Government of Nepal

Ministry of Physical Infrastructure and Transport

Department of Roads

Maintenance Branch

Guidelines for facilities for blind and vision impaired pedestrian

2018

Forward

According to first sample survey, in 1980-81 in the eyes of (International Year of Disabled), the population of blind was estimated 0.84%. Likewise, according to recent National Population Senses 2011 the population of Blind is 96,000.

When moving around the pedestrian environment, visually impaired people will actively seek and make use of tactile information underfoot, particularly detectable contrasts in surface texture. Tactile ground surface indicators provide cues to alert, guide and assist pedestrians on the urban street footway network who have a visual impairment. A number of typical layouts for TGSIs at intersections, bus stops and mid block treatments on the road network can be the primary reference for design principles associated with the installation of TGSIs within the road network.

The purpose of guideline development is to provide best practice design and installation principles for pedestrian facilities that assist people who are blind or have low vision. Standardizing pedestrian facilities will give consistent directional and warning messages to blind and vision- impaired people, as well as increasing their safety while crossing roads and throughout the entire walking journey. All pedestrians benefit from consistent facilities that also meet the needs of mobility impaired users.

Therefore, "Guidelines for facilities for blind and vision impaired pedestrian" has been approved and has been recommended to follow, to address these issues/scenarios. The contribution of Er. Prabhat Kumar Jha, Senior Divisional Engineer, the Expert "Dr. Padam Bahadur Shahi" and; suggestions and experience shared by peer review team for finalization of the manual; is highly appreciated.

I hope the guideline will lead the Department of Roads better way to be more responsible to all type of pedestrians.

Thank You

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Er. Rabindra Nath Shrestha

Director General

Department of Roads

Acknowledgement

The Guidelines for facilities for blind and vision impaired pedestrian has been prepared with reference to IRC: 103:2012, Guidelines for Pedestrian Facilities; First revision, Indian Roads Congress, Guidelines for placement of tactile ground surface indicators, RDN 06-06 – JULY 2010; VICROADS, Australia., Design for access and mobility. AS/NZS 1428.4:2002; Part 4: Tactile indicators; New Zealand/Australia and many other relevant best practices.

These guidelines include planning, design and construction as well as maintenance of pedestrian facilities including the specific case for the blind as well as vision impaired pedestrian which shall be strictly implemented for ensuring the inclusive mobility. It incorporates various aspects of barrier free transport system.

These guidelines are intended to use by Municipal organizations for the ensuring the universal accessibility and social equity for sustainable transport.

The effort and dedication of Er.Prabhat Kumar Jha,(SDE); is highly appreciable. The support of review team members Er. Dip Barahi (SDE), Er. Ramesh Kuamr Singh (SDE) & Er. Narayan Pd. Lamichhane, is also acknowledged by the department.

And, also the department is grateful to Road Board Nepal for kind funding support for the manual preparation.

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1. Introduction

Pedestrian traffic in the context of developing countries is significantly higher than other trips. Therefore, Walking should be considered as an important mode of transport. Each of the journey start and ends as a walking trip. For the purpose of pedestrian facility footpath construction is taken as an important element of street design. Footpath design criteria should include the pedestrian characteristics such as speed, pedestrian size and others. As a universal right of people, pedestrian may be a person with disabilities for movement and vision impaired or blind person as well. Therefore, special design criteria shall be considered for all types of pedestrian.

A concept of accessible design of pedestrian facilities includes the planning, designing, operation and maintenance of such facilities and useable by everyone, including those with disabilities or using mobility aids. Pedestrians are most vulnerable road users from the road safety point of view. Moreover, pedestrians with disabilities are much more susceptible to any incident while moving along footpath. It is therefore, important to address various issues of pedestrian while providing facilities to them. Care has to be taken to construct facilities to pedestrian not only along the road and intersections, but also at the areas like work places, access to transport services, markets, schools and etc. In guidelines consider the cases for blind and vision impaired pedestrian.

1.1 Scope

These guidelines include planning, design and construction as well as maintenance of pedestrian facilities including the specific case for the blind as well as vision impaired pedestrian which shall be strictly implemented for ensuring the inclusive mobility. It incorporates various aspects of barrier free transport system.

These guidelines are intended to use by DoR/Municipal organizations for the ensuring the universal accessibility and social equity for sustainable transport.

1.2 Urban road network and pedestrian facility

Urban road network has been intensively expanded in recent years. Pedestrian traffic in the form of walking trips in Kathmandu and major cities of Nepal occupies significant portion of trip composition. Recent transport studies exhibited that walking trips are more than forty percentages in Kathmandu Valley. Footpath has been taken as one of the major component of urban road space or right of way. However, most of the arterial as well as urban streets do not have sufficient space for footpath. Furthermore, footpath space has been utilized for various purposes such as street vending, parking, and other activities. Most important feature of the footpath design should include the proper space distribution for various pedestrian activities.

Footpath along the urban road network shall be designed as per the pedestrian volume and nature of the street network such as street crossing, bus stops, parking lane and street junctions. Pedestrian facilities along the urban road network should be designed to accommodate the pedestrian activities while on the street such as for walking, for waiting at transit stations, for crossing streets and others.

1.3 Important principles of pedestrian facilities

Walking trips in an urban area are shall be planned, constructed and maintained with the great considerations of their functional attributes. Major principles of pedestrian facilities should take considerations regarding comfort, safety and continuity. Besides this main principle following points shall be taken into considerations as:

- Pedestrian facilities should be planned in such a way that these facilities shall ensure continuous pedestrian flow. It should be for pedestrian requirement of that area,
- Pedestrian mobility and safety for all types including those with disabilities and reduced mobility should be ensured to promote inclusive mobility and universal accessibility.
- Main objective of these facilities should be aimed at reducing pedestrian conflicts with vehicular traffic to the minimum. Design efforts should be made to create such conditions that pedestrian are not forced to walk in unsafe circumstances, and that the motorists reject the position of pedestrian.
- Planning shall consider the pedestrian convenience for ensuring the fully utilization of these facilities.
- Creating the pedestrian-friendly environment is one of the main items of a complete design. Engineering approaches for the improvement of quality of pedestrian movement should be taken in to considerations for all categories of pedestrian such as: children, families with young children, elderly person, persons with disabilities, and people carrying luggage and etc.
- Planning of regular maintenance of these facilities is one of the important components for sustainable pedestrian movement. All these facilities and design elements should be undertaken to maintain accessibility, reliability, usability, safety and continuity.

1.4 Pedestrian level of service

Quality of service tendered to the users is an important feature for any engineering amenities. Therefore, these amenities should be designed in greater consideration of user convenience and have to be qualitatively suitable to the user requirements. Most important features for the quality of service of footpath are as:

a. Physical features: footpath quality can be evaluated in terms of these physical parameters: footpath width, footpath surface, obstruction, encroachment, potential of vehicular conflict and continuity.
b. Environmental features: these parameters are as pedestrian volume, security, comfort and walking environment.

Pedestrian level of service (LOS) is referred as the quality of walking environment of a pedestrian space and service as a guide for development of standards for pedestrian facilities. Pedestrian space is designed in considerations of human convenience and has to be qualitatively suitable to the requirement of pedestrian. Planning and design considerations for pedestrian facilities are mainly based on the vehicular traffic flow theory. In addition to this concept, environmental factors related walking experience and perceived level of service such as comfort, convenience, safety and attractiveness should also be considered. Six level of service for pedestrian facilities are described as below:

i. LOS A: it refers the pedestrian environment where ideal pedestrian conditions are prevailing and the factors that negatively affect pedestrian LOS are negligible.
ii. LOS B: It is that realistic pedestrian condition which exists but a small number of factors impact on the pedestrian safety and comfort. As LOS A is the ideal, LOS B is an acceptable standard.
iii. LOS C: it indicates that basic pedestrian conditions exist but a significant number of factors impact on pedestrian on pedestrian safety and comfort.
iv. LOS D: it indicates that poor pedestrian conditions exist and factors that negatively affect pedestrian LOS are wide-ranging or individually severe. Pedestrian comfort is minimal and safety concerns within the pedestrian environment are evident.
v. LOS E: it indicates that the pedestrian environment is unsuitable. This situation occurs when all or almost all of the factors affecting pedestrian LOS are below acceptable standards.
vi. LOS F: it is the condition that all walking speeds are severely restricted, and forward progress is made only by distress. There is frequent, unavoidable contact with other pedestrian. Cross and reverse-flow maneuvers are virtually impossible. Flow is irregular and unstable. Space is more characteristic of queued pedestrian than of moving pedestrian streams.

The quantitative pedestrian LOS for footpath and threshold for cross walks are given in the ANNEX-II. The relationship between pedestrian flow characteristics of speed, flow and density are also illustrated in the ANNEX II.

1.5 Physical characteristics

Pedestrian facilities including footpath are important elements in the urban road network. These facilities shall comply with the following physical characteristics:

a. Footpath surface: an even surface without cracks or bumps for comfortable walking. All surfaces should be stable, firm, and slip resistant.
b. Footpath width: the footpath should be wide enough to accommodate pedestrian flow at any given point of time.
c. Obstructions: the obstructions can be an electric pole, tree, garbage bin, and hoardings. The locations of garbage bin, electric pole and any other feature like signage etc. should be on one side of the footpath so as to give a clear walkway to the pedestrian.
d. Encroachment: the informal commercial activities are an integral part of the footpath environment in Nepal. The pedestrian also need them as they cater to their day to day needs, but sometimes the extent of encroachment rises to a level of that the footpath facility becomes inaccessible or non-useable by the pedestrian. The informal sector has to be integrated in the overall design of the footpath facility by providing space for them to operate.
e. Potential for vehicular conflict: the footpaths need to be segregated from the roads, where fast moving vehicles ply. The two ways to protect the pedestrian from the vehicle conflict are the raised footpath and guardrails.
f. Continuity: the continuity of pedestrian facility is very important for the pedestrian with disability and of old age. Frequent kerb cuts along a street both impede traffic flow and create more conflict points between vehicles and pedestrian, thus reducing the effectiveness of footpaths. Frequent ups and downs

make the footpath uncomfortable to use by the pedestrian especially the old age and forces the pedestrian to share carriageway along with vehicles. The provision of kerb ramps is essential for continuity of the footpath.

1.6 User characteristics

Pedestrian characteristics shall be given the consideration while planning and designing the pedestrian facilities. Following parameters must be considered:

a. Safety and Security: the feeling of being secure is most foremost important factor. A pedestrian should feel safe during the day as well as night while suing a footpath or a crosswalk. Characteristics of this factor include provision of adequate street lighting, police patrolling during the night time and sufficient activities on the surrounding areas to ensure safety. Separation of pedestrian traffic and vehicular traffic with the provision of pedestrian's footpath ensures safety of pedestrian and ensures less chance of pedestrian from entering the carriageway even unintentionally. It is therefore, strongly recommended that pedestrian footpaths be provided on all new facilities, and on all existing facilities as far as practicable.
b. Comfort: A pedestrian needs to be protected from the extreme weather like harsh sun and rain. The trees protect the pedestrian but if planted in an unplanned manner also act as an obstruction. The location of trees and plants need to be carefully planned. Provision of chairs or benches, rain shelters and wash rooms is another factor that adds the comfort of pedestrian.
c. Walk environment: it is governed by the surrounding of the facility. The walking should be a pleasant experience. The footpath should be clean and free from stink.

2. Vision Impairments

This group includes people with low vision or blindness. Each category and in fact each individual will have differing functional capabilities. However the correct use of tactile ground surface indicators (TGSIs) will impact on everyone.

Vision Impairment: Vision impairment is often referred to as 'low vision'. Pedestrians with vision impairment may have decreased visual acuity, blurred vision, tunnel vision, 'colour blindness' and difficulty with glare. Therefore visual information must be clear and designed to accommodate all needs.

Blind: Pedestrians who are blind will generally be oriented to an environment before attempting to independently navigate. Tools such as a guide dog, a white cane, electronic navigation devices or a sighted guide may be used. All of these will require increased circulation space. Pedestrians who are blind maximize the use of their senses other than their vision, such as smell, hearing and touch to assist them to orientate to their environment. Therefore surroundings that impact on other senses need to be carefully considered.

3. Pedestrian facility design standards

In the context of urban road network pedestrian facilities should be planned, designed and constructed by the consideration of following standards.

3.1 Footpath

Pedestrian footpaths are referred as the area primarily used by all pedestrian. They can be adjacent to roadways or away from the road.

Footpaths should be considered as a transportation network system which is connected and continuous, as highways or railways. They should not be sporadically placed where ever convenient, but instead should be provided consistently between all major attraction, trip generators, and other locations where people walk. In order to be effective, the sidewalks should be provided on both sides of the road and above the level of the carriageway separated by kerbs. Height of the kerb at the edge should be 150 mm. however, not exceed the height of a standard public step riser.

3.1.1 Clear walking zone

Minimum width of the footpath should be 1.8 m wide to accommodate wheelchair users and person with vision impairments assisted by a sighted person or guide dog. This width could also allow an adult and a child to walk together. If existing paths are less than 1.8 m wide, provision of passing places shall be made at a reasonable frequency of size 1.8 m wide and 2.5 m long. Where the effective width is constricted by trees or walls path may be reduced to 1.2 m for short distances. This width is too narrow for persons to pass each other; hence provision passing places should be made frequently. A minimum 1.8 m (width) x 2.2 m (height walking zone should be clear of all obstructions both horizontally and vertically. No utility ducts, utility poles, electric, water or telecom boxes, trees, signage or any kind of obstruction should be placed within the "walking zone".

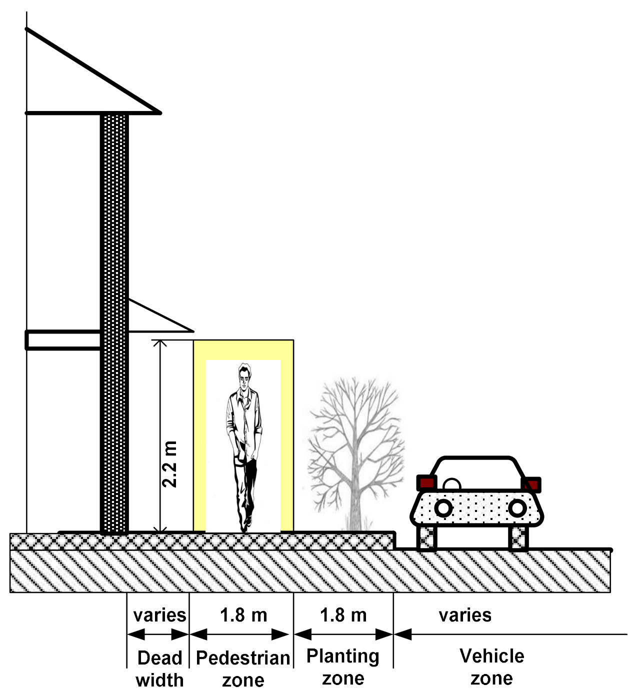

Figure 1Clear walking zone

3.1.2 Clear height

A clear height of 2.2 m is required for the entire width of the footpath walking zone. No tree branches, trees, utility poles, electric/water/telecom boxes or signage should be placed within the clear height and width of the walking zone.

3.1.3 Width

The width of the footpath is fundamental to the effective functioning of the pedestrian system. Without an optimum width, footpath will not help move enough pedestrian flows. The pedestrian flow capacity and width of the footpath is given in Table 1. Minimum width of a clear unobstructed footpath should be 1.8 m in roads of right of way of 10 m and above. This width allows two wheelchairs to pass each other easily. In the case of road with right of way less than 10 m or in the area with light pedestrian traffic, a width of 1.5 m is acceptable, giving enough space for a wheelchair user and a walker to pass each other.

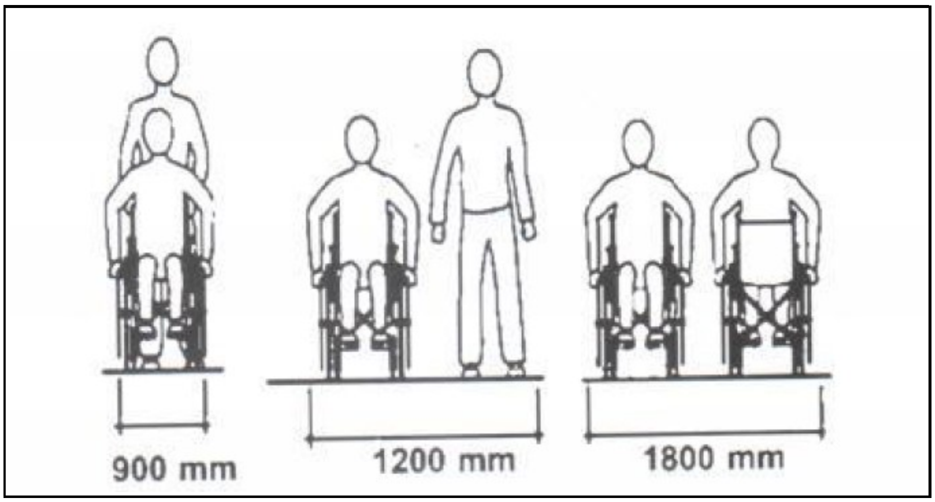

Figure 2 Minimum width required for a clear footpath

Footpath should normally be designed for the pedestrian Level of Service B, thereby providing wide pedestrian facilities for pleasant and comfortable walking. In case of resource constraints, Level of Service C can be adopted for deciding width of footpath as in Table 1. The width of the footpaths depends upon the expected pedestrian traffic may be fixed with as given in Table 1 subjected to not being less than 1.8 m.

Table 1 Footpath Capacity

Width of side walk (m)	Design flow of number of persons per hour			
	In both directions		In one direction	
	LOS B	LOS C	LOS B	LOS C
1.8	1350	1890	2025	2835
2.0	1800	2520	2700	3780

Width of side walk (m)	Design flow of number of persons per hour			
	In both directions		In one direction	
	LOS B	LOS C	LOS B	LOS C
2.5	2250	3150	3375	4725
3.0	2700	3780	4050	5670
3.5	3150	4410	4725	6615
4.0	3600	5040	5400	7560

(Source: IRC: 103-2012)

Generation of pedestrian traffic mainly depends on the adjacent land-use. Therefore, footpath width for the typical adjacent land-use is given in the Table 1Table 2

Table 2 required width of footpath according to adjacent land-use

Adjacent Land-use type	Minimum obstacle free walkway width (m)
Residential /mixed land-use areas	1.8
Commercial /mixed land-use	2.5
Shopping frontages	3.5 – 4.5
Bus stops	3.0
High intensity commercial areas	4.0

(Source: IRC: 103-2012)

3.1.4 Frontage zone or dead width

In shopping areas, an additional 1.0 m should be added to the stipulated 4 m footpath width. This extra width is called “dead width”. In other circumstances where footpath pass next to the building and fences, a dead width of 0.5 m can be added. In busy areas like bus stops, recreational areas, the width of footpath should be suitable increased to account for accumulation of pedestrian.

3.1.5 Surface quality

Paved and even footpath surface is necessary for the people using sticks or crutches or wheelchairs, or for the people walking with difficulty. Any obstacles like potholes, tree roots and storm water drains crossing the walkway should be removed for the safety and making it serviceable. The footpath surface paved with the tiles, bricks or concrete slabs should be even and vertical deviation between slabs should not exceed 5 mm.

3.1.6 Cross falls

Cross falls should only be provided where absolutely necessary for drainage purpose and should be 1:50 maximum. Steeper gradient 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 may cause the footpath to become slippery, lead to glare in bright sunshine after other parts of the footpath have become dry and become hazard in frosty weather. Any break in the surface should not be greater than 12 mm and should cross perpendicular to the direction of the movement.

3.1.7 Service covers

Service covers to the manholes and inspection chambers should not be positioned on footpath. They can be dangerous when opened for inspection, forming a tripping hazard and reducing the clear width. Covers and gratings should be non-slip, flush with the footpath surface, and be such that openings are not more than 10 mm wide. Grating and slot type drainage should be located away from pedestrian flows and perpendicular to the main line of pedestrian flows and perpendicular to the main line of the pedestrian so as not to trap small wheels.

3.1.8 Pedestrian guardrails

Pedestrian guardrails are important design elements to prevent haphazard crossing and spilling over of pedestrian on the carriageway. Their careful use can help to ensure that the pedestrian cross the street at predetermined and safe locations. Guardrails would confine the movement of pedestrian to the footpath, it is obligatory that sufficient width of footpath be made available in such conditions.

Design of guardrails should be neat, simple in appearance and so far as possible vandal proof. Height of the guardrail and the obstruction to visibility are main design considerations. Height should be sufficient so far as to deter people from climbing over it. The visibility of the approaching vehicles by the pedestrian as well as the visibility of pedestrian by drivers of the approaching vehicles should be adequate.

Pedestrian guardrails in reinforced cement concrete have been found to be common in urban locations. Iron tubes, steel channeled sections, polymer fiber railings and pipes may also be adopted so as to fit in with the environment or for better aesthetics.

Pedestrian guardrails are recommended to install in the following conditions:

a) Hazardous location on straight stretches: in busy reaches where the road is congested and vehicles move at a fast speed, guardrails should be provided on both sides of the carriageway so as to channelize the pedestrian on to the planned crossing locations.
b) At junctions/intersections: Railing barriers should be provided to prevent people from crossing the junctions diagonally at signalized intersections. The barriers must be opened only at the planned crossing facility (Zebra-crossing)
c) School /colleges: it is recommend to install guardrail near the school or colleges to prevent student from running straight into the road.
d) Bus stops: it is necessary to install guardrail near the bus stops or other places of pedestrian concentration so as to ensure pedestrian safety.

e) Overpass or subway: it is necessary to construct the guardrail to complain the pedestrian to use the overhead or subway crossing facilities.
f) Central medians: in the case of central median, guardrails are installed for the purpose of restriction of crossing the carriageway or it is also discourages the pedestrian from attempting the crossing.
g) Places of pedestrian concentration: the places, where pedestrian generation is high such as at supermarkets, cinema halls, transport hubs or terminals, guardrails are installed so as to streamline the pedestrian flow and ensure safety.

3.1.9 Obstructions

Obstructions on the footpath surface shall be properly distinguished by adopting the following design elements:

a) A straight shape raising from the footpath,
b) A 100 mm raised platform,
c) Tactile warning marking on the ground around the obstruction. The warning marking should extend over a width of at least 600 mm outside the projected area.
d) Manholes and other should be placed outside the path of travel should be placed along the continuous line.
e) Overhanging signs or vegetation should be mounted at a minimum height of 2.2 m,
f) Undetectable obstacles mounted lower than 2.2 m may project a maximum distance of 100 mm into footpath,
g) Protruding elements should be avoided. Bicycle stands should be located on a raised platform.
h) Fixed poles should have contrasting durable colour marking strip of 300 mm height, placed with the center line at a height between 1.4 m – 1.6 m.
i) Garbage bins attached to the lampposts should not face the line of pedestrian flow so as to minimize collisions and should be painted in a contrasting colour for easy identification by persons with low vision.

3.2 Kerbs

3.2.1 Kerb height

Maximum height of a pavement (including kerb, walking surface, top-of-paving) shall not exceed 150 mm from the road level, which is the standard anthropometric height of a public step. Medians should be maximum 250 mm high or be replaced by crash barriers.

3.2.1 Kerb radius and slip road (left turn pocket)

Smaller turning radii increase pedestrian safety in terms of reduction of crossing distances, increasing pedestrian visibility for driver, decreasing vehicle turning speed: and making drivers look out for pedestrian while taking the turn.

Maximum corner radius of kerb shall be 12 m, as this allows the movement of the largest size of trucks, buses and emergency vehicles. In the residential area, corner kerb radius may be reduced up to 6m.

Left turning slip roads provide at road junctions are meant for signal free movement of vehicular traffic. However, such left turning slip roads may make crossing by pedestrian and cyclist unsafe in case of high volume of left turning vehicular traffic.

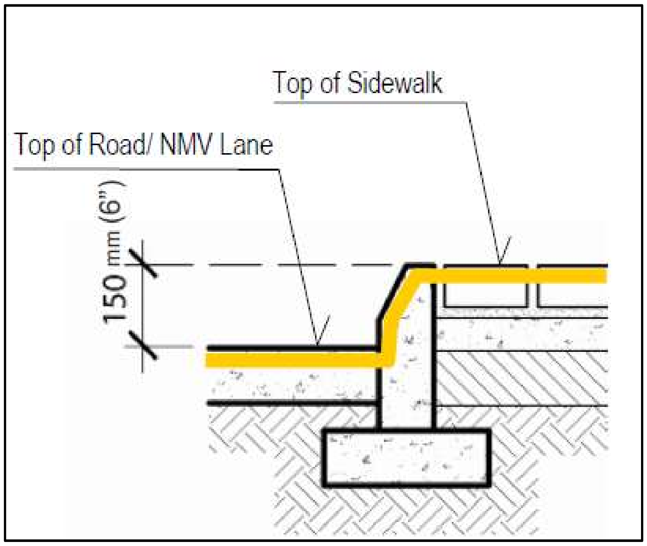

Figure 3 Maximum height of kerb

3.2.2 Kerb ramps

Kerb ramp is useful for a smooth transition, to overcome changes in level between the footpath and the road carriageway, at each pedestrian crossing on opposite sides of the street and in the vicinity of building entrances. Absence of kerb ramp prevents persons with disabilities and reduced mobility from crossing streets.

a) Standard kerb ramps are cut back into the footpath (flush with roadway) at a gradient not greater than 1:12, with flared sides providing transition in three directions. At street intersection and turnings kerb ramps should be provided.
b) Width of the kerb ramp should not be less than 1.2 m.
c) Tactile warning strip shall be provided on the kerb side edge of the slope, so that persons with vision impaired do not accidentally walk onto the road.

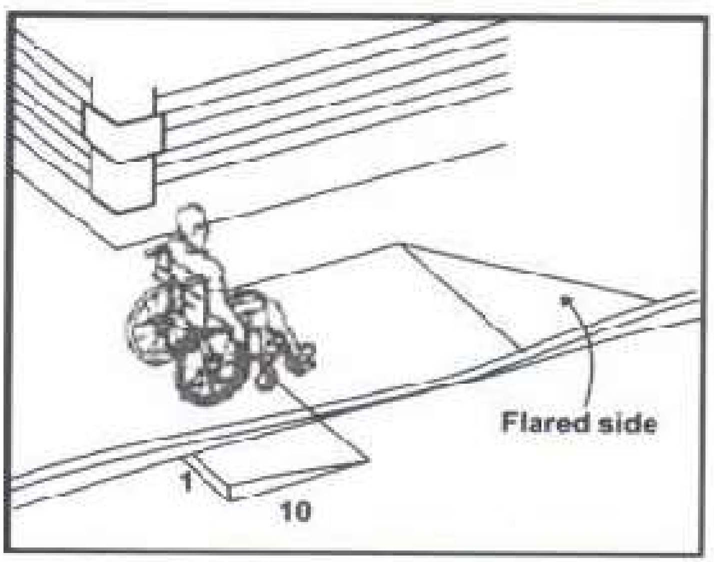

Figure 4kerb ramp

d) The ramps should be flared smooth into the street surface.
e) It is desirable to provide two cuts per corner. Single ramp located in the center of a corner is less desirable. Separate ramps provide greater information to pedestrian with vision impairment in street crossing.

3.2.3 Continuity and consistency

It is obligatory that footpaths to be continuous between junctions or where at-grade crossing is provided. A change in colour of pavers can emphasize and highlight the crossing area to all users. Consistency of design elements, colour and texture should provide visual continuity. Footpath interruptions must be avoided by minimizing cuts in kerbs. These act as traffic calming measures and make such conflict points safer. Continuity of the footpath shall be maintained as follow:

a) The paver on the footpath should be continued at the crossing with vehicular traffic by considering vehicle load,
b) The number of driveways crossing should be minimized,
c) The continuity of the footpath in the public right-of-way should be maintained,
d) Connections for missing links should be provided by installing footpath to connect pedestrian areas to each other.
e) Every changes in level of the footpath (steps, kerbs or cross roads) should be made clearly visible through the use of bright contrasting colour and tactile pavers for persons with low vision and vision impairment.

4. Tactile Ground Surface Indicators (TGSI)

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 available or when pedestrian need guidance around obstacles.

Tactile blocks are rectangular paving blocks with small extrusions or raised tactile nodules with an embossed profile that translates into information and guidance to the visually impaired, underfoot or by using a cane, when combined with other environmental information on the safe crossing of the road. TGSI mainly serves two purposes and should be exclusively used for the reserved use and insistently be installed in the same manner as per the guideline.

4.1 Luminance Contrast:

Majority of the people who are blind and vision impaired have some vision. The provision of sufficient luminance-contrast in the design of signage and the choice of TGSIs will enhance access to information for people with vision impairment and for all pedestrians. The use of luminance-contrasting strips on the nosing of stairs and other types of steps has been proven to improve safety for people who are vision impaired, as well as for all pedestrians.

TGSIs are laid for the specific use to assist the vision impaired pedestrian. General requirement for effective functioning, application of the TGSIs can be pointed out as:

a) It shall be detectable by tactile means,
b) It shall be luminance-contrast to the base of surface so that it would:

- Have not less than 30 % across its entire area, where TGSIs are of the same colour as underlying surface,
- Have not less than 45%, where discrete TGSIs are used,
- Where discrete TGSIs are constructed using two colours and materials the raised surface shall have a section that has 60 % luminance contrast for a diameter of 25 mm.

4.2 Hazard or warning TGSIs (Round shaped)

Hazard warning TGSIs are constructed for the purpose of warning to vision impaired pedestrian of the hazards on the footpath. Main characteristics of the warning TGSIs are described as:

a) They are to be placed across the full width of the direction of travel at the top and bottom of stairs, ramps, escalators and moving walks and to highlight overhead obstacles.
b) They should be between 600 mm and 800 mm deep and set back 290 mm to 310 mm.
c) These TGSIs themselves must be made according to a specified design and arrangement standard (height no more than 5mm above base, dot spacing at 50mm, slip resistant, high luminance contrast and no likelihood of edges lifting).
d) Standard size of the hazard TGSI is shown in
e) Figure 5.

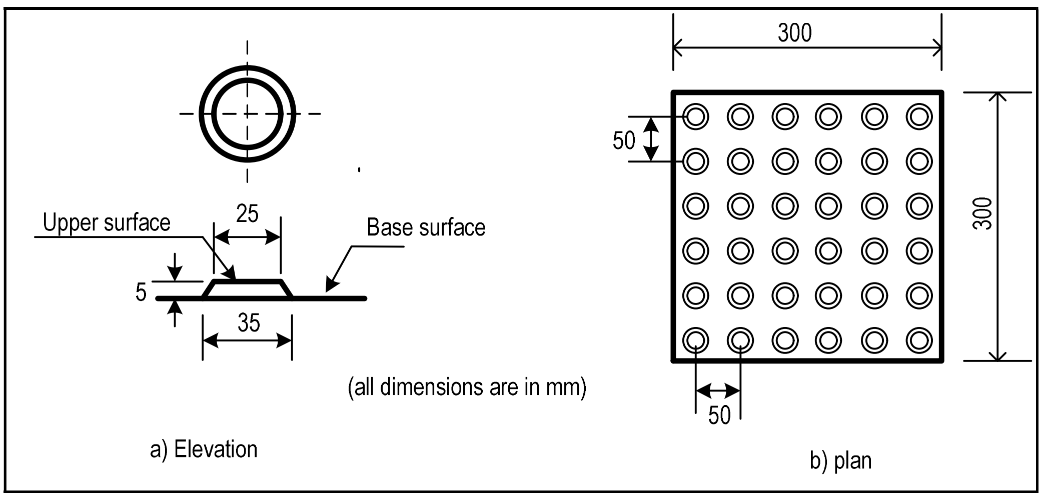

Figure 5: Warning TGSI (Size: 300 mmx300 mmx40 mm)

4.3 Directional TGSIs (Strips)

Directional TGSIs are laid along the footpath for the purpose of assisting vision impaired pedestrian to walk forward. Main characteristics of directional TGSIs are as:

a) Used to designate a route to be taken to avoid a hazard or to indicate a path of travel across an open space. They are prescribed for application in transport settings.
b) A standard size of the directional TGSI is in
c) Figure 6.

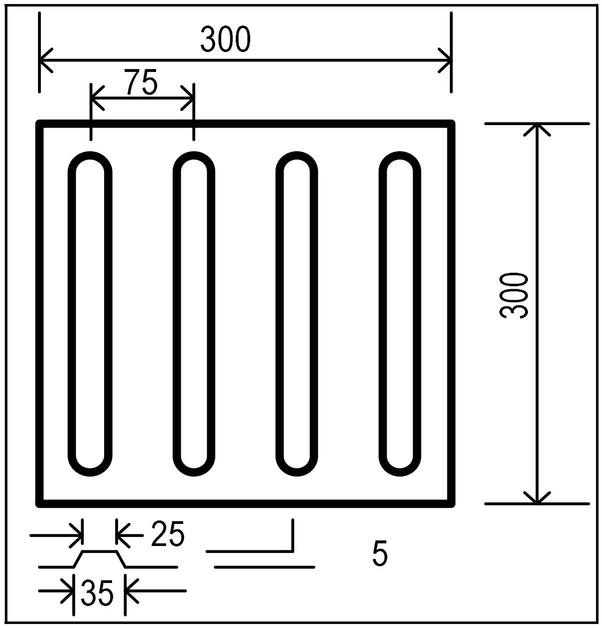

Figure 6 Directional TGSI (size: 300 mmx300 mm x40 mm)

5. Criteria and Application of Warning TGSIs

Specific requirements for the design, construction, application and functioning of TGSIs are given in the sub-topics below:

5.1 Application of warning TGSIs

Warning TGSIs should be used to warn of hazards such as the following:

a) Life threatening hazards where serious falls may occur, such as at railway platforms or wharves.
b) Overhead hazards that protrude into the continuous accessible path of travel, such as the underside of a staircase that is unprotected. Wherever possible an architectural treatment should be used, e.g., the installation of a railing, seating or railing.
c) Suspended hazards that protrude into a continuous accessible path of travel, such as a telephone booth, drinking fountain, fire hose reel or the like. Such hazards should be installed out of the continuous accessible path of travel.
d) Vehicle hazards on roadways that are not separated from pedestrian access ways by a change of grade, such as vehicular driveways that intersect with clear continuous accessible paths of travel from large vehicular precincts, where a motorist's vision is limited, e.g., exits from car parks.

Warning tactile ground surface indicators should be used following directional indicators, to indicate that a point of importance has been reached, such as:

a) The location of a bus stop; or
b) The location of a change of direction on a pedestrian crossing island associated with a side lane crossing.

5.2 General Requirements for Warning TGSIs

General requirements for the warning TGSIs are as follow:

a) TGSIs shall be laid so that there is no likelihood of the edges lifting.
b) Where the TGSIs are placed across the direction of travel, to ensure they are detected, they shall be arranged as in
c) Figure 5. The dimension is 300 mm X300 mmX 40 mm.
d) A TGSI shall be slip resistant.
e) TGSIs shall have top surface no more than 5mm above the base surface.

5.3 Design and Installation Requirements for Warning TGSIs

The design and arrangement of warning tactile ground surface indicators (TGSIs) shall comply with

Figure 5. The warning TGSIs shall be installed by considering the following criteria:

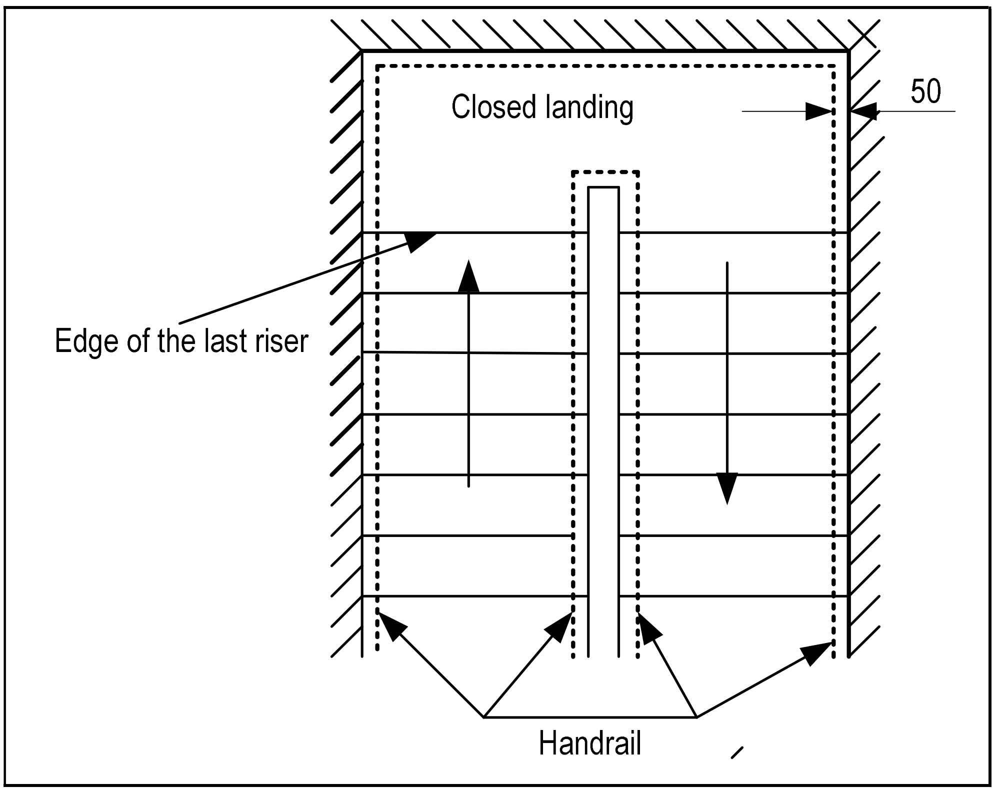

Figure 7 Plan of installation of an enclosed stairway with handrails all around (TGSI not required)

a) It should be installed for the full width of the continuous accessible path of the travel.
b) It should be perpendicular to the angle of the approach to the hazard.
c) Set back shall be 300 mm from the edge of the hazard,
d) It should be laid on the intermediate landings for stairs, stairways and ramps. Where handrails provided on both sides of the stairs or ramp and are continuous around the landings (e.g., not broken by a doorway or the like), TGSIs are not

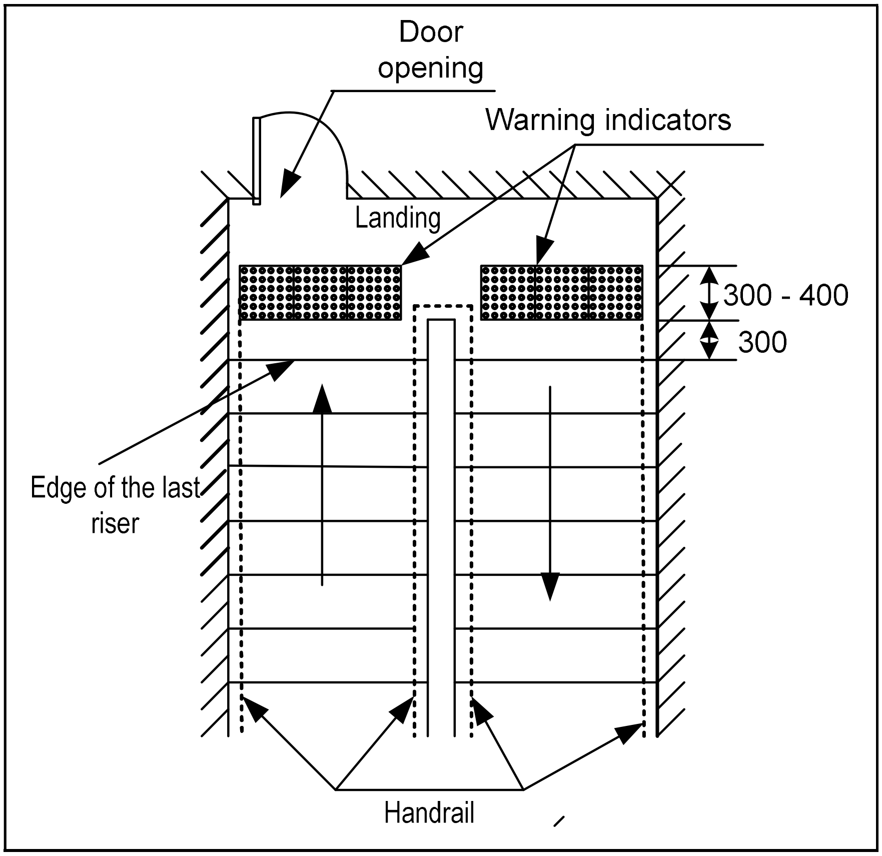

Figure 8 Plan of Installation of Warning TGSIs at a stairway

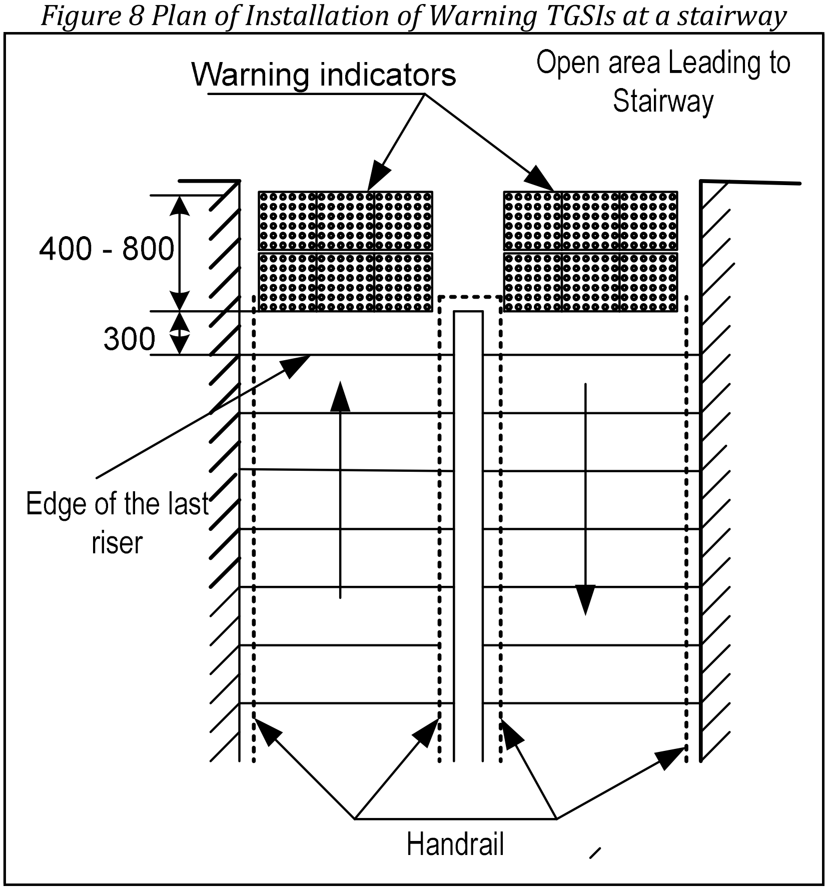

Figure 9 Plan of installation of warning TGSI at open area leading to stairway

required on intermediate landings. Examples of these are shown in Figure 7, Figure 8 and Figure 9.

e) Where integrated warning TGSIs are used, they are arranged over a squared size of 300 mm to 400 mm and where discrete warning TGSIs are used, with a minimum of 6 discrete warning TGSIs.

f) Where integrated warning TGSIs need to be detected by a person approaching at an angle to the continuous accessible path of travel, the TGSIs shall be arranged as shown in Figure 10 over a minimum distance of 600 mm to 800 mm (with a minimum of 12 discrete warning TGSIs) in depth from the direction of approach.

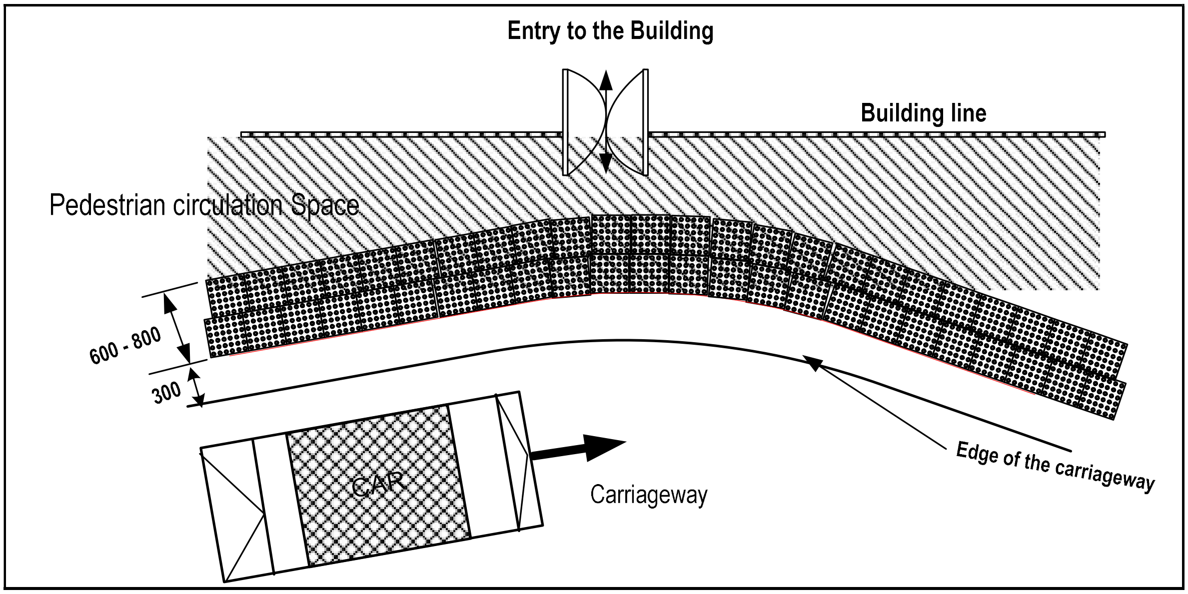

Figure 10 Warning indicators along Carriageway at the same grade

5.4 Warning TGSIs installation at Ramps and Stairways

Warning TGSI shall be installed at the continuous accessible path of travel, at the top and bottom of the stairways and ramps. Typical installations at the ramp and stairways are shown in Figure 11 and Figure 13respectively.Warning TGSIs for hazards in the circulation space is shown in Figure 12.

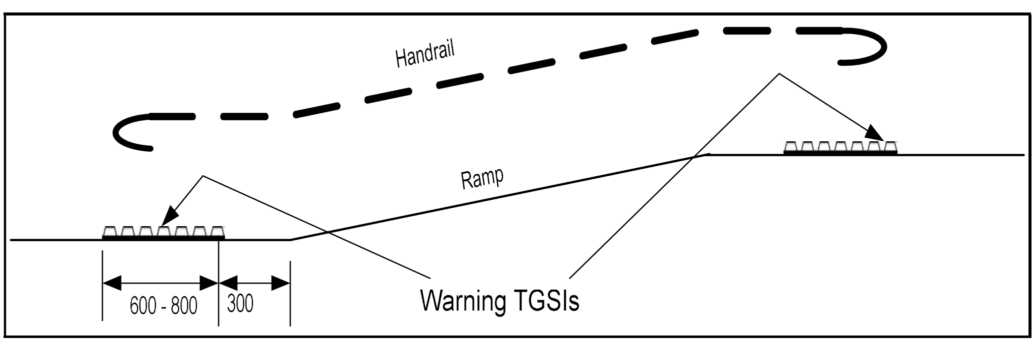

Figure 11 Side elevation of ramp with installed warning TGSI

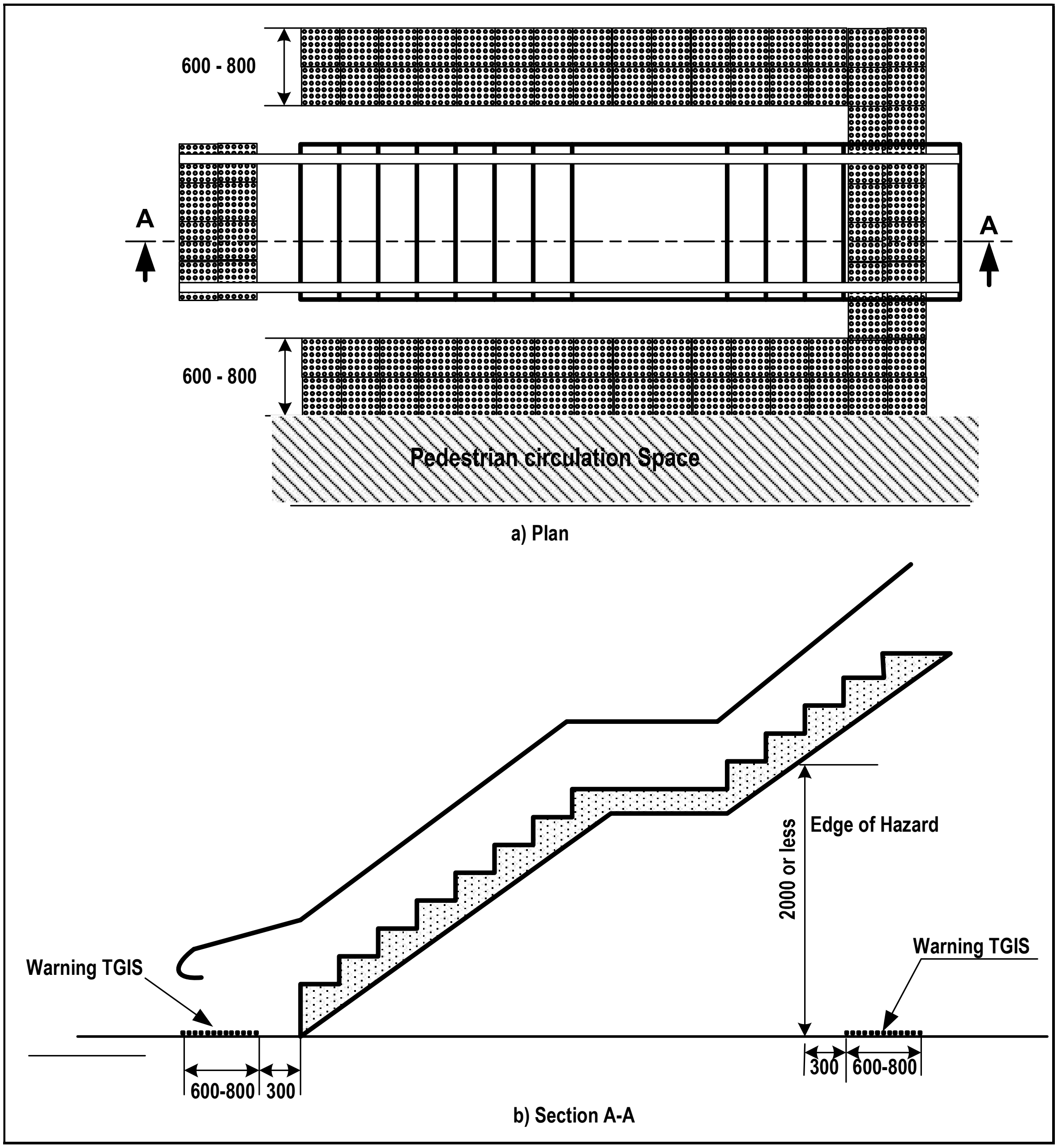

Figure 12Tactile Indicators warning of hazards in a circulation space

6. Criteria and Application of directional TGSIs

Directional tactile ground surface indicators (directional TGSIs) shall be installed as applicable for the following cases:

a) to give directional orientation in open spaces where there are insufficient tactile directional cues, e.g., handrails or walls;
b) to designate the route to be taken to avoid a hazard in the absence of existing tactile cues; and

c) to give directional orientation where a person must deviate from the regular continuous accessible path of travel to have access to:
    - a mid-block kerb ramp or street crossing;
    - public transport access point, e.g., bus, tram or light rail stop ;
    - point of entry to a significant public facility, e.g., railway station, public hospital, community health center, sports or entertainment venue or public toilet.

d) Additional directional information may be provided by the use of raised pavement markers, refer to **ANNEX IV**.

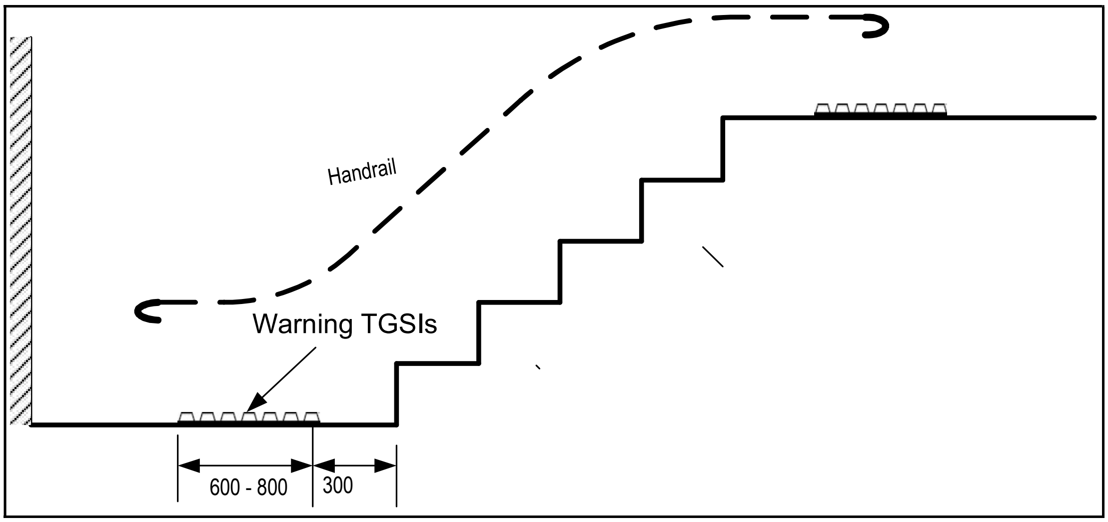

Figure 13: Warning TGSIs: staircase ends at open area and bottom is enclosed

6.1 General requirement

Criteria and application of directional TGSI following general conditions shall be considered:

a) Directional TGSIs shall be laid so that there is no likelihood of the edges lifting.
b) Where directional TGSIs are placed across the direction of travel, to ensure they are detected, they shall have a dimension of 600 mm to 800 mm, as described in subsections below.
c) A directional TGSI shall be slip-resistant,
d) Directional TGSIs shall have the top surface no more than 4 mm to 5 mm above the base surface as shown in (see Figure 14).
e) The base surface of an integrated directional TGSI shall not be more than3 mm above the abutment surface of the surrounding floor or ground surface.

6.2 Placement of directional TGSI

Placement of directional TGSIs shall comply with the following conditions:

a) Directional TGSIs shall be installed parallel with and along the centre-line of the required direction of travel.
b) Where integrated directional TGSIs indicate the continuous accessible path of travel, they shall be arranged according to Figure 14over a distance of 300 mm to 400 mm in width.

c) Where integrated directional TGSIs need to be detected by a person approaching at an angle to the continuous accessible path of travel, the directional TGSIs shall be arranged as shown in Figure 14 over a minimum distance of 600 mm to 800 mm in depth from the direction of approach.
d) Where discrete directional TGSIs are used, the arrangement shall be as shown in Figure 14 with a minimum of 4 discrete directional TGSIs to indicate a continuous accessible path of travel.
e) Where discrete directional TGSIs need to be detected by a person approaching at an angle to the continuous accessible path of travel, the directional TGSIs shall be arranged as shown in Figure 14 with a minimum of 8discrete directional TGSIs.
f) Drainage gaps shall have a width of 10 ± 2 mm and be located not more than600 mm apart.

6.3 Change of direction

At the point of the change of direction of a continuous accessible path of travel with the directional tactile ground surface indicators, this point shall be indicated by warning indicators as shown in Figure 15.

6.4 Change of direction

The combination of directional and warning TGSIs shall be installed at the bus as shown in Figure 16.

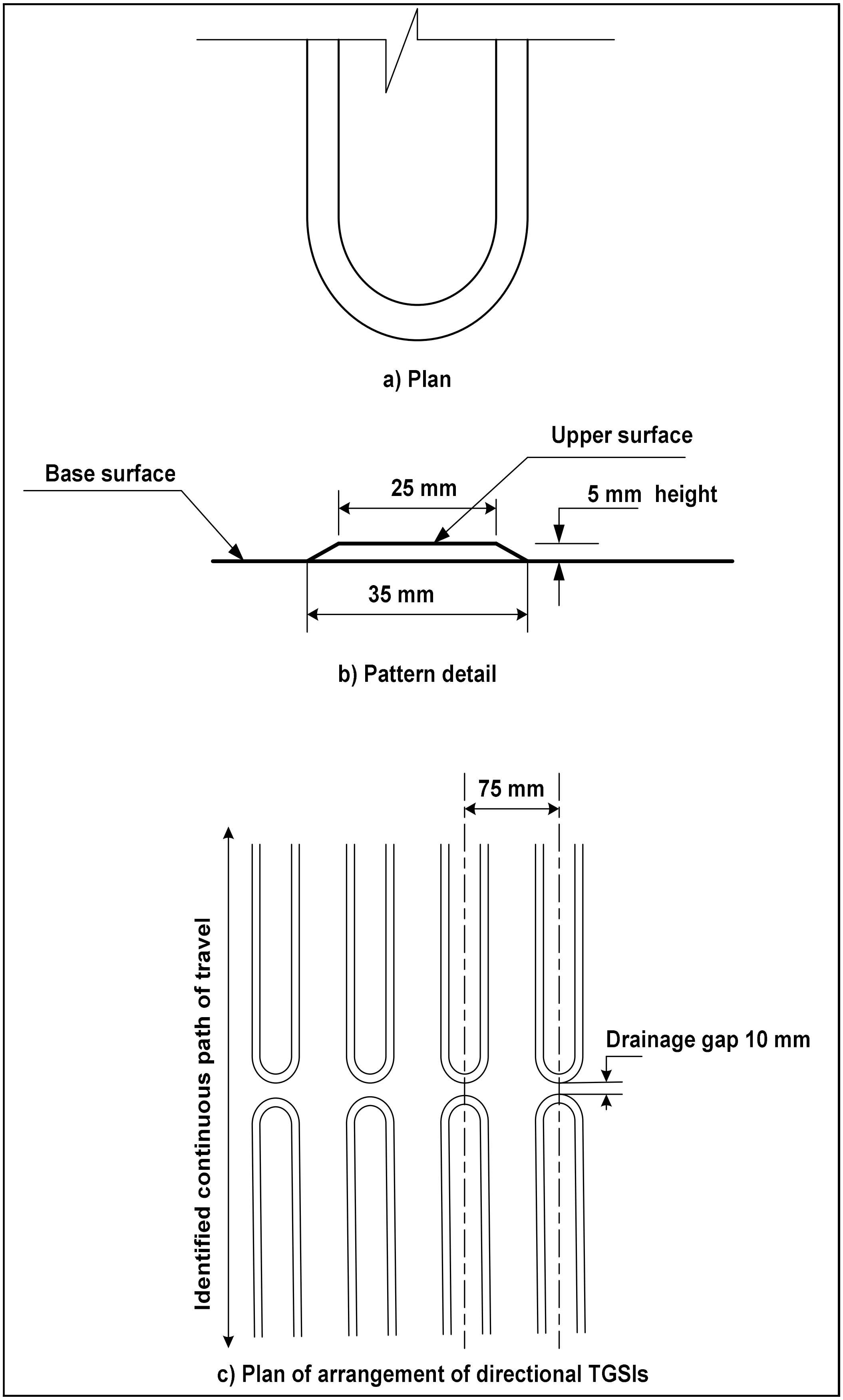

Figure 14: Design and arrangement of directional TGSIs

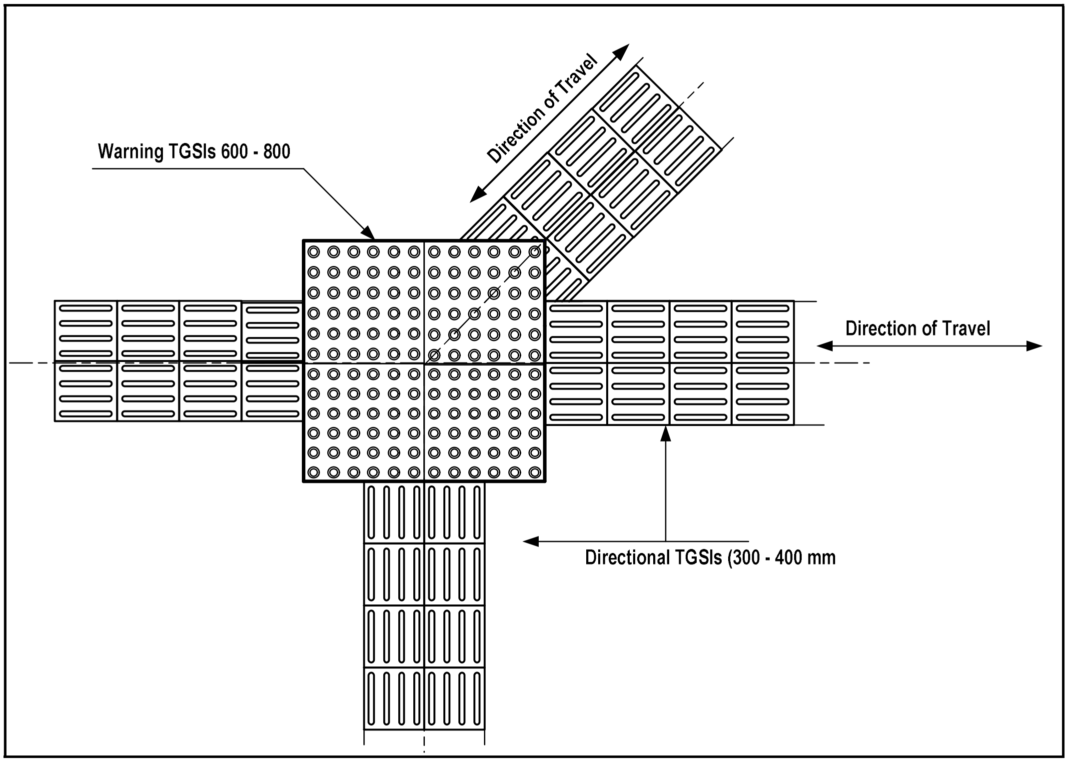

Figure 15: Installation of TGSIs at the point of change of direction

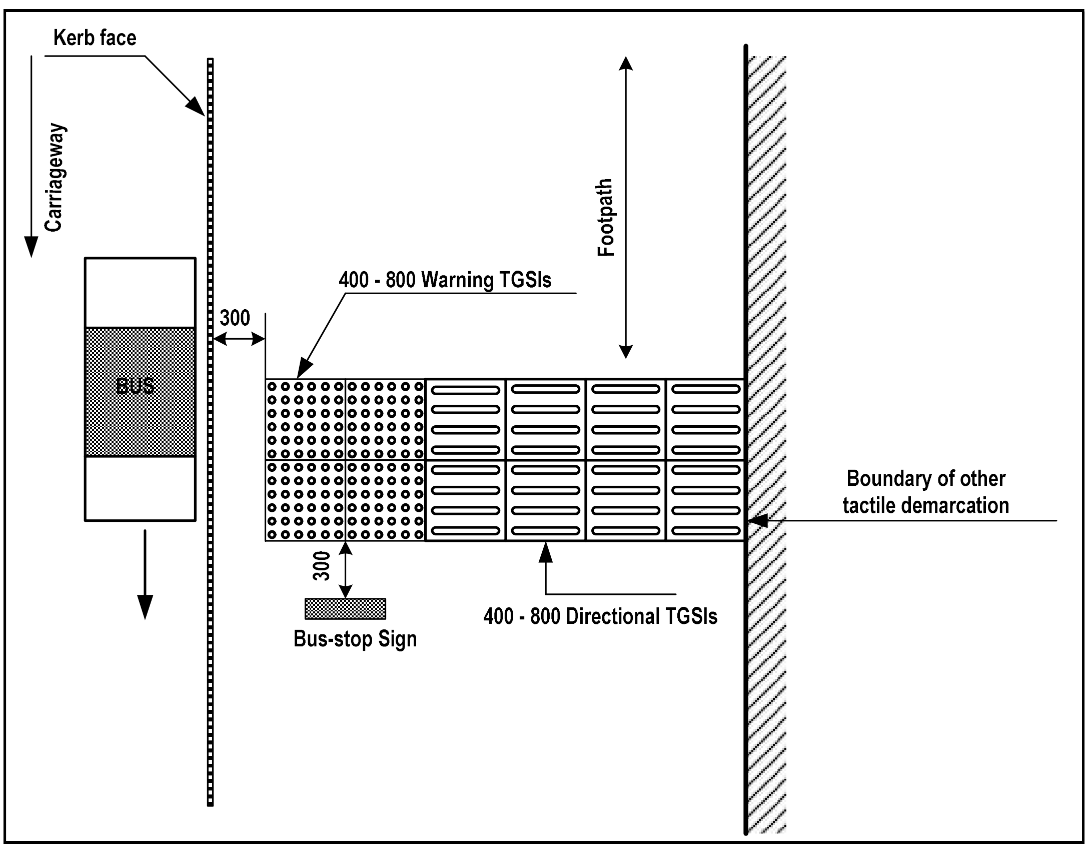

Figure 16: Installation of TGSIs at Bus-stops

7. Design of Kerb Ramps

An alternative point of entry to the roadway should be established for blind and vision-impaired pedestrians at the kerb adjacent to a kerb ramp and within the confined path of travel on the road. Examples of the placement are given in the paragraph below. Warning TGSIs should be provided at right angles to the path of travel for a minimum of 900 mm and for 600 mm to 800 mm in the direction of travel. These indicators should be set back 300 ± 10 mm at the closest point from the beginning of the roadway. The placement of TGSIs at the kerb ramp shall comply with the following requirements:

a) Where the upper entry point of a fully compliant ramp with a gradient of between 1:8 to 1:8.5 is within 3 m of the property line, TGSIs are not required (Figure 18).
b) Where the gradient is shallower than 1:8.5, warning TGSIs should be provided as shown in *Figure 19*, Figure 20 and *Figure 21*.

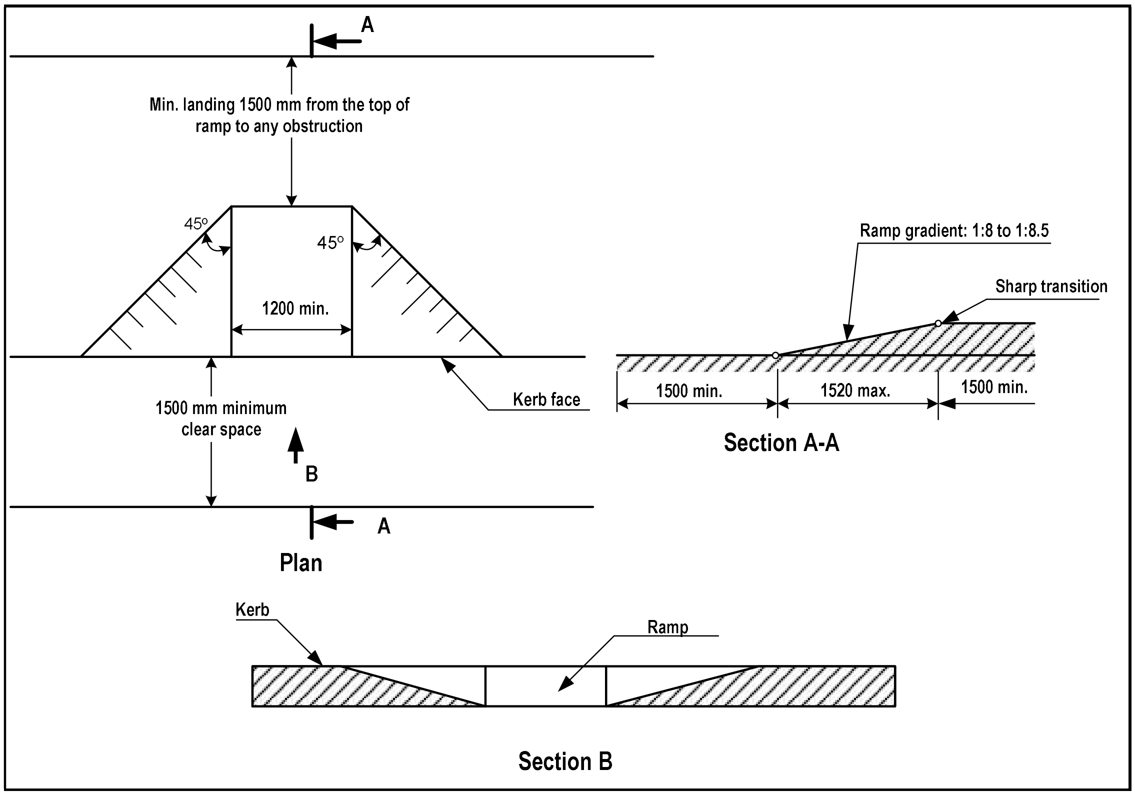

Figure 17: Design criteria for kerb ramps

c) Where the top of the ramp is more than 3 m from the property line, directional indicators (600 mm to 800 mm wide) should be provided from the property line to the top of the ramp. As shown in *Figure 22* and *Figure 23*.
d) In the case of mid-block crossing TGSIs are installed as shown in

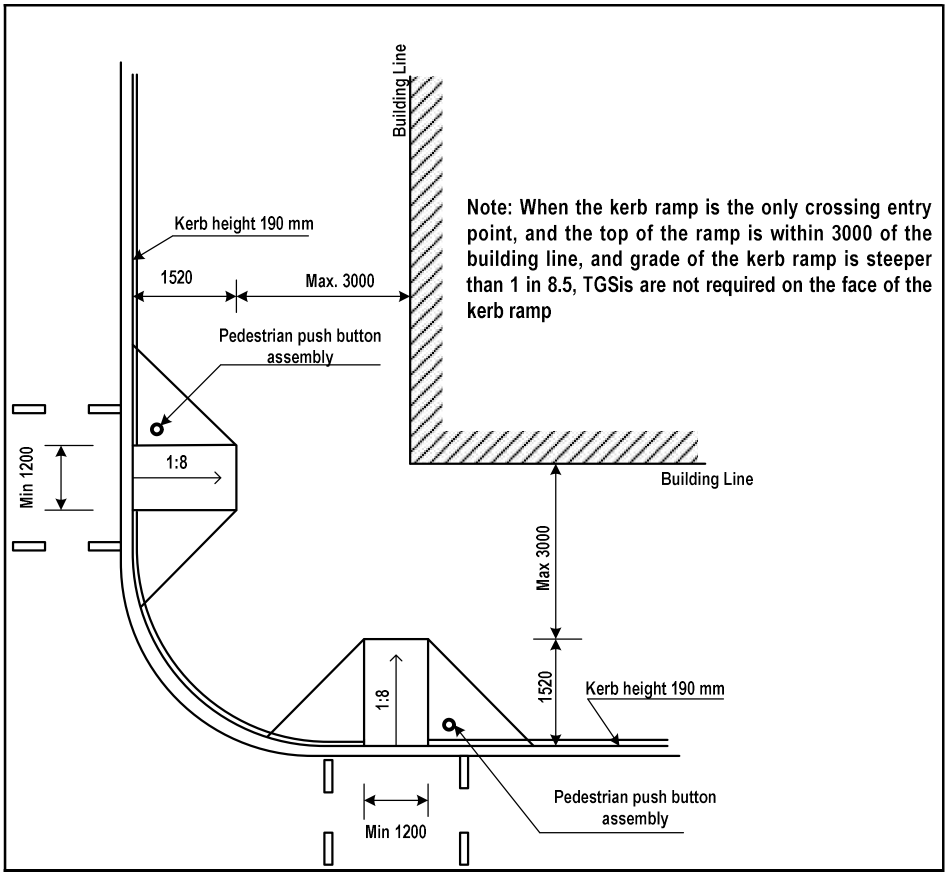

Figure 18: Right angled intersection & top of the ramp within 3 m of the building line

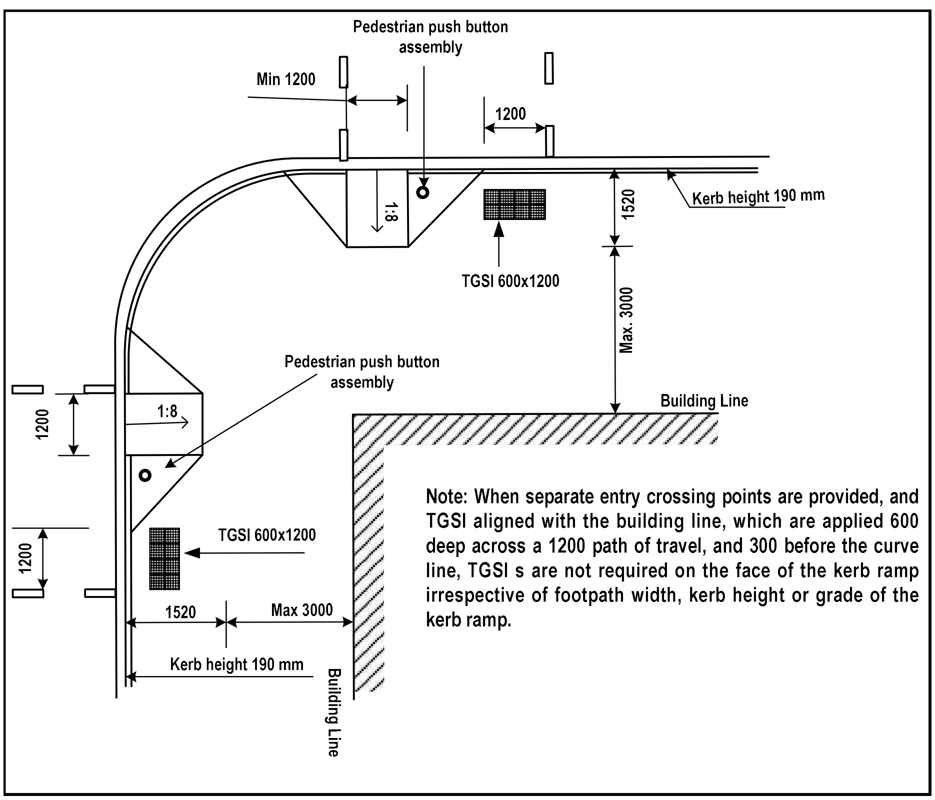

Figure 19: Right angle intersection &, dual separate entry crossing top of the ramp within 3m of the building line

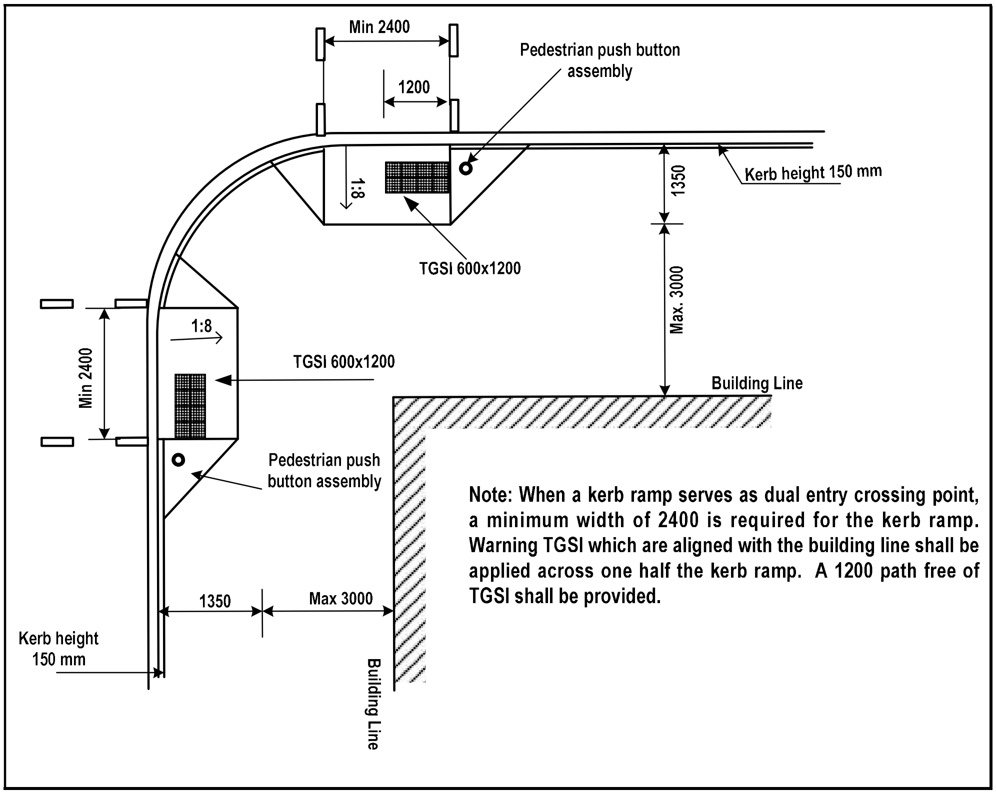

Figure 20: *Right angle intersection, dual entry crossing, 150 kerb height, 1:8kerb ramp, top of the ramp within 3000 of the building line*

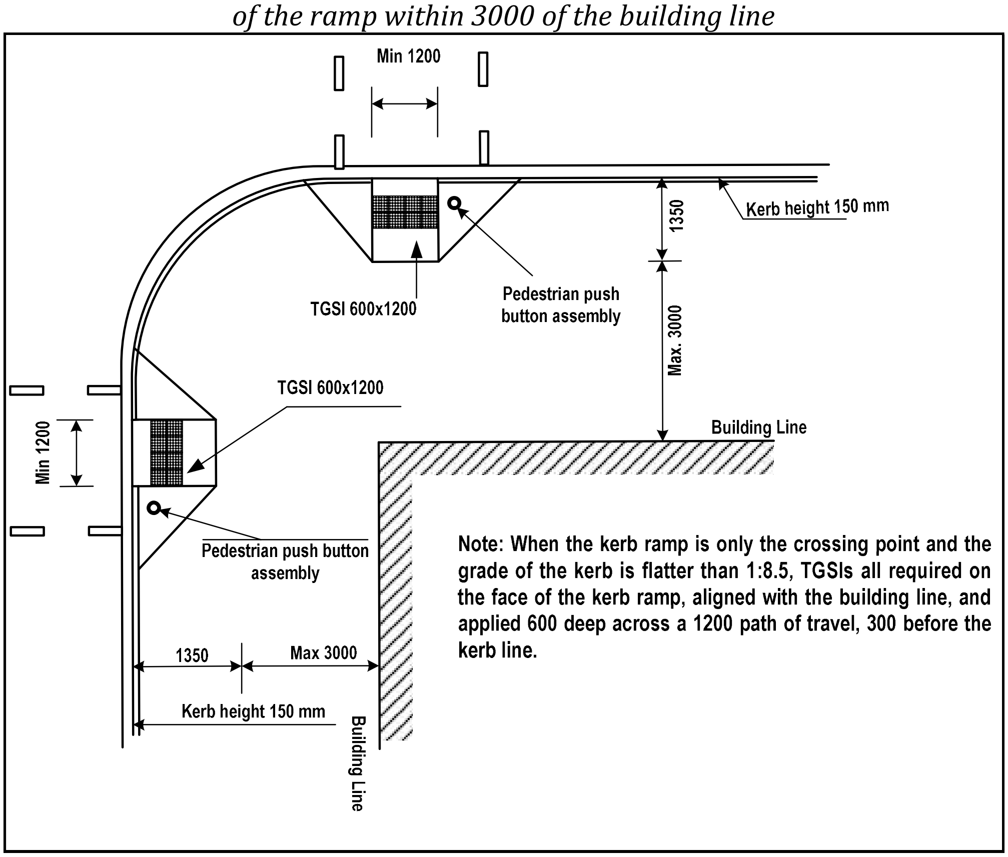

*Figure 21: **R**ight angle intersection, 150 kerb height, 1:9kerb ramp, top of ramp within 3000 of the building line*

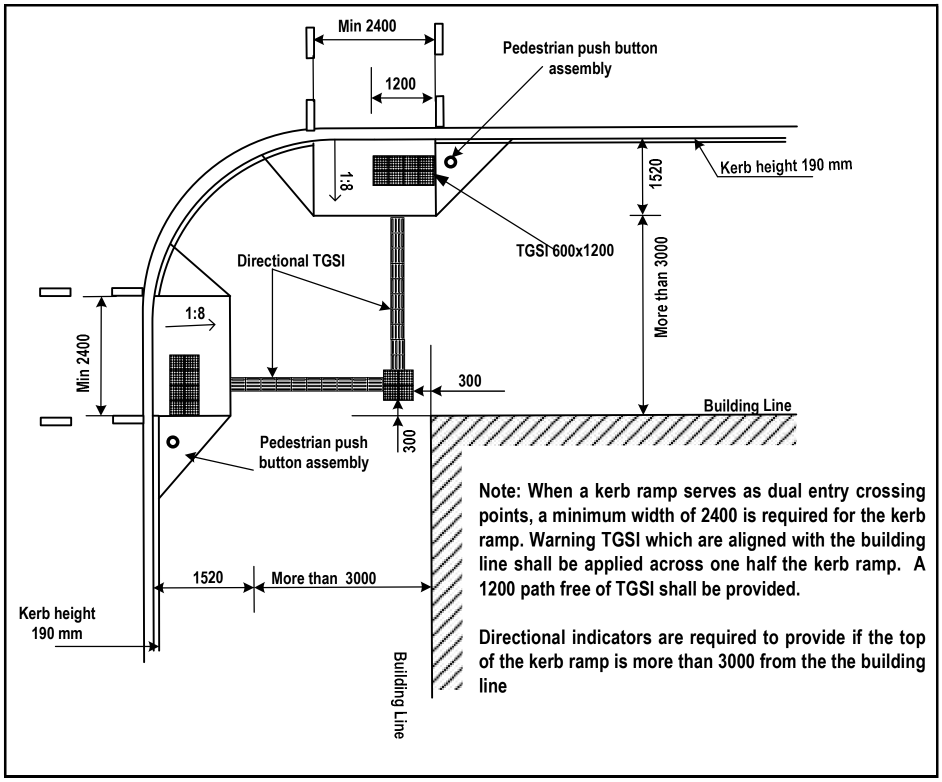

Figure 22: Right angle intersection, dual entry crossing, 190 kerb height, 1:8kerb ramp, top of the ramp greater than 3000 form the building line

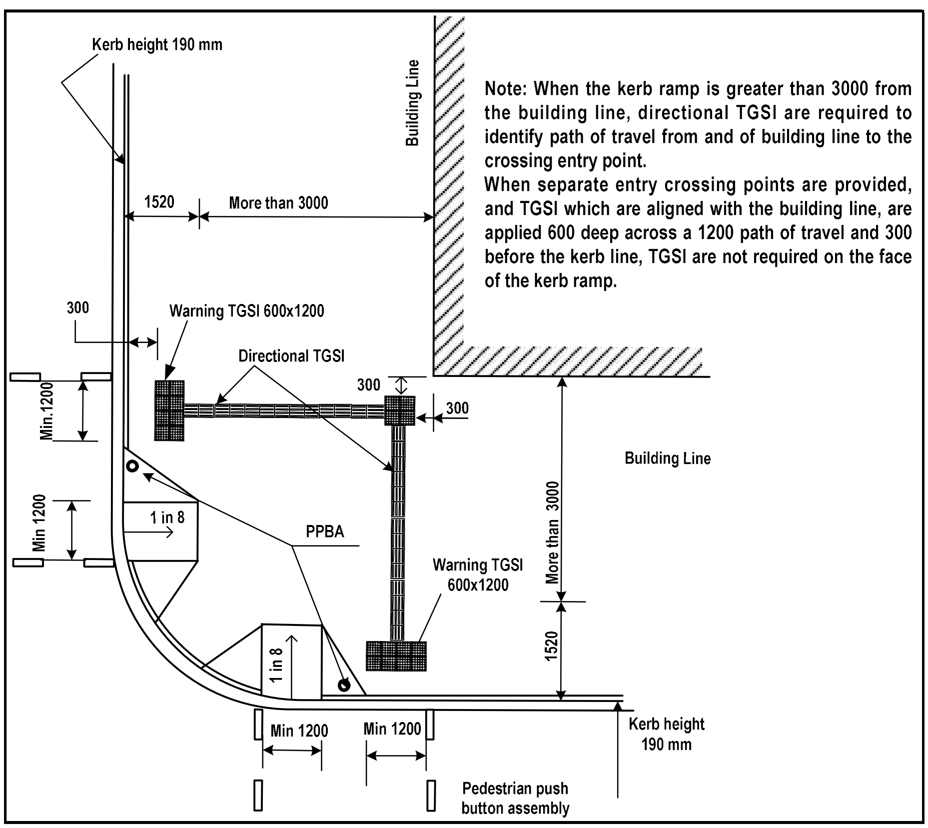

Figure 23: Right angle intersection, dual entry crossing points, 190 kerb height, 1:8kerb ramp, top of the ramp greater than 3000 form the building line

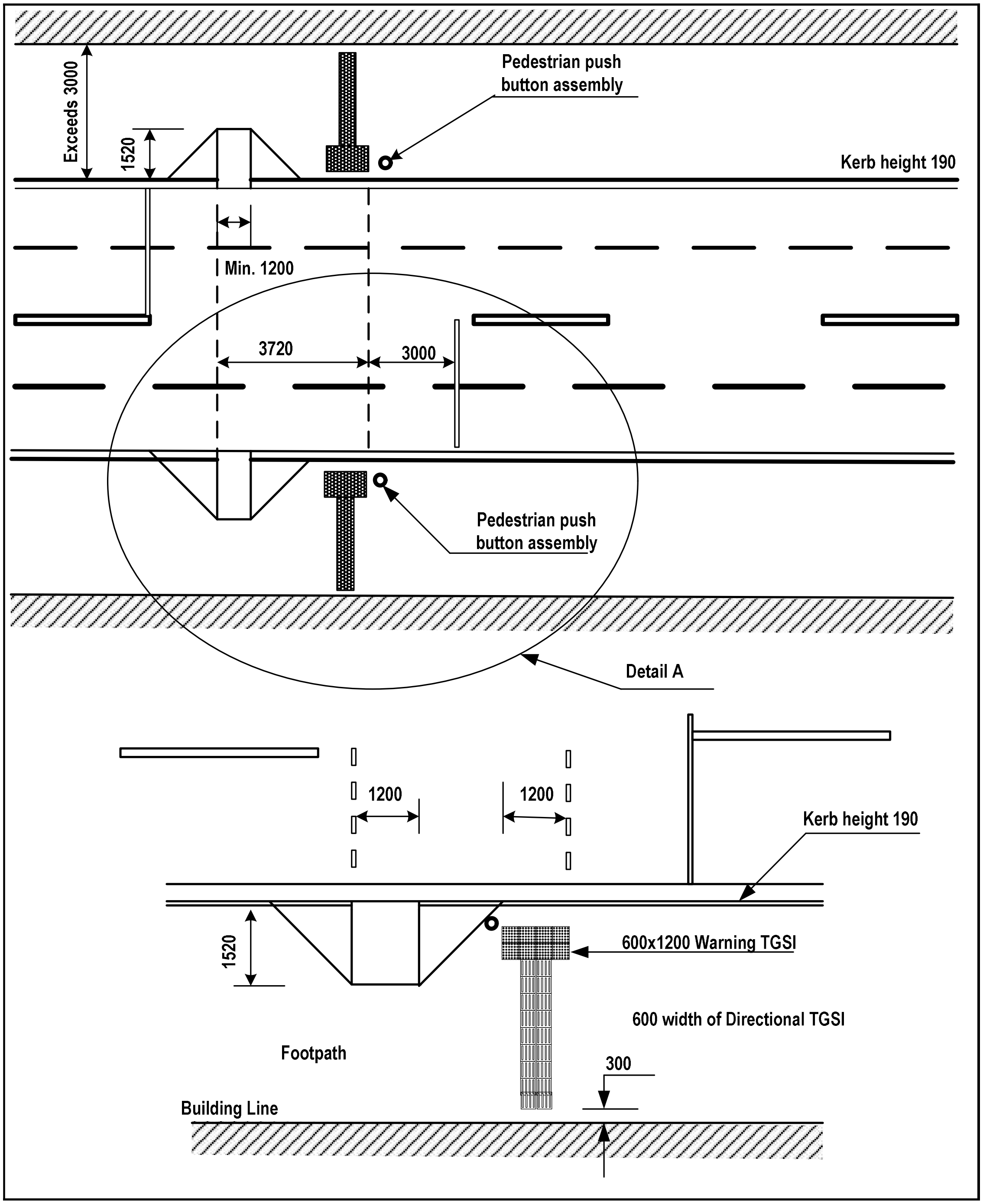

Figure 24: Mid-block crossing, dual separate entry crossing points, 190 kerb height, 1:8 kerb ramps, footpath greater than 3000

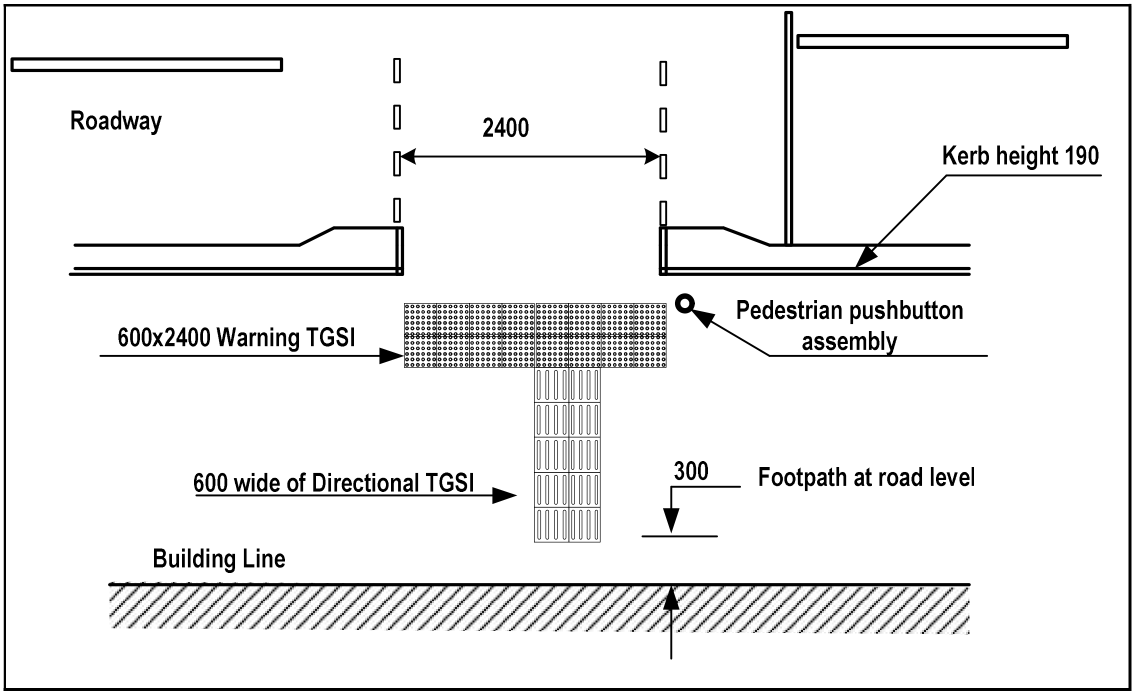

Figure 25: Mid-block crossing, at grade, no kerb ramp, footpath less than 3000

8. Audible Tactile Traffic Signals

The primary technique of street crossing for visually disable pedestrian at signalized locations is to initiate their crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move, corresponding to the onset of the green interval. This technique is effective at many signalized locations. The existing environment is often sufficient to provide the information those pedestrians who have visual disabilities need to operate reasonably safely at a signalized location.

ATTS improve the safety and confidence of people who are blind or have low vision as well as benefiting fully sighted people with an audible reminder that it is time to cross. ATTS may also increase the safety of people with cognitive impairments.

Audible Tactile Traffic Signals (ATTS) are recommended to installed at all new or upgraded signalized intersections wherever traffic signals include pedestrian signals. These types of signals facilitate pedestrians to cross the street.

8.1 Installation of AATS

The upgrade of pedestrian signals to fully compliant ATTS systems shall be prioritized after considering the following factors:

- **Road Crossing Distance:** Wide streets are more difficult and dangerous for pedestrians to cross because they are exposed to traffic for a longer period of time.
- **Pedestrian Accident History:** Generally speaking, if there have been any pedestrians involved in accidents at the signalized intersection then this could identify the need to improve safety at that intersection.

- **High Pedestrian Flows:** Consider the frequency and flow of pedestrians. Where there are sites/routes with high pedestrian usage, upgrading these sites means assistance is likely to be provided to a significant number of blind and visually-impaired people.
- **Consultation with Disability Group**: actual scenario about the site condition can be in consultation with the disable people of that locality. After then priority could be listed. This can be a useful source of information when considering signal upgrades.
- **Intersection Configuration:** crossing difficulties for the vision impaired pedestrian is greatly affected by the intersection geometry. Intersection parameters such as the number of approaches, number of traffic lanes can cause difficulties for people with visual impairment when they are crossing the intersection. Three leg intersections can pose difficulties for people who are blind or have low vision because they do not always provide adequate audible cues about the traffic phases.
- **Vehicle Speeds:** The higher the vehicle speed, the less time a pedestrian has to get out of the way of an approaching vehicle. In the event of an accident, the higher the speed of the vehicle, the greater the severity of an injury.
- **The Proximity of Public Facilities:** Determine how many bus stops or access routes there are within one block of the intersection. There may be people who are blind or have low vision in a particular area that rely heavily on public transport.

If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross reasonably safely and effectively, an engineering study should be conducted that considers the safety and effectiveness for pedestrians in general, as well as the information needs of pedestrians with visual disabilities. Design and installation of ATTS shall consider the following issues.

- Proximity to key public facilities: the priority of installation of ATTS at the locality of major public facilities shall be put at first. For example intersection near to the hospital or administrative centers should be prioritized.
- Street intersections near to the transfer points such as railway or bus transits shall be provided with the ATTS for providing the safe crossing for visually impaired pedestrian.

- Light Traffic Flow: It can be difficult for people who are blind or have low vision to determine when it is safe to cross the road because less traffic means fewer audible cues.

Priority for the installation of ATTS shall be established after the consultation with user group of user associations or charity organizations.

8.2 Design features of ATTS

The design of ATTS shall include the determination of location of pedestrian push button, information to assist them with their orientation and information of the status of pedestrian crossing signal (i. e. cross or do not cross the road).

8.2.1 Location of Pedestrian push button assembly

Pedestrian push button (PPB) is one of the important types of ATTS. It shall be installed in a consistent way so that vision impaired pedestrian shall understand the application of this facility. Good practice design of the push- button assembly is specified in AS 2353: -1999: Pedestrian pushbutton assemblies an Australian Standard document. The typical layout of the push button is given in the Figure 26.

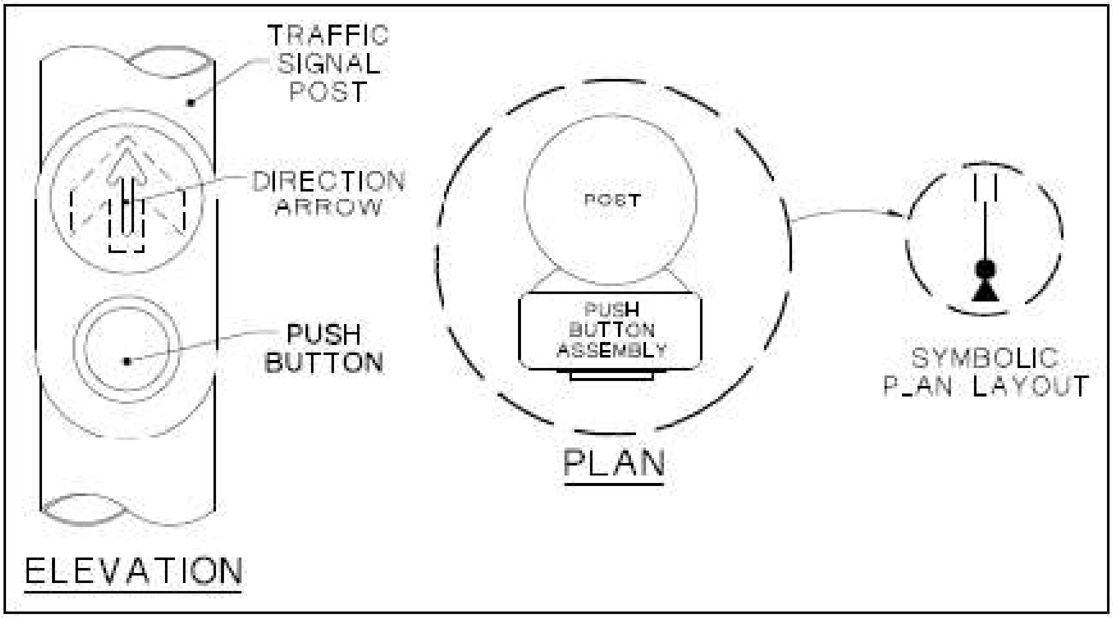

Figure 26 Pedestrian push-button assembly

8.2.2 Design and features of PPB

General features of the push button shall be designed and located to convenient for mobility impaired users in wheelchairs. The assembly contains a transducer that alternately produces both sounds and vibrations that provide clues to people who are blind or have low vision and those who have a hearing impairment. It has a large push button easily used by a person with mobility impairment. There is an arrow above the push- button. The main function of the arrow on the call box is to provide pedestrians who are blind or have low vision with directional orientation, and the centre of the arrow has a an element that vibrating element for tactile sensing when a finger is held against it, that coincides with the audible sounds so that people with both hearing and vision impairment can sense the crossing signal. Design features of ATTS can be described as below:

a. Locating Signal

The purpose of the 'locating signal' is to assist people who are blind or have low vision to find the pedestrian push button.

- Audible Component: the audible signal consists of a short pip (25 ms of 1000 Hz square wave) repeating every 1.8 seconds.
- Tactile Component: the audible signal is linked to a vibrating tactile pulse (which vibrates to 145 Hz). This facility is used by touching the directional arrow on the push button unit. Both audible and vibrating tactile locating signals operate for the whole time that the “Crossing Signal” is not sounding.

b. Crossing Signal

The purpose of the crossing signal is to indicate that the green pedestrian crossing signal is displayed and the pedestrian may enter the roadway.

- Audible Component: The audible crossing signal commences with a square wave that descends exponentially in pitch from 3,500 Hz to 700 Hz over 115 ms. This is immediately followed by a rapidly pulsing sinusoidal 500 Hz signal that decays over 35 ms, before ceasing momentarily and being repeated at 8.5 times a second for the duration of the cross signal. The duration of this signal may be restricted to a maximum time that is less than the cross signal as vision impaired pedestrians are likely to cross more slowly.
- Tactile Component: When the audible crossing signal sounds, the centre of the tactile arrow vibrates at 145 Hz pulsing at 8.5 times per second.

c. Audible volume

Audible signals shall have a volume control that is automatically responsive to the ambient noise level. This means that a louder tone will be produced when vehicle and other noise at the intersection is high. A quieter sound will be produced during low traffic periods e.g. at night. This is especially useful for signalized intersections in residential areas, so that noise nuisance is kept to a minimum. However, ambient noise microphones may also pick up "noise" generated by wind blowing across the microphone, which increases the level of tones emitted. This may cause the resulting tones to be significantly louder than traffic noise. While the automatic volume control feature should minimize noise pollution from ATTS, there may still be situations where ATTS annoy neighbours.

If the audible signal is not desired or produces a noise pollution then following action can be adopted:

- The audible component of the "Crossing Signal" feature of the ATTS may be switched off during the night.
- The audible component of the "Locating Signal" may also be switched off if the pedestrian push- button pole is in a predictable location.
- The vibrating tactile components of the ATTS must operate at all times.

8.3 Installation and location of ATTS

It is generally recommended to install ATTS with the new traffic signal with pedestrian movement, because installation with the existing one requires separate budget and prioritizations. The installation and upgrading of ATTS involves similar criteria to that for tactile ground surface indicators.

Pedestrian push buttons are usually mounted on traffic signal posts, poles. There are some basic principles that should be considered while installing pedestrian push buttons at signalized intersections.

Pedestrian push- buttons should be:

- Located consistently in relation to the continuous accessible path of travel and kerb ramps,
- Placed with the push button facing the direction of travel, except on narrow medians where a single push- button for both directions may be located with the face parallel to the crosswalk,
- Considered in the central median where pedestrians have to cross more than four lanes of traffic, or where a two stage pedestrian crossing exists. Care must be taken to avoid confusion between separate phases or sections of a crossing

in such circumstances, to ensure pedestrians don't try and cross the full distance when not meant to, or stop in the median when this is not required,

- Located on the traffic pole adjacent to the pedestrian crosswalk,
- Located less than 1 meter outside the outside pedestrian crosswalk line and less than 1 meter from the kerb face,
- Not closer than 4m from the next nearest pedestrian push button (to avoid confusion between audible signals),
- Where there is no traffic signal pole or are too far from the crosswalk, an additional pole must be installed. The additional pole must be correctly positioned so as not to confuse pedestrians,

The position of Push Button shall be determined in Relation to Ground Surface, Tactile Ground Surface Indicators (TGSI) and Kerb Ramp. In any case, ATTS shall be easily accessible to all pedestrians and installation should satisfy placement:

- Within 350 mm from the end of the TGSI zone (for persons, particularly those who are blind or have low vision, waiting on a warning indicator, and to ensure persons cannot accidentally pass between the warning indicators and push-button pole)
- Within 300 mm from the top edge of the kerb ramp if its slope is greater than 1:10 (such that wheelchair users do not need to enter steep ramps to activate call- buttons)
- Between 800 mm and 1000 mm above the ground surface (for children and wheelchair / mobility scooter users)
- Away from obstructions such as a raised portion of an island (which may inhibit wheelchair occupants access to the pedestrian push- button with their elbow).

If the pedestrian push button is on a signal pole located between the limit lines and pedestrian crosswalk lines, a person on the kerb ramp may not be able to reach the push button. This would require pedestrians to step over the vertical up-stand of a kerb or move away from the signal pole, which is not suitable for people who are blind or have low vision or those who have mobility impairments. It is recommended that either:

- The width of the kerb ramp be extended so that a person operating the pedestrian pushbutton can do so while standing on the kerb ramp,
- The pedestrian push button is relocated onto a separate pole closer to the kerb ramp.
- Poles closer than four meters apart may confuse pedestrians who are blind or have low vision over which direction the audible signal applies. If the poles cannot be located more than 4 m apart then consideration should be given to reducing the volume of the signal. The vibrating tactile signal must never be turned off.

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3. Design for access and mobility. AS/NZS 1428.4:2002; Part 4: Tactile indicators; New Zealand/Australia
4. Traffic Engineering Hand Book, Second Edition, Institute of Traffic Engineers; new Haven, Connecticut
5. IRC: 103:2012, Guidelines for Pedestrian Facilities; First revision, Indian Roads Congress.
6. Guidelines for placement of tactile Ground Surface Indicators.
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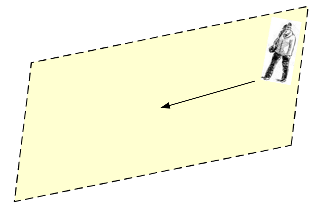
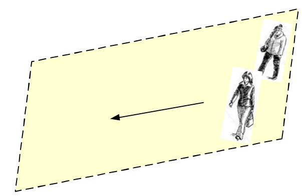
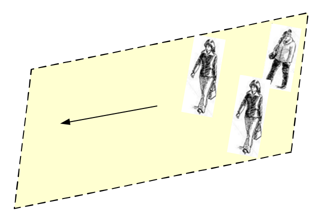
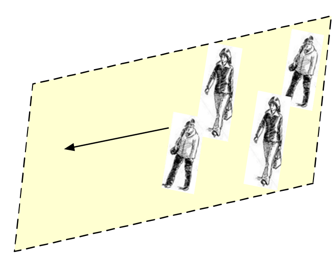
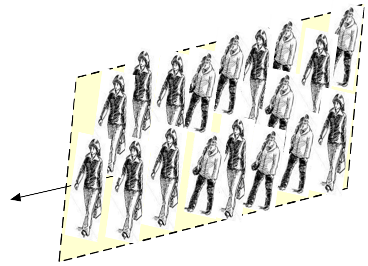
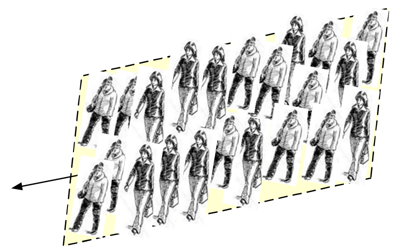
ANNEX I: GLOSSARY

Kerb	A side barrier to a trafficable surface including walkways and ramps.
Ramp:	This is the commonly understood meaning of the term 'ramp'. It is a walkway that lets people walk between two levels or landing places on a gradual slope. It is steeper than 1:20 (which is almost flat), but shallower than 1:14 and be must slip resistant.
Kerb ramp:	Kerb ramp is a ramp that gives access from a footpath to a roadway. Kerb ramps must have a slope of no more than 1:8 and a slip resistant surface.
Step ramp:	Step ramps are like a kerb ramp but not attached to a kerb. It might assist someone to ascend a small step (no more than 190 mm) in a store but can't be longer than 1900 mm or steeper than 1:10. It must have a slip resistant surface.
Threshold ramp:	Threshold is a short slip resistant ramp which allows access to a doorway. They can only service a rise of 35 mm and can't cover a distance of more than 280 mm (a maximum slope of 1:8). A threshold ramp will enable people with prams, strollers and mobility devices such as wheelchairs to access the store or shopping centre more easily.
Street crossing:	It is the place where street cross each other.
Footpath:	It is a portion of right of way of road used for the movement of pedestrian traffic.
Tactile Ground Surface Indicators (TGSI):	TGSI are truncated cones and or bars installed on the ground or floor surface designed to provide pedestrians who are blind or vision-impaired with warning or directional orientation information. Tactile ground surface indicators provide clues to alert, guide and assist pedestrians on the urban street footway network who have a visual impairment.
Angle of approach	The angle of intersection between the center-lines of two continuous accessible paths of travel.
Carriageway	The portion of a road or bridge assigned to the movement of vehicles, inclusive of any shoulders and auxiliary lanes. It is usually designated as that part of a public road (way) between kerbs.
Directional indicator	An indicator used as a guide to a safe route indicating a direction of travel
Direction of travel	The path a person travels along, which may include a footpath, passageway, walkway, ramp, and stairs, landing or similar.

Discrete TGSIs	Tactile ground surface indicators that are individually installed.
Hazard	Any object in or immediately adjacent to a direction of travel, which may place people at risk of injury
Integrated TGSIs	A series of TGSIs in a defined pattern of the same colour and material as the underlying surface
Luminance-contrast	The amount of light reflected from one surface or component, compared to the amount of light reflected from the background or base surfaces.
Tactile perception	The process of feeling the shape, surface and size of an object.
Vision impairment	Any significant loss of sight is referred as vision impairment.
Audible Tactile Traffic Signals (ATTS)	ATTS provide audible and vibrotactile information to pedestrians at signalized pedestrian crossings. The audible signals help people who are blind or have low vision to locate the signals and inform them of the status of the crossing phase. The vibrating tactile pulse assists people who are blind, vision impaired and hearing impaired people with their orientation and also indicates the status of the crossing phase.

ANNEXII: PEDESTRAIN LEVEL OF SERVICE FOR FOOTPATH

LOS A: Pedestrian Space >4.9 m^2/p. Flow rate≤ 12 p/min/m At walkway LOS A, pedestrian move in desired paths without alerting their movement in response to other pedestrian. Walking speeds are freely selected and conflicts between pedestrian are unlikely.	
LOS B: Pedestrian Space >3.3 - 4.9 m^2/p. Flow rate≤ 12 - 15 p/min/m At LOS B, there is sufficient area for pedestrian to select walking speed freely, to bypass other pedestrian and to avoid conflicts. At this level, pedestrian begin to be aware of other pedestrian, and to respond to their presence when selecting a walking path	
LOS C: Pedestrian Space >1.9 – 3.3 m^2/p. Flow rate≤ 15 - 21 p/min/m At LOS C, there is sufficient space for normal walking speeds, and for bypassing other pedestrian in primary unidirectional streams. Reverse direction or crossing movements can cause minor conflicts, and speeds and flow rate are slightly lower.	
LOS D: Pedestrian Space >1.3 – 1.9 m^2/p. Flow rate≤ 21 - 27 p/min/m At LOS D, freedom to select individual walking speed and to bypass other pedestrian is restricted. Crossing or reverse flow movements face a high probability of conflict, requiring frequent changes in speed and position. The LOS provides reasonably fluid flow, but friction and interaction between pedestrian is likely.	

LOS E: Pedestrian Space > 0.6 – 1.3 m^2/p. Flow rate ≤ 27 - 45 p/min/m At LOS E, virtually all pedestrian restrict their normal walking speed, frequently adjusting their step. At the lower range, forward movement is possible only by shuffling. Speed is not sufficient for passing slower pedestrian. Cross or reverse flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity with stoppages and interruption to flow.	
LOS F: Pedestrian Space ≤ 0.6 m^2/p. Flow rate varies At LOS F, all walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrian. Cross and reverse flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrian	

ANNEX III: PEDESTRIAN SPEED – FLOW - DENSITY RELATIONSHIP

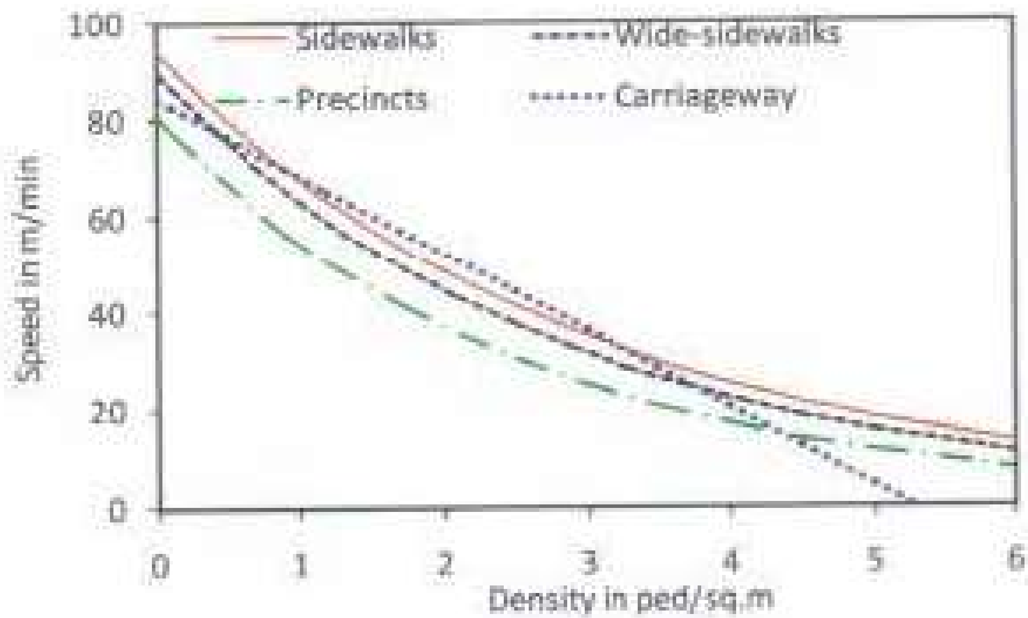


Figure 27 Pedestrian Speed – Density relationship

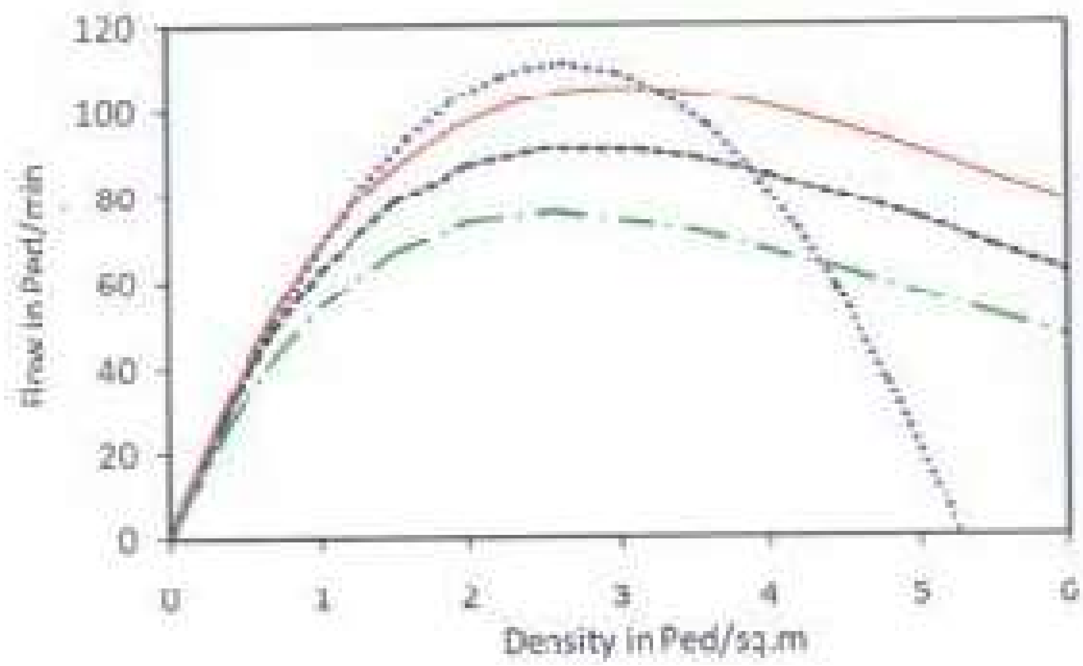


Figure 28 Pedestrian Flow – Density relationship

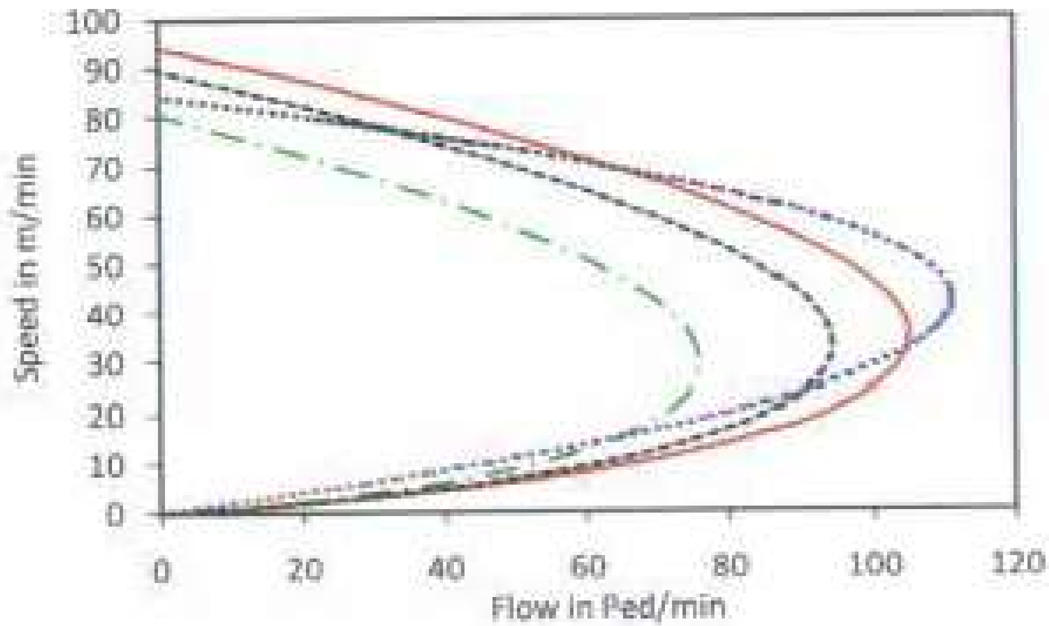


Figure 29 Pedestrian Speed – flow relationship

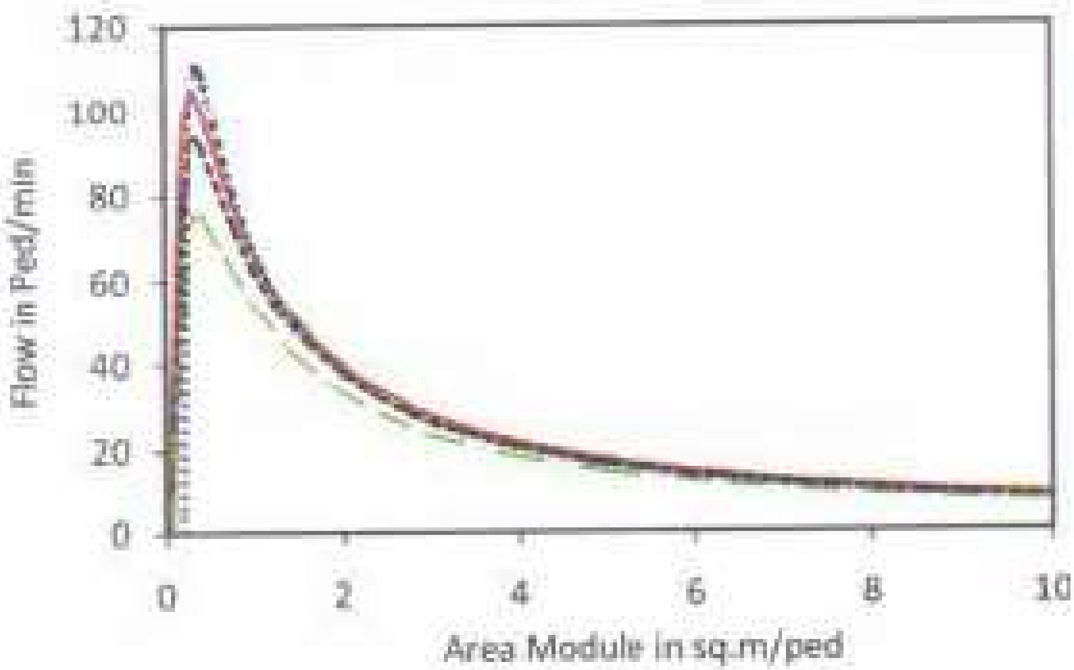


Figure 30 Pedestrian flow – area module relationship

APPENDIX IV: RAISED PAVEMENT MARKERS

Where pedestrian crossings are across the roads of four lanes or greater, raised pavement markers to delineate the edges of the crossings are helpful to people who are blind or vision impaired. Raised pavement markers are not warning or directional TGSIs as defined in this Standard. The profile and dimensions specified for raised pavement markers are, therefore, markedly different from both warning and directional TGSIs.

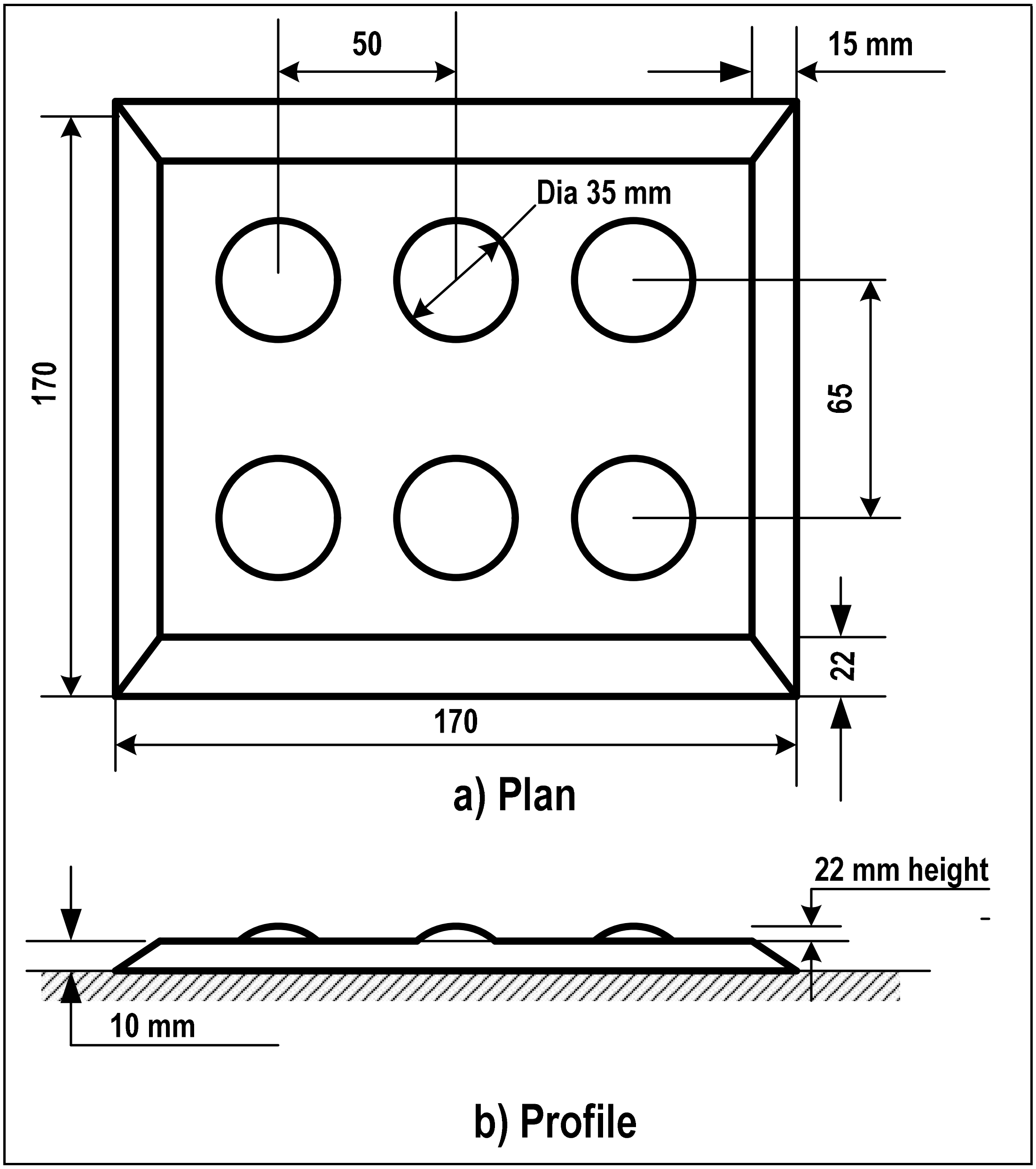


Figure 31 Details of Raised Pavement Markers

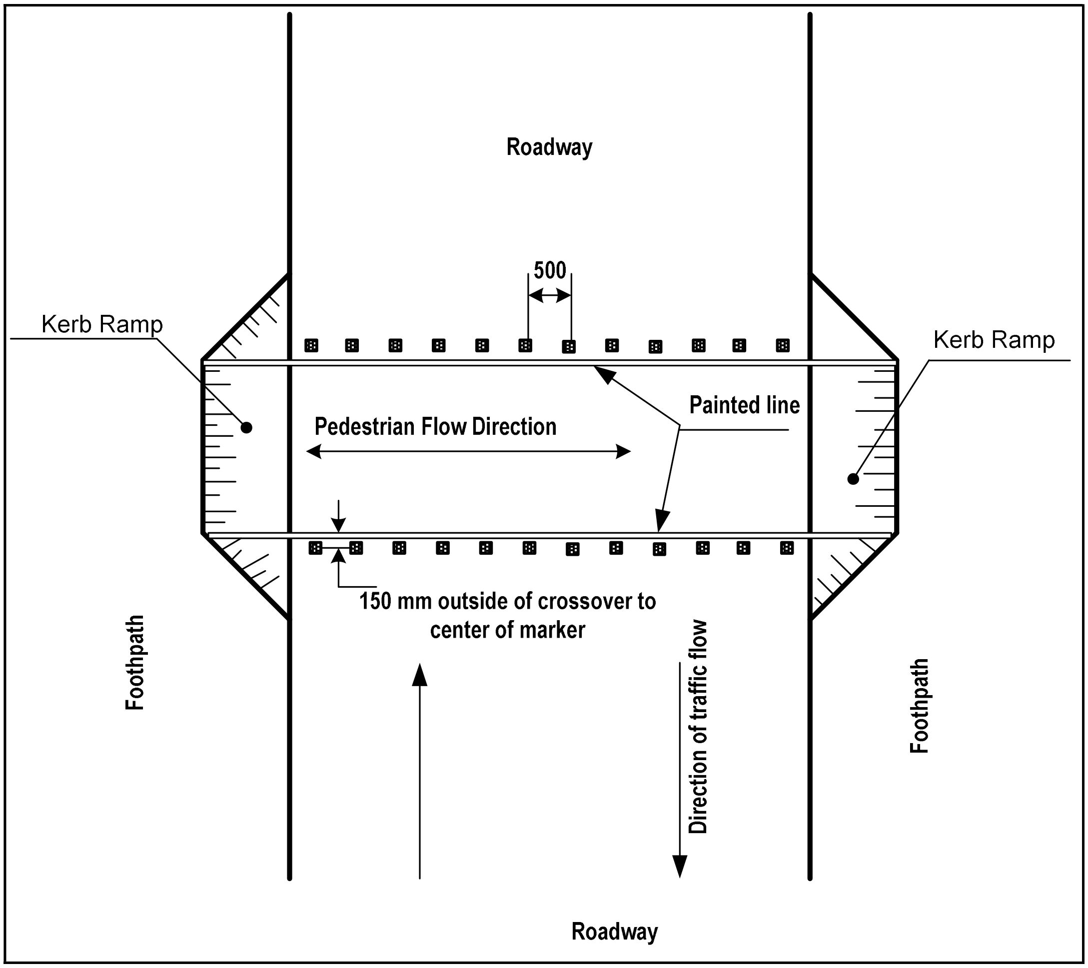


Figure 32 Raised Pavement Markers at pedestrian crossing