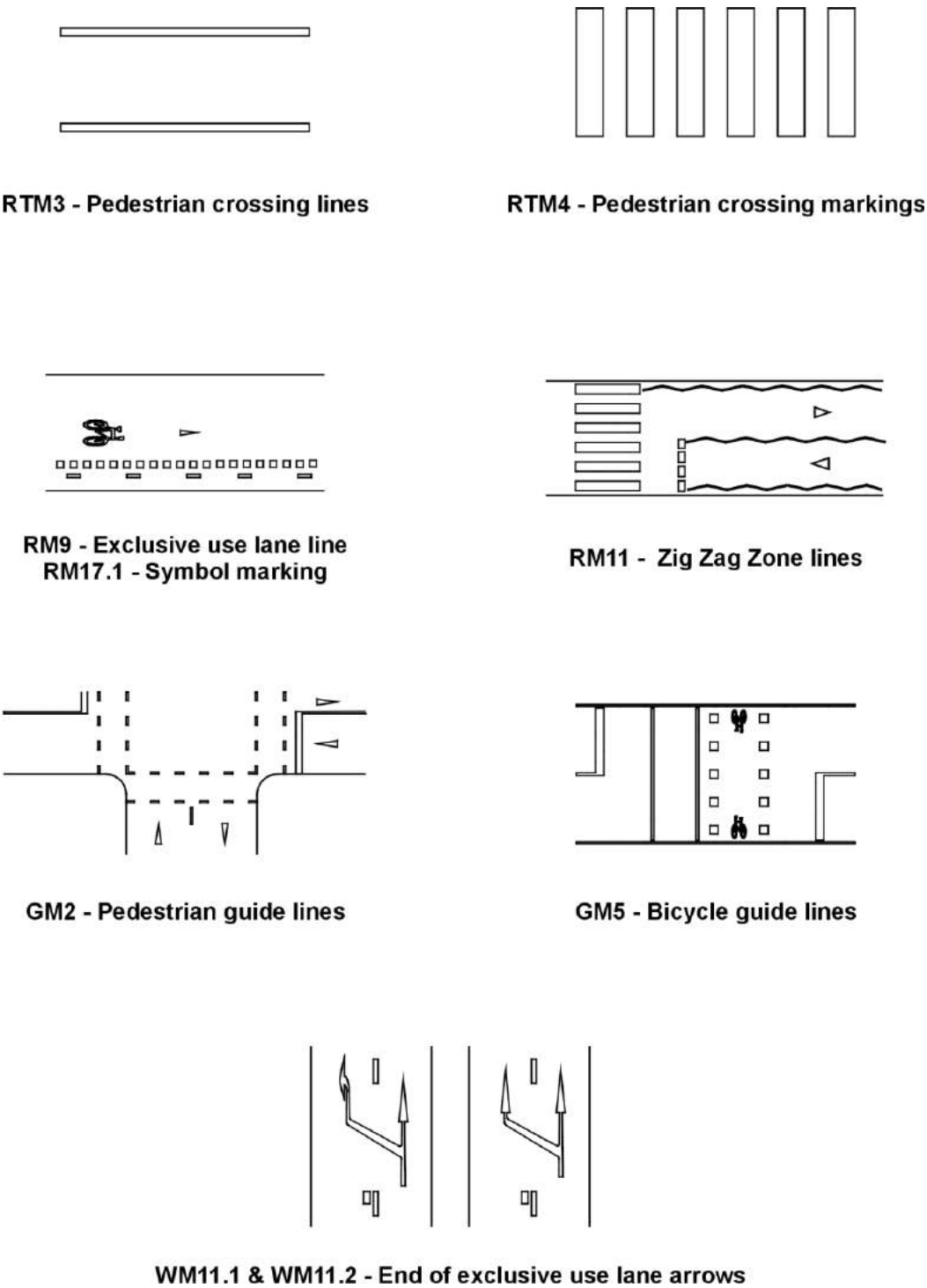


Figure A.7: Pedestrian and cyclist road markings

A.4. PEDESTRIAN AND CYCLIST CONTROL SIGNS

Regulatory signs are used to control the actions of road users. Failing to obey such a sign is an offence in terms of the National Road Traffic Act and Regulations.

A.4.1. R2.1 Yield to pedestrians



The YIELD TO PEDESTRIANS regulatory sign R2.1 imposes a *mandatory requirement that the driver of a vehicle approaching such a sign shall yield right-of-way to pedestrians crossing the public road, or waiting to cross the public road.*

The sign may only be used at marked pedestrian crossings:

- The crossing point must be marked with a BLOCK PEDESTRIAN CROSSING marking RTM4.
- The crossing must be preceded on each approach by a YIELD LINE marking RTM2.
- The PEDESTRIAN CROSSING AHEAD LINE marking RM11 must be used on the approaches.
- The YIELD TO PEDESTRIANS sign must be located between 3 m and 6 m in advance of the BLOCK PEDESTRIAN CROSSING marking RTM4.

Sign R2.1 may also be located on turning roadways or slipways, which are not subject to some other form of control, to indicate the location of a pedestrian crossing point and the requirement that drivers must yield right-of-way to pedestrians in the prescribed manner.

A.4.2. R5 Pedestrian priority



The PEDESTRIAN PRIORITY sign R5 is *to indicate to drivers of vehicles that only:*

- *Vehicles for the purpose of delivering goods.*
- *Vehicles used in connection with maintenance.*
- *Emergency vehicles.*

shall be permitted in an area set aside as a pedestrian precinct marked by such signs and such vehicle shall:

- *Yield right-of-way to all pedestrians who are in, or who are crossing or about to cross their path.*
- *Observe a maximum speed of 15 km/h unless another speed limit is indicated by an appropriate sign.*
- *If they are delivering or loading goods, shall only do so in places marked for such purpose in such area by a road traffic sign.*

Sign R5 should be displayed at all possible vehicular points of entry to a pedestrian precinct where full access control is not exercised. The sign may be used in conjunction with an appropriate

RESERVATION sign if access to the area is required to be given to a specific class of vehicle such as those used by hotel residents or post office officials.

In some cases traffic regulations will prohibit access to all vehicles and/or motor vehicles at all times. In such cases the use of sign R5 is not required, however, depending on circumstances it may be necessary to permit access to emergency or maintenance vehicles. Such provision is best made by having movable or demountable barriers, of an aesthetic design, with provision for access by such vehicles being covered by by-law rather than signs.

A.4.3. R110 Pedestrians only



The PEDESTRIANS ONLY regulatory sign R110 indicates that the public road or portion of public road is set aside for pedestrians only and imposes a mandatory requirement that pedestrians shall only use such public road or such portion of public road. This has the effect that no other class of road user may use the public road or portion of public road indicated by the sign.

Sign R110 should be displayed at the beginning of a path, route or lane which has been specifically provided for pedestrians only. It is, however, not required that the normal sidewalk or footpath provided for pedestrian movement in urban business districts or residential areas be so signed unless there is a particular problem of control which requires such a sign. It may be necessary to repeat the sign at intervals along the pedestrian path.

The sign should be located on the left side of the pedestrians only facility provided that, if a physical separator exists between the path or route, and an adjacent roadway it may be more effective to locate the sign on the right side of the pedestrians only facility. A NO PEDESTRIANS sign R218 should not be displayed on the traffic side of a PEDESTRIANS ONLY sign R110.

Sign R110 should not be used as a pedestrian direction sign in combination with an arrow. If there is a need to guide pedestrians, specific rectangular guidance signs should be provided.

A.4.4. R111 Cyclists only



The CYCLISTS ONLY regulatory sign R111 indicates that the public road or portion of public road is set aside for cyclists only and imposes a mandatory requirement that cyclists shall only use such public road or such portion of public road. This has the effect that no other class of road user may use the public road or portion of public road indicated by the sign.

Sign R111 should be displayed at the beginning of a path, route or lane which has been specifically provided for cyclists only. It may be necessary to repeat the sign at intervals along the cycle path, route or lane where crossing traffic, including pedestrians may need to be advised of the presence of the cyclists only facility.

The sign should be located on the left side of the cyclists only facility provided that if a physical separator exists between the path or route, and an adjacent roadway it may be more effective to located the sign on the right side of the cyclists only facility.

A NO CYCLISTS sign R219 should not be displayed on the traffic side of a CYCLISTS ONLY sign R111.

A.4.5. R112-R114 Cyclists and pedestrians only



The CYCLISTS and PEDESTRIANS ONLY regulatory signs R112, R113, R114 and R115 indicates that the public road or portion of public road is set aside for cyclists and pedestrians only and imposes a mandatory requirement that cyclists and pedestrians shall only use such public road or such portion of public road. This has the effect that no other class of road user shall use the public road or portion of public road indicated by the sign.

Signs R112 and R114 should be displayed to indicate that the shared facility is an INTEGRATED one. Cyclists and pedestrians utilize the same path which may or may not be divided longitudinally by a broken white road marking. When such a marking is used it is recommended that painted symbols indicating which portion should be used by cyclists and which by pedestrians should be marked on the roadway surface in appropriated positions.

Signs R113 and R115 should be displayed to indicated that the shared facility is a SEGREGATED one. Cyclists and pedestrians utilize separate but parallel paths. The division between paths may be a physical separator or a single continuous white painted line. Painted symbols depicting a cyclist and a pedestrian should be applied to the surface of the roadway to indicate which portions each should use.

The correctly handed versions of the CYCLISTS and PEDESTRIANS ONLY signs should be used for integrated and segregated facilities. The decision as to which sign is most appropriate is likely to be subjective based on local conditions. If in doubt, arrange signs so that pedestrians are furthest from passing vehicular traffic. Signs R112 or R113 will then be used in one direction and signs R114 or R115 in the opposite direction.

The signs should be displayed, as appropriate, at the beginning of the shared path which has been specifically provided for cyclists and pedestrians only. It may be necessary to repeat the appropriate sign at intervals along the path to indicate to other crossing traffic that is a cyclist and pedestrian only facility.

The signs should be located on the left side of the path provided that if a physical separator exists between the path(s) and the adjacent roadway it may be more effective to locate the sign on the right side of the path.

A.4.6. R207 No hitchhiking



The NO HITCHING-HIKING regulatory sign R207 imposes a mandatory requirement that pedestrians shall NOT attempt to secure a lift from a passing vehicle AND that drivers of vehicles shall NOT pick-up passengers. The prohibition on hitchhiking is effective for a distance of 500 m beyond such sign.

The sign should be displayed on the left-hand side of the roadway to indicate the point from which the prohibition on hitchhiking shall apply.

If the length of prohibition required exceed 500 m, the sign must be repeated at intervals of 500 m. The first sign in the sequence may carry a SUPPLEMENTARY PLATE sign IN1.2 indicating "For 5 km".

The use of freeways by persons on foot is prohibited by the National Road Traffic Act, except in an area indicated by an appropriate road sign, or for a cause beyond their control. Sign R207 should not be used on freeways.

A.4.7. R218 No pedestrians



The NO PEDESTRIANS regulatory sign R218 imposes a *mandatory requirement that pedestrians shall NOT proceed beyond such sign*.

Sign R218 should be displayed at the beginning of, and at entrances to, a roadway, lane or path to indicate that pedestrians are prohibited from using that roadway, lane or path. Sign R218 may be used to indicate to pedestrians that they should not cross a roadway at the point indicated by the sign. In the latter case, it is recommended that additional signs be displayed to guide pedestrians to a safe crossing point. If sign R218 is used in this manner at a junction, the junction should not be marked with PEDESTRIAN CROSSING LINE marking RTM3 at that point.

A NO PEDESTRIANS sign may not be displayed between a roadway and a pedestrian way at the commencement of a pedestrian way when such a point is signed with PEDESTRIANS ONLY sign R110 or one of the CYCLISTS AND PEDESTRIANS ONLY signs R112 to R115.

A NO PEDESTRIANS sign may not be displayed at the beginning of a cyclists only facility which is already signed with a CYCLISTS ONLY sign R111.

A.4.8. R219 No cyclists



The NO CYCLISTS regulatory sign R219 imposes a *mandatory requirement that cyclists shall NOT proceed beyond such sign*.

Sign R219 should be displayed at the beginning of, and at entrances to, a roadway, lane or path to indicate that cyclists are prohibited from using that roadway, lane or path.

The sign should normally be used at the beginning of roadways where, for safety reasons, it is desirable to prohibit bicycle traffic.

A NO CYCLISTS sign may not be displayed between a roadway and a cycle way at commencement of a cycle way when such a point is signed with a CYCLISTS ONLY sign R111 or one of the CYCLISTS AND PEDESTRIANS ONLY signs R115.

A NO CYCLISTS sign may not be displayed at the beginning of a pedestrians only footpath which is already signed with a PEDESTRIANS ONLY sign R110.

A.4.9. R220 No pedestrians and cyclists

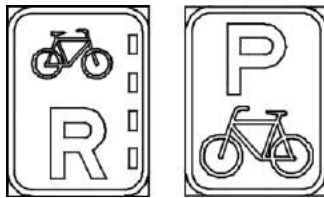


The NO CYCLISTS AND PEDESTRIANS regulatory sign R220 *imposes a mandatory requirement that cyclists and pedestrians shall NOT proceed beyond such sign.*

Sign R220 should be displayed at the beginning of, and at entrances to, a roadway, lane or path to indicate that cyclists AND pedestrians are prohibited from using that roadway, lane or path. Sign R220 may be used to indicate to cyclists and pedestrians that they should not cross a roadway at the point indicated by the sign. In the latter case it is recommended that additional signs be displayed to guide cyclists and pedestrians to a safe crossing point.

A NO CYCLISTS AND PEDESTRIANS sign may not be displayed between a roadway and a shared cyclist and pedestrian way at its commencement when such a point is signed with one of the CYCLISTS AND PEDESTRIANS ONLY signs R112 to R115.

A.4.10. R304/R304-P Cycle reservation



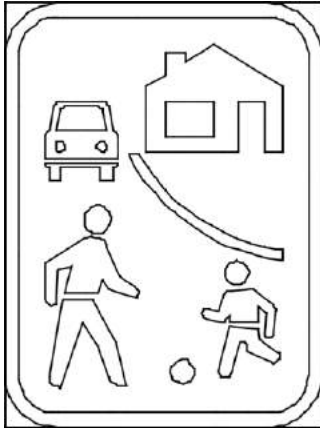
The CYCLE LANE RESERVATION regulatory sign R304 indicates a conditional requirement to drivers of vehicles that the portion of public roadway marked by EXCLUSIVE USE LANE LINE marking RM9 and BICYCLE SYMBOL marking GM6.1 is reserved for cyclists only. Sign R304-P indicates a conditional requirement to cyclists and drivers that a parking area is reserved for cyclists only.

These signs have the effect that no other class of road user may use the road or parking area indicated by the signs. It should, however, be noted that the use of sign R304 does not make it mandatory for cyclists to use the reserved area. Such a requirement is the function of CYCLISTS ONLY command regulatory sign R111.

Sign R304 should be used in conjunction with EXCLUSIVE USE LANE LINE marking RM9 and BICYCLE SYMBOL marking GM6.1 to indicate a BICYCLE LANE reservation. Sign R304 and symbol GM6.1 must be positioned at regular intervals along the bicycle lane to adequately indicate to drivers of vehicles that the lane is reserved for bicycles. The distance between repeat signs should not exceed 250 m.

The treatment of a BICYCLE LANE at an intersecting side road requires careful consideration. If potential conflicts between cyclists and turning or entering traffic are likely, a formal bicycle crossing of the side road may be provided using BICYCLE CROSSING LINES marking GM5. When this option is exercised the use of END OF EXCLUSIVE USE LANE ARROW markings WM11, WM12 or WM13, positioned immediately beyond the end of marking RM9, may be considered.

A.4.11. R403 Woonerf



The WOONERF regulatory sign R403 indicates *comprehensive requirements that drivers of vehicle shall:*

- *Not enter the area driving a vehicle with a gross vehicle mass exceeding 3 500 kg and/or more than 10 seats for passengers, except for local access or delivery.*
- *Yield right of way to pedestrians, and children who may be in the roadway.*
- *Observe a general speed limit of 30 km/h within the area unless another speed limit is indicated by road sign.*
- *Not enter the area by vehicle and drive through the area to exit at another point or the same point without breaking their journey.*

Sign R403 should be displayed on the left side of all points of access to all residential areas declared for the purpose of traffic control as “WOONERF”.

A.5. PEDESTRIAN AND CYCLIST WARNING SIGNS

Warning signs are used to alert drivers to hazardous or potentially hazardous locations on or adjacent to a road. Warning signs indicate a need for additional caution by road users, and may require a reduction in speed or other manoeuvre.

A.5.1. TW305 Scholar patrol ahead



The SCHOLAR PATROL AHEAD warning sign may only be used as a temporary warning sign TW305 and is *to warn road users that a temporary scholar patrol is operating ahead.*

Sign TW305 should be a temporary portable sign and should be displayed only for the period during which the scholar patrol is in operation. The reserve side of portable signs must be marked with alternating black and yellow stripes.

These signs should be displayed in the centre of a two-way roadway or on the left side of the median island of a dual roadway. It is recommended that when the signs are mounted in a sunken socket in the roadway that where possible this and the signpost be of a square section to prevent the swivelling of the sign due to wind.

Pedestrian crossings subject to part-time control by scholar patrols should be preceded by permanent PEDESTRIAN CROSSING warning signs W306 and CHILDREN warning signs W308.

A.5.2. W306 Pedestrian crossing



The PEDESTRIAN CROSSING warning sign W306 is to warn road users of a marked pedestrian crossing ahead.

Sign W306 should, where possible, be displayed not less than 90 m or more than 180 m in advance of any block-marked pedestrian crossing. In addition, if the block-marked crossing is primarily for school children a CHILDREN warning sign W308, should be placed a suitable distance in advance of sign W306. A pedestrian crossing controlled by a traffic signal should be preceded by a TRAFFIC SIGNALS AHEAD warning sign W301.

A.5.3. W307 Pedestrians



The PEDESTRIANS warning sign W307 is used to warn road users of the possible presence of above average numbers of pedestrians ahead.

Sign W307 is intended for use where a formal pedestrian crossing point has not been. It should normally be reserved for areas or sections of road where pedestrian activities are significantly higher than normal. This applies particularly in rural areas. The use of a supplementary advisory speed plate may be considered for use with PEDESTRIANS warning signs. In addition if the section of road on which pedestrian activities are significantly higher than normal exceeds 2 km the sign should be repeated at suitable intervals, not greater than 2 km apart. When used, a supplementary plate should be mounted below the warning sign on the same post.

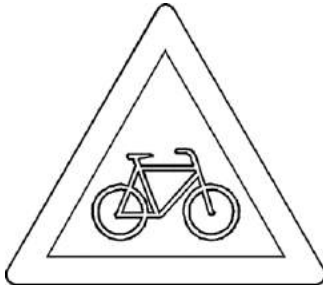
A.5.4. W 308 Children



The CHILDREN warning sign W308 is used to warn road users of the possible presence of children near schools, playgrounds, sports fields or other places ahead.

Sign W308 should, where possible, be displayed not less than 90 m nor more than 180 m in advance of a point or area where children may be expected. The CHILDREN warning sign may be appropriate some distance from a school particularly if a system of "safe routes" to the school has been established for children. If there is a combination of pedestrian and cyclist children present the CHILDREN warning sign W308 should be used in preference to the CYCLISTS warning sign W309.

A.5.5. W309 Cyclists



The CYCLISTS warning sign W309 is used to warn road users of the possible presence of cyclists ahead.

Sign W309 should preferably be displayed on sections of roadway where a significant volume of cyclists cross or travel along the roadway and no separate provision such as a cyclist lane or track has been made. When a separate cyclist facility is provided the use of sign W309 should normally be reserved for places where such facilities cross roadways. If the section is longer than 2 m the sign should be repeated at suitable intervals. A supplementary distance information plate may be displayed below sign W309 and mounted on the same post.

It is generally not necessary to use the sign near schools to supplement the CHILDREN warning sign W308. However, if separate cyclist facilities exist near a school, sign places where such facilities cross roadways, particularly if there are few children other than cyclists present.

A.6. PEDESTRIAN GUIDANCE SIGNS

Guidance signs are provided to assist road users in navigating the road network. The signs typically provide information on the names of destinations along a road, but can also contain various types of symbolic signs. A number of guidance signs have been developed for specific use by pedestrians.

The pedestrian guidance signs have been developed from signs used within pedestrian transport environs such as railway stations (and similar to airports). These stations often include a number of different transport modes, distributed in such a way that pedestrians may need direction to guide them from one transport mode area to another. Such directional guidance can also include destination information and even departure times displayed by means of variable message signs integrated into the PEDESTRIAN signing system.

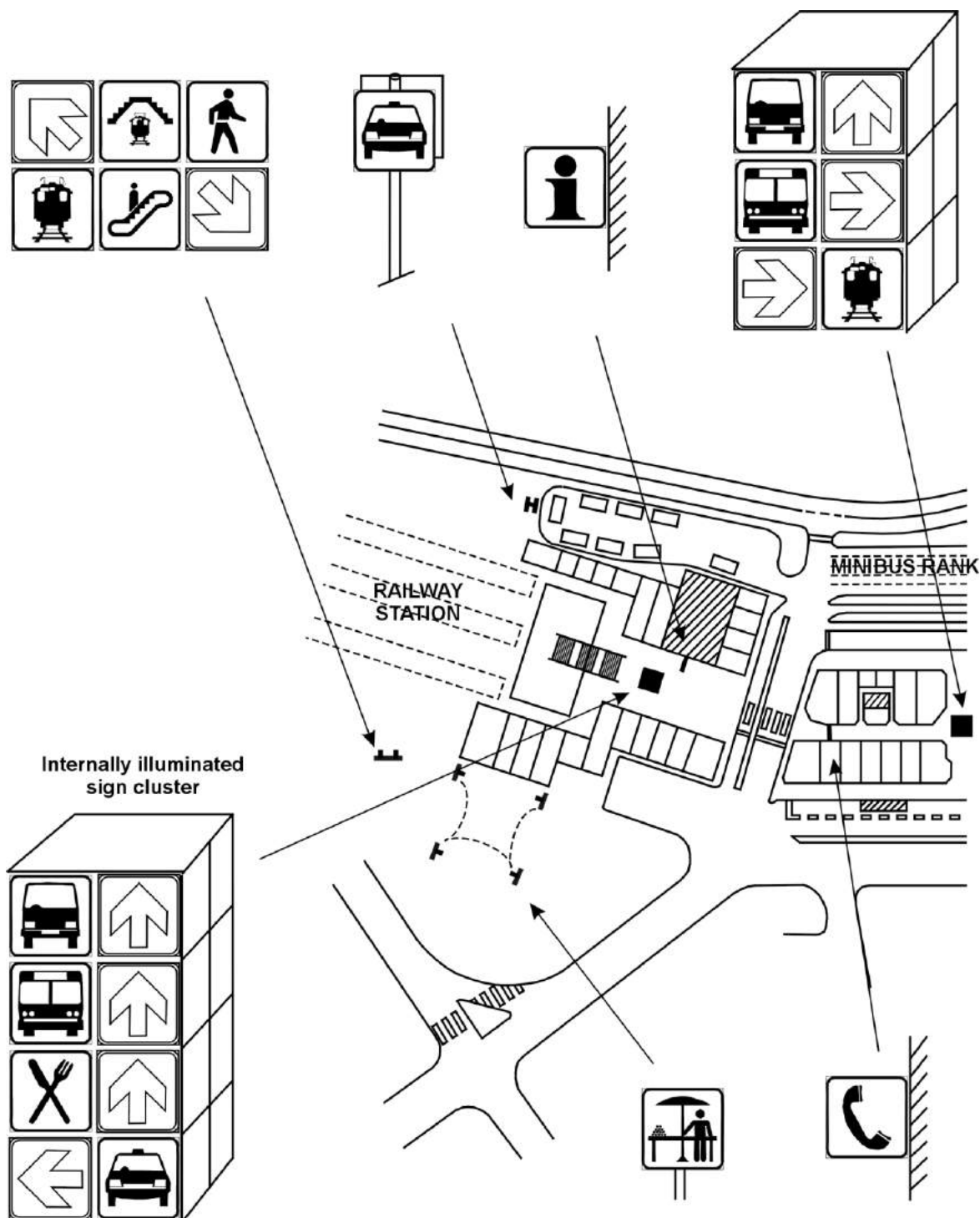
The majority of PEDESTRIAN GUIDANCE signs are square in shape. The signs have been designed on a modular basis to facilitate the combination of individual square modules into specific sign messages, with the potential for a wide variation in these messages.

PEDESTRIAN GUIDANCE signs, because of their modular development, may be used in true guidance function as:

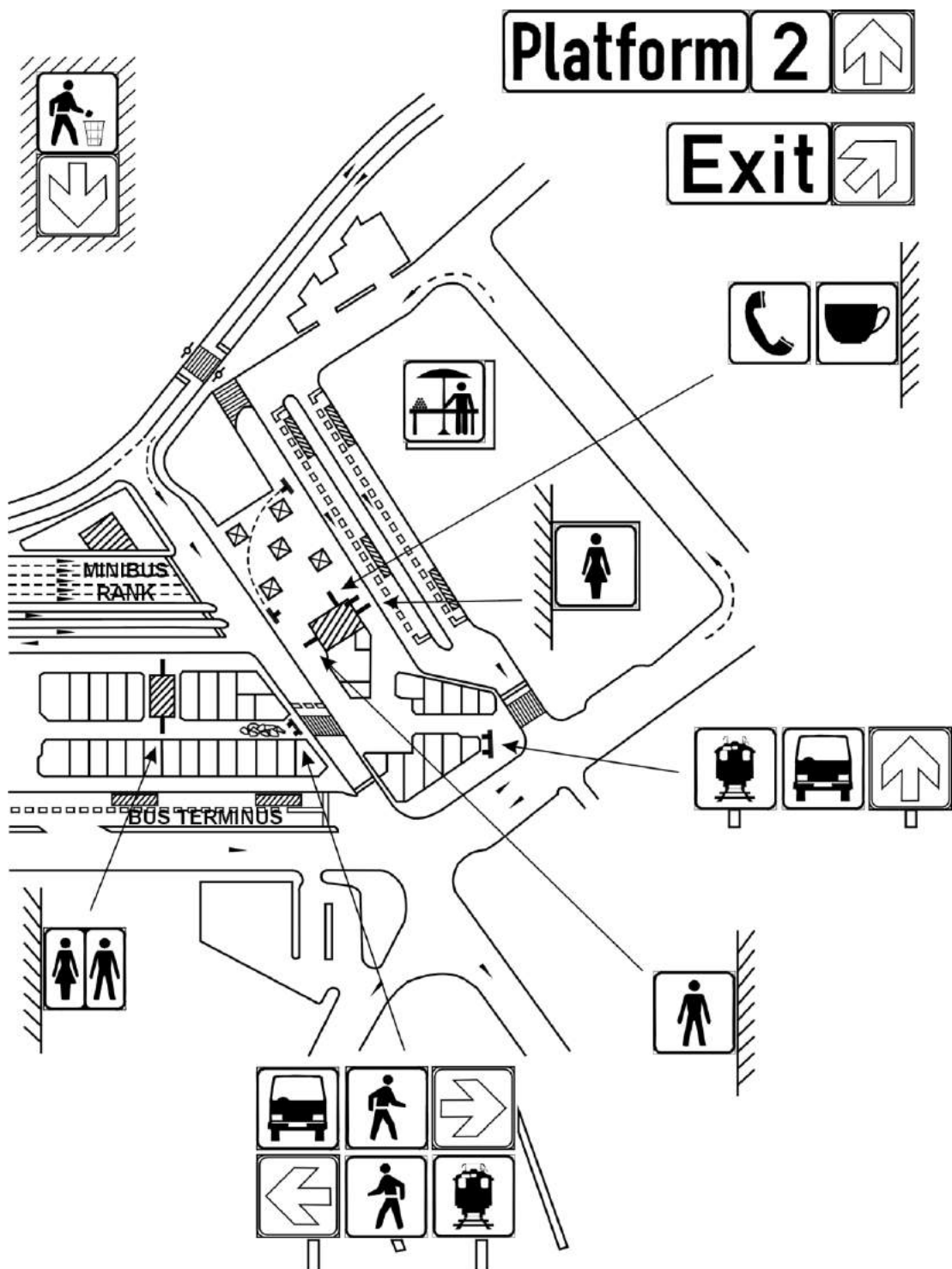
- LOCATION guidance signs, whereby individual signs, whereby individual signs may be used to identify (the location of) specific pedestrian facilities;
- DIRECTION guidance signs clusters whereby one or more signs may be combined in a clusters with an appropriate arrow module to indicate the direction to pedestrian facilities.

A selection of PEDESTRIAN GUIDANCE sign applications in the environment of an integrated railway station, minibus and bus transport termini are illustrated in the following figures. The provision of commercial facilities such as shops, take-away food, and restaurants is becoming common at this type of terminal, in order to make the whole terminal financially viable. This, together with the various services also available, make the provision of signs of the type illustrated increasingly necessary. The figures include a selection of PEDESTRIAN LOCATION signs,

commonly wall mounted, and PEDESTRIAN DIRECTION signs that are normally located on conventional pole supports. Options can even be exercised to provide strategically located, multi-faced internally illuminated sign combinations.

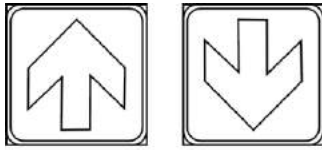


Typical use of pedestrian guidance signs at a railway station

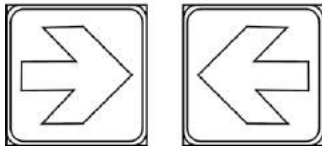


Typical use of pedestrian guidance signs at a bus station

A.6.1. GP1-GP4 Pedestrian arrows



PEDESTRIAN DIRECTION arrow signs GP1 to GP4 may be used in combination with PEDESTRIAN SYMBOLS and TEXT signs to *guide pedestrians towards a range of facilities only approachable, within the area concerned, on foot*. These ARROW signs therefore must not be used on their own.

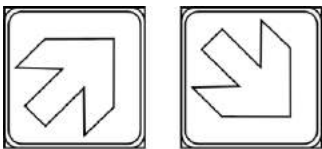


Signs GP1 to GP4 may be used to indicate directions straight forward (or up), back (or down) and to the right and left. Four other ANGLED ARROW signs are available to indicate directions up-wards to right or left, and downwards to right or left.

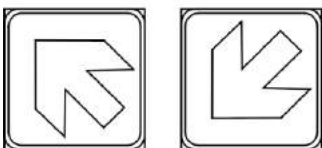
GP1 to GP4 signs may be mounted in horizontal or vertical clusters with relevant modular symbolic or text signs. To permit maximum flexibility in the manner of display, and unlike any other type of guidance sign, more than one horizontal cluster of signs may be displayed pointing in the same direction. In other words if there are four facilities in one direction it is likely to be more practical to display these in two rows of two signs, each row with an appropriate arrow, rather than in one long row of five modules.

The vertical order of arrows displayed on a common support must be the same as for normal stack-type direction signs.

A.6.2. GP5 – GP8 Angled arrows



PEDESTRIAN DIRECTION angled arrow signs GP5 to GP8, and TGP5 to TGP8, may be used in combination with PEDESTRIAN SYMBOLIC and TEXT signs to guide pedestrians upwards or downwards, and to the right or left, towards a range of facilities only approachable, within the area concerned, on foot.



Signs GP5 to GP8 (and TGP5 to TGP8) may be used to indicate directions upwards to the right and left, and downwards to the right and left. Four other ARROW signs are available to indicate directions straight forward (or up), back (or down) and to right or left without change of level.

GP5 to GP8 signs may be used in the same manner as described for signs GP1 to GP4.

A.6.3. GP Symbolic and text signs



PEDESTRIAN SYMBOLIC and TEXT signs GP9 to GP32 may be used in combination with one of the ARROW or ANGLED ARROW signs to guide pedestrians towards a range of facilities only approachable on foot.

Signs GP9 to GP27 may be used on their own to identify the specific types of facility displayed on the sign. For this function, the signs will commonly be mounted on wall of the facility, either flush with the wall or at 900 to the wall.

The mounting height of LOCATION application signs should be at least 2.1 m, and preferably 2.4 m, when placed at 900 to a wall or other surface

Signs GP9 to GP32 may be used in combination with ARROW or ANGLED ARROW signs GP1 to GP8 to direct pedestrians towards the various types of facility. The groups or clusters of PEDESTRIAN signs may be mounted in horizontal or vertical cluster. Horizontal clusters may be mounted one above the other in the same way as stack-type signs. When mounted as stacks, PEDESTRIAN signs must follow the general rule applicable to stack-type signs, so that straight on signs are above right or left signs, and right signs are mounted over left signs.

As a result of the nature of many areas in which PEDESTRIAN signs may be provided, the signs are likely to compete for attention with advertising signs. It is therefore advisable to consider using the same techniques as are used for advertising signs to achieve acceptable levels of conspicuity. Such techniques may include:

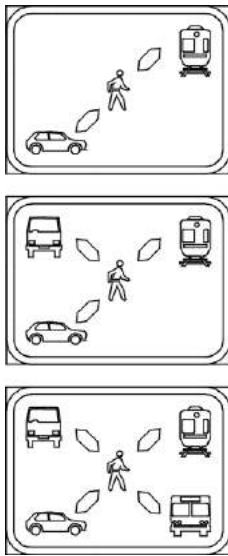
- Internal illumination.
- Variable messages.
- Larger signs than the minimum required for legibility.

When new pedestrian environments are being planned, local authorities should ensure that any PEDESTRIAN signs that are specified for the area are “protected” to the greatest possible extent from the intrusion of advertising signs. This will require that authorities are shown specific details of any competitive signing before the integrated signing plan is finalised.

A.7. PEDESTRIAN AND CYCLIST INFORMATION SIGNS

Information signs are used to provide information of a very general nature. The information is typically non-directional in nature.

A.7.1. IN17 – IN19 Modal transfer



MODAL TRANSFER signs IN17, IN18 and IN19 may be used to *inform commuters that there is a transport interchange point or terminal close by at which they may change their mode of transport*. The symbols used on the sign should represent as closely as possible the modes of transport involved. Symbols may be combined to represent transfer between informal and formal transport modes or between two modes of the same category. No attempt should be made to try to represent all possible classes of vehicle. In the general sense, a motorcar or mini-bus symbol represents informal transport, and a bus or train symbol formal transport.

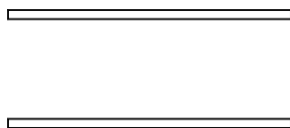
The sign should be located on the left side of the roadway where adequate space is available for vehicles to stop to discharge or take on passengers.

Care should be taken when siting STOPS for the relevant transport modes that safe and adequate pedestrian passage is possible between the stops used by the different transport modes. The siting of such stops within the general area of a freeway access interchange may even be feasible if treated carefully.

A.8. PEDESTRIAN AND CYCLIST ROAD MARKINGS

Road markings are road signs that are applied to the road surface. Road markings also include roadstuds and other lateral delineating devices such as guardrail delineators and traffic cones.

A.8.1. RTM3 Pedestrian crossing lines



A PEDESTRIAN CROSSING LINES regulatory marking RTM3 imposes a mandatory requirement that drivers of vehicles *shall yield right-of-way, by slowing down or stopping if need be to so yield, to a pedestrian who is crossing the roadway or a portion of roadway, AND regulatory marking RTM3 imposes a mandatory requirement that pedestrians shall only cross the roadway within the crossing defined by the markings and the edges of the roadway and/or median or other traffic island (if such are provided)*.

PROVIDED that:

- If such PEDESTRIAN CROSSING LINES marking RTM3 is used in conjunction with a road sign or traffic signal, or STOP LINE marking RTM1 or YIELD LINE marking RTM2 the significance of these road traffic signs shall take precedence;
- Pedestrians are crossing the roadway or portion of roadway in accordance with the prescribed indications of a traffic signal when such is provided.

PEDESTRIAN CROSSING LINE markings must always comprise two continuous white lines. These lines must be a minimum of 100 mm wide and must be placed at least 2,4 m apart, a separation of 3 m is preferred, and where large volumes of pedestrians are present the distance separating the lines should be increased. The lines should extend across the full width of a roadway or portion of roadway and should normally be parallel to each other and at 90° to the direction of traffic movement. However, crossings may be skewed if this is in the best interests of pedestrians and the safe movement of traffic.

PEDESTRIAN CROSSING LINES must be preceded by a STOP LINE marking RMT1 when used at a traffic signal controlled crossing, or a YIELD LINE marking RTM2 when used at a road sign controlled crossing. Marking RTM3 may not be marked on top of, or as an extension to such lines, but as separate markings. It is not recommended that PEDESTRIAN CROSSING LINES be marked on the approaches to uncontrolled or partially controlled junctions. If it is required to provide guidance to pedestrians when their numbers do not warrant the installation of a formal crossing it is recommended that GUIDE LINE marking GM2 be provided in a similar manner to PEDESTRIAN CROSSING LINES. This type of informal crossing is intended to assist pedestrians identify the section of public road over which they may most safely cross.

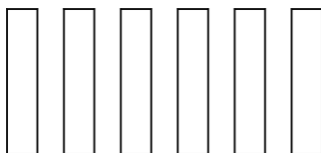
As a general rule PEDESTRIAN CROSSING LINES marking RTM3 should be provided at all approaches to a junction controlled by traffic signals. However, they may be omitted if:

- For some reason it is considered unsafe for pedestrians to cross a particular approach; in such circumstances the normal crossing position should be covered by a NO PEDESTRIANS sign R218 and the safe route through the junction made clear to pedestrians if necessary by means of pedestrian guidance signs;
- The pedestrian crossing volumes in a particular direction average less than 50 per hour during daylight.

It is recommended that PEDESTRIAN CROSSING LINES marking RTM3 is only used in conjunction with a traffic signal either at a junction or in a mid-block location. Pedestrian crossings controlled by YIELD TO PEDESTRIAN sign R2.1, which may operate with or without part-time control by a traffic officer or a school patrol must use the BLOCK PEDESTRIAN CROSSING marking RTM4 because of the greater visual impact of this marking. In the event that the type of control at a mid-block pedestrian crossing is altered from road sign to traffic signal, or vice versa, it is acceptable to use both markings. In such situations the “block” markings should be separated from the line markings to obtain a better visual effect.

Where PEDESTRIAN CROSSING LINES are marked in a mid-block location they should be preceded by a PEDESTRIAN CROSSING warning sign W306 on each approach.

A.8.2. RTM4 Block pedestrian crossing markings



A BLOCK PEDESTRIAN CROSSING regulatory marking RTM4 imposes a *mandatory requirement that drivers of vehicles shall yield right-of-way, by slowing down or stopping if need be to so yield, to a pedestrian who is crossing the roadway or a portion of roadway, AND regulatory marking RTM4 imposes a mandatory requirement that pedestrians shall only cross the roadway within the crossing defined by the markings and the edges of the roadway and/or median or other traffic island (if such are provided).*

PROVIDED that:

- If such BLOCK PEDESTRIAN CROSSING marking RTM4 is used in conjunction with a road sign or traffic signal, or STOP LINE marking RTM1 or YIELD LINE marking RTM2 the significance of these road traffic signs shall take precedence;
- Pedestrians are crossing the roadway or portion of roadway in accordance with the prescribed indications of a traffic signal when such is provided.

BLOCK PEDESTRIAN CROSSING markings must comprise a number of rectangular white painted markings of minimum length 2,4 m and minimum width 600 mm, spaced 600 mm apart which must extend across length full width of the roadway or portion of roadway. A length of marking of 3 m is preferred, and this dimension may be further increased if large volumes of pedestrians are present. The necessary width may be determined by marking by making the length of marking equal to 0,6 m for every 125 pedestrians/hour based on the four peak hours. A maximum length of 5 m is recommended.

BLOCK PEDESTRIAN CROSSING marking RTM4 must be preceded by a STOP LINE marking RTM1 if used at a traffic signal controlled crossing, or a YIELD LINE marking RTM2 when used at a road sign controlled crossing.

It is recommended that BLOCK PEDESTRIAN CROSSING markings be used at any pedestrian crossing controlled by YIELD TO PEDESTRIAN sign R2.1. Such crossings should normally be mid-block pedestrian crossings that may operate with or without part-time control by a traffic officer or scholar patrol. In the event that the type of control at a mid-block pedestrian crossing is altered from road sign to traffic signal, or vice versa it is acceptable to use both BLOCK PEDESTRIAN CROSSING marking and PEDESTRIAN CROSSING LINES markings to avoid the need to erase the “block” markings. The line markings should be separated from the “block” marking to achieve a better visual impact. BLOCK PEDESTRIAN CROSSING markings may be used elsewhere if necessary to enhance the visibility of a pedestrian crossing point at traffic signal controlled road junctions or mid-block crossings.

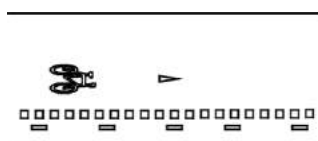
BLOCK PEDESTRIAN CROSSINGS may be used in rural areas but their common application is in busy in urban areas where, at schools, arcades, malls, cinemas and other centres of attraction, it is necessary to assign priority to pedestrians crossing the roadway.

Where BLOCK PEDESTRIAN CROSSING markings are marked in a mid-block location they should be preceded by a PEDESTRIAN CROSSING warning sign W306 on each approach.

Non-signalised pedestrian crossings should not be marked:

- On any section of roadway with inadequate vertical or horizontal sight distance;
- Close to a junction controlled by traffic signals.

A.8.3. RM9 Exclusive use lane line



Regulatory marking RM9, when used in conjunction with an appropriate SYMBOL marking GM7, imposes a mandatory requirement that drivers of vehicles *shall not drive, park or stop in a lane with such markings if the vehicles they are driving are not of the class indicated by the symbol or word marking RM17; PROVIDED, that if such a marking is used in conjunction with any appropriate road sign, the lane may be used by such class or classes of vehicle as indicated by the symbol of such sign.* The significance of the marking may be time limited by the virtue of the enabling regulatory sign message.

EXCLUSIVE USE LANE LINE marking RM9 may be designated for the exclusive use of bicycles by the addition of SYMBOL marking RM17.11 and CYCLE LANE RESERVATION regulatory sign R304, subject to a maximum spacing of 250m.

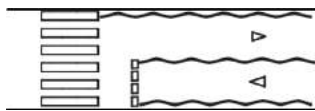
EXCLUSIVE USE LANE LINE marking RM9 must comprise a broken yellow line with a minimum width of 150mm. A standard line-to-gap ratio of 1to1 must be used with line and gap lengths of 750mm.

If a situation arises where it is required to provide an EXCLUSIVE LANE with other lanes both sides of it then the marking RM9 should be used on both sides of the lane as described above.

If the bicycle lane width is 2,8 m or wider, marking RM9 must be marked in addition to, and on the inside of, a LANE LINE marking GM1 or the appropriate marking (such as a length of “stacking line” CHANNELISING LANE RM3). The parallel lines should be marked with a 50 mm lateral space between them.

An EXCLUSIVE USE LANE LINE marking RM9 must be end at least 20 m before an intersecting side road where vehicles are permitted to turn left or right, as the case may be, across the line of the lane. In such situations, the use of warning road markings END OF EXCLUSIVE USE LANE ARROWS WM11.1 or WM11.2 is recommended.

A.8..4. RM11 Zig Zag Zone lines



ZIG ZAG ZONE LINES regulatory markings RM11 impose a mandatory requirement that drivers of vehicles:

Shall not bring their vehicles to a stop within the “zig-zag” zone marked by such lines EXCEPT to:

- Yield right-of-way to pedestrians on the crossing; or
- Stop behind a vehicle complying with paragraph (i);

Shall not change lanes within the zig-zag zone.

AND the markings impose a mandatory requirement that pedestrians shall not cross the roadway within a zig-zag zone except at a PEDESTRIAN CROSSING LINES marking RTM3 or BLOCK PEDESTRIAN CROSSING marking RTM4.

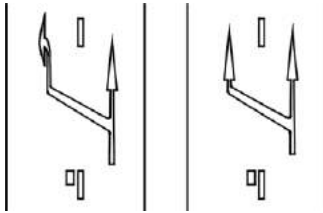
ZIG ZAG ZONE LINE markings must comprise a broken white zig-zag line with a minimum width of 100 mm, using a line length of 2 m and a gap length of 150 mm.

ZIG ZAG ZONE LINES must replace LEFT EDGE LINE markings RM4, LANE LINE markings GM1, and DIVIDING LINE markings WM3, or NO OVERTAKING LINE markings RM1, on both approaches to a non-signal controlled mid block pedestrian crossing, PROVIDED that for reasons of safety, road curve delineation etc, a NO OVERTAKING or NO CROSSING LINE marking may be retained in addition to marking RM11. PEDESTRIAN CROSSING AHEAD LINES should extend at least 30 m back from the YIELD LINE marking RTM2 on each approach.

Parking bays should not be marked within 30 m of a non-signalised mid-block pedestrian crossing. They may, however, be provided within 30 m of the crossing if they are marked on an area that is fully recessed to the left of the normal kerbline. If parking bays are provided in this manner the ZIG ZAG ZONE LINE markings RM11 must be retained.

Pedestrian crossings should be located so that no crossing of zig-zag marking RM11 by traffic is necessary.

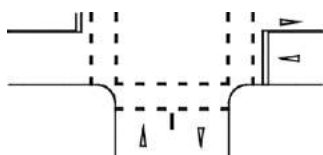
A.8.5. WM11.1/WM11.2 End of exclusive use lane arrows



END OF EXCLUSIVE USE LANE ARROW warning markings WM11.1 and WM11.2 are used to *warn road users that an exclusive use lane has ended and that they may move into the continuation of such lane subject to normal lane changing protocols.*

At intersections, the END OF EXCLUSIVE USE LANE ARROW markings must be followed by a MANDATORY DIRECTION ARROW marking RM8.1 (or RM8.5).

A.8.6. GM2 Guide lines



GUIDE LINE guidance markings GM2 may be used to *give additional guidance to road users within a junction.* Use of the markings is **OPTIONAL**.

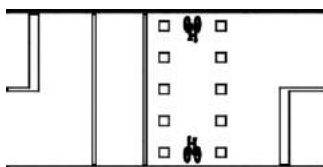
A GUIDE LINE marking must comprise a broken white line with a minimum width of 100 mm and a line-to-gap ratio of 1 to 3 with dimensions of 500 mm and 1,5 m.

A pair of parallel guide lines may be used at uncontrolled junctions to guide pedestrians to a preferred crossing point when a formal pedestrian crossing can not be provided, in situations such as:

- Footpath extensions in wide road reserves when the surface roadway takes up a small portion of the reserve.
- Turning roadways at channelised junctions to guide pedestrians on the most efficient or safe route through a complex junction.

The guide lines have the risk that pedestrians may infer a false sense of security from the markings. It is important to understand that the principle employed in the use of the markings is one of guidance only.

A.8.7. GM5 Bicycle guide lines



BICYCLE GUIDE LINES guidance marking GM5 is a *transverse marking which may be used to indicate to road users the section of roadway to be used by cyclists to cross the roadway.*

BICYCLE GUIDE LINES must comprise a pair of broken white lines with a minimum width of 300 mm and a line-to-gap ratio of 1 to 3 using dimensions of 300 mm and 900 mm. For the normal application of this marking the pairs of lines must be spaced at least 1,5 m apart.

Bicycle crossings may require to be marked when an exclusive bicycle path, or shared bicycle/pedestrian path, crosses a roadway, normally in a mid-block situation, OR where a bicycle lane running parallel to one roadway crosses an intersecting side road.

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Bicycle crossings will frequently be adjacent to pedestrian crossings. In such situations, if space is limited, one BICYCLE GUIDE LINE of the marking may be omitted and that side of the bicycle crossing may be defined by the PEDESTRIAN CROSSING LINE marking RTM3, or BLOCK PEDESTRIAN CROSSING marking RTM4. If there is insufficient space for two separate crossings a pedestrian crossing should be marked and both pedestrians and cyclists directed to use it.

Appendix B

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