Manual on Universal Accessibility for Urban Roads and Streets

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MANUAL ON UNIVERSAL ACCESSIBILITY FOR URBAN ROADS AND STREETS

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ACKNOWLEDGEMENT

Manual on Universal Accessibility for Urban Roads and Streets is a standalone document which elaborates all the necessary guidelines and strategies for planning, development, management and inspection of urban roads and streets for making our cities inclusive and sustainable.

H-8 committee of IRC was assigned to prepare the 'Universal Accessibility Manual'. This document, named as '**Manual on Universal Accessibility for Urban Roads and Streets'**, **has been prepared as per decision of H8 committee meeting headed by Mr. Ajit Pawar , Convener with Ms. Anjlee Agarwal, Team leader held on 11 Feb. 2017 at IRC Office, R.K. Puram.** The first draft manual was presented before the committee in IRC meeting held on 25 March 2017. The second draft was then presented on 28 July 2017 for views and suggestions from the experts of the committee. Final draft of the document was prepared based on comments provided by various members of the committee. The draft contains specific inputs from, Dr. Bagishwar Prasad, Dr. D. Sanyal, Dr. M. Parida (IIT, Roorkee), Pawan Singh (3M India Ltd), Romi Roy (DDA), Mr. Ashok Bhattacharjee (Ex. Advisor, CSE), Sonal Shah and Shreya Gadepalli (ITDP), Amit Bhatt and Snehil Sinha (WRI), Dr. Sewaram (SPA, Delhi), Dr. P. K. Sarkar (SPA, Delhi).

The compilation of the manual has been done by Anjlee Agarwal and Nidhi Madan (Samarthyam). The graphics have been created by Debabrata Chakravarti (Samarthyam). Editing is done by Mr. D. P. Gupta (Former DGRD, MoRTH).

The document is the outcome of co-ordinated effort of multi- disciplinary experts under the leadership of Ms. Anjlee Agarwal. The document shall serve as a reference for future road/ street development project as well as restructuring /retrofitting of existing urban roads.

PREFACE

The Government of India enacted the Rights of Persons with Disabilities Act, 2016 and signed and ratified the UN Convention on the Rights of Persons with Disabilities (CRPD) in 2008. To realize all the rights under the Rights of Persons with Disabilities Act and the UNCRPD, stakeholders need to understand and implement universal accessibility in its holistic sense.

The Government of India aim to create world-class and smart cities in the country cannot be truly realized, unless these are inclusive. This will require many interventions at macro and micro level to address the needs of all users. Therefore, it is essential to understand universal accessibility as “utilization of all the facilities to the fullest by ALL people” i.e. use is more important and not restricted only to reach. Fundamentally, good design addresses user abilities, needs and preferences, using technology to put users’ needs first.

The guiding principle of ‘universal accessibility’ is to create obstacle-free environment. It encompasses broad-spectrum ideas to create accessible and inclusive roads and streets and pedestrian environment.

Improved accessibility allows for greater use of non-motorized vehicles (NMV), and promotes walkability and NMV traffic over motorized traffic, a need that cannot be ignored for a safe and equitable commute.

This Manual aims at promoting universal accessibility and fill the knowledge gap by providing guidance to practitioners, city officials and authorities while planning, design and implementation in new projects and retrofitting of existing urban roads and streets.

Contents

Chapter 1. Introduction

1.1 Background

Roads occupy 15-20 percent of the total land area in a typical city (ITDP and EPC, 2011). They are an important and ubiquitous form of public space and core component of any city's transportation framework. The location, design and continuity of the road network determines how effectively people, goods, and materials move through the city.

A comprehensive design approach, implementation, monitoring and consistent communication on universal accessibility in the street, road and pedestrian environment and access to and use of public transport infrastructure are essential for all users.

Improved accessibility allows for greater use of non-motorized vehicles (NMV), and promotes walkability and NMV traffic over motorized traffic, a need that cannot be ignored for a safe and equitable commute.

The guiding principle of 'universal accessibility' is to create obstacle-free environment. It encompasses broad-spectrum ideas to create accessible streets, buildings and environment to the maximum extent possible. Accessibility here refers not only to persons with disabilities but to all possible users. It emphasizes inclusive environment in public spaces and infrastructure, accommodates the mobility needs of '**all individuals'**.

Table 1.1 shows a wide range of persons who may or may not have "disability", however, require accessible design elements.

Table 1.1 Highlighting difficulties experienced by diverse user groups.

Special Characteristics Requiring Attention	User Groups							
	Children (up to 8 years old)	Pregnant Women	Elderly/Senior Citizen	Speech &Hearing Impaired Persons	Visual Impair-ments	Physically Injured Persons (upper and lower body)	Wheelchair Users	Cognitive/Intellectual Disability
Difficulty in Interpreting Information (Visual/Audio)	■		■	■	■			■
Poor or Complete Degradation of Sight			■		■			
Poor or Complete Degradation of Hearing/Speech			■	■				■
Prevalence of Poor Balance		■	■			■	■	■
Prevalence of Poor Coordination and Orientation	■		■		■			■
Poor or Inability in using Upper Extremities		■	■			■		
Poor or Inability in using Lower Extremities		■	■			■	■	
Limitations of Stamina	■	■	■			■	■	
Limitations of Strength	■	■	■			■	■	
Vertically and Horizontally Challenged (in terms of height or size)	■	■					■	■
Require Physical Assistance/ Supervision	■	■	■	■	■	■	■	■
Require Family-friendly Facilities	■	■						■
Mobility aids/ Assisted Devices			■		■	■	■	

Source: (Universal Design Guidelines (Commercial Buildings), September 2006

1.2 Comprehensive Approach to Universal Accessibility

Every day a vast majority of the population encounters barriers in public spaces and in public transport. Many travelers, particularly persons with reduced mobility and persons with disabilities often depend on personalized vehicle for their daily trips, due to the barriers they encounter in public spaces and public transport. Persons with reduced mobility include senior citizens; families with young children; unescorted children; persons with temporary ailments, medical conditions and hidden diseases; pregnant women; persons carrying heavy luggage; those with communication problems, etc.

To comprehensively address universal access and suggest application of its principles and standards to promote walkability, non-motorized vehicle and public transport usage, three critical parts of a journey have been identified-

1. **Point of Origin or Destination** (home/ healthcare facility/ educational institution/ entertainment venue)
2. **Connecting Route to Transit Terminal** (street and footpath infrastructure/ NMV infrastructure used for the commute)
3. **Accessibility of the Transit Terminal** (to facilitate transportation through public transportation such as Bus Stops, BRT, Metro, Monorail, Railway Stations, Feeder and Paratransit Stops).

These together make up the critical elements of a complete trip chain for a seamless journey. **A complete trip chain** starts from the point of origin to the walk/ commute, cycle and/or wait for transport, boarding, travel and alighting followed by the walk/ commute to the final destination (Figure 1.1). Each trip chain must ensure 'safety for all' including persons with and without disabilities.

Any break in the trip chain results in lack of access and independent mobility. Inaccessible links require taking an indirect route, increasing travel times, fatigue, uncertainty and potential modal conflicts. The goal must be for people to have access to all vehicles and the full-service area, as well as the pedestrian environment (WHO, 2011). The complete trip chain must be universally accessible with a mandatory training, implementation, and maintenance and monitoring to ensure that it remains so in perpetuity.

Universally accessible design will help increase the number of people walking and the number of people using public transportation. For this, pedestrian environment and all transit systems – buses, bus shelters, bus rapid transit (BRT), metro, rail terminuses and stations, etc. should be accessible.

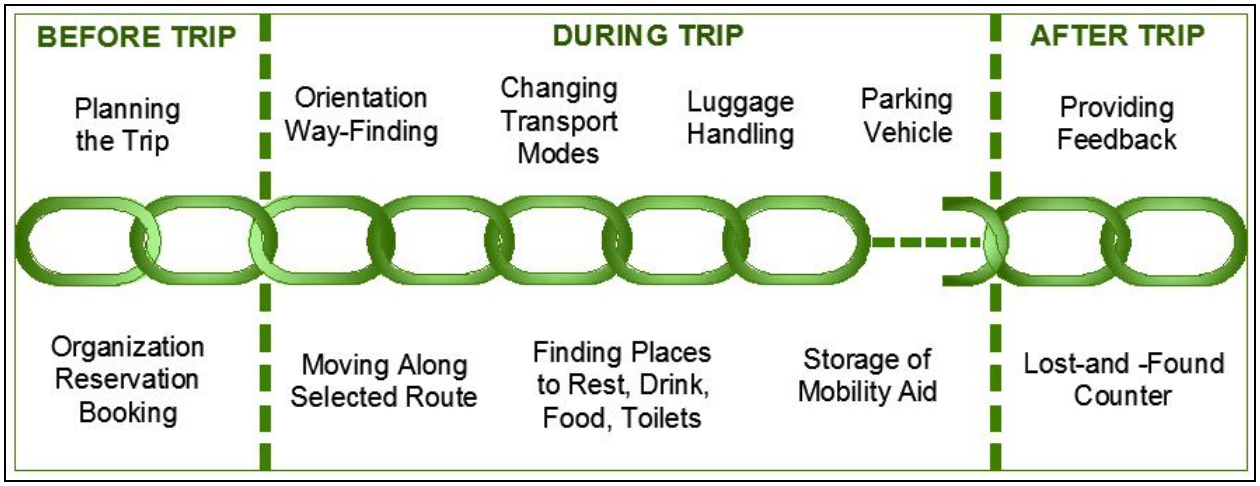


Figure 1.1 Trip chain.
Source: (www.isemoa.eu, 2010)

By improving the accessibility of the entire travel journey, local and regional authorities can enable persons with reduced mobility to adopt a less car-dependent lifestyle and use sustainable modes (walking, cycling, and public transport) instead. Furthermore, local and regional authorities can also achieve fuel and energy savings and promote independent mobility, which will increase the quality of life and the attractiveness of the city or region for inhabitants and visitors.

Universally accessible infrastructure benefits everyone irrespective of age, gender and disability. Thus, improving the accessibility of door-to-door mobility-chains.

1.3 Need for Manual

There is need to fill the knowledge gap on universal access and provide guidance to practitioners, city officials and authorities to plan, design pedestrian environment and sustainable transportation on urban roads and streets. The objectives of this manual are:

- To suggest application of universal access principles and standards to promote walkability, non-motorized vehicle and public transport usage;
- To highlight physical and environmental barriers in the public realm and recommend universal accessibility standards; and
- To highlight benefits of universal accessibility and sustainable transportation, and to promote sensitivity and innovation in design.

By doing so we:

- Ensure safe and independent commute between place of origin and destination, including first and last mile connectivity;
- Provide convenient, quick access and exit and usage of all areas;
- Implement inclusive design and achieve social inclusion; and
- Increase energy-efficiency in transport by improving the trip chain of all citizens (including persons with reduced mobility and persons with disabilities).

Figure 1.2. shows that at some point of the life cycle, trans-generation population will require an inclusive and accessible environment.

Figure 1.2 Life cycle/ trans generation population

Who benefits: Everyone (Photo 1.1 and 1.2), including

- Persons with reduced mobility such as senior citizens; families with young children; unescorted children; persons with temporary ailments, medical conditions and hidden diseases; pregnant women; persons carrying heavy luggage and people with communication problems (including different linguistic and ethnic groups like migrants, tourists etc.). They are commonly referred to as transport disadvantage group.
- Persons with diverse disabilities

Other Advantages

There are a number of social, moral, legal and commercial advantages of improving accessibility on urban roads and streets and public transport infrastructure. These are:

- **Social advantages:** Improves accessibility for pedestrians (including wheelchair users), cyclists/ tri-cyclists, etc. Improved public transport access to daily activities contributes directly to increased quality of life. This promotes independence of persons with reduced mobility and persons with disabilities. It enables everyone to use sustainable transport modes, contribute to reduced pollution and save energy. It ensures that day-to-day services are also accessible for non-motorists.
- **Moral advantages:** Improved service quality (for pedestrians, cyclists, and public transport users) and facilities adapted to everyone's needs makes inclusion happen. Increased independence, better visibility and enhanced opportunities to education, employment, health facilities, recreational and social activities will help mainstream vulnerable groups.
- **Legal advantages:** Incorporation of universal accessibility standards will ensure compliance with various laws and byelaws of the country, which is mandatory.
- **Commercial advantages:** Investing in accessibility is a cost-effective way of contributing to a sustainable economy and tackling the future challenges of demographic, economic and environmental changes. Integrated accessible design exhibits demonstrable cost savings by avoiding the necessity of costly subsequent amendments and reconstructions. Universal accessible environment attracts untapped users resulting in more passenger inflow and more revenue.

Travel for livelihood

Travellers with small children

Woman with reduced mobility

Travel for household work and livelihood purposes

Garbage collection cart users

Family with child in pram

Motorised wheelchair user

Photo 1.1 Persons with disabilities and reduced mobility

Mobility aid users

Person with temporary ailment (fractured leg)

Person with visual impairment

Families with young children

School children

Senior citizen crossing road

Photo 1.2 Diverse Road Users

1.4 Application of the Manual

IRC: 103–2012. Guidelines for Pedestrian Facilities have highlighted design standards for pedestrian facilities and specifically mentions that *"Accessible design is the foundation and primary concern for all pedestrian design, hence all pedestrian facilities need to be planned, designed, operated and maintained so that it is usable by everyone, including those with disabilities or using mobility aids".*

Aspects covered in IRC 103: 2012 Guidelines for Pedestrian Facilities are:

- Inclusive street infrastructure
- Inclusive grade separators
- Continuity and consistency
- Level change
- Maintenance
- Pedestrian crossings
- Pedestrian facilities-parking
- Pedestrian facilities at transit areas
- Bollards
- Lighting
- Ramps/stairs
- Elevators/lifts
- Washrooms/toilets
- School zone improvement

IRC 103:2012 sets the tone for need for universal accessibility. Provision of comprehensive planning and design principles and detailed technical specifications on mindset of “people first” approach including promotion of NMV vehicles over Motorized one linked with gender safety and of otherwise able people should be more detailed. This Manual makes it mandatory for the executing agencies, urban local bodies and concerned stake holders to plan, design, implement and maintain environment and infrastructure. It also provides practical guidance towards evaluating and improving accessibility through a comprehensive approach in all geographical areas of India including hills, plains and deserts. The standards and design guidelines shall be applied with some modifications, if required, in all weather conditions.

1.4.1 Structure

This Manual introduces the concept of accessibility and its importance in the Indian context. It focuses on the evaluation of accessibility in existing street and road infrastructure and the relevant planning and designing principles to improve the same.

The first few chapters introduce concepts of universal accessibility, best practices and highlights the multidisciplinary approach required for Universal Accessibility. The following chapters provide technical design standards of Street and Road Infrastructure, and Access to Public Transportation.

Using data from an extensive literature survey, existing legislation, a study of best practices across the world, focus group discussions with diverse users, advocacy groups, architect, planners and civic agencies, recommendations have been made. Prerequisites have been listed to guide practitioners, policy makers and implementing agencies and stress has been laid on the collaborative approach required to achieve the recommended level of access and each step in this direction.

Each chapter is structured to account for

- Essential Considerations
- The Technical Design Standards
- Construction and Monitoring Process during implementation
- Operations and Maintenance thereafter.

1.5 Laws and Legislations in India and Around the World

The Government of India enacted the **Rights of Persons with Disabilities Act, 2016 a**nd signed and ratified the **UN Convention on the Rights of Persons with Disabilities (CRPD) in 2008**. To realize all the rights under the Rights of Persons with Disabilities Act and the UNCRPD, stakeholders need to understand and implement universal accessibility in its holistic sense.

The Government of India aim to create world-class and smart cities and transport systems in the country cannot be truly realized, unless these are inclusive. This will require many interventions at macro and micro level to address the needs of all users. Therefore, it is essential to understand universal accessibility as "utilization of all the facilities to the fullest by ALL people" i.e. use is more important and not restricted only to reach.

1.5.1 Rights of Persons with Disabilities Act, 2016

The Government of India enacted the Rights of Persons with Disabilities Act, 2016[1].
Responsibility has been cast upon the appropriate governments to take effective measures to ensure that the persons with disabilities enjoy their rights equally with others. Following definitions are laid down in the Act and are relevant for the users of this Manual.

"public building" means a government or private building, used or accessed by the public at large, including a building used for educational or vocational purposes, workplace, commercial activities, public utilities, religious, cultural, leisure or recreational activities, medical or health services, law enforcement agencies, reformatories or judicial, transport terminuses and hubs for example, railway stations or platforms, roadways, bus stands or terminus, airports or waterways;

"transportation systems" includes road transport, rail transport, air transport, water transport, para transit systems for the last mile connectivity, road and street infrastructure, etc.;

"universal design" means the design of products, environments, programs and services to be usable by all people to the greatest extent possible, without the need for adaptation or specialized design and shall apply to assistive devices including advanced technologies for particular group of persons with disabilities.

Chapter VIII, Section 41. (1) clearly mentions "The appropriate Government shall take suitable measures to provide, (c) accessible roads to address mobility necessary for persons with disabilities. Time limit for making existing infrastructure and premises accessible and action for that purpose within a period not exceeding five years from the date of notification of such rules.

1.5.2 UN Convention on Rights of Persons with Disabilities, 2008

Article 9 Accessibility of UNCRPD clearly states:
The countries will eliminate barriers that persons with disabilities face in buildings, the outdoors, transport, information, communication and services, in both cities and the countryside. They will

[1] http://www.disabilityaffairs.gov.in/upload/uploadfiles/files/RPWD%20ACT%202016.pdf

make rules and put them into practice for buildings, roads, transportation, indoor and outdoor objects; information, communications, and other things, for example, electronic services and emergency services.

Hence, the CRPD implementation process in India requires a clear, unequivocal link between universal design and accessibility in the built environment, in information and communication, and for transportation standards.

1.5.3 Sustainable Development Goals

Target 11.2 under Sustainable Development Goals (SDG): mandates to provide access, by 2030, to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport with special attention to the needs of those in vulnerable situations such as women, children, persons with disabilities and older persons.

1.5.4 Motor Vehicle (Amendment) Bill, 2017

Government policy aimed at promoting universal accessibility and sustainable urban roads and streets for all in India.

1.6 Best Practices

Various cities around the world have planned and designed their pedestrian environment, vehicles and public transit systems to ensure inclusive designs and barrier free elements. These planning and design principles have been adapted differently.

Although some European cities have exemplary accessibility networks, it is important to emphasize that these may be adapted for the Indian context, but they cannot be replicated as it is. For example, European cities like Amsterdam and Rotterdam have provided very good cycling and pedestrian connectivity and integration to its public transport systems, yet these cities do not have to deal with intermediate public transport like cycle rickshaws, auto- rickshaws, etc. (TRIPP for IUT & MoUD, 2013).

In Japan, the pedestrian and transport infrastructure is designed with universal accessibility principles (Photo 1.3). Accessible street design features from Colombo, Sri Lanka, Geneva, London and Canada are also highlighted in this section. Also, illustrated are Mass Rapid Transit Systems from some Indian cities, which include universal design features, connected pedestrian pathways and provisions of NMV lanes (Photo 1.4).

Photo 1.3 Accessible street design features, Hong Kong

Photo 1.4 Accessible street design features, BRT Delhi

Projected Benefits

1: Physical Connectivity

Visual and physical continuity of footpaths makes navigation and orientation easier and saves time and energy. Choices in the accessible environment with coherent, direct, safe, and comfortable features attract pedestrians, cyclists and tri-cycle users. By providing a safe walking environment, the footpath will also provide opportunities for a healthy environment. Public transport within reach, integration with other modes and availability of accessible feeder modes too, is an important link in the travel journey/trip chain.

2: Social Inclusion

A safe walking environment particularly for women, children and persons with disabilities promotes social interaction in different public spaces that the walkways connect . Well designed and maintained pedestrian infrastructure benefit persons with diverse disabilities, including users of wheelchairs and tricycles, elderly, temporary ailments, carrying packages/luggage, hawkers etc. by providing a safe alternative to sharing the roadway with fast-moving traffic. Access and use of public transport allows all commuters the opportunity to explore more and experience better, the environment that surrounds them. It promotes enhanced opportunities to livelihood and employment, access to health, education and leisure for all.

The pictographic illustrations on best practices are given in Sections 1.6.1, 1.6.2 and 1.6.3 on walkability, Non-Motorized Vehicles (NMV) and access to public transport system.

1.6.1 Best Practices- Walkability

Comprehensive Footpath Design

1. Continuity of footpath
2. Tactile paving on footpath for persons with visual impairments.
3. Table top for safe and comfortable pedestrian crossing.
4. Coloured (yellow color) guard rails to warn persons with visual impairments.

New Delhi, India

Comprehensive Footpath Design

1. Alignment of street furniture in multi-utility zone and exclusive pedestrian and NMV lane.
2. Shaded trees to safeguard against adverse weather.
3. Way finding and guide maps for visitors and tourists.

Bhubaneshwar, India

Comprehensive Footpath Design

1. Kerb ramp for footpath.
2. Anti-skid flooring for ease of movement.

New Delhi, India

Comprehensive Footpath Design

1. Alignment of street furniture and right of way for pedestrians.
2. Shade trees providing comfortable environment for pedestrians.

Geneva, Switzerland

Pedestrian Kerb and Crossing

1. Bollard spacing is more than 1m to allow wheelchairs, tri-cycles and prams to cross.
2. Tactile paving on footpath for persons with visual impairments.
3. Anti-skid flooring texture demarcated with visual contrasts.
4. Audio traffic signals to help persons with visual impairments to cross independently.

Tokyo, Japan

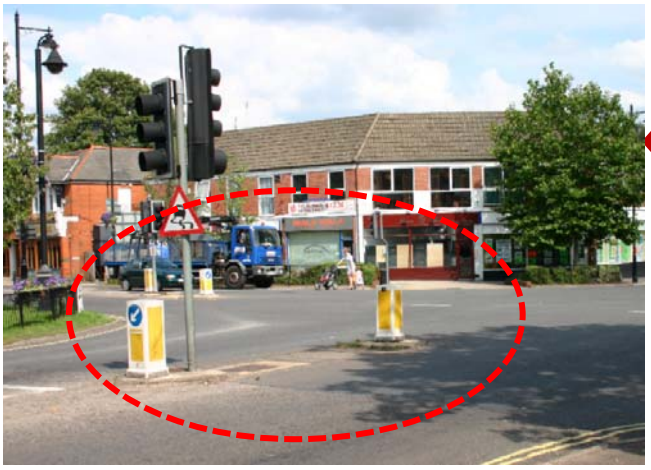
Pedestrian Crossing with illumination

1. Well illuminated pedestrian crossing with white bollard spacing and signage at two levels.

Geneva, Switzerland

Pedestrian Pelican Signals for light-controlled crossing and tactile paving

Extensive bollards for uninterrupted mobility from encroachment of vehicles etc.



Light-controlled crossroads with central pedestrian refuges on each arm (Cost Effective)

Crossings should be safe, barrier free and continuous for completion of pedestrian trip chains.

Photo 1.5 Pedestrian trip chain with safe crossing

1.6.2 Best Practices- Non-Motorized Vehicles (NMV)

1. NMV lanes connectivity for cyclists, tri-cycle users, etc.
2. Table top (raised footpath) to maintain continuity.
3. Cobble stones on slopes for reducing speed of motorized vehicles.

Delhi, India

1. Designated NMV lane with concrete floor and broom finish (friendly for non-motorized vehicle users).

Ahmedabad, India

1. Demarcated cycle lane in color contrast benefits persons with low vision and old people.
2. Color contrast also helps motorized vehicle drivers to easily distinguish lanes.

Aldgate Station Area, London

1. Eyes on the street, friendly design for women, elderly and children.
2. Segregated NMV lanes, which increases safe and comfortable mobility.
3. Cycle stands given close to habitat and integrated with public transport stop.

Amsterdam, Holland

1. Cycle lane with road markings in good color contrast.

Amsterdam, Holland

1. Cycle lanes are used by many wheelchairs users who have battery operated wheelchairs and tri-cycles.
2. Road marking with cycle symbol are easy to identify by all non-motorized vehicle drivers, cyclists and persons with cognitive and intellectual disabilities using mobility aids.

Vienna, Austria

1. Cycle stands provided in parking areas, markets, transport terminals and shopping centres to promote extensive use of cycles.
2. Availability of parking stands, cycles on rent/hire and locking mechanisms for cycles.

Geneva, Switzerland

1. Integration of NMV with public transportation.
2. Promoting use of NMVs for trip chain connectivity.

Montreux, Switzerland

1. Tri-cycles are used as mobile telephone kiosks/ eateries and serve as good livelihood options for persons with loco-motor impairments. *(Source: ALIMCO-adaptation in standard tri-cycle)*

Pune, India

1.6.3 Best Practices- Access to Public Transport

1. Clearly marked bus stops, low kerb height and weather-proof design of bus shelter.

Laussane, Switzerland

1. Cost effective universally accessible Bus-Q-Shelter, a solution for smaller cities where there are no shelters or those which are being renovated.

New Delhi, India

1. Precision docking of the buses helps everyone to board/ alight with safety, independence and dignity.
2. Vertical and horizontal gap is minimized.

New Delhi, India

1. Modified bus stops, precision docking and drivers training helps in reduced efforts in boarding and alighting in high steps buses.

Raipur, India

1. Route map display in the buses with audio announcement system.

Geneva, Switzerland

1. Waiting areas/ resting benches in transit terminals benefit everyone.
2. Easy identification of waiting areas by persons with visual impairments by the use of tactile pavers.

Osaka, Japan

Unisex multi-use accessible toilets near transit terminals and cycle lanes.

Geneva, Switzerland

Chapter 2. Multidisciplinary Process

An inclusive transport framework should have the following goals:

- Enhance safety for pedestrians and users of all modes of transport.
- Create a meaningful network of non-motorized vehicles (NMV) lanes and NMV priority streets to provide connectivity within and across neighborhoods in the city.
- Increase public transport and NMV usage through the provision of dedicated right-of-way (ROW).
- Improve network of public transport in the city such that it is accessible within a 5-minute walking distance.
- Ensure that the entire street network is universally accessible.

2.1 Challenges Related to Implementation

Knowledge gap: Professionals, practitioners and other people such as draftsmen, contractors and masons do not have first-hand information on universal accessibility elements. This can result in faulty designs and/or expensive retrofitting and creation of unsafe and inaccessible environment.

Lack of awareness: At present, the civic agencies, road owning agencies and public transport providers including private contractors lack understanding and technical knowhow of inclusive design. The fundamentals and basic principles are often overlooked or incorporated in a piecemeal manner resulting in creation of islands of accessibility.

Enforcement: DPRs and contract documents must include specific provisions to ensure that universal accessibility is integrated into the road project.

2.2 Recommended Approach

2.2.1 Stakeholder Consultation

There needs to be a strong emphasis on the continuous involvement of all relevant stakeholder-groups (all persons including those with reduced mobility and disabilities, city-consultants, local/ regional authorities, etc.) from the very start of the project. Towards this goal, a two-pronged approach is proposed.

***(a) Establish a system of effective stakeholder involvement and awareness raising*:** Create platforms for educating, sharing ideas and information and learning from each-other's experiences with the stakeholders, in all the phases of creating and maintaining inclusive transport systems. The stakeholders will include users, planners, architects, engineers, contractors, civic agencies, and government departments that construct and maintain public facilities and outdoor environment. Raise awareness among the local and regional decision-makers of the link between accessibility and energy-efficiency in transport, by initiating communication among all relevant local and regional stakeholders to improve accessibility.

(b) Establish a structure of systematic and effective approach for comprehensive design including universal accessibility in planning, implementation, and evaluation: Piecemeal implementation will not be effective until the intermediate links are

established. For example, the efficacy of an accessible BRT or Metro system will be incomplete, if people cannot access the footpaths, roads and intermediate pedestrian infrastructure to reach these facilities. A seamless trip chain is necessary to close the loop.

(c) Capacity Building and Trainings: Transport networks keep changing and evolving based on user requirements, climatic conditions and infrastructure depreciation in real time. Regular monitoring of all systems and services within this framework is imperative to maximize its efficacy. Any shortfall in implementation and maintenance and/or lack of understanding on the part of implementing agencies, civic bodies, user groups and other service providers will compromise the accessibility of this network. It is heartening that there is now enhanced commitment to invest time, funds and technology in capacity building, maintenance, monitoring and operational activities.

A strategic planning effort involving all relevant stakeholders (persons with reduced mobility, persons with disabilities, government departments, consultants including planners, architects, engineers, implementing and maintaining agencies including contractors and vendors) is needed. It provides local stakeholders with the understanding of the attitudinal, social and physical challenges that confront persons with disabilities of different ages and gender, and, need for creating seamless travel chains. Conducted by a team of qualified access auditors, design professionals (architect, transport planner and urban planner), persons with diverse disabilities and senior citizens, it provides information for effective implementation of the audit recommendations. Capacity Building and training of professionals and practitioners would help ensure implementation of universal accessibility standards. This will result in:

- Improving credibility, efficiency, and effectiveness of the work;
- Fulfilling the needs of ageing society;
- Facilitating the integration of immigrants by improving accessibility and
- Avoiding costly corrections by taking into account the accessibility requirements right from the start (Photo 2.1).

A dedicated training module and training material can be easily prepared based on this Manual and arrangements made to expose all concerned to the requirements of universal accessibility for urban roads and streets.

Photo 2.1 Planning and implementation of access features with users perspective

2.2.3 Design and Planning

Design Review

Prior to implementation, design review may be undertaken to verify the viability of accessible elements/ routes proposed, to minimize any potential hazards or constraints in the trip chain.

To achieve the consistency of accessibility along the trip chain, it is therefore important to identify contextual barriers, alternate routes for pedestrian and NMVs that may be different from vehicular road network, particularly for arterial roads, and design to existing conditions.

As per the findings of the Walkability survey conducted by CAI Asia in six Indian cities, consistent low ratings were observed for the parameters- amenities and 'disability infrastructure'. The surveys highlight only one element of accessibility i.e. need for kerb ramp for footpaths, and does not cover other essential elements such as height and width of footpath, unobstructed walking zone, surface, continuity of tactile pavers and color/visual contrast. Absence of a kerb ramp does not only hamper mobility of those using mobility aids like wheelchairs and walkers, but also deters other pedestrians such as baby pram users, families with young children, persons carrying heavy luggage and persons with reduced mobility. Some of the essential elements are:

- Pre-journey planning information including signage/ maps/ accessible route information;
- Adequate space requirements including clearances, widths, heights, rest spaces;
- Level differences – steps, ramps, kerbs, elevators;
- Clarity of route- wayfinding tools including tactile pavers (Photo 2.2)., color contrast, materials and adequate illumination
- Road crossings, traffic signaling, safety features; and
- Equitable access to transit terminus, toilets, information kiosks and other facilities.

Photo 2.2 Incorrect tactile pavers layout on footpaths.

2.2.4 Construction and Monitoring Process

Designing and planning of inclusive road and street framework is insufficient, without stringent implementation and monitoring. Regular monitoring of all systems and services within this framework is imperative to maximize its efficacy. Any shortfall in implementation and maintenance on the part of implementing agencies, civic bodies, user groups and other service providers will compromise the accessibility of this network.

2.2.5 Accessibility Audits

Access Audits are an important means of ensuring universal accessibility and must cover all stage of the process of planning, design, construction, maintenance, monitoring and evaluation. Audits identify deficiencies in road/street infrastructure and developing strategies to overcome them in the most effective, practical and aesthetic way at an early stage. Audits are valuable from the perspective of identifying deficiencies in road/street infrastructure and developing strategies to overcome them in the most effective, practical and aesthetic way. As a result of audits, physical and informational barriers are identified, removed and implementation is possible (Photo 2.3).

Photo 2.3 Access audit implementaion, Mumbai

2.2.6 Walkability Audit

It is a strategic planning effort that involves all relevant stakeholders (persons with reduced mobility, persons with disabilities, government agencies, consultants including planners, architects, engineers, implementing and maintaining agencies including contractors and vendors). It provides local stakeholders with the understanding of the attitudinal, social and physical challenges that confront persons with disabilities of different ages and gender, and, need for creating seamless travel chains. Conducted by a team of qualified access auditors, design professionals (architect, transport planner and urban planner), persons with diverse disabilities and senior citizens, it provides information for effective implementation of the audit recommendations. An audit checklist is provided in the Appendix 1.

2.2.7 Operations and Maintenance

Further, post- implementation, continued maintenance is vital to maximize the benefit of the access measures taken. The absence of clear, unobstructed paths, temporary barriers or utilities added later on, can easily compromise the entirety of accessible trip chain. Therefore, it is important that all agencies involved remain alert to changes, modifications required and the access required prior to any intervention. Access audits on a periodic basis would be of help as post occupancy surveys or access audits also provide further insights into site specific concerns or usability that were unforeseen. Regular oversight will avoid exacerbating these issues and resolve them in a timely way.

Regular maintenance of the infrastructure is essential for safety, accessibility and reliability. Infrastructure once in place and not maintained (Photo 2.4) will have both health and cost implications. Funding for maintenance should be incorporated from the start and the timeline for refurbishment should be clearly defined.

Photo 2.4 -Incomplete tactile path and un-maintained footpaths.

Chapter 3. Street and Road Elements

3.1 Essential Design Considerations

The road infrastructure should provide safe and secure, convenient, and fast connectivity for NMV users. The essential principles are as follows:

- Provision of segregated track or path for most part of the journey.
- Speed reduction by design on roads where NMVs mix with motorized vehicles.
- Reduction of speeds of motorized vehicles at pedestrian crossings and intersections.
- Combining shortest and safest routes.
- Improve visibility for both NMV and motorized modes, especially at intersections.

3.2 Technical Design Standards

3.2.1 Footpath

Footpath should be regarded as part of road infrastructure. It should be connected and continuous. Footpaths should be provided consistently between all major origin/destinations, trip generator activities, and other locations where people walk.

A footpath should:

- Have height of a standard public step riser i.e. 150 mm maximum;
- Be at least 2m wide, where there are trees on the footpath spacing of 1m should be maintained (Figure 3.1);
- Have non-slip/ anti-skid surface;
- Preferably have well defined edges of paths and routes by use of different colors and textures;
- Gratings gaps should be less than 10mm wide, oriented at right angles to the path centerline;
- Have no obstacles or projections along the pathway. If this is unavoidable, there should be clear headroom of at least 2200 mm from the floor level;
- Have kerb ramps, wherever a person is expected to walk into or off the pathway; and
- Have tactile warning pavers for persons with visual impairments installed next to all entry and exit points from the footpath.

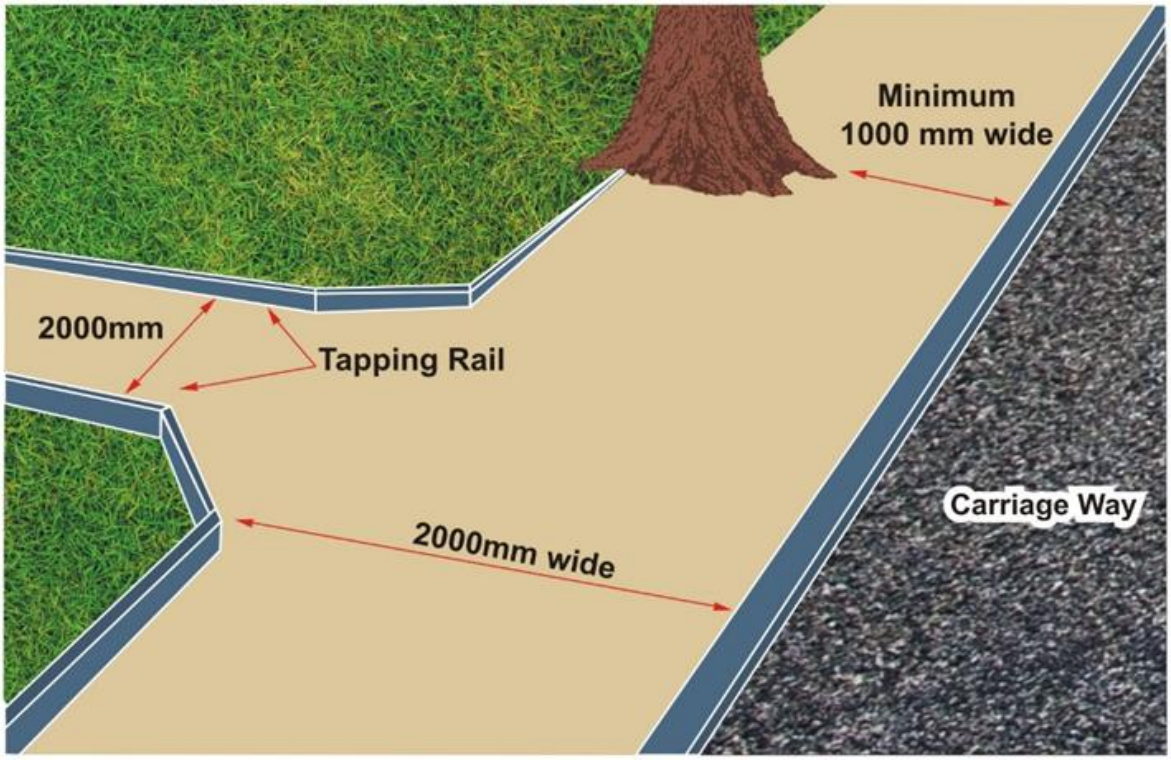


Figure 3.1 Spacing for walking with tree on footpaths

Design standards for footpath are given (Indian Roads Congress, 2012) with footpath widths along different land-use areas and hierarchy of roads. Footpath width along residential areas and arterial roads should be of minimum 1.8m, whereas for commercial areas along arterial roads it should be of minimum 2.5m (Table 3.1). It also highlights the surfaces and lighting levels required (Table 3.2).

Table 3.1 -Walking conditions shows footpath widths required for people to cross comfortably and/or using mobility devices.

Walking Conditions	Footpath width
Minimum width for two people to cross each other comfortably	1.8m (min.)
Minimum width for maneuvering wheelchair	900 mm
Minimum width required for a wheelchair and a person to cross each other comfortably	1200 mm
Minimum width required for two wheelchairs to cross each other comfortably	1800 mm

The length, width and visual height of people using assistive devices/equipment are given in Table 3.2. and Figure 3.2.

Table 3.2-Clear passage widths needed by people with/without equipment.

Minimum passage width – stick/walker user	750mm
Minimum passage width - double crutch user	920mm
Minimum passage width - adult and child	1100mm
Minimum passage width - adult plus helper	1200mm
Minimum passage width - adult plus guide dog	1100mm

Minimum passage width – wheelchair user plus ambulant person	1500mm
Minimum passage width – single stroller	610mm
Minimum passage width – person using white cane (visual impairment)	1500mm
Length of pram plus pusher	900mm
Length of 95th percentile wheelchair	1250mm
Length of wheelchair plus pusher	1750mm
Length of adult plus guide dog	1500mm
Length of powered scooter	1270mm
Length of electric footpath vehicle (average)	1400mm
Eye level of wheelchair user	1265mm
Seated height of wheelchair user	1300-1400mm
Turning circle - manual wheelchair (also small electric)	1575mm
Turning circle - outdoor electric wheelchair	2420mm
Turning circle - electric footpath vehicle	4350mm

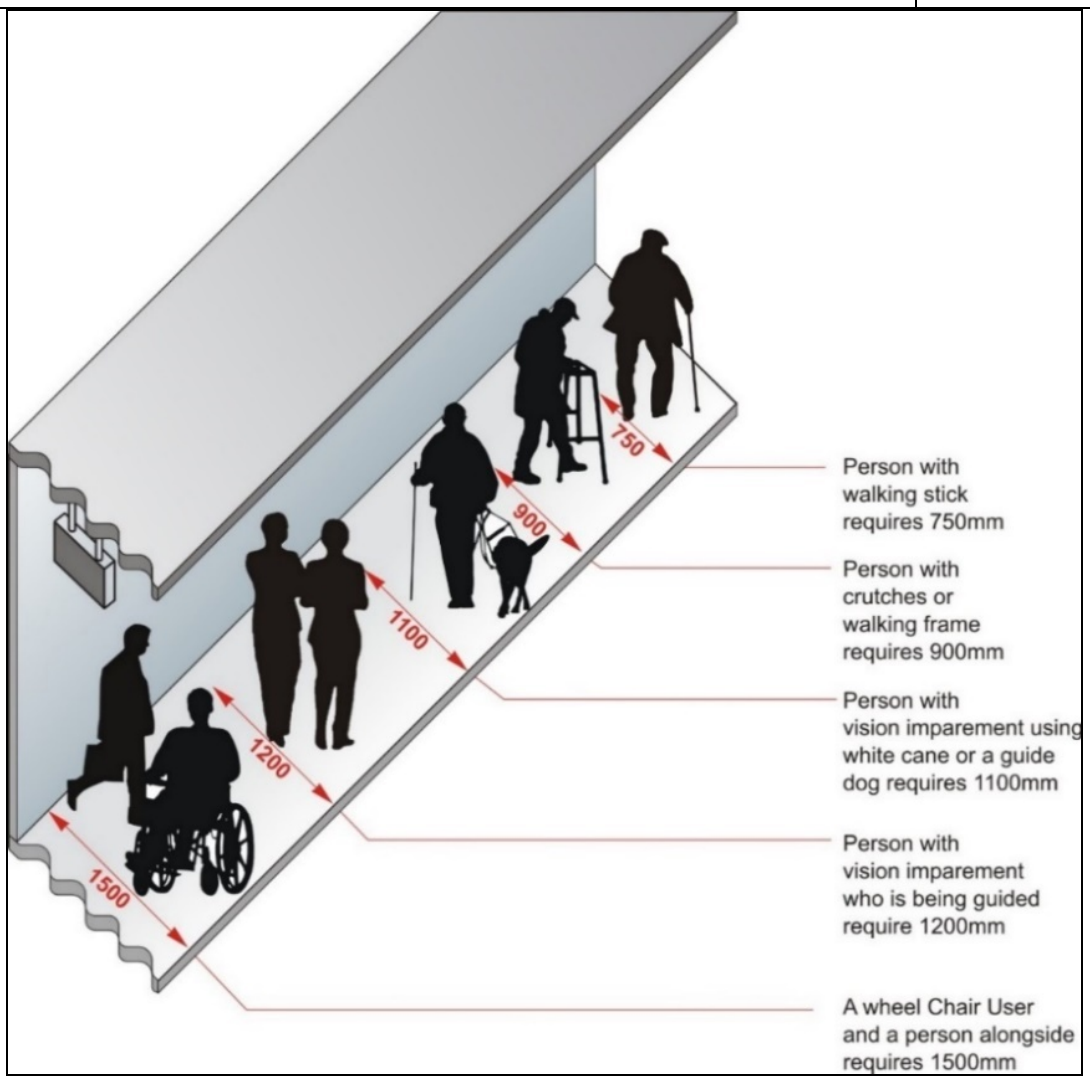


Figure 3.2 -Clear passage widths needed by people and equipment.
Source: Samarthyam

Pedestrian Traffic

Pedestrian width are shown in cross sections (Figure 3.3 to 3.6) are the minimum specified; width should be increased as per needs of pedestrian traffic.

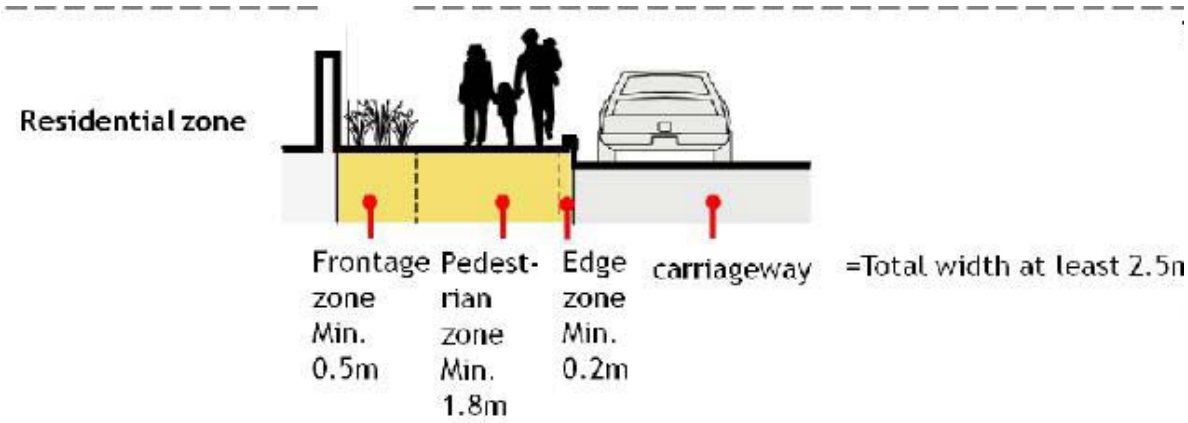


Figure 3.3 Residential Zone.

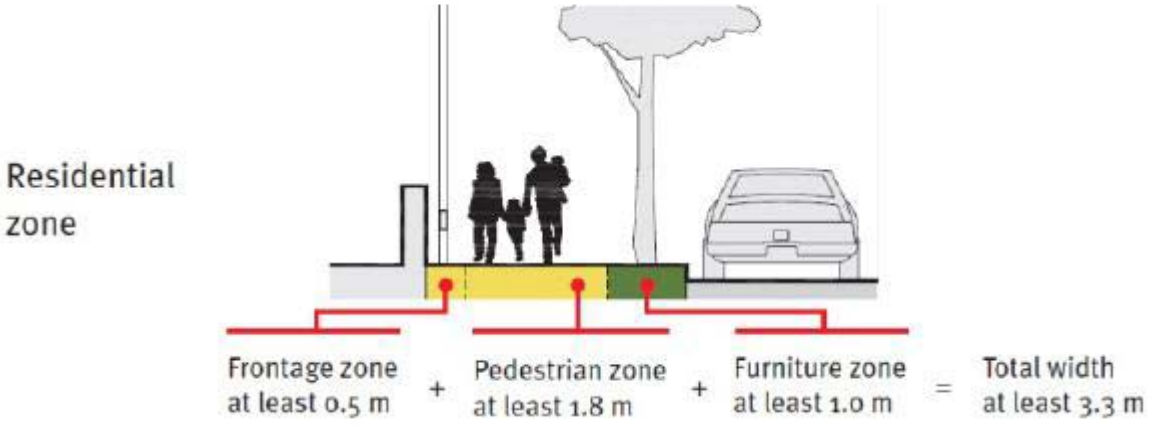


Figure 3.4- Residential Zone.

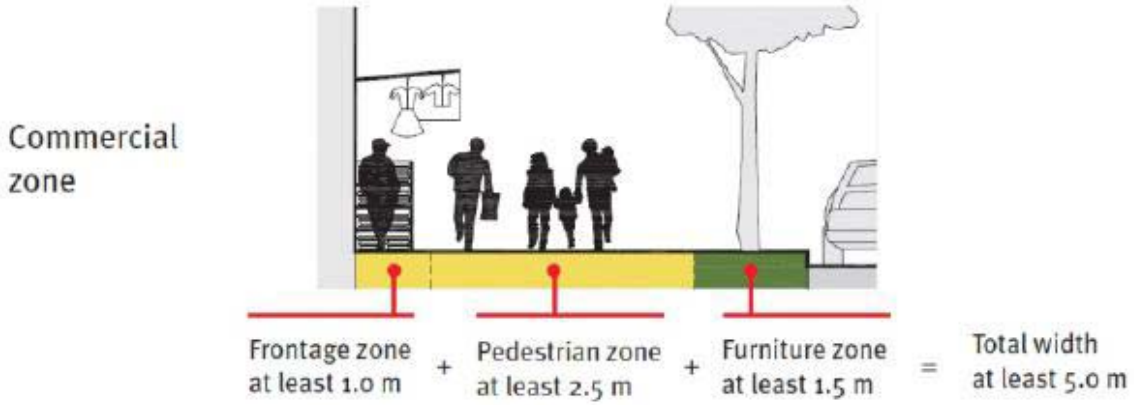


Figure 3.5- Commercial Zone.

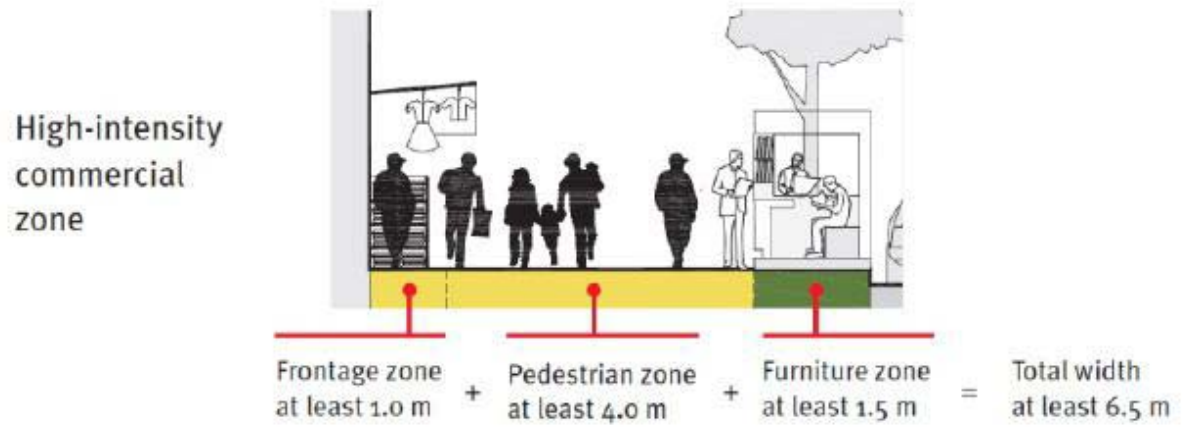


Figure 3.6- High-intensity Commercial Zone.

3.2.2 Kerb Ramps

Kerb ramps are a mandatory design element to access footpaths. Absence of kerb ramp prevents wheelchair users, pram users and users of other assistive devices to utilize footpaths. When designing kerb ramps, it is important to ensure that:

- Kerb should be dropped, to be flush with walk way, at a gradient no greater than 1:10 on both sides of necessary and convenient crossing points (Figure 3.7).
- Floor tactile paving- Guiding & Warning paver shall be provided to guide persons with visual impairment so that a person with visual impairment does not accidentally walk onto the road (Figure 3.8 and Photo 3.1);
- Finishes shall have non-slip surface with a texture traversable by a wheel chair;
- If there is a kerb ramp on one side of the roadway, there is also one on the other to prevent pedestrians being 'stranded' on the roadway itself;
- There are no low points in the gutter where water can collect; and
- If installed at a pedestrian crossing point, the whole kerb ramp is contained within the crossing markings.

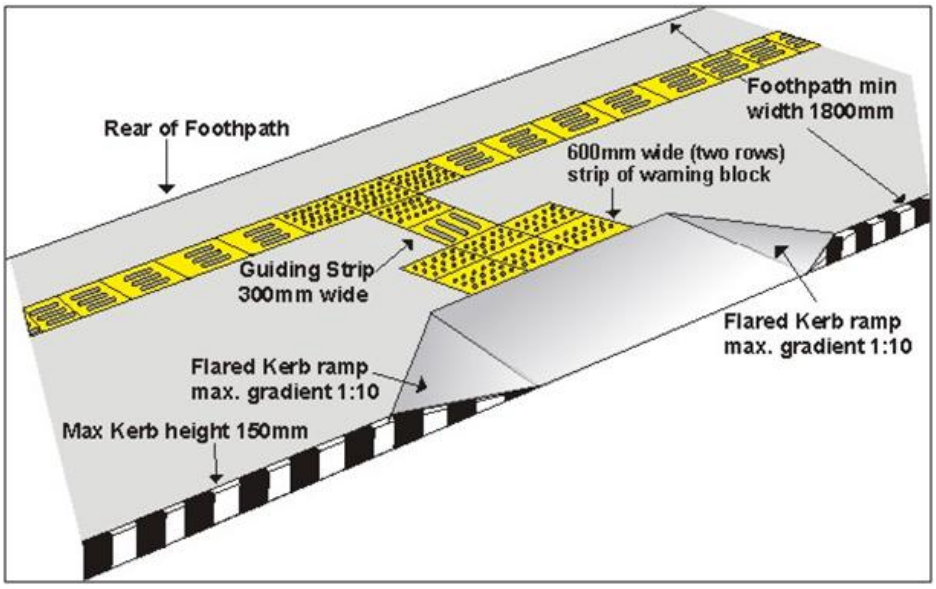


Figure 3.7 Kerb ramp

Photo 3.1 -Kerb ramps with tactile warning pavers at transition points

Cross falls

Cross falls should only be provided where absolutely necessary for drainage purposes and can range from 1:50 to 1:100. If the change in cross fall is so severe that one wheel of a wheelchair or one foot of a walker leaves the ground, it may cause the user of the wheelchair or walker to fall. Steeper gradients tend to misdirect buggies and wheelchairs. Where falls are not adequate, silt will accumulate after rain and cause the surface to become slippery. Puddles also cause the footpath to become slippery, lead to glare in bright sunshine after other parts of the footpath have become dry and become a hazard in frosty weather. Any break in the surface, e.g. drainage channels/ gratings or the gaps between boards on a walkway, should not be more than 12mm and should cross perpendicular to the direction of movement (Refer Section 3.2.13). This will prevent walking sticks and wheels getting caught in the gaps.

3.2.3 Ramps (Slope Ramps)

- Ramps gradient should ideally be 1 in 15 and no greater than 1 in 12;
- Width of the ramp should not be less than 1200mm and preferred width is 1800mm min.;
- Surface materials should be slip-resistant, non-reflective, firmly-fixed and easily maintained;
- The edge of the ramp should have an edge protection with a minimum height of 100mm;
- Landings every 750mm of vertical rise and should be provided at regular intervals as indicated in Table 3.3.
- On long ramps, a horizontal resting space should be provided every 9 meters;
- A tapping or lower rail should be positioned so that its bottom edge is no higher than 200 mm above ground level;
- Handrails on the ramps should be on both sides at two levels: upper at 900mm and lower at 760mm; both end to be rounded and grouted; extend 300 mm beyond top and bottom of ramp (Figure 3.8); and
- A row of tactile warning paver should be placed 300mm beginning and end of each run,

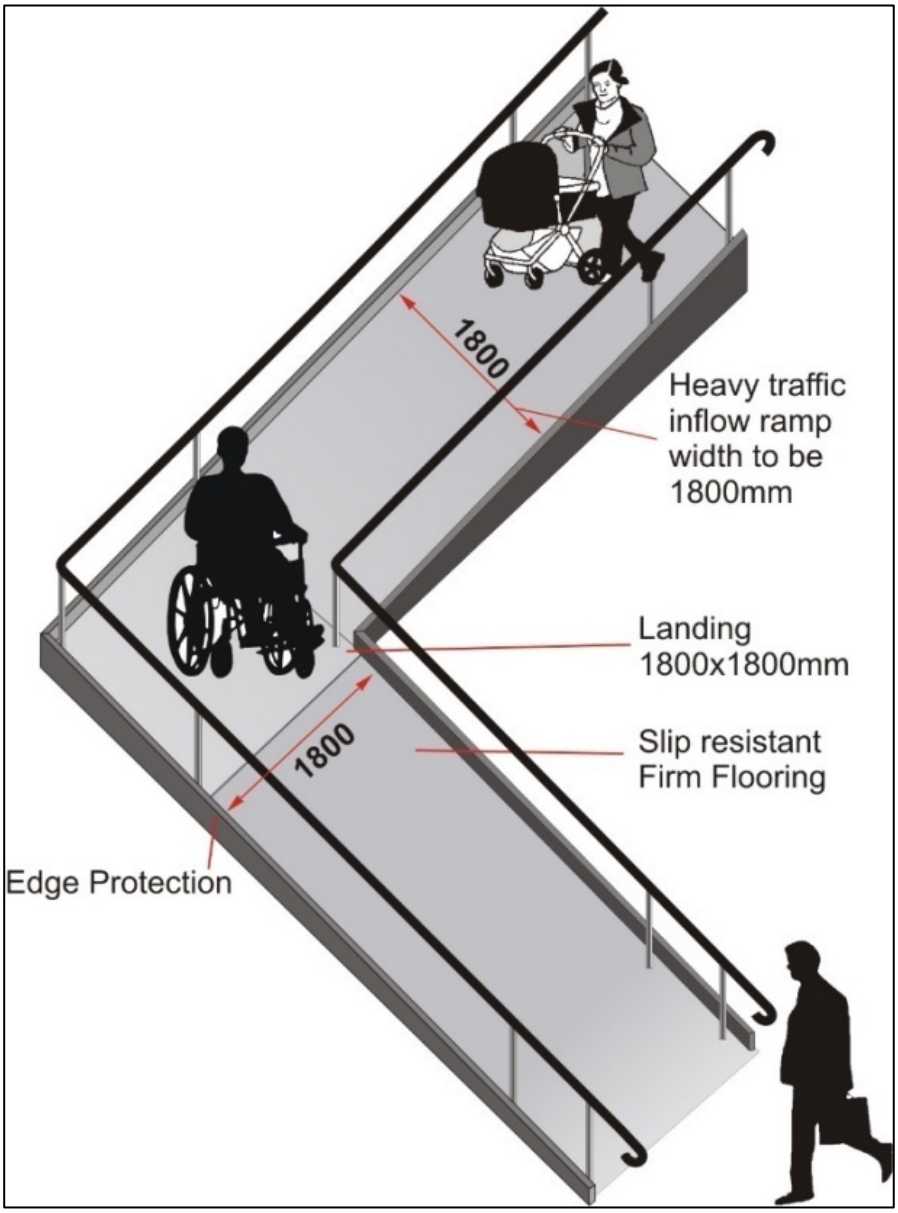


Figure 3.8 Ramp with handrails with rounded edges

Table 3.3- Specification for ramps.

Level difference	Max. gradient of Ramp	Ramp Width	Handrail on both sides	Comments
≥ 150 mm ≤ 300 mm	1:12	1200 mm	√	
≥ 300 mm≤ 750 mm	1:15	1500 mm	√	Landings every 5 m of ramp run.
≥ 750 mm≤ 3000mm	1:15	1800 mm	√	Landings every 9 m of ramp run.
≥ 3000 mm	1:20	1800mm	√	Landings every 9 m of ramp run.

Source: NBC, 2016

3.2.4 Elevators/Lifts

In grade separators such as foot over bridges, elevated stations, etc.,l ifts should be provided.

- Lift locations should be clearly signposted from the main pedestrian route and recognizable through design and location;
- The colour and tone of the lift doors should contrast with the surrounding wall finish to assist in their location (Figure 3.9). Lift doors with metallic finishes such as steel grey and silver should be avoided as they are difficult to identify by persons with low vision;
- The lift lobby shall be of an inside measurement of 1800mm X 2000mm or more. A clear landing area in front of the lift doors of minimum dimensions 1500mm x 1500mm should be provided (Figure 3.10);
- Changes in floor finish must be flushed. There should be no level difference between lift door and the floor surface at each level; the gap if unavoidable should not be more than 10 mm; and
- The floor level/location should be indicated on the wall adjacent to or just above the call buttons, and opposite the lift doors where possible.

Figure 3.9 Contrast colour signage with Braille

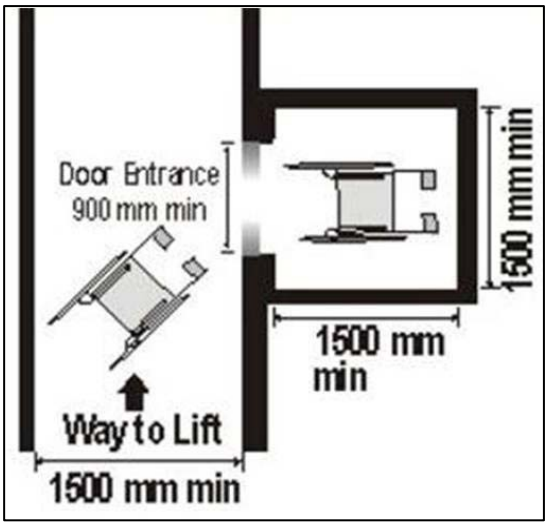


Figure 3.10 Lift lobby turning radius for wheelchair

Lift Dimensions

- Provisions of at least one lift shall be made for people using wheelchairs with the following car dimensions (minimum):
  - Clear internal depth &width -1500 mm x 1500 mm minimum
  - Where ever possible 13 passengers lift to be provided, which allows easy maneuverability of wheelchair user
  - Entrance clear door width - 900 mm minimum

Lift Controls

- The lift call button should be wall-mounted adjacent to the lift and should contrast with wall finish, either by using a contrasting panel, or a contrasting border around the button panel;
- The call buttons should be located within the range 800-1000mm above floor finish;
- The control buttons should contrast with their surroundings and illuminate when pressed and should incorporate highly visible tactile embossed (NOT engraved) characters and in Braille;
- Time of closing of an automatic door should be more than 5 seconds and there should be a provision of censor enabled closing; and
- In larger lifts, controls should be positioned on both side walls, at least 400mm from front wall and between 800-1000mm above floor level (Figure 3.11).

Lift Car Design

- A mirror (750 mm above floor level) on the rear wall can be useful to persons using wheelchairs and other mobility aids should they need to reverse safely out of the lift car or view the floor numbers;
- Internal lighting should provide a level of illumination of minimum 100 lux (approximately 50-75 lux at floor level), uniformly distributed, avoiding the use of spotlights or down lighters; and
- A grab bar should be provided along both sides and the back wall, 900mm above floor level. It should be of tubular or oval cross section, in order to be easily gripped and capable of providing support. Grab bar should be positioned so that there is a clear space behind the handrail to allow it to be grasped i.e. knuckle space should be 50mm.

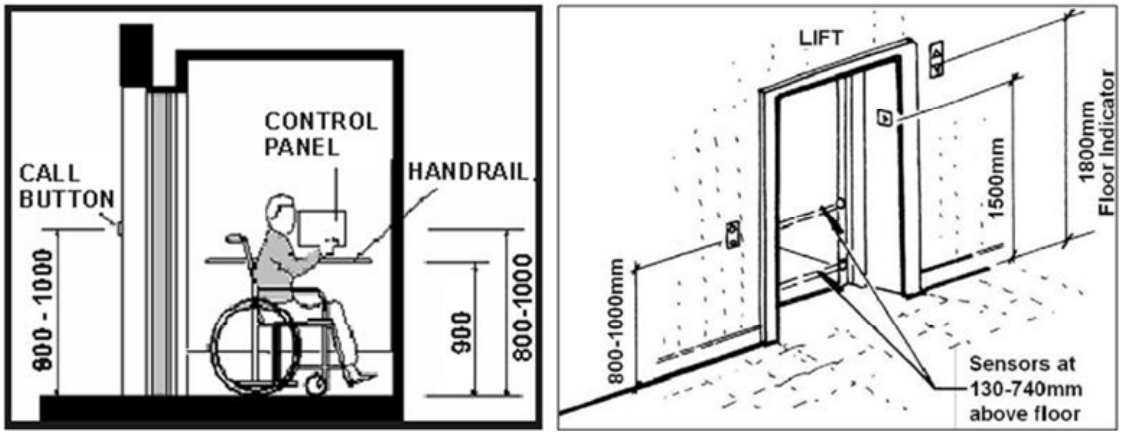


Figure 3.11 Lift call button and control panels heights

Information Systems

- Lifts should have both visual and audible floor level indicators;
- Audible systems are also usually capable of incorporating additional messages, such as door closing, or, in the case of an emergency, reassurance (with manual over-ride allowing communication with lift occupants);
- Announcement system should be of 50 decibels; and
- The display could be digital or segmented LED, or an appropriate alternative. A yellow or light green on black display is preferred to a red on black display, as it is easier to read.

3.2.5 Platform/Stair Lift

In grade separators such as foot over bridges, elevated stations, etc., where there is no space to provide access by a ramp and to accommodate a regular elevator; platform or stair lift can be provided. This is feasible only where the payload and the travel distance is not too much.

- No lift well/ shaft required, available with both manual and mechanical system (Photo 3.2).
- Size 900mm x 1200mm minimum; and
- Provision of handrails, edge protection and emergency stop buttons makes it a safe and comfortable option.

Photo 3.2 Hydraulic stair lift

3.2.6 Steps & Stairs

- Steps should be uniform-tread not less than 300 mm and the risers 150 mm minimum;
- The risers should not be open;
- The steps should have an unobstructed width of 1200mm minimum (preferred 2000 mm);
- All steps should be fitted with a permanent colour and tone contrasting at the step edge, extending the full width of the step, reaching a minimum depth of 50 mm on both tread and riser (Figure 3.12 and Photo 3.3);
- Have continuous handrails on both sides including the wall (if any) at two levels complying with Section 3.2.7;
- Tactile warning pavers to be placed 300mm at the beginning and at the end of all stairs (preferred two rows of warning pavers);
- Nosing to be avoided;
- The staircase should be adequately and uniformly illuminated during day and night (when in use). The level of illumination should preferably fall between 100-150 lux;

- The rise of a flight between landings must be no more than 1200mm;
- There should be no more than 12 risers in one flight run;
- The stair covering and nosing should be slip-resistant, non-reflective, firmly-fixed and easy to maintain; and
- Soffit (underside /open area under the stairs) of the stairs should be enclosed or protected.

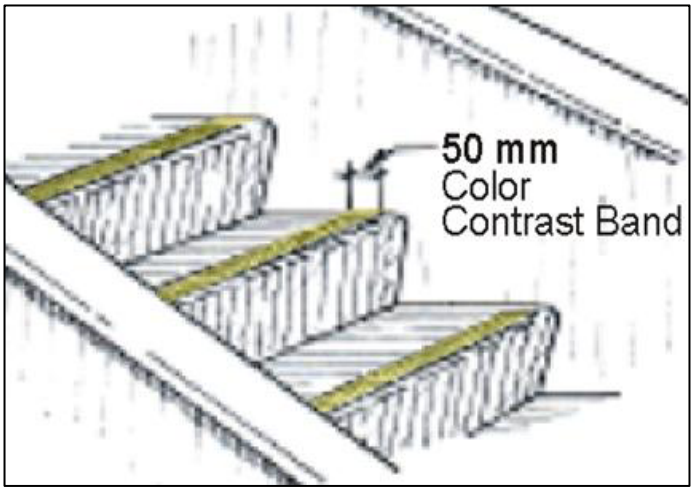


Figure 3.12 Contrast colour band on step edges

Photo 3.3 Step edges highlighted for persons with low vision

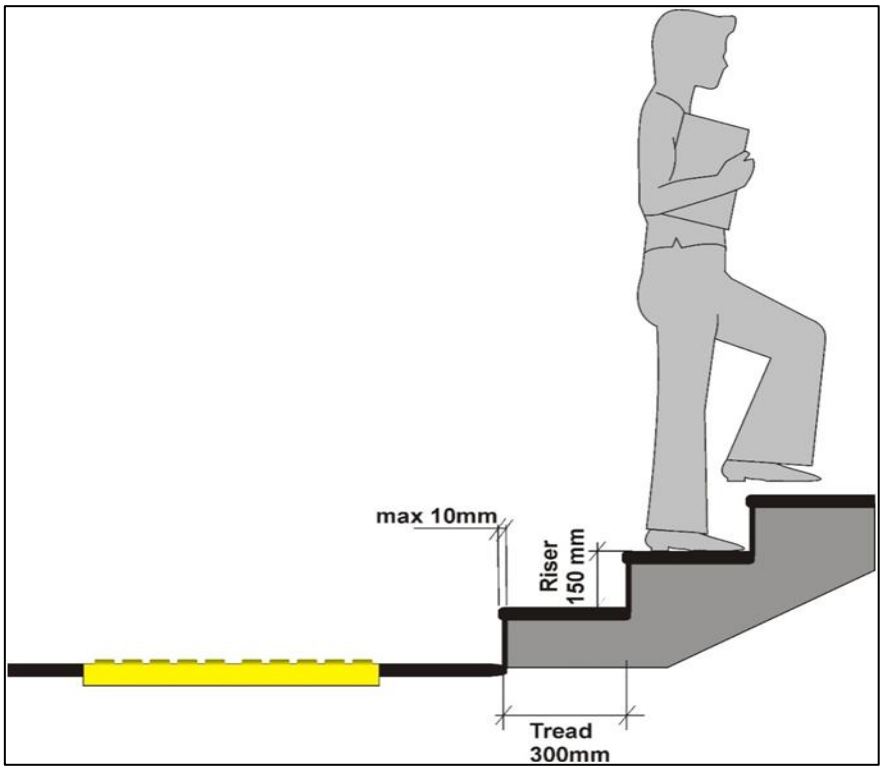


Figure 3.13 Placement of tactile pavers before the steps

3.2.7 Handrails

- Handrails should be circular in section with a diameter of 38-45 mm and formed from materials, which provide good grip such as timber, nylon or powder coating, or matt finish metal finishes;
- The handrail should contrast in colour (preferably yellow/orange) with surrounding surfaces (Photo 3.6);
- These should be at least 50mm clear of the surface to which they are attached and should be supported on brackets, which do not obstruct continuous hand contact with the handrail (Figure 3.14);
- The handrail should be positioned at two levels- 760mm and 900mm above the pitch-line of a flight of stairs (Figure 3.15); and
- Handrail at foot of the flight of stairs should extend 300mm beyond the stairs in the line of travel and returning to the wall or floor or rounded off, with a positive end that does not project into the route of travel. Rounded handrails ends reduce risk of catching clothes or injury from the exposed handrail end (Photo 3.4).

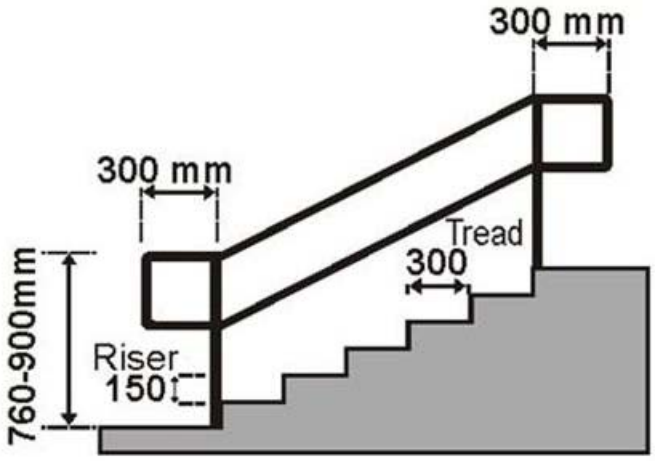


Figure 3.14 Handrails at two levels

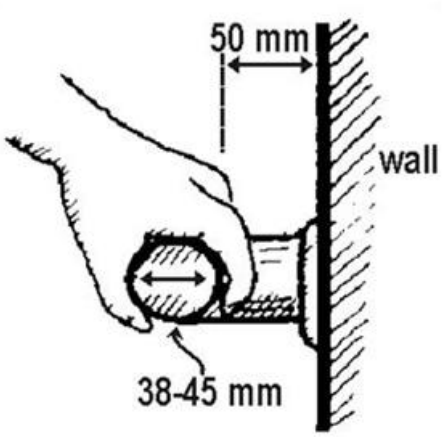


Figure 3.15 Knuckle clearance

Photo 3.4 Rounded handrails ends

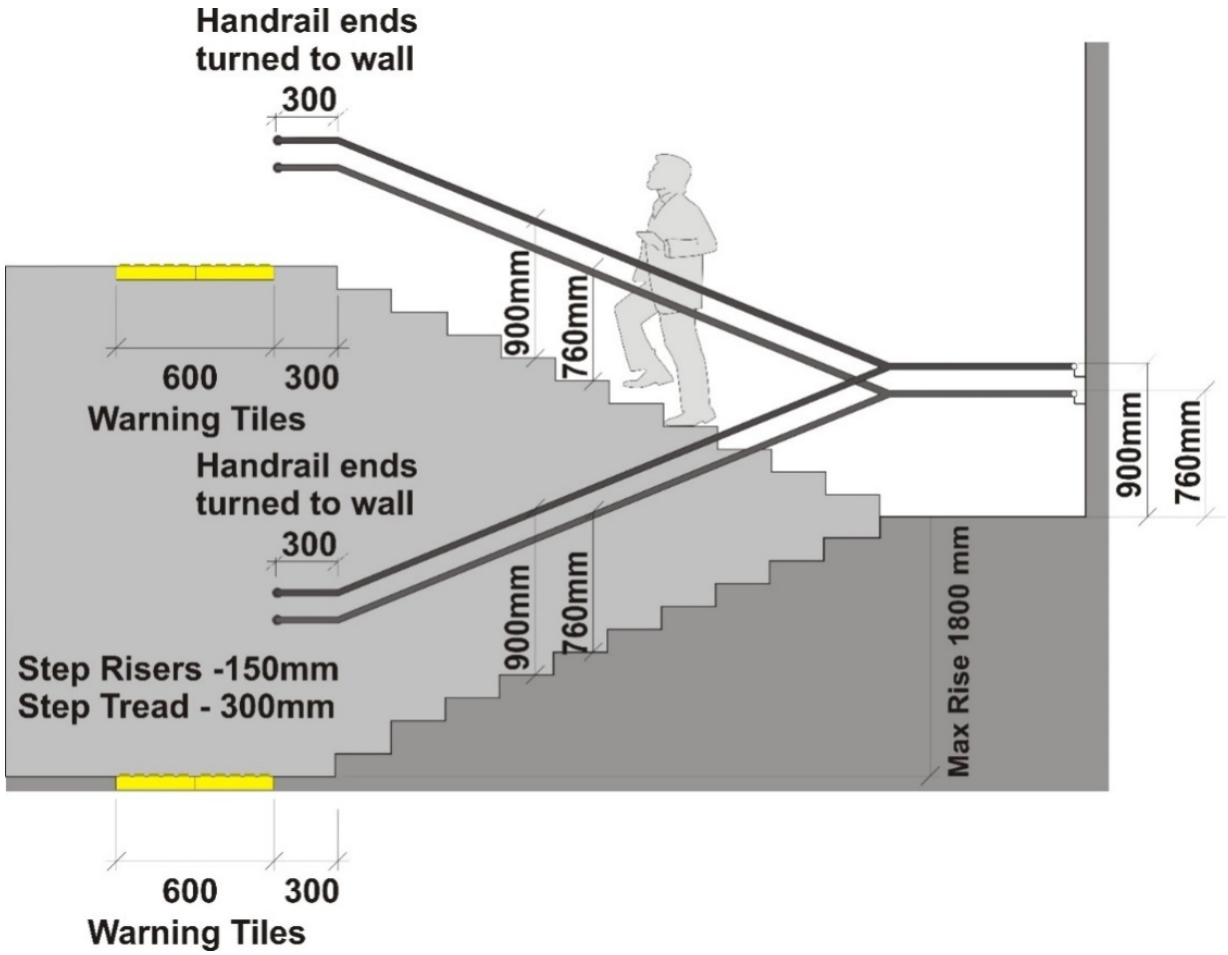


Figure 3.16 Placement of tactile pavers and handrails extension

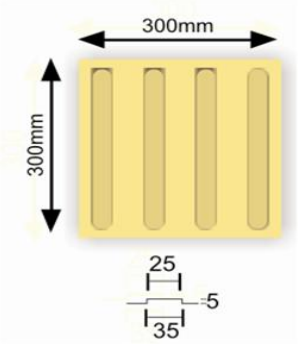
3.2.8 Tactile Pavers- Guiding and Warning

Usually persons with vision impairment need guidance in using a pedestrianized area, especially if the footpath crosses larger open spaces where the usual guidance given by the edge of the footpath or building base is not available, or when pedestrian need guidance around obstacles. These are readily available in the domestic Indian market. For external areas, such as roads and streets, vitrified pavers are preferred to ceramic/ cement.

It is important that, whichever tactile pavers are used i.e. guiding or warning, they should be used consistently to avoid confusion. The different texture can be followed by people using a long or white cane, and can also be detected tactually through the soles of their shoes, with a cane and any remaining residual vision that they may have.

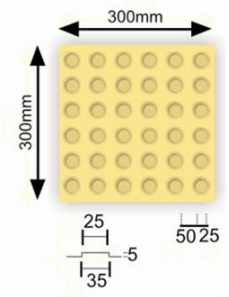
Guiding pavers

These pavers/blocks/tiles have straight continuous line (Figure 3.17) and indicate the correct path/route to follow, leading to building entrances, an amenity, bus stop etc. It should be laid in a simple and logical manner and not be located close to manholes or drains, to avoid confusion for persons with vision impairments. A continuous path of guiding pavers in the direction of pedestrian travel, which has a different texture to the rest of the footpath, can provide this guidance.

Guiding pavers
These are 300 x 300 mm pavers that incorporate flat topped bars that are 5mm (± 0.5mm) high, 25mm wide and spaced 50mm from the centre of one bar to the centre of the next. They are used externally to guide persons with visual impairments along the circulation path (Figure 3.14). These shall be used internally in large busy areas and transport terminals.  Figure 3.17 Guiding pavers

Warning pavers

Warning pavers/blocks/tiles provides warning signal to screen off obstacles, drop-offs or other hazards, to discourage movement in an incorrect direction and to give warning of a corner or junction (Figure 3.18). It should be placed 300mm at the beginning and end of the ramps, stairs and entrance to any door. It should be laid across the entire footpath where the crossing occurs and be 600mm wide so that someone can't miss it by stepping over it. Provide warning paver strip along the inner edge of a footpath where there is a break in the line of the corridor, e.g. at a garage forecourt or a gap in a building façade for an archway. Tactile paving at intersections, turnings, building entrances, etc. should be provided.

Warning pavers
These are 300 mm x 300 mm pavers that incorporate rows of 5 mm (± 0.5 mm) high flat-topped blister like domes. These indicate a potential hazard or change in direction installed within or on a ground surface in both the internal and external environment. These blocks are placed to warn persons with visual impairments of the approaching danger. Warning blocks are used along the approach path to unavoidable obstacles and hazards.  Figure 3.18 Warning pavers

Source: (MoUD, 2016)

Some examples of tactile pavers are given in Figure 3.19 and 3.20

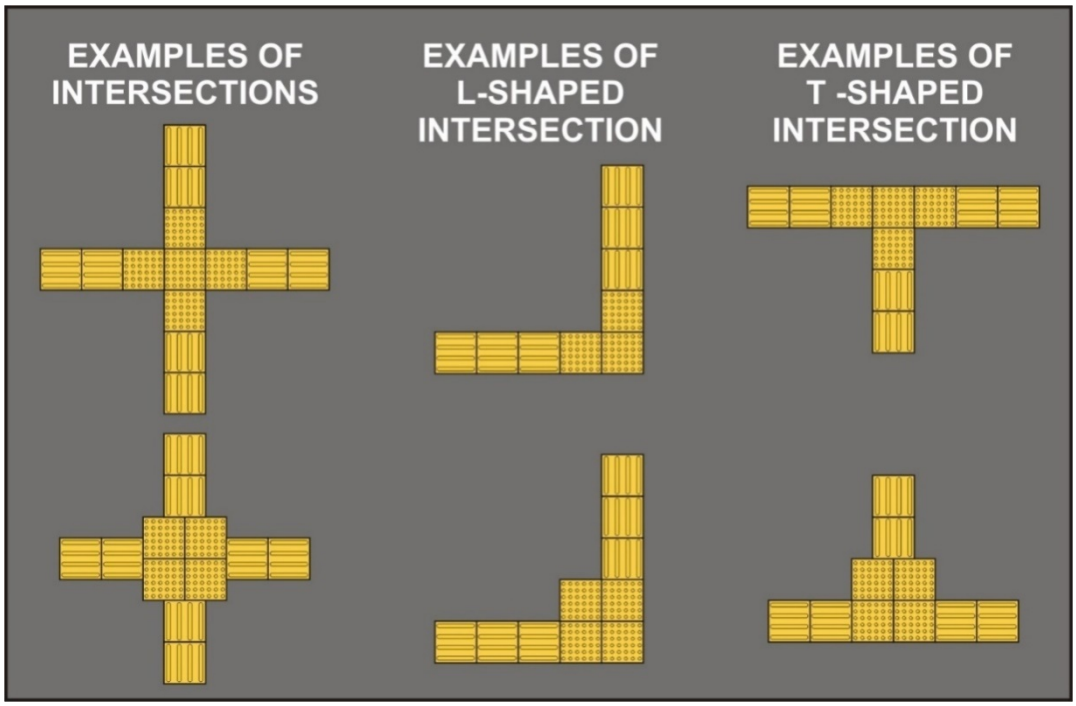


Figure 3.19 Layout of tactile pavers at intersections

Source: Samarthyam

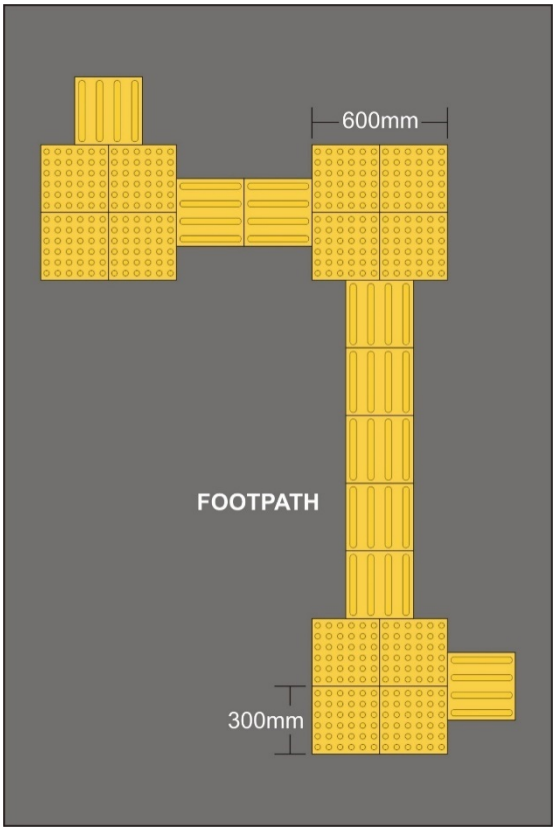


Figure 3.20 Layout of tactile pavers at turnings

The layout and colour of tactile paving used to assist the visually impaired in navigating the pedestrian environment should ensure that a consistent logic is applied. This includes the cumulative impact of tactile pavers with other material choices. For example, the use of strong red or yellow tactile paving may not be appropriate to avoid visual clutter associated with too many surface types or colours. In such instances, the use of a more varied palette or contrasting tones is preferable. Pavers should have a colour which contrasts with the surrounding surface. Tactile paving must be maintained to ensure that the profile does not erode away. This will allow persons with visual impairments to recognize that they are continuing in the right direction and that they have not reached a junction or missed a turning (Photo 3.5). Distance of 600mm to be maintained from the edge of footpath/ boundary wall and any obstruction to navigate persons with visual impairments.

Photo 3.5 Tactile pavers in open areas

Tactile paving should be provided in the line of travel avoiding obstructions such as manholes/ tree guards/lamp posts etc. and also at raised crossing. Figure 3.21 and 3.22 provides two options for correct layout of warning pavers to warn off manholes/ trees.

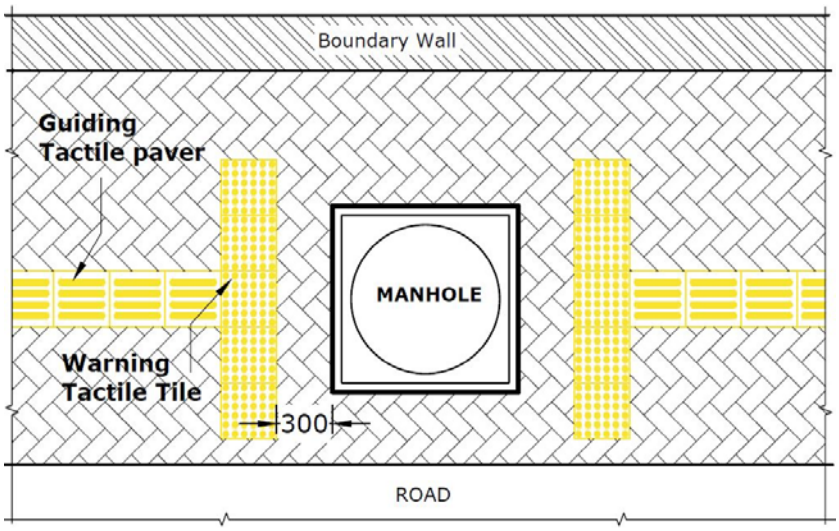


Figure 3.21 Correct layout of warning pavers on footpath to warn off manholes/ trees

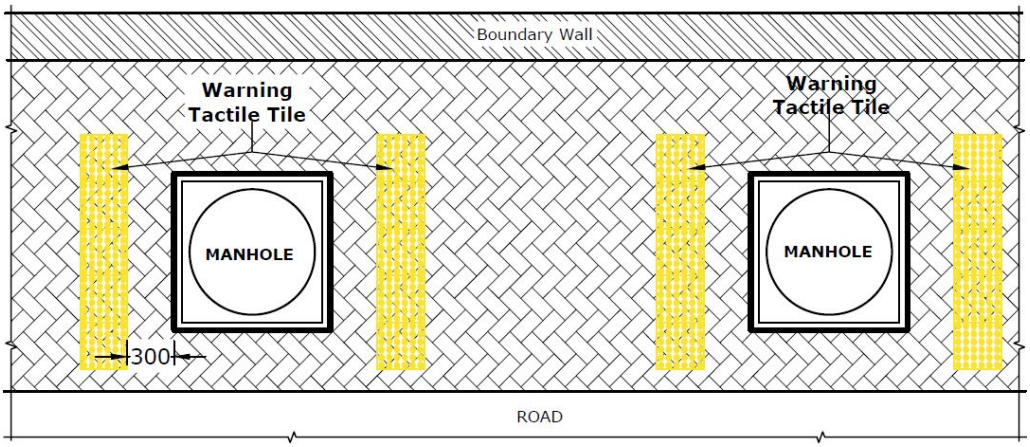


Figure 3.22 Correct layout of warning pavers on footpath to warn off manholes/ trees

3.2.9 Pedestrian Crossings

Many cities have erected barriers to prevent pedestrians from crossing the streets. Pedestrians are forced to use over bridges or subways. However, due to the difficulty and risks associated with the use of over bridges and subways, pedestrians continue to cross at ground level. In that case, pedestrians cross at random locations and do not benefit from the safety that crossing in groups at planned at-grade crossings can provide.

Measures that discourage walking induce more motorized trips, exacerbating traffic congestion. This tempts policymakers to build more high-speed roads that disrupt pedestrian movement even more. Properly designed pedestrian facilities can help break this vicious cycle and Guidelines for Pedestrian Facilities, IRC 103:2012 have provided standards for the same. Well-designed pedestrian crossings allow pedestrians to cross busy streets safely and conveniently. When paired with traffic calming elements such as speed tables, they can improve safety and create a seamless connection between the two sides of a street. Photo 3.6 shows tabletops marked by tactile pavers for persons with visual impairments. Figure 3.23 to 3.27 provides situations/ options table top crossing details for properties/ building entrances, junctions, etc.

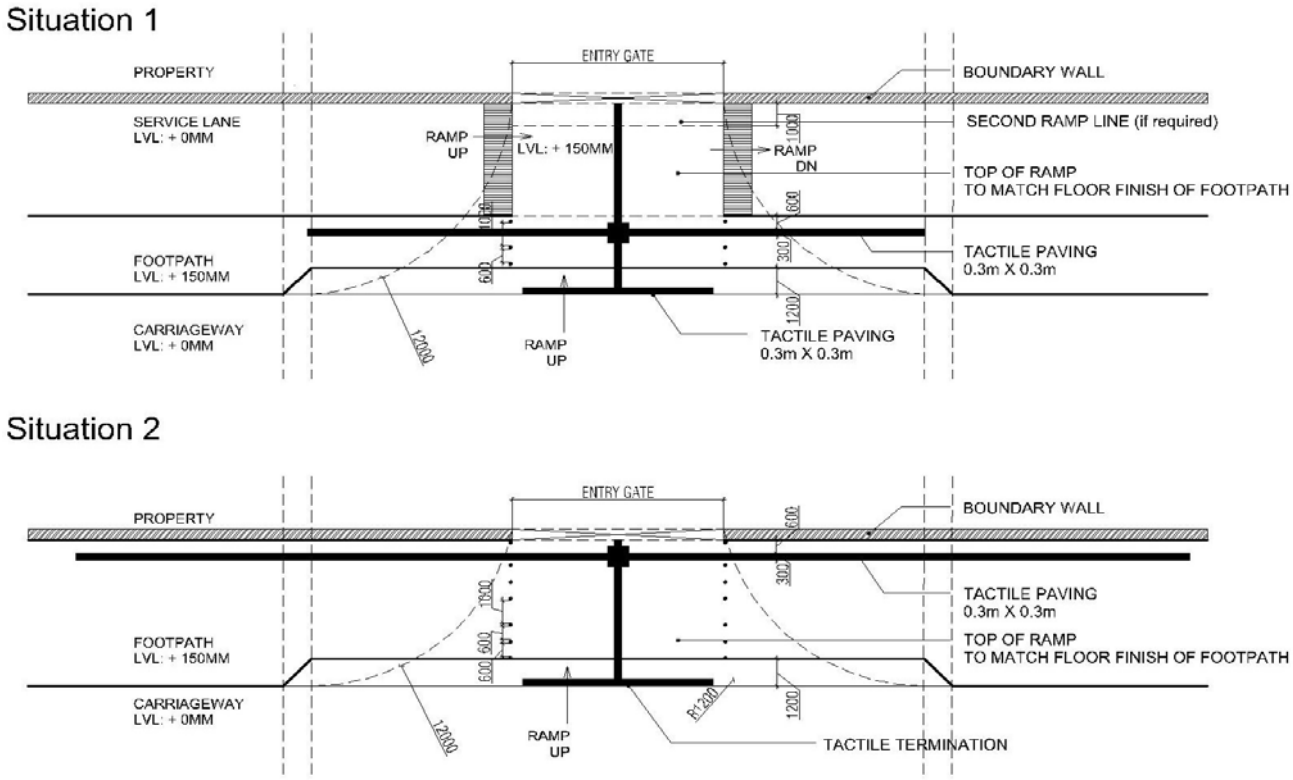


Figure 3.23 Crossing details near property/building

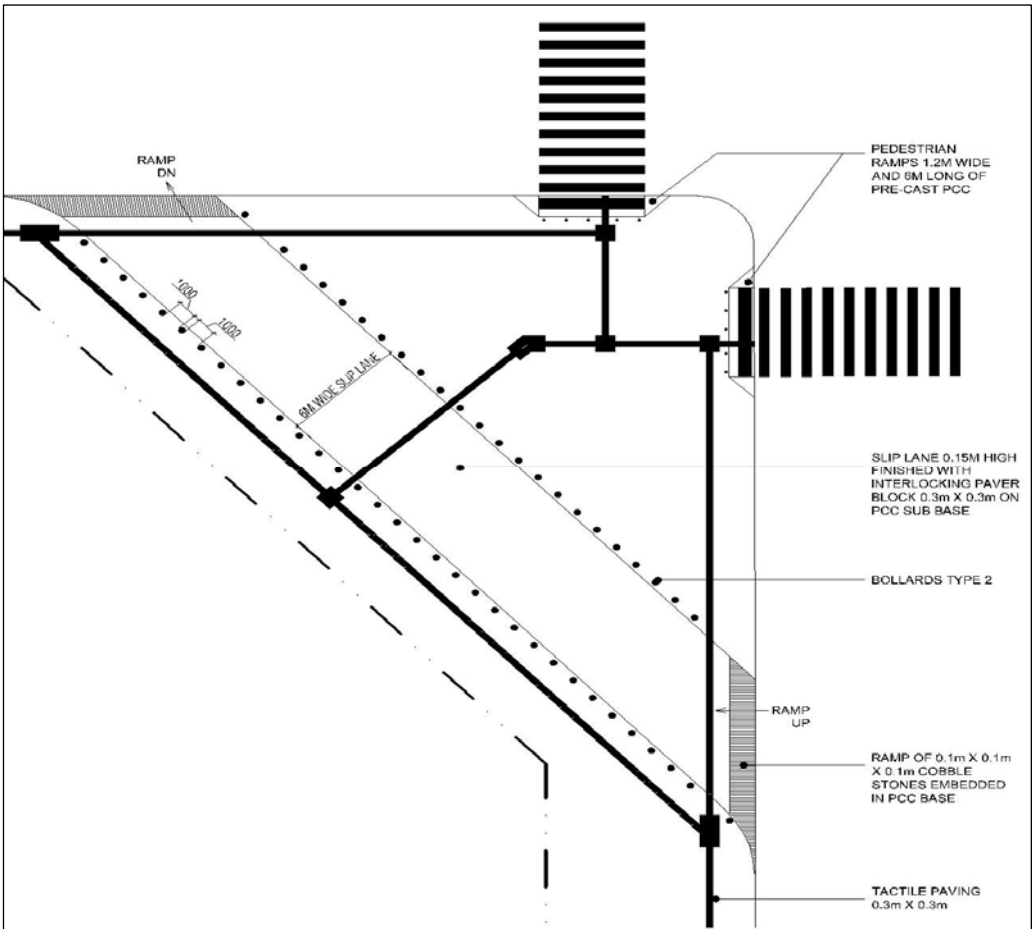


Figure 3.24 Crossing details with table top

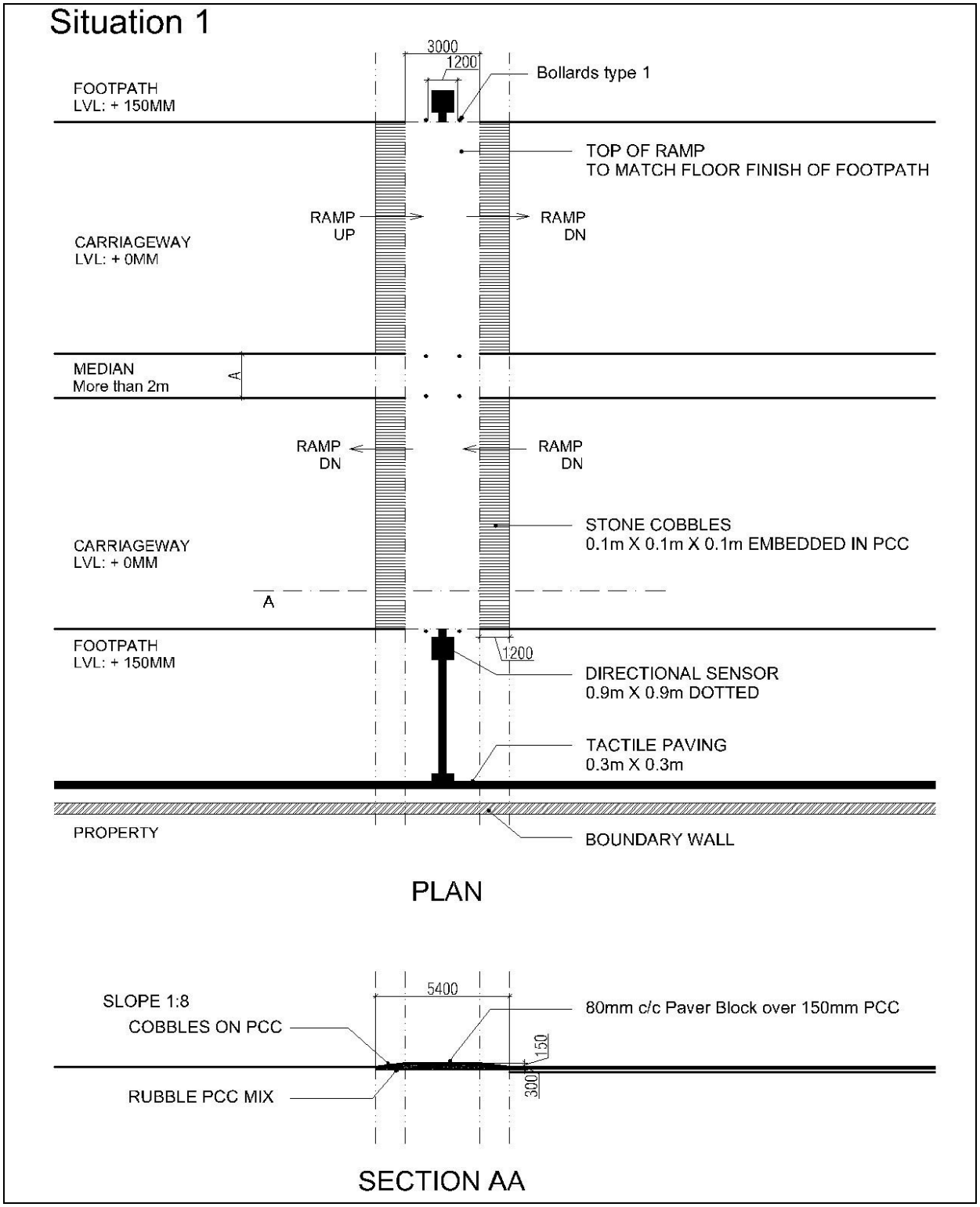


Figure 3.25 Table top crossing: situation 1

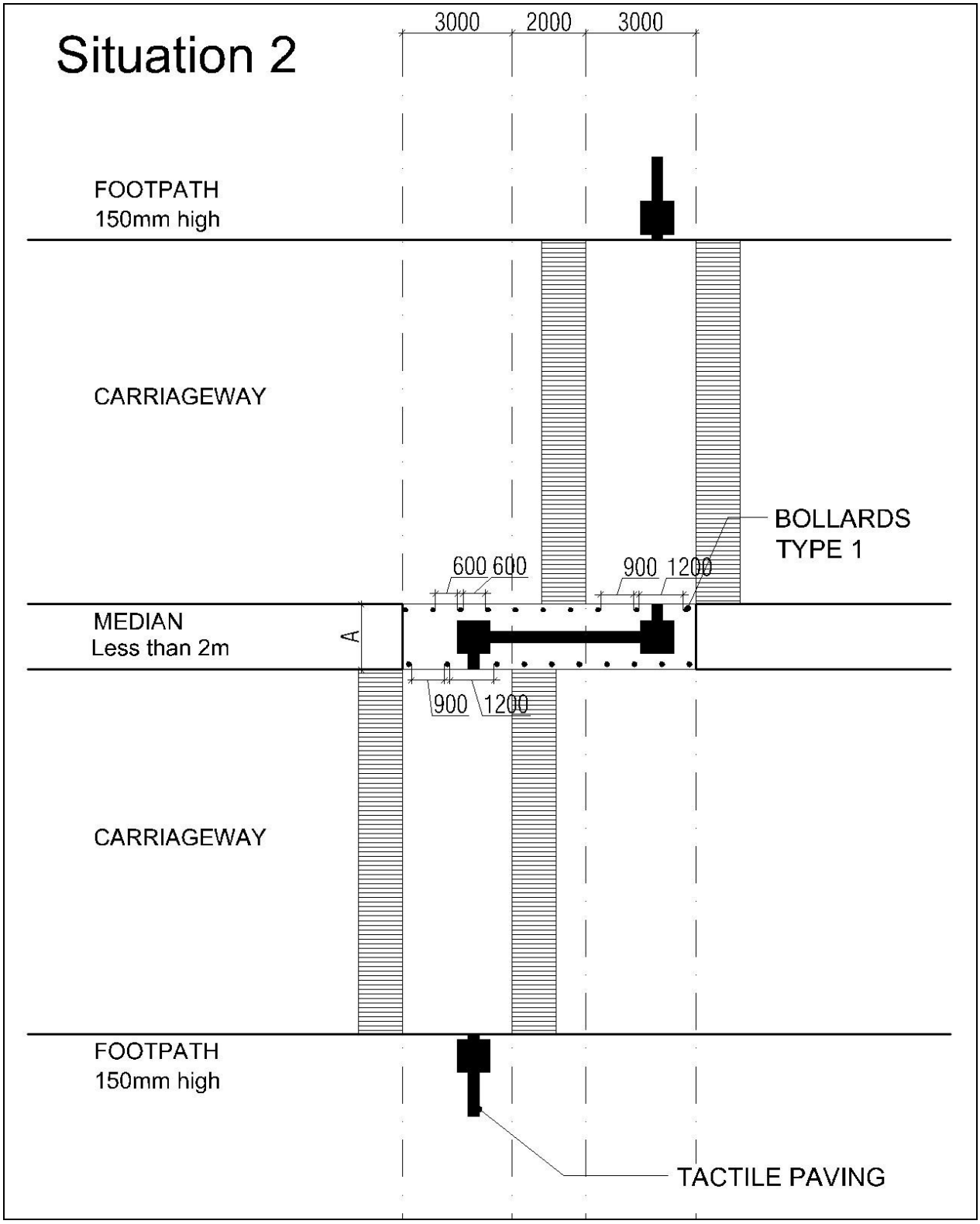
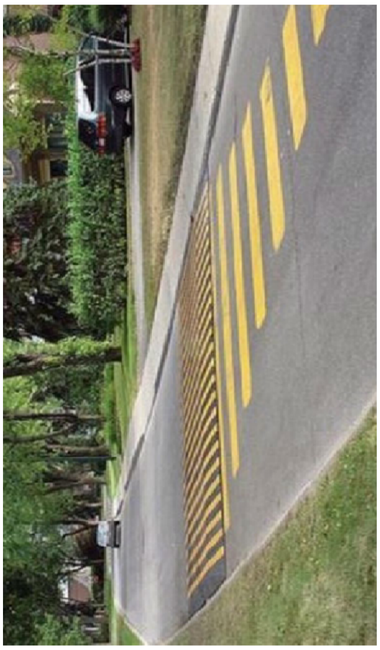


Figure 3.26 Table top crossing: situation 2

Tactile warning pavers should mark the table top to guide persons with visual impairments

Tactile warning pavers and 3D zebra crossing on the table top to guide persons with visual impairments



Drivers must be made aware of a table top

Photo 3.6 Table tops with design standards to warn persons with visual impairments and drivers

3.2.10 Central Medians and Refuge

- Pedestrian refuge is required for safe and barrier free road crossing, as many persons with reduced mobility cannot cross the road in one stretch as they feel exhausted;
- Uniformity in crossing distance should be maintained;
- It is essential to have pedestrian refuge (islands) in crossings with following standards:
  - o Cut through and level with the street (Figure 3.27 - Figure 3.29); or
  - o Have kerb ramps on both the sides and have a level area of not less than 1500 mm long in the middle; and
  - o A coloured tactile marking strip of warning pavers at least 600 mm wide should mark the beginning and end of a median/ pedestrian refuge to guide pedestrian with visual impairments to its location.

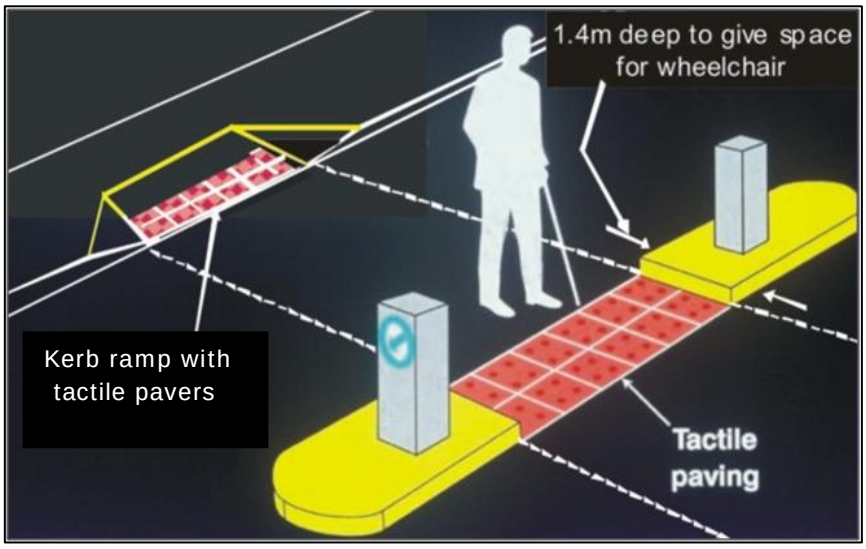


Figure 3.27 Median refuge with tactile pavers

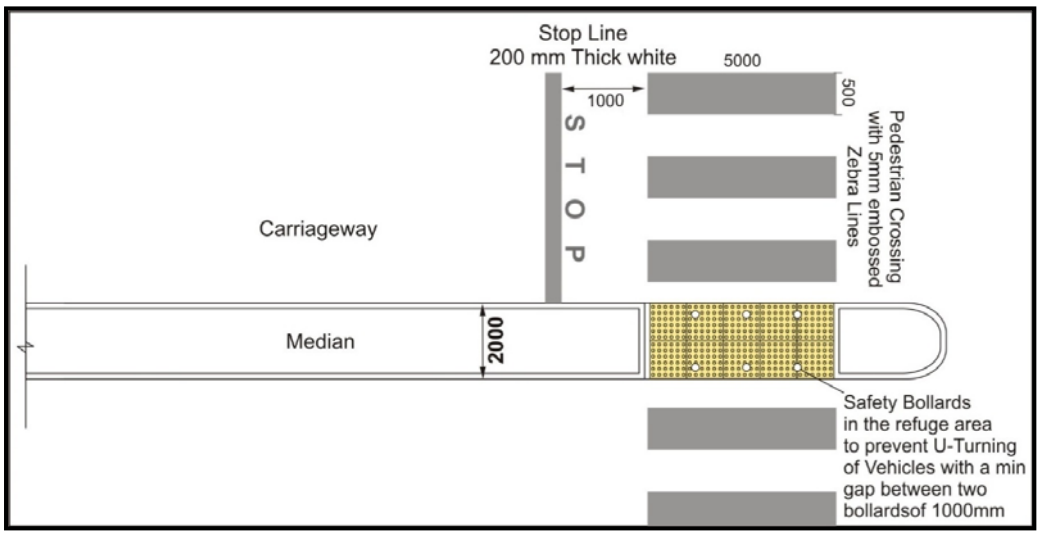


Figure 3.28 Placement of tactile warning pavers in a refuge

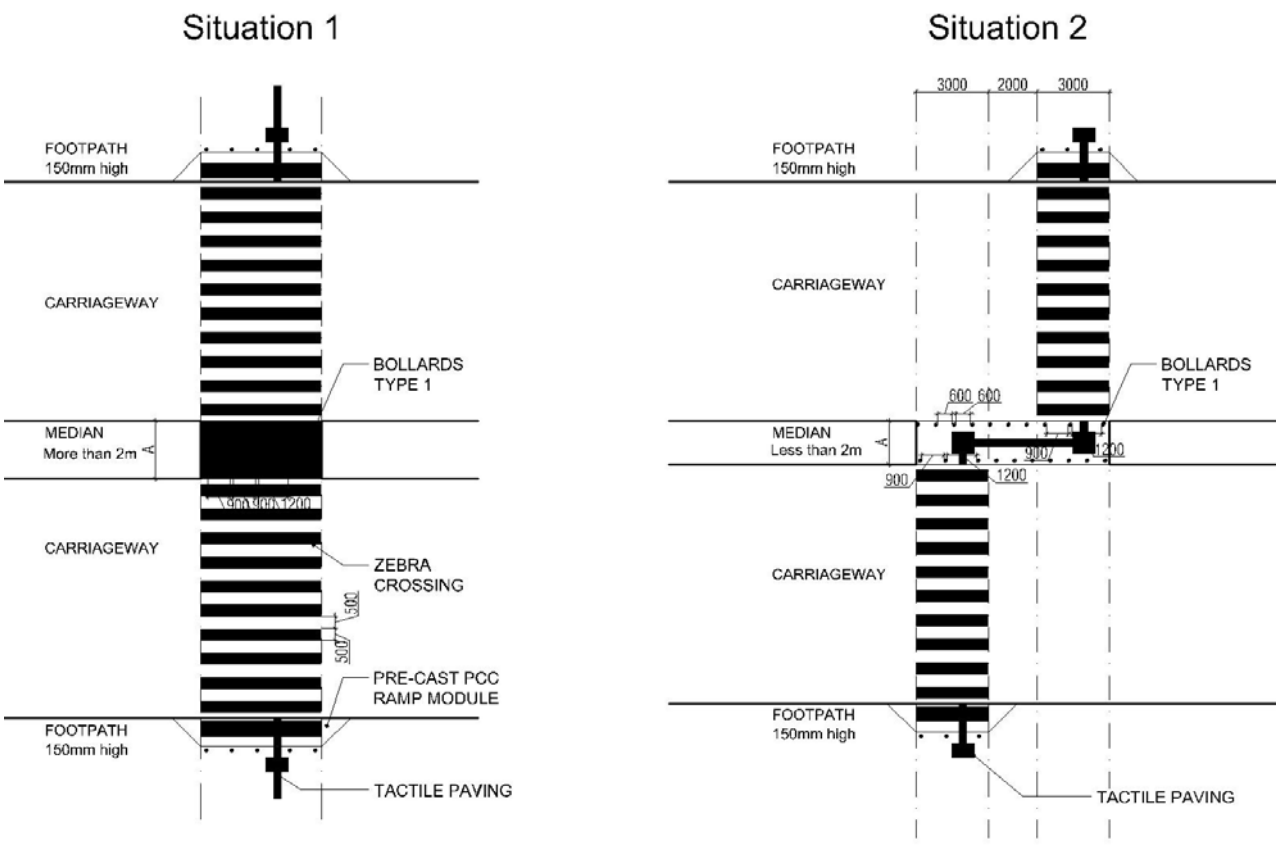


Figure 3.29 Median ramp and zebra crossing for persons with disabilities

A good median reduces conflict between opposite directions of traffic and acts as pedestrian refuge but has frequent enough breaks to discourage motor vehicle users from driving in the wrong direction. Medians can help streamline traffic and ensure safety on higher-speed streets where there is a risk of collisions involving right-turning traffic. In addition, they prevent speeding drivers from crossing into the opposing traffic lane. Medians improve safety for pedestrians by functioning as refuge islands, which allow pedestrians to cross one direction of travel at a time. It is much easier to find an adequate gap in half the traffic flow rather than all of it. Central medians can accommodate other elements such as landscaping, pedestrian and cycling boulevards, and parking.

Medians that extend too far without any opportunities to cross, turn right, or make a U-turn make the other side inaccessible and unnecessarily increase the total distance travelled. They encourage vehicle movement on the wrong side, thereby compromising safety. Hence, the provision of breaks in a median at appropriate intervals is critical. Sometimes, guardrails or high kerbs are built to prevent pedestrians from crossing the street. However, they are surmounted anyway. If a median is not wide enough, pedestrians may spill over into the carriageway while waiting for traffic to clear.

3.2.11 Resting Spaces

Elderly and pedestrians with disabilities can rest at reasonably frequent intervals. Provision of resting places - simple sitting areas with chairs, benches or steps where one can have a break - is an important element of pedestrian spaces. Resting spaces and shelter should also be there where frequency is more.

- As with all street furniture, seating should be placed next to the footpath without obstructing it, and painted in contrasting colors. Seats can be as simple as wooden benches or perch-type rails to lean against.
- Seats should be 450mm and backrest 700mm high.
- Tables with knee clearance of 700mm and 600mm deep should be provided with clear width of table 600mm and wheelchair space of 1000mm.
- Along frequently used pedestrian ways, seating should be provided at regular intervals, typically every 50metres.
- In commonly used pedestrian areas, such as the one access audited, resting places should be provided at intervals not greater than 100m at strategic points.
- It is helpful to people with sight problems if these and other amenity areas adjacent to information signages, walkways and pedestrian routes and have contrasting colours for persons with sight problems and visual impairments (Photo 3.7 and Figure 3.30).

Photo- 3.7 Resting benches in contrast colour and near information signage

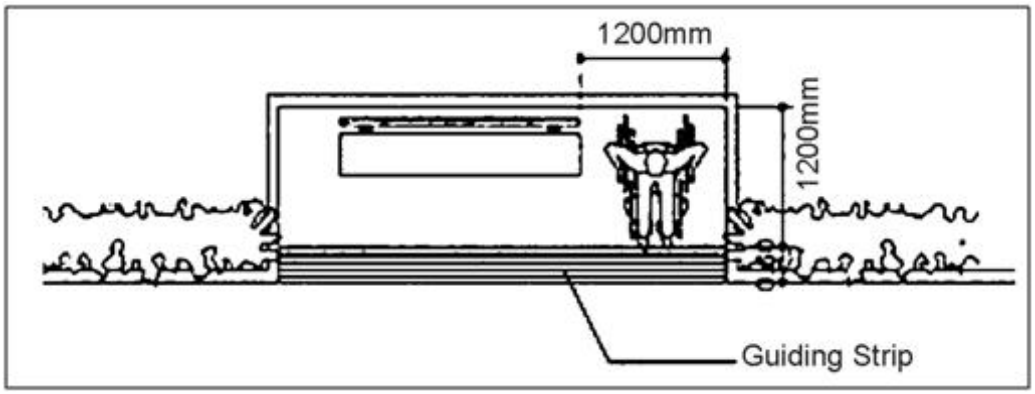


Figure 3.30 Resting space

Source: (Indian Roads Congress, 2012)

3.2.12 Materials and Finishes

Importance of Material Selection

Appropriate selection of materials in design impacts the aesthetics, usability and comfort of the street for all its users – and in the long run has a huge impact towards endearing these places to the citizens.

Materials selected should have minimal impact on the environment in terms of carbon emissions, embodied energy, life-cycle costs, quarrying, transporting and top-soil preservation. Materials

selected should enhance

- universal accessibility,
- comfort and mobility for pedestrians, and
- least efforts for people using non-motorised vehicles and bi-cycles

Material Selection Guidelines

- All paving materials, as a rule – should be finished as anti-skid, non-slip, unglazed material.
- Locally available materials should be preferred.
- Use of contrasting materials and textures to inform pedestrians of changes to the function of space (i.e. to demarcate verges, footway, strips, cycle paths and driveways) and in particular to guide the visually impaired.
- Materials selected should reduce storm water runoff and urban heat island effect, as much as possible.
- Since most road projects are redevelopment projects – Reuse/ recycling existing road construction materials is preferable and advisable.
- Materials which have some recycled content or that can be recycled after use should be preferred e.g.:
    - Recycled Asphalt
    - Recycle Rubber
- Recycled stone or other existing construction materials. Long life, durability and ease of repair of materials must be factored in during material selection and project cost calculations.
- Use and depletion of finite raw materials should be reduced - by replacing them with rapidly renewable materials. (Rapidly renewable materials are ones that are typically
- harvested within a 10-year cycle, e.g., bamboo products, corn products, wheat based products, strawboards etc.).
- Materials with low cement content and low embodied energy should be given preference.

While providing pedestrian facilities such as ramps, kerb ramps, footpaths etc., it is important to consider different finishes to safe guard people from falling, slipping/ tripping. Table 3.4 provides common do's and don'ts in pedestrian areas.

Table 3.4 Do's and Don'ts

	Areas	Do's	Don'ts
1	Footpath	Anti-skid / matt finish tiles, interlocking paving tiles, sandblasted Stone, unpolished Stone, checkered tiles	Polished Stone finishes
2	Kerb ramps	Anti-skid / matt finish tiles; Flared sides with tactile paving, exposed Cement Concrete	Polished Stone finishes
3	Tactile Walking Surface Indicators (Tactile pavers)	Vitrified unglazed, must have tactile elements raised above adjacent surfaces and have high tonal contrast (50% LRV contrast) to adjacent surfaces (standardized as ISO 23599:2012)	Stainless steel or metal pavers in dull /slippery finish

4	Signage	Good colour contrast, big font signages on non- glare surface- acrylic, metal (fully painted) with retro reflective paints	Glass, stainless steel, aluminum
5	Bus Stops flooring	Anti-skid / matt finish tiles with vitrified unglazed tactile pavers in good colour contrast to the flooring surface	Glazed vitrified tiles, Granite, polished Kota stone
6	Street lights	White color, mercury lights- full cutoff fixtures	Yellow lights
7	Handrails	Stainless steel 304/316, OD- 38-45mm, scotch- bright or matt finish	Slippery, wood / bamboo which needs regular maintenance
8	Light signals	Audio signals with time display (Standardized as ISO 23600:2007, Assistive products for persons with vision impairments and persons with vision and hearing impairments − Acoustic and tactile signals for pedestrian traffic lights).	Light signals without timer and audio
9	Table top	Any load bearing anti-skid pavers	Cobble stone on table top flat surface
10	Table top slopes (on road side)	Cobble stone may be provided	Polished granite or any other Slippery Surface
11	Median refuges	Any load bearing anti-skid pavers, tiles	Cobble stone
12	Cycle tracks	Preferred Pavement Quality Cement Concrete	CC Paver Tiles and Polished Finishes

3.2.13 Cycle Tracks and Non-Motorized Transport (NMT)

Non-motorized Vehicles (NMV) includes cycles, tri-cycles, cycle rickshaws, pushcarts, and any other form of mobility that is powered by humans. NMV play an important role in provision of transport services.

Modal share in medium and large cities show that 13-21% of people cycle. It is the most affordable mode of transport for groups of all ages and low-income groups covering diverse accessibility needs.

In India, usually persons with disabilities from low economic groups use tri-cycle for employment/ livelihood and/or essential activities such as education, health and socialization purposes. As per Census 2011 report on Madhya Pradesh Mode of Transportation, tricycle used by persons with disabilities was also considered as bicycle. Tri-cycle users at times commute long distances ranging from 10 to 20 km (Samarthyam, 2012). This mode provides access to opportunities and is the most affordable means of transport for the disabled.

3.2.14 NMV Infrastructure

Citywide NMV networks should be created by combining segregated cycle tracks, and traffic-calmed areas. Traffic calming is required on local roads to ensure that motorized vehicles speed remains below 30km/h and cyclists are safe without segregated tracks

The most effective option would be to segregate users into separate tracks or paths (Figure 3.31) along the road network, especially for arterial and sub-arterials; and increase signals timing

for them. On other streets, there is a need to reduce their speed difference by traffic calming without affecting directness or coherence (TRIPP, IIT Delhi, 2014).

Security from harassment on the streets also becomes an important consideration for NMV users especially for women and children. Planning and design elements that introduce eyes on the streets – by removing setbacks and compound walls, having active building fronts and mixed land use, and street vendors –should be a part of the spatial planning to ensure security.

In addition, NMV infrastructure should meet the following criteria:

- Provision of infrastructure suitable to road typology, which is coherent, direct, safe, comfortable and attractive.
- Parking spaces for NMV public modes.
- Signage placed at strategic locations for identification of NMV lanes (Photo 3.8 and 3.9)

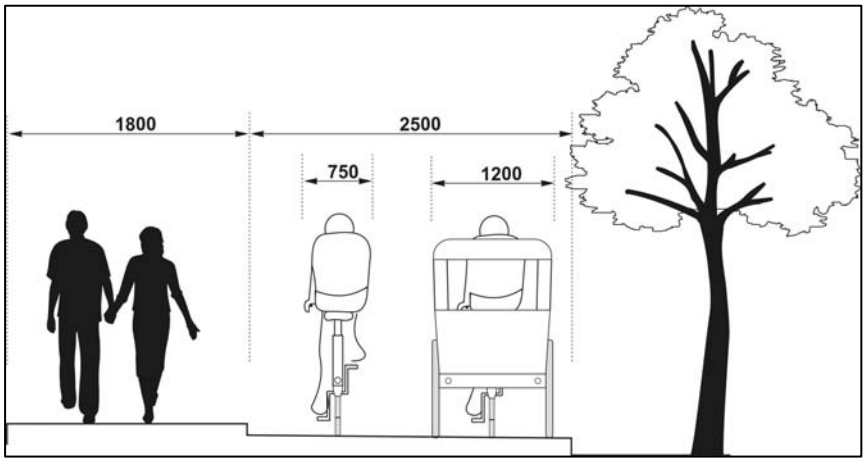


Figure 3.31 Segregate users into separate tracks or paths

Photo 3.8 Signage for NMV

Photo 3.9 Signage for cycle lanes (Lucknow, UP)

Source: Samarthyam

3.2.15 NMV Lane Design Considerations

- Provide adequate space—such as slow-speed shared spaces, footpaths, cycle tracks, and greenways—for NMV users;
- Accommodating NMV involves two simple techniques:

    - Systematic traffic calming to ensure that smaller streets are safe places for the mixing of pedestrians and other modes “shared lanes”.
    - Pedestrian and cycle infrastructure be physically separated from motor vehicle traffic (by raised kerbs, vehicle parking lanes, bollards, landscaping, etc.) on larger streets.
- Continuity to allow for reasonable speeds;
- A smooth surface material—asphalt or concrete;
- Paver blocks are to be avoided;
- Avoid high, uneven and unmarked speed breakers as these are hazardous;
- Manhole covers should be avoided and, if unavoidable, should be level with the surrounding surface;
- Continuous shade through tree cover;
- Elevation above the carriageway (e.g. +150 mm) that allows for storm water runoff;
- At property access points, the cycle track remains at the same level and vehicle access is provided by a ramp in the buffer;
- Dedicated non-motorized transport infrastructure also includes walkways and cycle paths that utilize an independent right-of-way (ROW), such as in a park or along a transport corridor;
- Cycle stations (parking, sharing and hiring) should be arranged in close space network so that a station is always within walking distance from any point in the coverage area;
- Adopt building control regulations that encourage street frontage with many shop fronts, doors, windows and patios that open directly to pedestrian environments create a feeling of safety (eyes-on-street), while producing a more active and vibrant atmosphere. Discourage the construction of compound walls at the edge of public rights-of-way;
- Provide adequate street furniture for people to sit, rest and interact with each other. Street furniture also includes services-related infrastructure, such as dustbins, street vending, toilets, and signage. Street furniture can help make a street an attractive place to spend time. When positioned on narrow shared streets, benches, tables, street vending spaces, and other furniture can also function as traffic calming elements. Vending stands, tables, roofs, and water taps can support the formalization of street vending and promote better sanitary conditions;
- Employ traffic calming elements (including speed humps, raised speed tables, bollards, roundabouts, and textured pavements) to ensure pedestrian and vehicle safety by reducing the top speed of motor vehicles. Traffic calming elements are particularly important in places where large numbers of children are present, such as schools, parks, and residential areas; and
- Provide street lighting of 35-40 lux level to ensure visibility by persons with low vision and safety on NMV facilities (CPWD & MoUD, 1998).

A 0.5 m buffer is needed between a cycle track and motor vehicle or parking lanes. The buffer can accommodate ramps and storm water catch pits. The buffer should be paved if it is adjacent to a parking lane. (Source: ITDP)

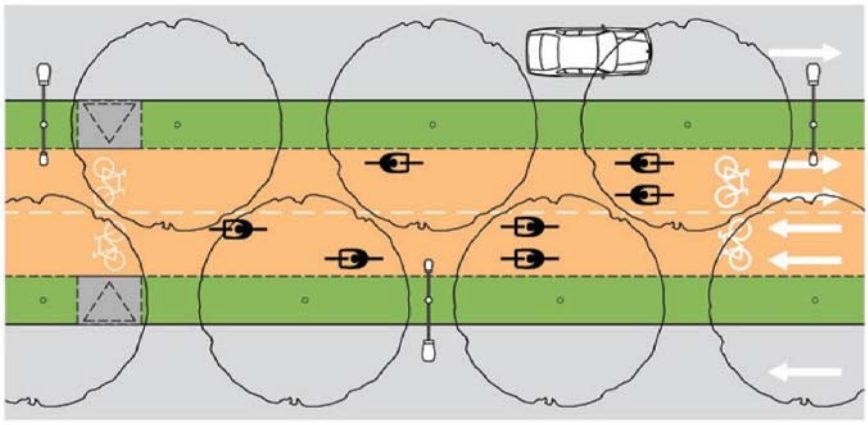


Figure -3.32 Segregated NMV Lane

Median cycle tracks reduce conflicts with parking and property access. Frequent access points with ramps are essential. Turning movement conflicts at intersections can be mitigated through bicycle boxes and appropriate signal phasing.

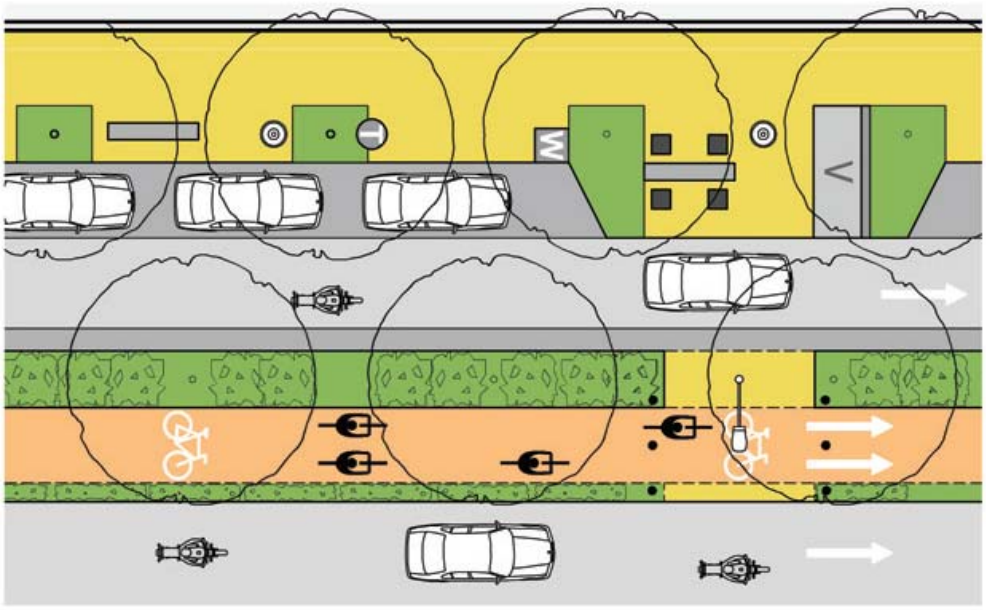


Figure- 3.33 Median cycle tracks with bicycle boxes

In streets with service lanes, parking should be located on the left side so that passengers do not spill over on the cycle track when they exit a vehicle.

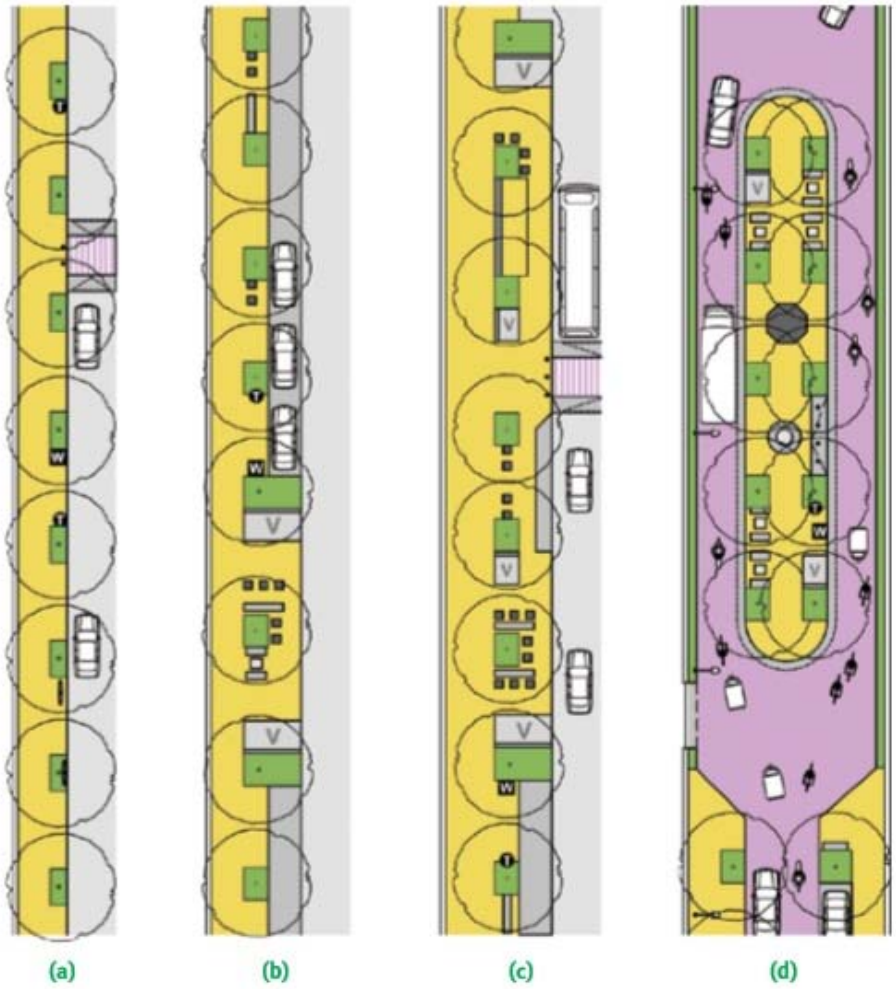


Figure 3.34 Bulbouts in parking lanes and street vending islands

3.2.16 Accessible Parking

The following guidelines must be followed for design of accessible on-street 4-wheeler or tri-cycle parking facilities.

- Designated accessible parking with overall minimum dimension of 3.6m x 5.0m must be provided, arranged perpendicular to the kerb and 3.5m x 5.5m must be provided for parallel parking.
- If provided perpendicular to the kerb, a minimum clear space of 1200mm must be provided to facilitate transfer of wheelchair from the car to footpath. Appropriate kerb ramps must be provided to access footpaths from the parking slots. The gradient of a kerb ramp should not be steeper than 1:12; the flared sides should not be more than 1:10.
- In case of parallel parking, where people prefer to transfer on the roadside, a clear space of 1.2m must be available at the ends of the car to allow user to gain access to the footpaths.
- These slots should be located within 30 meters of the main entrance.
- Accessible parking must be clearly defined and integrated into street design (Figure 3.35). Bulbouts can be used to address differences between parking geometry between accessible parking and other street elements.
- Access points to and from these parking slots must be level, with a firm surface to enable smooth movement of users in wheelchairs, crutches and walking sticks.
- Footpaths leading to and from these parking slots must also be designed to be wheelchair-accessible, in compliance with the guidelines stated in IRC 103-2012.

- Accessible parking slots should have international symbol of accessibility painted on it on the ground also on a signpost/ board near it (Figure 3.35). The signs should meet the following conditions:
    - A square with dimensions of at least 1.0m but not exceeding 1.5m in length;
    - Be located at the centre of the lot; and
    - The colour of the symbol should be white on a blue background.
- Two accessible parking lot should be provided for every 25 car parking spaces and well connected with building accessible entrance/s (Figure 3.36) (MoUD, 2016).

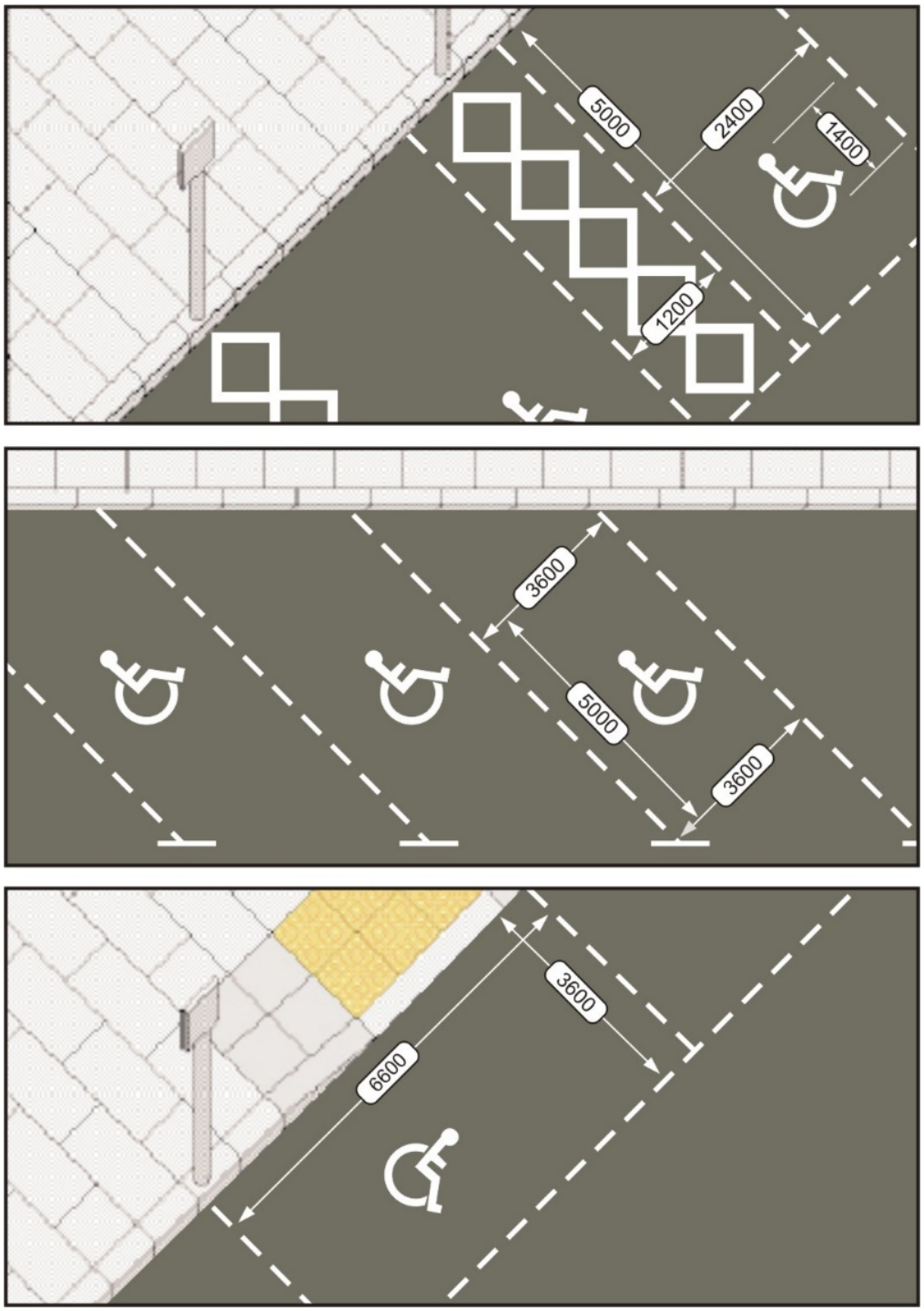


Figure 3.35 Accessible parking layout

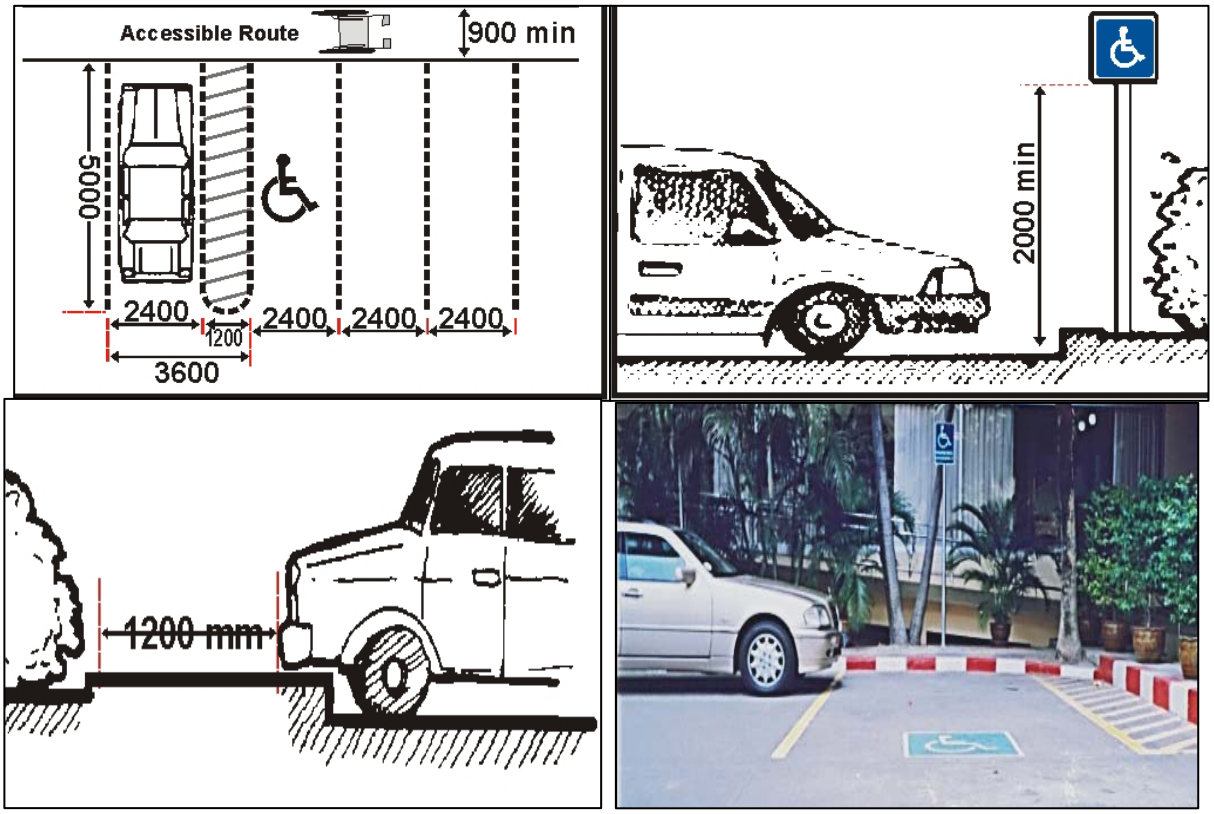


Figure 3.36 Sign posting and aisle demarcation for accessible parking

In case of perpendicular parking, a common aisle of 1200mm can be shared between two accessible parking spaces (Photo 3.10) Signs indicating accessible parking slot should be visible even when cars are parked in the vicinity.

Photo 3.10 Asiles in contrast colour

3.2.17 Drop-off/ Boarding

Provide a drop-off/boarding point near entrances marked by wheelchair (access) symbol painted on the floor and put on a pole at height of 2m (Photo 3.11). Passengers with impaired mobility often move slowly and therefore are vulnerable in bad weather. Persons with visual impairments also benefit from having direct access to the building entrance. Provide protection from the weather wherever possible. A canopy height of 2500mm facilitates most passenger vehicles.

Photo- 3.11 Signage for Drop off/ pick up

Drop-off points should be level, with a firm surface. Avoid siting manholes, drainage gullies etc. in areas where persons get out of cars, in particular at kerb ramps. Such items can impede walking sticks, crutches and wheelchairs and can become hazardous in cold weather. Drop-off points should not obstruct circulation areas. Avoid transfer directly onto footpaths or, if this is not possible, ensure that the footpath is at least 2000mm wide at the drop-off, point.

Source: IRC: 103-2012, Guidelines for Pedestrian Facilities

3.2.18 ITS, Traffic Signals (Manual, Electronic)

ITS is a cost-effective means of increasing the efficiency of the urban transport network, to manage the crisis of congestion in urban areas, reduce the number of crashes and fatalities, improving safety & security of commuters, promoting public transport usage, and efficient management of freight traffic. Following universal accessibility measures should be provided in ITS:

- All visual signage and information should be supplemented with audio announcement and digital displays;
- Signal timings should be controlled as per the pedestrian volume and time interval allowed for crossing should be programmed according to the slowest crossing persons;
- Pedestrian traffic lights should be provided with clearly audible signals for the benefit of pedestrians with visual impairments (Photo 3.12);
- Acoustic devices should be installed on a pole at the point of origin of crossing and not at the point of destination. In noisy areas, any spoken information should be repeated at least once. Audible traffic signals should operate at least 15dB over the prevailing sound level, with a maximum of 140dB;
- The installation of two adjacent acoustic devices such as beepers is not recommended in order to avoid disorientation; and

- Acoustical signals encourage safer crossing behavior among children as well.

Photo- 3.12 Traffic signal, bus rapid transit, Delhi (left) and audio signal (right)
Source: GAATES, USA

Note: Minimum dB human ear can hear is 0db and from 85dB the damage begins to start, whereas sound traffic noise can go from 100db up to 130db and for that auditory signals require 15db above the background noise.
(McCartey, 2009), (Moore, 2012), (Franks, 1998), (Dangerous Decibels, 2014)

3.2.19 Active Street Edges

Active street edges provide passive surveillance of the street environment and promote pedestrian activity. This should be a principal aim of the design team. Increased pedestrian activity also has a traffic-calming effect as it causes people to drive more cautiously.
The streets shall be designed to make it active and vibrant public space. Street vendors, public sit out spaces and the adjoining commercial establishments make the street edges a thriving public space. This improves the safety and accessibility for women. 'Eyes on street' concept of urban planning shall be encouraged for a safer and accessible built environment. Where larger retail/commercial floor plates are proposed at ground floor level, an active street edge may be achieved by creating multiple entrances and/or wrapping them with smaller perimeter units that front on to the street.

3.2.20 Railings and Bollards

Currently designed guard-rails impede pedestrian access to footpaths. Their judicious use can help to ensure that pedestrian cross the streets at predetermined and safe locations. As the guard-rails would confine the movement of pedestrian to the footpath, it is obligatory that sufficient width of footpath be made available (IRC 103, 2012).

Bollards are often used to stop vehicles from mounting the footpath and to keep pedestrian away from traffic. Unless positioned carefully, they can form a barrier to wheelchair users and are a particular hazard for persons with visual impairments. Where they are essential, such as to ensure clear escape routes, bollards should be identifiable by using contrasting colours by providing reflective tapes and be minimum 1m high. To stop use by bicycles/bikes bollards at suitable locations should be provided with clear gap/space between two bollards should be

1.2m. Staggered bollards do not prohibit motorized two wheelers and make it more difficult for them to pass through, while allowing convenient access for wheelchair users and cyclists. Bollards should be avoided but where necessary be at least 1000 mm high, provide a wheelchair passage width of at least 900 mm (Figure 3.37 and 3.38), and should not be linked with chains.

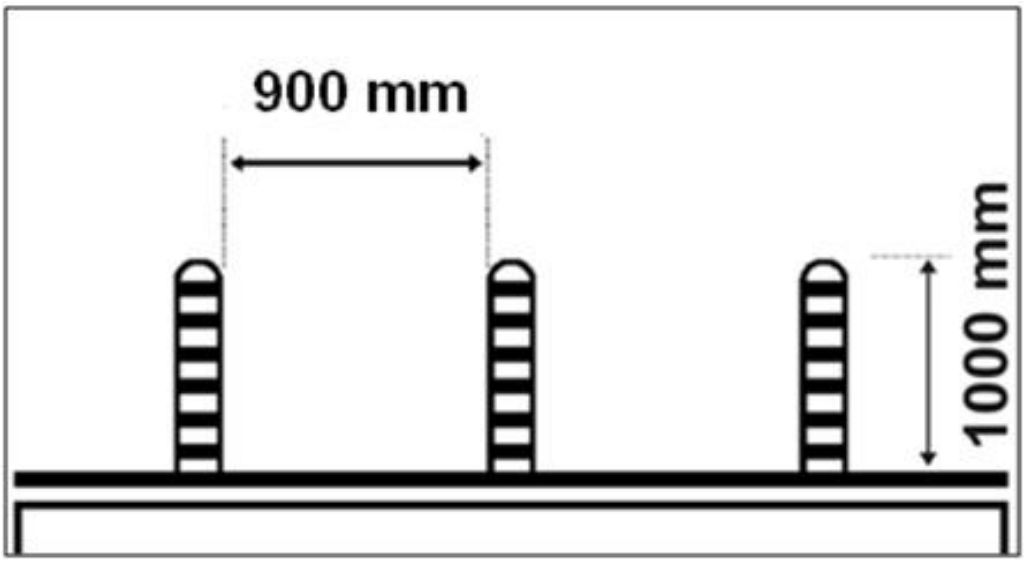


Figure 3.37 Space between bollards

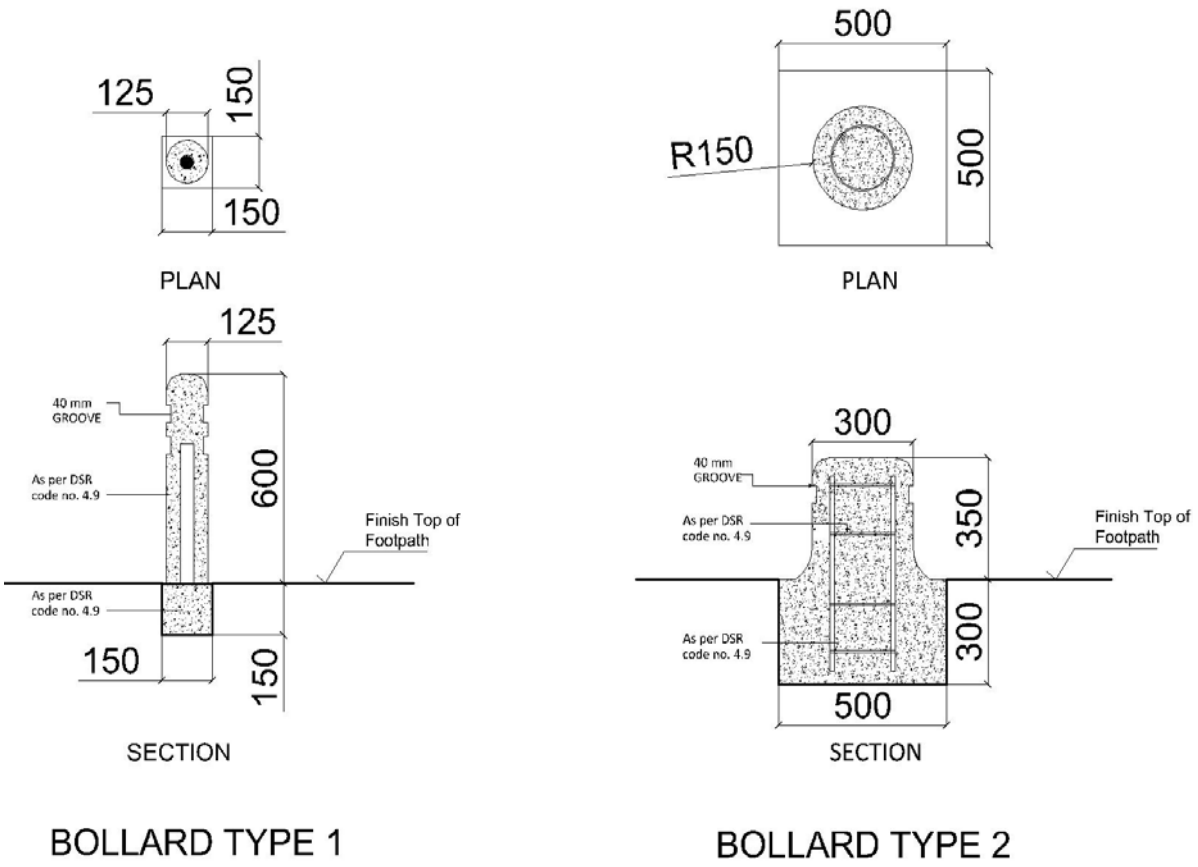


Figure 3.38 Bollard detail (all

Guardrails should not be used as a tool for directing and/or shepherding pedestrians. Guardrails should only by installed where there is a proven or demonstrable safety benefit, for example where people may inadvertently step onto the carriageway (e.g. at a school entrance).

3.2.21 Wayfinding and Signage

Wayfinding

Way finding references should be available at decision points. While providing way finding cues, following checks and measures (Samarthyam, 2013) should be taken care of:

- Users need clear instruction regarding the purpose and layout of the space to maintain a sense of direction and independent usage.
- Color can be used to identify routes and provide assistance in locating doors, walls and hazards. Proper color contrast between different elements greatly improves visibility for all users and is critical for persons with low vision. For example, color contrasting of doorframes can assist in locating doors, and likewise floors should be contrasted with walls. In addition, furniture should contrast with walls and floors so as not to create an obstacle.
- Structural elements such as columns should be color contrasted or brightly marked so as to be visible to those who may have a visual disability.
- Generally, patterns on flooring should be avoided or else should be minimal and small to avoid visual confusion.
- In addition to identifying hazards or warnings, tactile floor surfaces can also be used to inform that there is a change in area (e.g. leaving a corridor and entering a boarding area).
- Tactile systems should be consistent throughout the building. For example, terminals should not have mats/carpeting in some areas and tile in others as this may create confusion for those who rely on tactile surfaces to guide them to their destination.
- Good lighting assists those with a visual disability to see better and allows people who have a hearing impairment to lip read easier. However, care should be taken to properly direct lighting and to use matte finishes on floors, walls and signage, so as not to create glare, which may create difficulties for all travelers.
- Blinds can be used to adjust lighting levels in areas where the natural lighting changes significantly throughout the day.

Signage

- Signs should be mounted between 1400 mm and 1800 mm from floor level. Braille signboards should be located between 1400 mm to 1600 mm for accessibility and touch for persons with visual impairments;
- The surface of the sign should not be placed behind glass nor should it be reflective.
- Signs should be raised wherever possible so that they can be read by touch;
- Contrasting colors should be used to differentiate the signage content from the background of the sign. Typically, white if used for the content and blue for the background. The colors must contrast with the surrounding surface to be clearly distinguishable. The color combinations red/green and yellow/blue should not be used in order to avoid confusing persons who are color blind;
- Audio signals should be installed at entry, exit and important movement junctions such as entrance lobby, lift, stairways, escalators etc.;

- Illumination levels on the sign surface should be in 100 - 300 lux range and shall be uniform. Signs should be located such that the illumination level on the surface is not exceeded by the ambient light or a visible lighting source from behind or in front of it;
- Sign typefaces must be standard, legible and clearly discernible. Only Sans serif family of fonts are recommended such as Arial, Helvetica Medium, Futura etc. Usage of too many type sizes on any one sign should be avoided. Italics or script texts should be avoided. The size of the letters must be in proportion to the viewing distance. Character width – to height ratio should be between 3:5 and 1:1 and the character stroke width-to-height ratio should be in between 1:5 to 1:10;
- The smallest letter type should not be less than 15 mm. All building entrances, house numbers and similar signage should be 150 mm; identification or directional signs should be 50-100 mm; while symbols should be at least 100 mm in height;
- Maps and information panels at building entrance, along roads and on public buildings should be placed at a height between 900 mm and 1800 mm; and
- Overhanging signs should allow a minimum clearance of 2300 mm to allow person with visual impairment to pass safely.

Elements of Signage Design: All signs should be treated consistently in terms of the basic principles used in determining their layout, specifically: lettering, color, shape, size, design and placement (Samarthyam, 2014). A detail of language and letters is given in Table 3.5.

Table 3.5 Elements of signage design.

Elements	Do's	Don't
Language	Should be clear, concise and unambiguous to enable ease of interpretation	Where words are required, 'Accessible' rather than 'Disabled' or "Differently Abled" is preferred as it promotes inclusion for all users. "Disabled Ramp", "Disabled Lift", etc. are not preferred rather the facility is used by persons with disabilities and reduced mobility, hence 'ramp', 'lift' marked by pictogram is required.
Letters	• Should be mix of Upper and lower case letters • Should be Left justified • Should be raised by 1 mm min. with Braille • Minimal use of bold type • Consistent font stem widths • Avoid italics, condensed text, light stems • Should have legible directional arrows	• Usage of too many type sizes on any one sign. • Italics or script texts.
Color	• Painting objects with contrasting colors can greatly enhance safety and ease of use. • The color combinations red/green and yellow/blue, in order to avoid confusing	• The recommended color contrast between the letters and background is a 70 point

	persons who are color blind. • Avoid using shades of the same color in the sign and avoid using same colors as safety signs.	LRV difference.

Accessibility symbol

The International Symbol of Accessibility (Figure 3.39) must be displayed at all accessible entrances. If an entrance is not accessible, directions to an accessible route, including the symbol, must be provided. Similar guidelines refer to elevators, evacuation and refuge areas, restrooms and bathing facilities. Symbols of accessibility are also required to identify volume control telephones, text telephones, and assistive listening systems. Colour to be navy blue with white lettering, symbols and border and size to be 200 mm x 200 mm square with 1.25 mm border. The specific pictograms shown in Figure 3.39 are required in certain signage situations. (TRIPP, 2012)

Figure 3.39 Symbols for accessible elements

Alternative formats etc. embossed letters with Braille and tactile

Braille, embossed letters, raised pictograms and raised arrows are tactile features that can be incorporated into signs, which can be particularly helpful to persons with visual impairment. This can occur in many ways but where signs are concerned a person who reads a sign tactually would want to experience all the information which is to be read as raised above the surface of the sign (Figure 3.40).

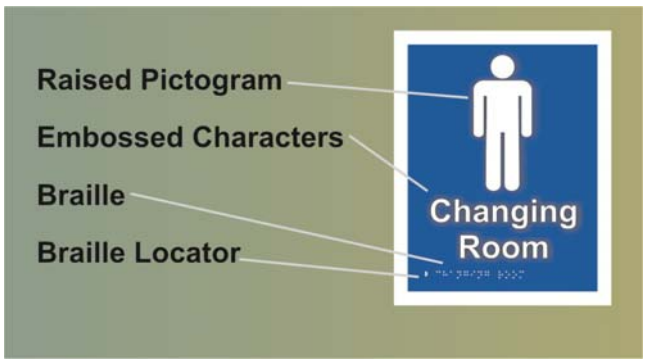


Figure 3.40 Braille signage Source: (CPWD, 2014)

This information would include pictograms, text and Braille or if the sign includes mapping elements then every element on the map would be raised above the element on which it is positioned. Such signs or directory layouts/maps need to be installed at appropriate heights and locations so that people in both standing and seated positions can access these.

Braille signage should not replace tactile/raised text signage as many people who are blind or visually impaired do not use Braille as their primary form of communication.

3.2.22 Street and Road Lighting

Well-designed street lighting enables motor vehicle drivers, cyclists, and pedestrians to move safely and comfortably by reducing the risk of traffic accidents and improving personal safety. Pedestrians, cyclists, rickshaws, and even some motorized vehicles do not have lights and depend on street lighting, not only to see but also to be seen.

From a traffic safety standpoint, street lighting is especially important in potential conflict points, such as intersections, driveways, and public transport stops. Additionally, lighting helps road users avoid potholes and missing drain covers.

Lighting should be designed to ensure that both the vehicular carriageway and pedestrian/cycle path are sufficiently illuminated. On roads and streets within urban areas white light sources should be used, such as metal halide, white SON, Cosmopolis and LEDs. Where orange (SOX) or softer honey (SON) coloured lights are currently used, they should be replaced with white light as part of any upgrade as white light highlights tactile pavers. Finally, from a personal safety standpoint, street lighting is essential for mitigating the pedestrian's sense of isolation and reducing the risk of theft and sexual assault. Thus, improved lighting is particularly important in isolated spaces such as under- and overpasses and walkways next to parks or dead façades.

Sufficient street lighting is rare, and even where it exists, infrequent maintenance reduces its effectiveness. Lighting systems need regular upkeep in the form of electrical maintenance, bulb replacement, and dust cleaning in order to remain effective.

The following design criteria and standards should be considered:

- Additional lighting should be provided at conflict points.
- The placement of street lighting should be coordinated with other street elements so that trees or advertisement hoardings do not impede proper illumination.
- Poles should be no higher than 12 m; especially in residential areas, they should be significantly lower than 12 m to reduce undesirable illumination of private properties.
- The spacing between two light poles should be approximately three times the height of the fixture, as indicated in the Table 3.6 and luminance criteria is given in Table 3.7.

Table 3.6 Light Pole Height and spacing options

Street type	Pole height (m)	Spacing (m)
Footpath or cycle track (< 5 m width)	4.5–6	12–16
Local street	8–10	25–27
Arterial or collector street (> 9 m width)	10–12	30–33

Table 3.7 Illuminance criteria for type of road

Classification	Type of Road	Remarks	Illuminance Criteria (Maintained Values) Eavg / Emin:Eavg / Emin: Emax
Cyclist Pathway	No motorized traffic	3m	50 lux
Pedestrian Crossings	Pedestrian Crossover Points	Clear Demarcated Zebra Crossings	50 lux
Bus Bays	Bus Alighting Points	Demarcated Bus Points	50 lux

Chapter 4. Access to Public Transport/ Transit Terminals

Public transport is sustainable, cost effective and environment friendly. The public transport systems- approach, vehicles, terminals and boarding/alighting locations should be designed to suit the needs of passengers. It is necessary that the system provided is universally accessible for its users.

Improvements that benefit people with impairments should be viewed as improvements that benefit all passengers. Offering 'Mobility for All' for use of buses, BRTS, and MRTS is a step towards inclusion and improved quality of life in cities. BRTS Guidelines by IRC should follow the universal accessibility norms given in the manual.

4.1 New Constructions and Existing Facilities

Standards for mobility improvement shall be applied when a facility is being planned/ under construction or remodeled on a large scale. Infrastructure such as new rail and bus stations and pedestrian facilities can be made accessible at negligible additional cost, if they are well-designed from the beginning. A good example is the Delhi Metro Rail system, which was designed to be inclusive and accessible. Timely implementation of access standards has made the system credible and replicable in other cities of India.

4.2 Essential Principles

Accessible infrastructure
Design standards for improving accessibility to and from the transit terminals and enhanced access to supporting facilities and services.

Accessible information
During travel, real-time information should be available visually and audibly at stations, at bus stops, and inside trains and buses. Travelers with visual impairments should have tactile and audible signage systems for orientation and way finding.

Access to Transit Terminals and Stations
These should have well-located signs with high-contrast large print to assist persons with hearing and visual impairments; icons to assist passengers who cannot read; a low ticket counter for use by wheelchair users and short statured persons. Tactile pavers should be provided to guide and warn- to and within transit terminals and stops. Tactile warning pavers to assist persons with visual impairments are mandatory, 300 mm before kerbs and 800 mm before platform edges.

4.3 Technical Design Standards

4.3.1 Bus Stand/Stop

General

- At least one accessible route should be provided from the alighting and boarding point of the bus stand to the walkway that leads to the accessible bus stand;

- Directional signs should be installed to direct persons with disabilities to an accessible entrance;
- Tactile guiding paver should be provided along the accessible walkway from the bus stand to the building entrance to aid persons with visual impairments; and
- The bus stand must have minimum illuminations level of 35 to 40 lux.

Approach

- Passenger walkways, including crossings to the bus stops (also, include taxi stands, terminal / station building, etc.) should be accessible;
- Uneven surfaces should be repaired and obstructions, if any, on the paths of travel should be removed to avoid creating new barriers. The obstructions or areas requiring maintenance should be detectable by a white cane, which is used by persons with visual impairments;
- The walkway should not have a gradient exceeding 1:20. The cross slope should also be not more than 5 percent;
- Texture change in walkways adjacent to seating by means of tactile warning paver should be provided for persons with visual impairments; and
- Avoid gratings in walks.

Location

- Bus stand should be located nearest to an accessible entrance; and
- The transfer from vehicle to the driveway, pathway or walkway should be blended to a common level or be ramped.

Passage width

- A clear passageway with a minimum width of 1200 mm should be provided.

Handrails

- Handrails should not be concealed by tree/ light pole, etc. (Photo 4.1). Handrails should be continuous to provide support while climbing up the kerb ramp of the bus stop Photo4.1 to 4.3).

Photo- 4.1 Handrails are not accessible due to incorrect placement

Seats

Seats should be provided at the bus stand for persons with ambulatory disabilities and persons with reduced mobility. These seats should be positioned such as not to impede the movement of

wheelchair users. Tactile paving should be provided to guide passengers with visual impairments to the seating areas.

Shelter

- A shelter should be provided at the bus stand for protection against adverse weather conditions.

Ramps

- Where a bus stand is not on the same level with the walkway or pathway, it should have two separate ramps for boarding and alighting; and
- Where there are kerbs between the access aisle and the vehicle pick-up space, it should have a kerb ramp.

Figure 4.1 Plan and layout of Bus stops with public amenities

Source: (ESCAP, 2002)

4.3.2 BRT Lanes and Stops

BRT designs should satisfy the following:

- Exclusive bus lanes must be provided in the center of the street except on small streets where mixed traffic runs as one-way on only one side of the street.
- The width of a BRT lane is 3.3m, plus buffer space next to mixed traffic.
- At crossings, a 1m pedestrian refuge between mixed traffic and a BRT lane is needed.
- Centrally located BRT stations require 3m (preferably 4m) in the cross section. Larger widths may be required if demand is high.
- Stations should be placed 37m or more off intersection stop lines to allow sufficient space for bus and mixed traffic queues.
- To achieve capacities as high as those of metro systems, passing lanes, substations, and express services are required at BRT stations.
- Cycle parking is needed at stations.
- Stop and bus level with precision docking is essential to get leveled entry for all users (Photo 4.2).
- Serious attention must be paid to finer details like ramp (Photo 4.3) handrail design, surface levels, contrasting colours, wheelchair movement, etc. for these can severely restrict or enhance accessibility for persons with disability.
- Various aspects of accessibility for BRT are given in Table 4.1

- For more details, IRC Manual on BRT should be referred to.

Photo 4.2 Level entry in BRT busses

Photo 4.3 Ramp entry in BRT busses

Table 4.1 Various aspects of accessibility to be taken care in designing BRT stop

Component	Impact on Accessibility	Possible solutions	Priority
1. Ramps to stations			
i. Crossing depth before ramp	The pedestrian crossing depth should accommodate wheelchair users.	Ensure that the pedestrian crossing is at least 1200-1500mm wide.	High
ii. Ramp slope	A slope greater than 1:12 makes it difficult for people with limited mobility.	Ensure a slope of at least 1:12. The ideal slope is 1:20.	High
iii. Ramp mid-landing depth	Inadequate mid-landing prevents wheelchair users from resting halfway up ramp	Ensure that if the ramp length exceeds 9m, a mid-landing area of the ramp width (or at least 1200-1500 mm) assists passengers with limited mobility to navigate the ramp into the station.	High
iv. Ramp landing in front of ticket booth	Wheelchair users require sufficient space to turn around in front of ticket booth. It is difficult for wheelchair users to wait on a slope, so providing a landing will allow a wheelchair user in line for the ticket booth to wait on	Ensure there is a level landing at least of 1200-1500mm between the top of the access ramp and the front of the ticket booth.	High

	a level surface.		
v. Wall adjoining ramp	A high wall obstructs the view of people with wheelchairs to see approaching buses along the bus ways. Railings along the wall can provide support to people with limited mobility. Adequate distance from the wall allows for comfortable hand grips of the handrail.	Ensure that the height of the adjoining wall along the access ramp is low enough for a person on the wheel chair to see. Consider redesigning the sharp profile of the wall to a straight edge. Provide continuous hand rails along entire length of the wall. Ensure top of handrail is 900mm above the ramp/ stair. Ensure that the railing is U-shaped and that the gap between the wall and the railing is at least 50mm.	Medium High High
vi. Tactile guiding pavers and warning Strips	All users would benefit from cues identifying the edge of the station, bus lane, mixed traffic lane and from cues for change in ramp slope gradients. It is hazardous to all users but especially persons with visual impairments, not to indicate where a staircase begins/ends.	Ensure that the guiding pavers have a clear obstruction-free path. Provide guiding pavers close to the hand rails along the ramps/ stairs so that persons with visual impairements can take support from it. Where tactile guiding pavers are already inserted, provide hand rails on one side for support. Extend the tactile guiding pavers across the bus way, road and sidewalks. They should be at least 300-400mm wide. Consider extending the tactile warning strips over entire width where the ramp slope changes and before the top and bottom step. The strip should be at least 560-600mm wide. Consider eliminating the tactile warnings on the stair treads.	High Medium High High

2. Station entrances and exits	Station entrance and exit widths should accommodate people in wheelchairs. Station ramps allow access for people on wheelchairs and are easier for people with limited mobility.	Ensure a minimum width of 900 mm at station entrances/ exits. Consider ramps on both sides of the station. If site conditions do not permit, indicate which side is accessible to people with wheelchairs through appropriate signage. It is preferable to have a ramp towards an intersection with enough distance for a refuge area of minimum 1500mm.	High
3. Ticket counters	A person in a wheelchair should be able to reach the ticket counter to communicate with the attendant. Softer edges of the counter are safer, especially for people with limited vision.	Ensure that the ticket counter is about 800 mm high, ideally with knee space for a wheelchair user, measuring approx. 500 mm deep and 900 mm wide, with 1200 mm clear space in front. A second row of holes in the ticket booth glass closer to the counter would enable wheelchair users, shorter people and children to communicate better with the attendant. Ensure the ticket booth glass is not reflective so that passengers can see the ticket booth agent's lip movements clearly. Lighting inside the ticket booth that illuminates the agent's face would help as well. Consider installing an induction loop or intercom system. Consider rounding the corners of the counter and providing colour contrast along the edge/corner.	High Medium
4. Fare Gates **i. Passageway width**	Wheelchair users require passageways at least as wide as their wheelchairs in order to pass.	Ensure a minimum clear passageway width (excluding doors) of 900mm beside the ticket booth.	High
ii. Fare gate configuration	If passengers can enter/exit from only one end of the station, proper signage is required. Turnstiles are not suitable for people with wheelchairs and flap gates are recommended.	Provide at least one entry and exit flap gate per station entrance. Allow persons with wheelchairs or persons with visual impairments through the door so that they have a direct route to the platform to enter or exit through the door.	High High
iii. Width of turnstiles / fare gates	Width of turnstile/ fare gates should be able to accommodate wheelchair users. Wheel chair users should be made to turn as little as possible at entrances and exits.	Ensure a direct path of at least 900 mm clear width as far as possible for people with limited vision and mobility. The station attendant can man the door. The tactile pavers should be planned accordingly	High Medium

5. Floor surface	A slippery floor can be hazardous to all passengers.	Use appropriate anti-slip flooring material that is effective even when wet, especially along the ramps.	High
6. Seats and supports	Absence of supports makes it difficult for old persons to move, sit down or get up. People with impaired vision are better able to identify objects with high visual contrast.	Provide continuous handrails on both sides of the platform and hand supports close to sitting areas. Ensure that the top of the handrail is 865-965mm above the floor. Consider improving visual contrast between edge/corner of benches and station walls/floor through material selection. Dark wooden benches against a lighter floor could be suitable.	High
7. Sliding doors	There might be a possible pinch hazard if the doors slide inside.	They should open outside the external walls.	High
8. Visual elements **i. Lighting**	All persons, especially people with limited vision and women benefit from sufficient lighting in and around stations.	Ensure adequate lighting inside and around accesses to the station, especially at night.	High
ii. Colour contrast	All passengers, especially the visually impaired would benefit from a visual warning at the edge of the platform, platform-bus gap and to distinguish key obstructions.	Consider colour contrast for railings, fare gates and ticket counter edges. A “safety colour” could be used.	
iii. Signage	Placing Route maps effectively can improve the movement in and around the station. Poor placement of maps can obstruct movement of passengers.	Consider placing BRT route map, fare details and other transit information at the bottom of the ramp before entering the station. Inside the paid area, consider displaying static route maps, showing the sequence of stations, perhaps above the bus boarding doors. These maps are also useful in the buses.	
	LED signs displaying dynamic passenger information are useful to all passengers, so long as the text is large enough to be read at a distance. Passengers with disabilities, especially wheelchair users, would benefit from being directed to the most accessible station entrance.	Ensure that messages displayed on the LED signs can be read from farthest points: bottom of the access ramp and opposite end of the station’s paid area. Alternatively, a double-side LED display could be mounted above the middle of the station paid area. Consider including a wheelchair icon in the bus shelter name sign at the ramped station entrance to identify the accessible entrance to approaching passengers. Consider using a wheelchair icon inside the station, on an overhead	Medium Medium Medium

		sign to direct alighting passengers towards the accessible exit.	
9. Audible Elements **i. Warning sounds**	Particularly helps people with limited visibility as they may not know when the doors will close and potentially hurt themselves.	Consider audible warnings to announce the opening and closing of sliding doors	
ii. Transit information	Particularly helps people with limited visibility as they would have to rely on others to know where the buses will dock.	Consider installing a public announcement system and speakers in the station platform area.	
10. Tactile Elements **i. Tactile Information**	Warning tiles indicate the edge of the station platform to persons with visual impairments and visually impaired	Ensure high contrast tactile warning strips to mark transition between sidewalks and traffic lanes, bus ways, station entrances and bottom or top of	High
	passengers. Warning tiles in a contrasting colour would benefit all users. Slim tactile warning strips can be easily missed. Tactile warning strips that extend all the way to the sliding doors could harm persons with visual impairments persons. Additional Braille signage could assist persons with visual impairments persons in independent movement.	ramps or stairs. Consider tactile warning strips of at least 560-600mm depth. Ensure the tactile warning strips end about 600-1000mm from the sliding doors. Ensure braille signage is installed preferably at all stations or at key stations for persons with visual impairments people.	High High
11. Platform to Bus Floor Gap	This poses a hazard for persons in wheelchairs.	Ensure that horizontal gap is not more than 50mm. Vertical gaps should be minimized as much as possible to no more than 20 mm. The platform-to-vehicle gap can be minimized by a combination of station and vehicle design, driver training, and ongoing vehicle and platform maintenance.	High

4.3.3 Grade Separated Transport (Metro, Monorail and Sub-Urban Rail)

General

- Access to railway/ metro stations should be provided by means of ramp, lift, and staircase at every entry and exit.
- Access to the stations should be made obstacle free and tactile pavers should be provided
- For persons with hearing impairments, an electronic signboard (digital display) along with visual signage (Figure 4.2) should be displayed on each platform, at strategic locations for all announcements made.

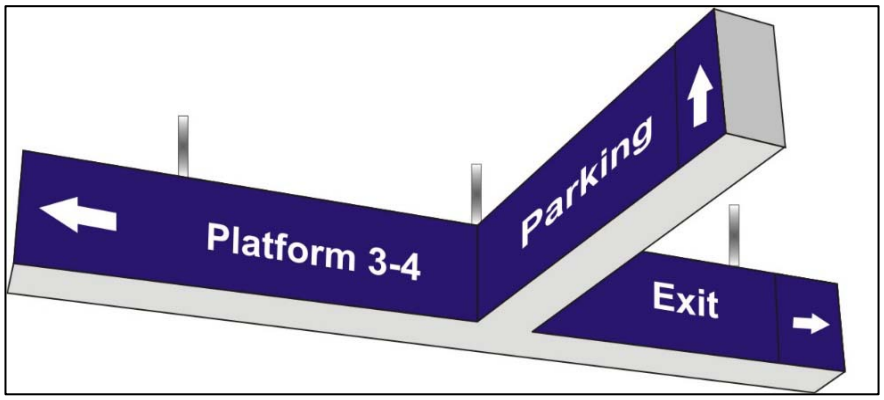


Figure 4.2 Way finding signage

4.3.4 Feeder and Para-Transit Stops

Taxi/Auto Rickshaw Stand

General

- All taxis to be made accessible for persons with disabilities by means of hinged ramp to take wheelchair users and/ or retractable steps to benefit senior citizens in climbing.
- At least one accessible route should be provided from the alighting and boarding point of the taxi stand to the walkway that leads to the accessible building entrance;
- Directional signs should be installed to an accessible entrance;
- Guiding pavers should be provided along the accessible walkway from the taxi stand to the building entrance to guide persons with visual impairments;
- The sign indicating the presence of a taxi/auto stand shall be on a vertical pole and the sign should be visible after dark- illumination of 35 – 40 lux level is required; and
- Where transfer has to be made from a vehicular surface to a pedestrian surface, the driveway, pathway or walkway should be blended to a common level or be ramped.

Passage Way

- Continuity of the pedestrian pathway shall have minimum width of 1200 mm behind the taxi stand.

Ramps

- Where a taxi stand is not on the same level with the walkway or pathway, it should have two separate ramps for boarding and alighting; and
- Where there are kerbs between the access aisle and the vehicle pick-up space, it should have a kerb ramp.

Seats

- Seats should be provided at the taxi stand for persons with reduced mobility and disabilities; and
- These seats should be positioned such as not to impede the movement of wheelchair users and persons with visual impairments.

Shelter

- A shelter should be provided at the taxi stand for protection against adverse weather conditions.

Chapter 5. Safety Elements

5.1 Common Barriers

Persons with disabilities encounter many difficulties and extensive barriers in walking areas. Some of the problems faced by persons with visual impairments in pedestrian environment are:

Encroached footpaths
• Cars parked on footpath
• Inability to read visual cues (e.g. street signs)
• Irregular, uneven or broken surface
• Traffic lights without audible or pedestrian sequence
• Lack of railings
• Imperceptible kerb cuts (dropped kerbs)
• Traffic hazards
• Surface textures (lack of tactile cues)
• Overhead obstructions (overhanging signs, cables, vegetation)
• Steep slope

Some common barriers faced by persons with reduced mobility and persons with disabilities are as follows:

Absence of adequate kerb ramp to footpaths/ or damaged, uneven, slippery or steep ramps	
On footpaths, uncovered manhole is a hazard to all, particularly children, unwary and persons with visual impairments	
Unmaintained footpaths are inaccessible for all pedestrians	

Zebra crossings obstructed by median fencing are unusable	
Mid-block crossing (median refuge)- without level waiting area and without tactile information can be a hazard for crowds, and also for persons with visual impairments	

5.2 Design Principles: Safety, Accessibility, Reliability and Affordability

Fundamentally, good design addresses user abilities, needs and preferences, using technology to put users' needs first. Good access practice has four design principles in common; it provides a travel environment that is Safe, Accessible, Reliable and Affordable (SARA)[2]. This can be done by integrating universal design elements, so that all pedestrian and transport environment, system, services and facilities:

(1) be used fairly;
(2) provide high degrees of freedom;
(3) be simple;
(4) be easy to understand;
(5) be safe;
(6) shall not require unnecessary body strength, and
(7) maintain an appropriate space and size that is easy to use.

[2]The concept of SARA was first formulated by Help the Aged, Transport Council, UK

Figure 5.1 SARA

By letting their work guided by these four principles, practitioners, planners and service providers can ensure that they are promoting improved access for everyone.

Table 5.1 provides details on how these principles may be applied.

Table- 5.1 Basic principles for Universal Accessibility

Principles	Addressing Issues	Recommendations
Safety	Removal of obstructions that could injure pedestrians/ commuters.	Visualize a continuous three-dimensional travel path that is clear from obstacles, such as signposts, potholes, trees and overhanging branches. Ensure vehicle entrances, aisles and seats are free from sharp or protruding edges.
	Provision of adequate warnings and information to prevent pedestrians/ commuters from getting into danger.	Where there are obstacles, which cannot be removed, provide clues to inform pedestrians of their existence by using highly contrasting paint or sometimes even by putting physical barriers in place.
	Prolong the time available to accomplish certain tasks.	-Provide longer signal settings for street crossings. -Metro train/ bus drivers should keep the vehicle stationary until passengers with walking difficulties have boarded the vehicles and have reached their seat.
	Improve security to assist girls and women.	-Provide adequate lighting at bus stops and stations. -Integration of formal and informal activities; like hawking zones/ vendor areas, along pedestrian streets to ensure active edges and eyes on street.
Accessibility	Clear the way of physical barriers, such as kerb at street crossings.	Users of wheelchairs, tricycles, crutches and walking sticks, require or prefer both a step-free surface and extra space to accommodate their mobility aids.

	Many persons have reduced physical strength or stamina.	The design and operation needs to promote ease of movement – including short walking distances along the most direct routes, no steep slopes, easy entry into vehicles, adequate provision of grab-bars and seats to rest on.
	Orientation, navigation and way finding- for persons with visual impairments and intellectual disabilities, visitors and occasional users.	Simple design and layout makes facilities such as pedestrian areas and transit terminals easier to use.
Reliability	Increasing the modal share of the public transport users.	Increasing the attractiveness of public transport system.
	Footpaths are not continuous/ do not lead to public amenities/ are broken, hence people who want to use public transport cannot access pedestrian infrastructure.	-Consistency across all the elements of a journey. -Attention to be paid to the whole trip chain.
	If a passenger with disability can use an accessible bus to get to work in the morning, s/he must be able to trust that an accessible bus will be available again for the trip home. Persons with reduced mobility and persons with disabilities, often have a more limited ability to respond to unforeseen circumstances.	-Reliability over time. -Timely, real-time information on expected waiting times, service changes or delays enhances their ability to make alternative plans if needed.
Reliability	If a rail station is advertised as being accessible through the installation of lifts, then the lifts need to be in working order to avoid users becoming stranded.	Mechanical reliability
	Accessible facilities/services are usually mixed with non-accessible ones; it becomes very important for passengers with disability to be able to ascertain beforehand whether a specific facility or service is accessible.	-Information reliability - Consistent use of the international accessibility symbol to identify fully accessible services is useful -Reliable signage in terminals or at stops benefits all users
Affordability	Transport systems with enhanced connectivity for all users, which is cost effective	- Prioritize walking and cycling infrastructure - Provide accessible public transport, which costs less and is affordable by many

Adapted from Overseas Road Note 21, 2004, UK

Universal accessibility also helps in breaking myths related to special provision and covers attitudinal aspects. Diverse users encounter diverse barriers and require specific access solutions. Barriers encountered by various users are listed in Table 5.2.

Table 5.2 Barriers encountered by diverse users

Icons	Condition	Require/use	Barriers encountered
	Mobility Impairments	Mobility devices- wheelchairs, walkers, crutches, calipers	Difficulty negotiating steps, climbing stairs, walking long distances and fatigue
	Visual Sensory Impairments	Sensory devices- white canes and low vision devices	Lack of orientation, navigation in open spaces, wrong location of wayfinding signage, audible announcements and fatigue
 	Speech and/ or hearing impairments include persons who speak in single words and are not able to speak in sentences and those who are deaf	Hearing aids -sign language interpretation and/or other support in communication	Lack of communication, visual displays, signage and fatigue
	Elderly/senior citizen	Human assistance, medical equipment and mobility devices	Lack of mobility, difficulty negotiating steps, climbing stairs, walking long distances, hearing impairments and fatigue

 	Cognitive difficulties. Also, people from out of town or unaccompanied children/ passengers	Lack of orientation, wayfinding and navigation	Ignorance, confusion, restricted mobility and fatigue
 	Temporarily disabled as a result of accident or disease	Mobility devices- wheelchairs, walkers, crutches, calipers, stick, etc.	Lack of mobility, difficulty in negotiating steps, climbing stairs, walking long distances and fatigue
 	Health problems (for example, respiratory, cardio-vascular, back or joint problems)	Might require human assistance, medical equipment and mobility devices	Lack of resting spaces, drinking water units, washrooms, inquiry/help desk and fatigue
	Carrying heavy luggage/loads	Accessible, safe and comfortable pedestrian and public transport infrastructure	Lack of mobility, difficulty negotiating steps, climbing stairs, walking long distances, getting up from low seats and fatigue

1. Abbreviations and Acronyms

BRTS- Bus Rapid Transit System
CSO- Civil Society Organization
DTC- Delhi Transport Corporation
FOB - Foot Over Bridges
IRC – Indian Roads Congress
IPT- Intermediate Public Transport
ITDP- Institute for Transportation and Development
IUT- Institute of Urban Transport
Km - Kilometer
m- Meter(s)
MCD- Municipal Corporation of Delhi
mm- Millimeters
MoUD – Ministry of Urban Development
MRTS- Mass Rapid Transit System
MSJ&E- Ministry of Social Justice& Empowerment
NDMC- New Delhi Municipal Council
NGO - Non Government Organization
NMT - Non-Motorized Traffic
NMV- Non-Motorized Vehicle
PRM- Persons with Reduced Mobility
PWD- Public Works Department
PwDs- Persons with Disabilities
RITES- Rail India Technical and Economic Services
ROW- Right of Way
TRB- Transport Research Board (of USA)
ULB- Urban Local Body
UNCRPD- United Nations Convention on Rights of Persons with Disabilities
UTTIPEC- Unified Traffic and Transportation Infrastructure Centre of Delhi
WwD(s)- Woman (en) with Disability (ies)
WHO – World Health Organization

2. Terminology

Access Aisle- An accessible pedestrian space between elements, such as parking spaces, seating and desks that provides clearances appropriate for use of the elements.

Accessible- A site, building, facility, or portion thereof that complies with the guidelines given in this Manual and that can be approached, entered and used by all people.

Accessible Route- A continuous unobstructed path connecting all accessible elements and spaces in a building or facility that can be negotiated by persons with disabilities. Exterior accessible routes may include parking, access aisles, kerb ramps, walkways and ramps. Interior accessible routes may include corridors, ramps, elevators, lifts, and clear floor space at fixtures.

Accessible Signage- Any visual way finding system incorporates architecture, landscape design, lighting, landmarks and orientation points. Signage is one key element of an effective way finding system and should be accessible to all users.

Automatic Door- A door equipped with a power operated mechanism and controls that open and close the door automatically upon receipt of a momentary signal. The switch that begins the automatic cycle may be photoelectrical device, floor mat, sensing device, or manual switch mounted on or near the door itself.

Beveled- Smooth, slanted angle between two surfaces; for example, a slant or inclination between two uneven surfaces to allow easy passage of a wheelchair.

Braille Signage- Is a specialist way-finding device that incorporates Braille as a primary source of information for people who are visually impaired and may be aided with raised tactile lettering, maps or pictorial Photos.

Braille- Braille system is a method that is widely used by persons with visual impairments to read and write.

Circulation Path- An exterior or interior way of passage from one place to another for pedestrians, including walkways, hallways, courtyards, stairways and stair landings.

Clear- Unobstructed, without any obstruction

Color Contrast- The basic guidelines for making effective color choices are based on the hue value of the colors. The most commonly used methods of achieving color contrast incorporate either ‘harmonizing’ or ‘contrasting’ color combinations.

Disability- An umbrella term for impairments (WHO, 2004), activity limitations, and participation restrictions, denoting the negative aspects of the interaction between an individual (with a health condition) and that individual’s contextual factors (environmental and personal factors). Disability is neither simply a biological nor a social phenomenon but arises from the relationship between health condition and context.

Footpath (Sidewalk)- A footpath is a path for pedestrians that are situated alongside a road or a paved pathway. Footpaths should be regarded as a transportation system/network, which is connected and continuous, just like roadways and railways. They should not be sporadically placed, but instead should be provided consistently.

Grab Bars- A bar used to give a steadying or stabilizing assistance to a person engaged in a particular function.

Handrails- A rail used in circulation areas such as corridors, passageways, ramps and stairways to assist in continuous movement.

Hue- The perceptual attribute associated with elementary color names. Hue enables us to identify basic color categories such as blue, green, yellow, red and purple. Persons with normal color vision report that hues follow a natural sequence based on their similarity to one another. With most color deficits, the ability to discriminate between colors on the basis of hue is diminished.

Accessible Washrooms (toilets)- A compartment having the basic requirements of a water closet compartment, wash basin and other essential washroom accessories as required by persons with disabilities.

International Symbol of Accessibility- the International Symbol of Accessibility consists square overlaid with a stylized Photo of a person using a wheelchair. The symbol is often seen where access has been improved, and the symbol denotes a barrier free environment for persons with disabilities, older people, parents with prams, and travelers with luggage. The wheelchair symbol is "international" and therefore not accompanied by Braille in any particular language.

Kerb (curb)- A raised edge along a road with a footpath, road median or road shoulder.

Kerb Ramp- A short ramp cutting through a kerb or built up to it, with footpath, at a gradient no greater than 1:10 on both sides of necessary and convenient crossing points.

Knurled Surface- Brush texture, often in a crisscross pattern; used on either door knobs or grab bars. On door knobs, it is used to provide tactile clues to persons with visual impairments to indicate that passage leads to an area of danger. On grab bars, it is used to improve grasp and to prevent slipping.

LRV- Light Reflectance Value (LRV) is the total quantity of visible light reflected by a surface at all wave lengths and directions when illuminated by a light source.

Luminosity Contrast- Also known as tonal contrast is an important element that assists persons with visual impairments to distinguish between two different surfaces. A minimum difference of 26 points in the LRV of colors of two architectural surfaces produces an adequate luminosity contrast that is perceivable by persons with visual impairments.

Lux- Standard unit of illumination. It is used as a measure of perceived intensity of light.

Operable Parts- A part of a piece of equipment or appliance used to insert or withdraw objects, or to activate, deactivate, or adjust the equipment or appliance (for example coin slot, pushbutton, handle).

Passing Places- A space on footpath, single track road or one lane road that permits two ways travels when it is not wide enough to allow wheelchairs/vehicles to pass one another.

Persons with Disabilities- A person with disability is a person with any physical, mental, intellectual or sensory impairment which in interaction with various barriers may hinder full and effective participation in society on an equal basis with others. The term “persons with

disabilities", consistent with the terminology used in the United Nations CRPD, is used throughout these guidelines.

Persons with reduced mobility- such as senior citizens; families with young children; unescorted children; persons with temporary ailments, medical conditions and hidden diseases; pregnant women; persons carrying heavy luggage and people with communication problems (including different linguistic and ethnic groups like migrants, tourists etc.).

Public Use- Describes interior and exterior rooms or spaces that are made available to the general public. Public use may be provided at a building or facility that is privately or publicly owned.

Ramp- An inclined pathway connecting one level with another.

Signage- An object containing a printed message and/or symbol. Signage and signs are used synonymously in this document.

Space- A definable area (for example, toilet room, hall, assembly area, entrance, storage, room alcove, courtyard, or lobby).

Table Top- Road raised to footpath/ footway level at crossing or with leveled.

Tactile- Means information and interpretations derived from the sense of touch. This involves sensory transfer through physical contact of the hands or feet with other surfaces, as well as sensory transfers received by contact with non-physical elements such as pressure, wind and temperature.

Tactile Paver/ Tiles (Tactile Ground Surface Indicators)- Provide a distinctive surface pattern of "strips" and "truncated domes" or cones (which are small domes or cones that have had their tops cut off, or truncated) detectable by long cane or underfoot which are used to guide/alert persons with visual impairments of their approach to facilities, streets and hazardous drop-offs. People with visual imapirements are alerted of impending danger from vehicle impact or a grade change.

Tactile Signs (Refer also to Braille Signage)- Incorporates raised text or symbols to enable touch reading by people who are blind, and touch enhancement of visual perception for people who are visually impaired.

Traffic Island- Can be a median strip, a strip in the middle of a road. It can also be a narrow strip between roads that intersect at an acute angle. Some traffic islands may serve as refuge islands for pedestrians.

Universal Design- Defined as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design".

Vision Impairment- Is any significant loss of sight.

3. References

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9) Harmonised Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disabilities and Elderly Persons, 2016, Ministry of Urban Development
10) Inclusive Mobility, UK
11) Interior lighting - Safe movement: AS /NZS 1680.0:1998
12) IRC 103: 2012, Guidelines for Pedestrian Facilities
13) ISOMA, http://www.isemoa.eu/
14) IUT Codes- Signage, Intersections, Road Marking, Cross Section and Traffic Calming
15) Lifts, escalators and moving walks – General requirements: AS 1735.1:2003
16) Overseas Road Note 21, DFID, UK
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18) Public Transport Accessibility Toolkit. New Delhi: TRIPP for IUT & MoUD, 2013
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21) United Nations Convention on Rights of Persons with Disabilities (UNCRPD)

APPENDIX 1

Checklist for Audits regarding Universal Accessibility on Urban Roads and Streets

Location:

List of roads audited:

Date of Survey:

Team:

No.	Item	Yes/ No	Comments
1	**WALKING PATH MODAL CONFLICT**		
	Any conflict with heavy and fast vehicles which prevents walking?		
	Is there a high risk of accident?		
	Any conflict with other slow moving NMT modes?		
2	**AVAILABILITY OF WALKING PATHS** **Whether footpath exists**		
	What is the condition of footpath?		
	What is the width of footpath?		
	Is the footpath clear of all obstructions?		
	Is the footpath clear of steps and stairs?		
	Is the surface level, smooth and non-slippery?		
	Does the footpath have a different color and texture from the adjacent surface?		
	Are all manholes placed outside the pedestrian path of travel?		
	If there are gratings, are the openings narrow, not more than 12mm?		
	Are the gratings perpendicular to the direction/path of travel?		
	Is the kerb height 150mm or less?		
	Is there any graffiti on side walls and or bad odour?		
3	**AVAILABILITY OF CROSSING POINTS**		
	What is the average vehicular speed on the road		

	Pedestrian Crossings		
	Are there Pedestrian Crossings at all intersections?		
	What is the distance between pedestrian crossings?		
	Is there any traffic calming treatment that starts 25m before zebra-crossing?		
	Mid Block Crossings		
	Is there a mid block crossing near transit/bus-stop locations, shopping areas, schools and/or community centers?		
	Do the mid-block crossings include signage visible from min. 100m distance?		
	Is there a pelican crossing- pedestrian initiated traffic light at the mid block crossing?		
	Table top Crossings		
	Are raised, table top crossings, level with pavement located at I. Slip roads? II. Where high volume streets intersect with low volume streets? III. At mid block crossings?		
	Are there raised driveways in front of buildings for level crossing to enter the property?		
	Foot Over Bridges		
	If there is a foot over bridge/ subway, for streets with high speed transit corridors like BRT etc, does it have a combination of either “staircase + ramp or stair-case + elevator?		
	Does the foot bridge ramp have a slope of 1: 12 max with min 1500x1500mm clear landing after every 9.0m run (1:20 preferable)?		
	Are handrails at 760-900mm height from the walking surface provided on either side of the ramp?		
	Is a tactile warning band provided 300mm from the top & bottom of the flight of steps, 300mm width min?		
	Are elevator/lifts provided at both entrance/exits with minimum clear internal dimension of 1500 mm X 1500 mm?		
	Do they have Braille buttons & Audio announcement systems?		
4	**QUALITY OF CROSSING POINTS**		

	Are the crossing points manned or signalized?		
	Is the road surface even and slip resistant at pedestrian crossings?		
	Are pedestrian traffic lights installed?		
	Is the crossing point grade separated without escalator/elevator?		
	Do traffic lights have both audible and visual signals?		
	Do traffic islands/ median refuges at pedestrian crossings have street-level footpaths cut through them with a minimum width of 1500mm? (Clear width 1200mm without bollards)		
	Are tactile warning provided on the refuge areas?		
	Is the crossing time adequate (more than 15 seconds for two lane and 30 seconds for four lanes)?		
	Kerb Cuts		
	Are kerb ramps provided when there is level difference, between the road carriageway and footpath level: a) Pedestrian crossings? b) Accessible parking space? c) Building entrances?		
	Are kerb ramps located at each corner of street intersections?		
	Is every kerb ramp faced by another kerb ramp on the opposite side of the street?		
	Is the slope of the kerb ramp no less than 1:12 with flared sides of 1:10 min slope?		
	Is the width of kerb ramp 1.2m min?		
	Is there 1.2m min landing for waiting before the kerb ramp?		
	Are warning tactile pavers provided before and after the kerb ramp?		
5	**AMENITIES**		
	Parking		
	Is there any accessible parking reserved for people with disabilities?		

	Are number of parking slots adequate (required ratio 1:20)?		
	Is the accessible parking within 30 meters of the entrance of transit station/building?		
	Is the international symbol of access, imprinted on the ground of the parking bay?		
	Is there a vertical, visible signboard indicating that the lot is for use by a disabled driver only?		
	Do kerb ramps connect accessible parking spaces with the side kerbs?		
	Are there pre-cast wheel stoppers or bollards to separate footpath from the parking?		
	Is the size of the parking 3600mm x 5000mm?		
	Is the drop off area marked by signage and kerb ramp?		
	Does the drop off area have warning signs for persons with vision impairment?		
	Lighting		
	Does the street lighting provide even lighting for clear visibility of footpath and obstacles?		
	Are the street lights in working condition?		
	Signage		
	Is there clear and legible signage and accessible route information at bus stops, with contrasting colours?		
	Are there clear and legible orientation signage and/or orientation maps?		
	Are there signs about availability of Public Transit and traffic signs?		
	Are there signs for public conveniences:- public toilets etc.?		
	Are graphic/ pictorial symbols/ Braille used in signage?		
	Are legible fonts and bright colour contrast used in signage?		
	Bus Stop		
	Is it accessible from the adjacent footpath and road? (Preferably should not interfere with 1.8m clear walking zone)		

	If there is a kerb at the bus stand, then is there a kerb ramp leading to the footpath?		
	Is there wheel chair space under bus shelter?		
	What all facilities are provided for benefit of persons with reduced mobility?		
	Trees		
	Are there trees that provide shade cover?		
	Are they located in the footpath/ obstruct views to signage/ traffic?		
	Site Furniture		
	Are there rest areas - benches available at 100m intervals and these are in good condition?		
	Are there dustbins, located near bus stops and intersections to avoid littering?		
	Signs, lights and shade available but can be improved with better placement and alignment?		
	Public Toilets		
	Are there public toilets- for men and women, located near the bus stops/markets?		
	Is the entry to Ladies and Gents toilet opposite (facing each other) or parallel? (Parallel toilets are preferred as it reduces women/ girls abuse possibilities)		
	Are there open urinals with ramps and doors 900mm min.?		
	Are there unisex accessible toilets?		
	Are these toilets wheelchair friendly?		
6	**ACCESSIBLE INFRASTRUCTURE**		
	Do traffic lights have both audible and visual signals?		
	Are Zebra crossings embossed (3D) to be detected by persons with vision impairments?		
	Tactile pavers		
	Is there a tactile paving band 300mm wide min with 5mm raised blisters/rails for persons with vision impairment to detect?		

	Is there a tactile warning band with raised blisters/domes, 300mm away from top and bottom of all kerb ramp/ steps/footpath and along all hazards provided?		
	Is a continuous tactile guiding strip provided at a distance of 600-800mm from the edge of footpath/Boundary Wall/ any obstruction?		
	Is the tactile paving band of contrasting colour with surrounding surface? (Canary yellow preferred colour)		
	Is warm white light (not yellow light) provided for tactile pavers to stand out in darkness?		
7	**SECURITY**		
	Is it a busy street/ active/ unused- what is the activity levels?		
	Is there adequate and even lighting with no dark spots?		
	Are there high walls, setback of buildings, tinted windows of commercial spaces, high compound walls or inactive edges?		
	Do the buildings open onto the street, active edges, low walls?		
	Are there hawkers?		
	Are there any recessed doorways, alleys, demolished or unfinished buildings which could be unsafe?		
	Is there a dead width /width of frontage provided? I. 1m wide space provided in shopping areas II. 0.5m next to buildings and fences III. In busy areas like bus stops, transit stations, recreational areas, etc. width suitably increased to account for accumulation of pedestrians?		
	What is the condition of vacant/unused land? Are there overgrown bushes and hedges?		
8	**MOTORISTS' BEHAVIOUR**		
	Do motorists disrespect pedestrians and encroach on pedestrian space?		
	Do they yield to pedestrians?		
9	**OBSTRUCTIONS**		
	Are there any protruding objects within the path of travel, not detectable by a person with vision impairment with white cane- For e.g., Culverts, transformers, junction boxes, trees, light		

	poles, sign boards, property entry exists, fences etc.?		
	Are the protruding objects, marked with tactile warning at least 300mm beyond the projection area of the obstruction?		
	Are all overhanging obstructions with the path of travel marked with contrasting colour?		
	Do hawkers or utilities occupy most of the space leaving very little space to walk?		
	Do parked vehicles block the footpath (temporary)?		
10	**ANY OTHER**		
	Metro/BRT Stations		
	Are there way finding signage for the stations		
	Is the approach to the station free of any obstruction and hazards guarded?		
	Is the entry to the Metro station accessible?		
	Are there equal risers and treads for steps?		
	Are the handrails provided on both the sides of steps and at two levels?		
	Is there a tactile warning band with raised blisters/domes, 300mm away from top and bottom of ramp/ steps / escalators provided?		