

Accessible Sidewalks and Street Crossings

— *an informational guide*



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Introduction

Providing Accessible Sidewalks and Street Crossings

In order to meet the needs of all sidewalk users, designers must have a clear understanding of the wide range of abilities that occur within the population. Sidewalks, like roadways, should be designed to serve all users. This includes children, older people, parents with strollers, pedestrians who have vision impairments, and people using wheelchairs and other assistive devices. Just as a roadway will not be designed for one type of vehicle, the design of sidewalks should not be limited to only a single type of pedestrian user. Because the sidewalk is the basic unit of mobility within our overall system of transportation, every route and facility must be usable.

Pedestrian facility design and operation must comply with the accessibility standards in the *Architectural Barriers Act (ABA) of 1968*, the *Rehabilitation Act of 1973 (Section 504)*, and the *Americans with Disabilities Act (ADA) of 1990*. Implementing regulations for Title II of the ADA, which covers State and local governments, also address "communications and information access," requiring 'effective communications' with persons with disabilities. In the sidewalk/street crossing environment, this would include accessible pedestrian signals, markings, and signage. The latest version of the Manual on Uniform Traffic Control Devices (MUTCD) contains standards on Accessible Pedestrian Signals (APS) that have audible, visual, and vibrotactile features. These standards represent the minimum; designers should use more conservative design parameters whenever possible.

Temporary and alternate pedestrian routes where sidewalks are obstructed by work zones must meet accessibility standards, as well. Pedestrians who must cross the street and then cross back again in order to continue on their destination will be exposed to significantly increased risk from vehicles.

The intent of this guide is to focus on some of the emerging accessibility issues and the design parameters that affect sidewalk and street crossing design and operation.

The Legal Framework:

During the 1990s, several key pieces of legislation were passed that impacted transportation planning. The first, the Americans with Disabilities Act (ADA) of 1990, protects the civil rights of people with disabilities. Secondly, the 1991 reauthorization of the Federal transportation legislation, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), specifically called for integrating pedestrian travel into the transportation system. ISTEA increased the Federal-aid funding options for pedestrian facilities and programs. In 1998, the Transportation Equity Act for the 21st Century (TEA-21) extended the opportunities established in ISTEA and increased funding available for pedestrian facilities. These laws complimented more than 40 years of legislation aimed at guaranteeing the rights of people with disabilities. Following is a brief chronological summary of the laws and regulations mandating accessible environments and programs:

Americans National Standards Institute (ANSI A117.1), 1961: The first building standard to address issues of accessibility.

Architectural Barriers Act (ABA) of 1968 (Public Law 90-480): This was the first Federal law requiring new facilities constructed for Federal agencies or with Federal funding to meet accessibility standards (UFAS).

Rehabilitation Act of 1973, Title V, Section 504 (Public Law 93-112, amended by PL 516 and PL 95-602): Section 504 requires federally funded facilities and programs to be accessible to people with disabilities.

Education of All Handicapped Children Act of 1975 (now The Individuals with Disabilities Education Act (IDEA)): This Act greatly expanded educational opportunities by requiring school accommodations for children with disabilities.

Uniform Federal Accessibility Standards (UFAS, Federal Standard 795): The UFAS defined the minimum standards for design, construction, and alteration of buildings to meet the requirements of the ABA. UFAS derived from ANSI A 117.1-1980 and the Access Board's 1982 Minimum Guidelines and Requirements for Accessible Design (MGRAD).

Americans with Disabilities Act of 1990 (ADA): ADA extends the coverage of the ABA, and the Rehabilitation Act, Section 504 to include all public facilities regardless of funding. The Title II implementing regulations for the ADA require all newly constructed and altered facilities to be readily accessible to persons with disabilities. Transportation agencies are responsible for developing a transition plan for removing the structural barriers, including communication barriers, and providing access to existing pedestrian facilities.

State Laws: In some States, codes have been adopted that exceed the requirements set forth in the ADA guidelines. In these States, both the ADA and the State code must be satisfied.

2 Understanding Sidewalk Users:

People have differing abilities: A variety of users need to access the sidewalk system. Their abilities vary in agility, balance, cognition, coordination, endurance, flexibility, hearing, problem solving, strength, vision, and walking speed.

Designing for all abilities: The design of sidewalk environments is important to all pedestrians, but is particularly important to those with disabilities who have limited travel choices and rely most on the pedestrian environment. For example, older adults, persons with vision impairments, and children frequently rely on the sidewalk to travel independently within their community for shopping, recreation, exercise, and walking to school.

Traditionally, design parameters have been based on the "standard pedestrian," an agile person with good vision, hearing, and mobility. These design parameters do not meet the needs of the growing disabled population. The Bureau of Census data indicates that:

- Approximately 20 percent of all Americans have a disability, and that percentage is increasing.
- By the year 2030, one in five Americans will be 65 years or older.

Universal design principles are based on creating an environment that is usable for people of all abilities. Incorporating these principles into all aspects of sidewalk development can eliminate the barriers and create a truly functional sidewalk system.

Movement and Informational barriers may limit an individual's access to the sidewalk environment:

Movement barriers restrict an individual's ability to physically move along or within an environment. They may limit the individual's movement from one side of the intersection to the other, or ability to use the push button to activate the pedestrian signal. Movement barriers within the pedestrian environment include curbs, steep slopes, obstacles within the path (poles, etc.), and widths too narrow to pass through.

Information barriers restrict an individual's use of information contained in the pedestrian environment. These barriers limit the pedestrian's ability to recognize and receive information (e.g., loss of vision prevents the individual from utilizing visual signs), or understand the information received and decide on a course of action. Information barriers within the environment include complex intersections, diverted paths (e.g., in work zones), and lack of street crossing information.

Conflicting Pedestrian Needs

To create a truly accessible sidewalk network that is usable by all pedestrians, designers need to understand how the users' abilities are impacted by their design decisions. Pedestrians have varying needs, therefore, changing a design to enhance access for one group can create additional barriers for other individuals. The goal should be to make all sidewalks accessible to the largest possible number of pedestrian users by incorporating the principles of universal design.

Assistive Technology:

Assistive technologies play a valuable role in enhancing the ability of people with disabilities to travel independently through the environment. These devices may be used to minimize and eliminate the activity limitations and participation restrictions that exist within the sidewalk environment. Technologies may be personal, activity-specific, or environmental. Following are examples of personal technologies:

- A manual wheelchair provides easy mobility on flat, firm, obstacle free surfaces. However, it is difficult to maneuver on steep grades or cross slopes, and across uneven transition points like street to sidewalk.
- A prosthetic leg allows an individual to retain some mobility. However, a prosthetic leg does not provide the sensory feedback that is needed to ensure stable foot placement, detect obstacles, or maintain balance.
- A white cane used by individuals with severe vision loss provides advance warning about obstacles on the path ahead 0.6 m-0.9 m (2 ft–3 ft), but is not effective at detecting obstacles above 0.7 m (2.3 ft).
- Motorized wheelchairs and scooters can maneuver on steeper grades and travel longer distances than manual wheelchairs.
- Service dogs are trained to respond to specific commands and to avoid obstacles. Service dogs require care and maintenance.
- A hearing aid can be used to amplify the traffic sounds. The magnification is not selective, so the sounds of traffic and Audible Pedestrian Signal (APS) are all magnified.

Environmental technologies include APS, and engineering treatments like curb ramps and detectable warnings. (See Section 9).

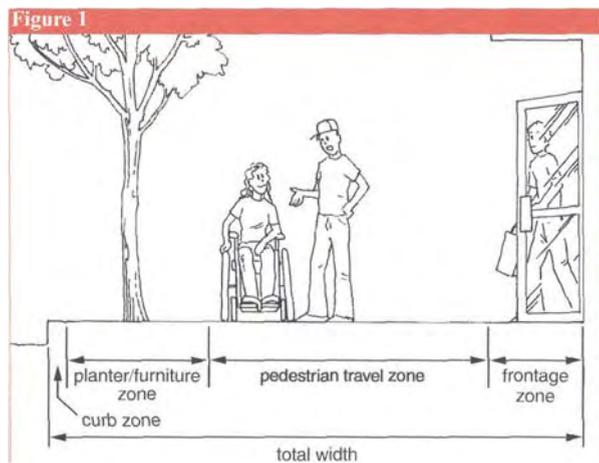
3 Sidewalk Corridors:

The "Sidewalk Corridor" is the portion of the pedestrian system from the edge of the roadway to the edge of the right-of-way (property line or building edge), generally parallel to the street. Attributes of good sidewalk corridor design include:

- Accessibility by ALL users.
- Adequate width.
- Safe to use (sidewalk users should not feel threatened by adjacent traffic or by the environment).
- Continuity and connectivity.
- Landscaping to create a buffer space between pedestrians and traffic and also provide shade.
- Social space (area where pedestrians can safely participate in public life).

The Zone System

(See Figure 1): Sidewalks in central business districts and downtown areas need to be designed to accommodate larger volumes of pedestrian traffic than in residential areas. Streetscapes in these areas often function for multiple purposes, and generally consist of the following zones: the building frontage zone, the pedestrian zone, the planter/furniture zone, and the curb zone.



The zone system divides the sidewalk corridor into four zones to ensure that pedestrians have a sufficient amount of clear space to travel.

Building Frontage Zone: The building frontage zone is the area between the building wall and the pedestrian zone. Pedestrians don't feel comfortable walking directly adjacent to a building wall or fence. At a minimum pedestrians prefer to keep at least 0.6 m (2 ft) of "shy" distance away from the building wall.

Depending on the use of this area, the frontage width should be increased and physically separated from the pedestrian zone (example, allow extra space for a door opening into the frontage area, sidewalk cafes, etc.). People with vision impairments often travel in the frontage zone and use the sound from the adjacent building for orientation. Some use the building edge as a guide for a white cane, traveling between 0.3 m-1.2 m (1 ft-4 ft) from the building. The frontage zone should be free of obstacles and protruding objects. If not,

obstacles in the frontage zone should be detectable by people who use long white canes. Level landings are required at building entrances and around sidewalk furnishings such as drinking fountains, benches, etc.

Pedestrian Travel Zone: The pedestrian zone is the area of the sidewalk corridor that is specifically reserved for pedestrian travel. This area should be free of all obstacles, protruding objects, and any vertical obstructions hazardous to pedestrians, particularly for individuals with vision impairments. The pedestrian zone should be at least 1.8 m-3.0 m (6-10 ft) wide or greater to meet the desired level of service in areas with higher pedestrian volumes. This allows pedestrians to walk side by side or for pedestrians going in the opposite direction to pass each other. The pedestrian zone should never be less than 1.2 m (4 ft), which is the minimum width required for people using a guide dog, crutches, and walkers. Wheelchair users need about 1.5 m (5 ft) to turn around and 1.8 m (6 ft) to pass other wheelchairs.

Planter/Furniture Zone: The planter/furniture zone lies between the curb and the pedestrian travel zone. This area provides a buffer from the street traffic and allows for the consolidation of elements like utilities (poles, hydrants, telephone kiosks, etc), and street furniture (benches, signs, etc). *The intent is to ensure that the pedestrian travel zone is free of ALL obstacles.* On local and collector streets, 1.2 m (4 ft) is preferred and on arterial and major streets 1.8 m (6 ft) is preferred. Additional space will be required for transit stops and bus shelters which may include a boarding pad typically 1.5 m x 2.4 m (5 ft—8 ft). States that have significant accumulations of snow during the winter months will require wider planter/furniture zones. This allows the snow to be stored in the planter/furniture zone and keeps the pedestrian zone obstacle free.

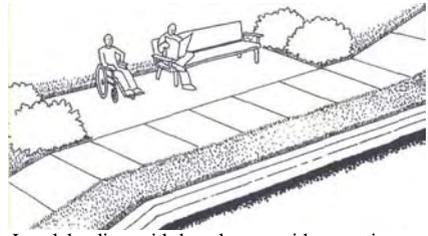
Curb Zone: The curb zone is the first 0.15 m (6 in) of the sidewalk corridor, located adjacent to the roadway. It is an integral part of the road/drainage system and keeps excess water off the sidewalk corridor. The curb zone also discourages motor vehicles from entering/exiting the sidewalk corridor except at designated locations and is a valuable safety and guide cue for pedestrians with vision impairments.

4 Sidewalk Grades and Cross Slopes:

Steep grades and cross slopes should be avoided where possible or integrated with level rest areas. Both powered and manual wheelchairs can become very unstable and/or difficult to control on sloped surfaces. When areas with steep sidewalks and ramps are wet, icy, or covered with snow, they have little or no slip resistance and a slide will usually end in the street.

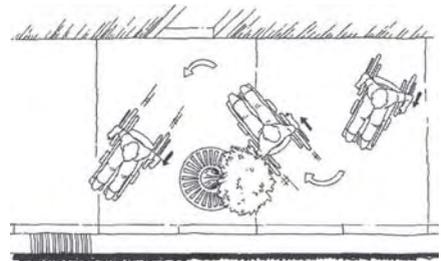
Grade: Grades are often difficult to control in the sidewalk environment because sidewalks follow the path of the street. The sidewalk grade ideally should not exceed 5 percent. Design parameters developed for ramps on buildings and sites, permit a maximum grade of 8.3 percent for a distance of 9.1 m (30 ft) before a level landing must be installed. Where the sidewalk grade approaches or exceeds that of the maximum permitted for a ramp, it is good practice to provide a level rest area. The slope of the level landing should not exceed 2 percent in any direction (See Figure 2). The dimensions of the level landing should be at least 1.5 m x 1.5 m (5 ft x 5 ft) to allow wheelchair users to stop and rest without blocking the flow of pedestrians. This area can be greater with the inclusion of other amenities such as benches, hand rails, and drinking fountains. In areas with steep slopes, consider installing wide sidewalk corridors that permit the wheelchair user to travel in a zig-zag motion (See Figure 3).

Figure 2



Level landing with benches provide a resting point that will not impede the flow of pedestrian traffic.

Figure 3



In areas of steep terrain, a wide sidewalk allows wheelchair users to travel in a zig-zag motion which reduces the grade they must travel, although the overall distance of their trip is increased.

Cross Slope: The maximum cross slope permitted by ADA Accessibility Guidelines (ADAAG) is 2 percent. Severe cross slopes require wheelchair users and other pedestrians to work against the effects of gravity to maintain their lateral balance. Pedestrians using crutches or canes may be forced to turn sideways in order to keep their base of support at a manageable angle. Severe cross slopes can cause wheelchair users to veer towards the curb and into the street (See Figure 4). The impact of cross slopes are compounded when combined with steep grades and uneven surfaces. Designers and those constructing

facilities need to understand the impact of grades and cross slopes and take particular care to stay within construction tolerances as well as within design standards. For example, Portland Cement Concrete has a construction tolerance of 1/4 in per 10 ft.

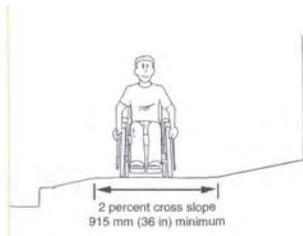
For *sidewalks with steep cross slopes* the designer can create a level area of at least 915 mm (3 ft) within the pedestrian zone (See **Figure 5**) or increase the height of the curb (See **Figure 6**) The latter case can create problems for curb ramp design and on-street parking (car doors may not be able to swing over the curb).

Figure 4



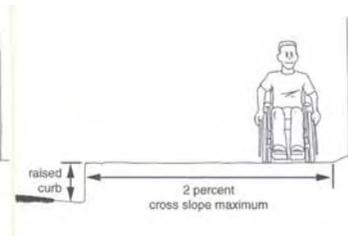
PROBLEM Wheelchair users traveling on a sidewalk with a cross slope greater than 2% use more energy to to offset the force of gravity that directs them towards the curb and into the street

Figure 5



GOOD DESIGN A level area at least 915 mm (36 in) wide improves access when the street elevation is lower than the building elevation

Figure 6



ACCEPTABLE DESIGN Increasing the height of the curb provides a level pathway when the street elevation is lower than the building elevation. This solution may not be ideal if sidewalks are not wide enough to install well-designed curb ramps

5 Sidewalk Surfaces:

Factors that affect the usability of the sidewalk surface include:

- Surface materials
- Changes in level
- Firmness, stability, and slip resistance
- Dimensions of gaps, grates and openings
- Visual consistency

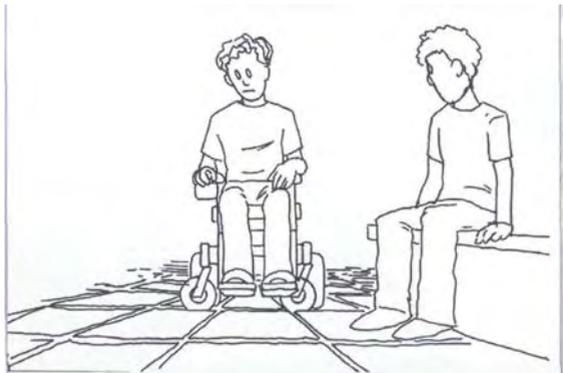
Surface materials generally consist of concrete or asphalt; however, tile, stone, and brick are also used. Typically, sidewalks of concrete and asphalt are firm, stable, and fairly slip resistant when dry. A broom finish used on concrete sidewalks increases the slip resistance. Surfaces that are not slip resistant are especially difficult for people who use wheelchairs or walking aids to travel across. Crutch users, for example, rely on being able to securely plant their crutch tip to travel effectively on the sidewalk. Surfaces that are not visually consistent (all one color and texture) can make it difficult for pedestrians with vision disabilities to distinguish the difference between a change in color and pattern on the sidewalk and a drop off or change in level.

Decorative surface materials such as paints and surface materials, polished stones or exposed aggregate rock, are not as slip resistant and should be avoided. Paint and thermoplastic materials, commonly used to mark crosswalks, are generally not as slip resistant when wet. Slip resistant contact is more difficult to achieve when the sidewalk material is wet or icy. Texture added to the thermoplastic will improve the slip resistance.

Brick and cobblestone may improve the aesthetic quality of the sidewalk, but may also increase the amount of work required by pedestrians with mobility impairments. For example, tiles that are not tightly spaced together can create grooves that catch wheelchair casters (See Figure 7). These decorative surfaces may also create a vibrating bumpy ride that can be uncomfortable and painful for those in

wheelchairs. The surface texture should not include more than a 1/4 inch rise every 30 inch. Brick and cobblestone may heave or settle, creating unsafe changes in level or become a tripping hazard for pedestrians, especially those with vision and mobility disabilities. Decorative textured surface materials can make it more difficult for pedestrians with vision impairments to identify

Figure 7



The space between the jointed surface causes wheelchair casters to swivel and catch and greatly increases the rolling resistance.

detectable warnings, which provide critical information about the transition **from** the sidewalk to the street. For these reasons, brick and cobblestone are not recommended. Creative alternatives include smooth walkways with brick trim, and colored concrete.

Changes in level/elevation are vertical rises between adjacent surfaces. Causes of changes in level include:

- Tree roots pushing upwards.
- Uneven transitions from street to gutter to ramp.
- Heaving and settling due to frost.
- Buckling due to improper sub-base preparation.

Changes in level/elevation can cause major problems for:

- Pedestrians with mobility impairments-difficulty lifting feet, or crutches (causing tripping).
- Pedestrians with vision impairments-difficulty detecting elevation changes, (causing tripping).
- Pedestrian using wheelchairs-small front caster wheels swivel sideways and cannot climb over.
- Pedestrian using wheelchairs-difficult time rolling over large changes in elevation.

Changes in level/elevation requirements:

- Up to 6 mm (0.25 in)-can remain without beveling.
- 6-13 mm (0.25 in-0.5 in)-bevel the surface with a maximum grade of 50 percent (1:2).
- Greater than 13 mm (0.5 in)-remove or install a ramp with a maximum grade of 8.3 percent.

Gaps, grates and other openings occur at railroad tracks, drainage inlets, air vents, tree grates, etc. Wheelchair casters, inline skating wheels, as well as bicycle wheels often get caught in openings and gaps wider than 1/2 inch or which are incorrectly aligned. In these cases there is potential for the person to be suddenly pitched forward. Walking aids such as canes and crutches can also get caught in grates and gaps. When the cane tip slips through an opening, the pedestrian can become unstable and risk falling. Grates should be placed within the planter/furniture zone (**See Figure 1**) away from the pedestrian travel area, **and** also away from the bottom of crosswalks and curb ramps.

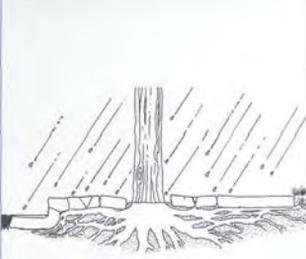
Gaps and grates should be designed so that:

- Openings do not allow the passage of a 13 mm (0.5 in) sphere.
- The long dimension of the opening is perpendicular or diagonal to the dominant direction of travel.

The impact of trees on the sidewalk corridor-- trees are generally planted because they improve the pedestrian experience, improve the aesthetic appearance of the streetscape, serve as a visual and auditory buffer between pedestrians and traffic, provide shade, and may have a traffic calming effect. Trees need a minimum of 1.2 m x 1.2 m (4 ft x 4 ft). They are also one of the

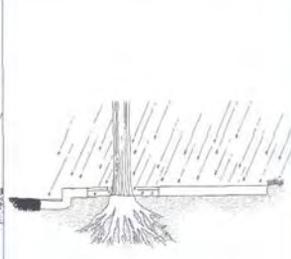
most common causes of sidewalk cracks and changes in level. When water is limited, tree roots tend to push through the surface (See **Figure 8**) and spread out rather than down (See **Figure 9**) to look for new water sources. Tree branches should be maintained to hang no lower than 2.0 m (6.7 ft) (See **Figure 10**). Low hanging branches can be a safety hazard, especially for pedestrians with vision impairments who may not detect them. Other pedestrians with mobility impairments may have difficulty bending under them. Careful selections of tree type, their placement and maintenance can provide a comfortable and safer environment for all road users including pedestrians.

Figure 8



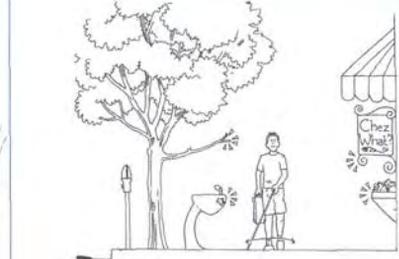
When trees do not get enough water they tend to spread their roots out, which can break up the surface of the sidewalk.

Figure 9



Trees planted with grates are less likely to cause sidewalk cracks than trees planted without grates because the grate allows a sufficient amount of water to reach the tree roots.

Figure 10



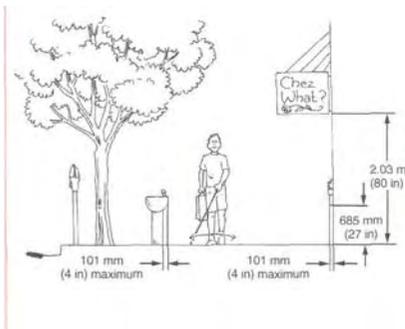
This pedestrian, who is blind is walking down a sidewalk that contains a number of obstacles that are difficult to detect using a long white cane, because they protrude into the path of travel between 685 mm (2.3 ft) up from ground level and below 2.03 m (6.7 ft) in height.

6 Protruding Objects:

Objects that protrude into the sidewalk corridor above 2 m (6.7 ft) are not generally a problem for pedestrians with vision impairments (See **Figure 11**). Pedestrians who use long canes will usually detect and avoid objects on the sidewalk that extend below 0.69 m (2.3 ft). However, obstacles that protrude into the sidewalk corridor between 0.69 m-2 m (2.3 ft—6.7 ft) and do not extend to the ground (See **Figure 10**) are more difficult to detect and avoid.

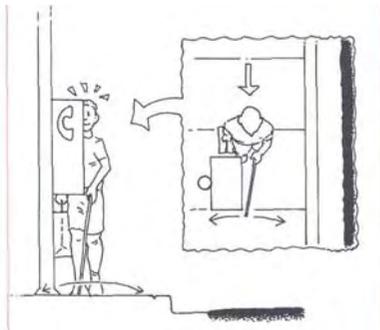
Pedestrians with vision impairments often travel using the edge of the building line. Objects mounted on the wall, post, or side of a building, should therefore not protrude more than 0.1 m (4 in) into the sidewalk corridor (See **Figure 12**).

Figure 11



This pedestrian, who is blind, will have a much easier time traveling on this sidewalk because there are no walls or post-mounted obstacles that protrude more than 101 mm (4 in)

Figure 12



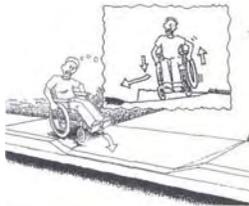
POTENTIAL PROBLEM:

When obstacles mounted on posts can be approached from the side they should not protrude more than 101mm (4 in). This pedestrian who is blind does not detect the pole, which could cause him to collide with the obstacle.

7 Driveway Crossings:

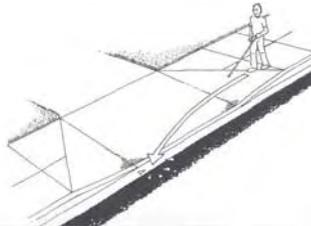
Driveway crossings serve the same purpose for cars as curb ramps serve for pedestrians. They consist of many of the same components found in curb ramps. Designers need to remember that as they change the grade to allow cars to effectively negotiate the elevation change between the street and the sidewalk, they **must not** compromise good pedestrian design practice. Unfortunately, this happens quite often and pedestrians using wheelchairs and other walking aids are sometimes put at risk of becoming unstable and falling. ADAAG does not permit the cross slope of the sidewalk to exceed 2 percent. Driveway crossings are often built with grade changes in the sidewalk corridor that have cross slopes greater than 2 percent. Driveway crossings without level landings force users to travel over the sidewalk flare. This design results in rapid changes in grade and cross slope (See Figure 13), wheelchair users can lose control and possibly tip over as the front wheel loses contact with the ground followed by the opposing back wheel. Pedestrians with vision impairments may not detect the difference in slope of the driveway flare and veer towards the street and may enter the street without realizing it (See Figure 14).

Figure 13



PROBLEM This driveway design is not allowed by ADAAG. Driveway crossings must be level and not force users to travel over the sidewalk flare. This design results in rapid changes in cross slope, which compromises balance and stability for people who use wheelchairs. The right front wheel loses contact with the ground followed by the opposing back wheel.

Figure 14



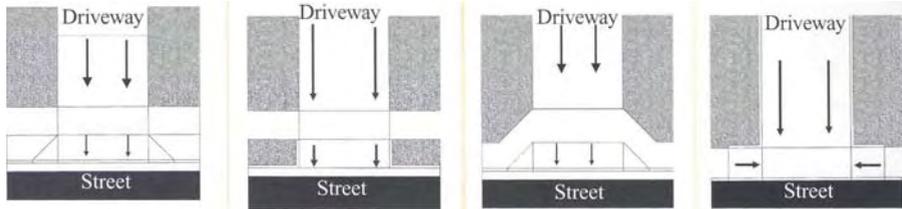
POTENTIAL PROBLEM Although gradually sloped driveway crossings are beneficial to people with mobility impairments, they can be problematic for people with vision impairments unless there is a detectable difference in slope at the edge of the street. If a visually impaired person veers toward the street and isn't able to recognize where the driveway ends and the street begins, he or she may enter the street without realizing it.

Driveway crossings should be designed with the following guidance:

- Cross slope = 2.0 percent maximum
- Level maneuvering space
- Changes in level = flush (1/4 inch maximum)
- Flare slope = 10 percent maximum

Figure 15 illustrates good or acceptable design practice

Figure 15 Driveway Crossings



Good Design
Driveway crossings with
wide level sidewalks

Good Design
Driveway crossings
with level sidewalk

Acceptable Design
Driveway crossing
with a level landing
jogged away from the
street
see *1

Acceptable Design
Driveway crossing with
ramps parallel to the
sidewalk and sidewalk
at grade with the street
see *2

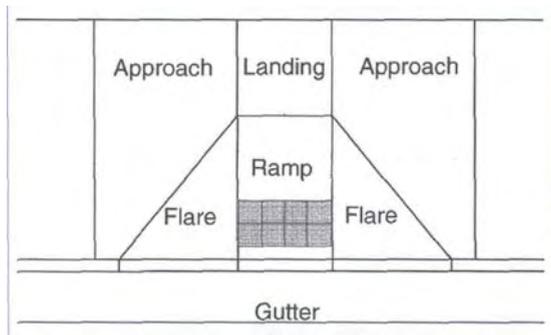
*1 Potential tripping problem for pedestrians traveling over flare

*2 May have drainage problems There needs to be a detectable edge or lip for pedestrians with vision impairments to distinguish the sidewalk and street boundary at the base of the driveway

Curb Ramps:

Curb ramps are necessary for access between the sidewalk and the street for people who use wheelchairs (See Figure 16). Title II of the ADA specifically requires curb ramps for existing facilities, as well as all new construction or altered facilities. However, curb ramps can create a barrier for people with vision impairments who use the curb to identify the transition point between the sidewalk and the street. Because curb ramps eliminate the vertical edge of the curb used by pedestrians with vision impairments, it is necessary to install detectable warnings (Section 9) to mark the boundary between the sidewalk and street. For some pedestrians who use walking aids such as canes, walkers or crutches, curb ramps may be difficult to access. The pedestrian must have strength to lift his or her body up over the supporting device. A wider crosswalk to allow use of curb and curb ramp (See Figure 17) will enhance access for all users

Figure 16

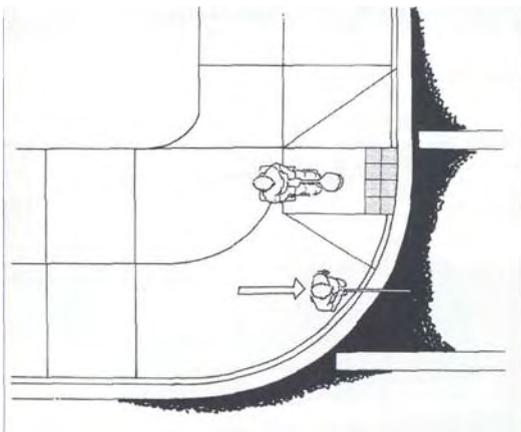


Curb ramp components.

Curb ramp types:

Curb ramp types are usually categorized by their structural design and how they are positioned relative to the sidewalk or street. Selecting a curb ramp design depends on site conditions. Curb ramp types include perpendicular, diagonal, parallel, combination, and depressed corners. Table 1 discussed the advantages and disadvantages of each curb ramp types.

Figure 17



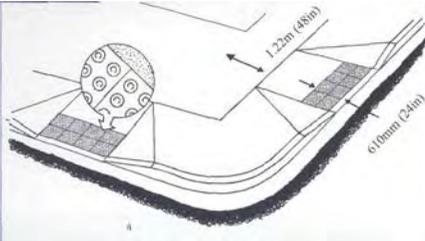
GOOD DESIGN:

When a portion of the curb is included in the crosswalk, it is easier for people with vision impairment to detect the transition between the sidewalk and the street

Table 2: Advantages and disadvantages of curb ramp types

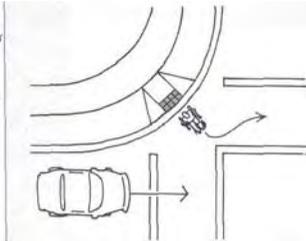
Ramp Type	Advantage to Pedestrian	Disadvantage to Pedestrian
Perpendicular See Figure 17,18	<ol style="list-style-type: none"> 1) Ramp aligned with the crosswalk. 2) Straight path of travel on tight radius. 3) Two ramps per corner. 	<ol style="list-style-type: none"> 1) May not provide a straight path of travel on larger radius corners.
Diagonal See Figure 19	Not recommended	<ol style="list-style-type: none"> 1) Pedestrian with a vision impairment can mistake a diagonal ramp for a perpendicular ramp and unintentionally travel into the intersection because it is not aligned with the crossing direction. 2) May conflict with motorists who are traveling straight or turning if corner radius is small. 3) Directs wheelchair users into the intersections. Requires wheelchair turning at the top and bottom of the ramp. A 1.2 m x 1.2 m (4 ft x 4 ft) bottom landing is required. (See Figure 19).
Parallel See Figure 20, 21, 22	<ol style="list-style-type: none"> 1) Requires minimal right-of-way. 2) Provides an area to align with the crossing. The bottom landing is contained in the sidewalk and not the street. 3) Allows ramps to be extended to reduce ramp grade. 4) Provides edges on the side of the ramp that are clearly defined for pedestrians with vision impairments. 	<ol style="list-style-type: none"> 1) Pedestrians need to negotiate two or more ramp grades (makes it more difficult for wheelchair users). 2) Improper design can result in the accumulation of water or debris on the landing at the bottom of the ramp.
Combined Parallel and Perpendicular See Figure 23	<ol style="list-style-type: none"> 1) Does not require turning or maneuvering on the ramp. 2) Ramp aligned perpendicular to the crosswalk. 3) Level maneuvering area at the top and bottom of ramps. 	<ol style="list-style-type: none"> 1) Visually impaired pedestrians need to negotiate sidewalk ramps.
Depressed Corners See Figure 24, 25	<ol style="list-style-type: none"> 1) Eliminates the need for a curb ramp. 	<ol style="list-style-type: none"> 1) Pedestrians with cognitive impairments may have the illusions that the sidewalk and street are unified pedestrian space (i.e., safe). 2) Improper design can allow large vehicles to travel onto the sidewalk to make tight turns which puts the pedestrian at risk. 3) More difficult to detect the boundary between the sidewalk and the street for persons with vision impairments. 4) Service dogs may not distinguish the boundary between the sidewalk and the street and continue walking. 5) The design may encourage motorist to turn faster by traveling onto the sidewalk.

Figure 18



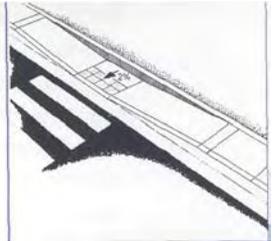
GOOD DESIGN:
A level landing at the top of the ramp of at least 1.2 m (4 ft). A 610 mm (2 ft) strip of detectable warnings must be installed at the bottom of a perpendicular curb ramp.

Figure 19



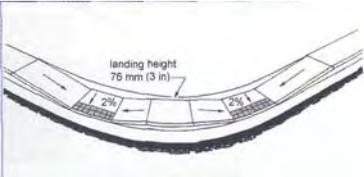
Diagonal curb ramps are not recommended. However, users must have enough room to maneuver towards the direction of the crosswalk. There must be a 1.2 m x 1.2 m (4 ft x 4 ft) bottom level landing of clear space outside the direction of motor vehicle travel.

Figure 20



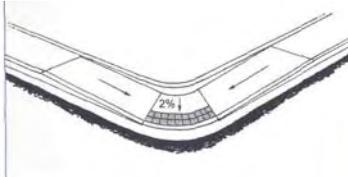
Parallel curb ramps won't work well on narrow sidewalks but require users continuing on the pathway to negotiate two ramp grades.

Figure 21



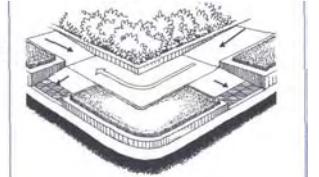
At intersections with narrow sidewalks and wide turning radii, two parallel curb ramps should be considered.

Figure 22



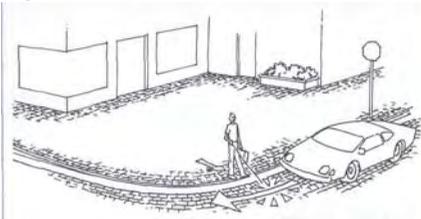
NOT RECOMMENDED

Figure 23



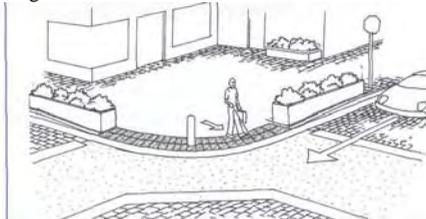
Combined parallel and perpendicular curb ramps lowers the elevation of level landings while bridging the remaining elevation gap.

Figure 24



PROBLEM: Decorative patterns used at depressed corners, such as this brick pattern, create a continuous pathway. People with vision and cognitive impairments have difficulty detecting where the street begins and ends.

Figure 25



Detectable warnings, contracting surface materials, and barrier posts are measures that can be used to convey the transition between the street and sidewalk at depressed corners. This corner would be a good location for accessible signals.

Curb Ramp Specifications:

- **Ramp Grade:** ADAAG permits a maximum curb ramp slope of 8.3 percent (preferred 7.1 percent to allow for construction tolerance)
- **Cross slope** on the ramp may not exceed 2.0 percent.

¹ Minimum **ramp width** should be 1.2 m (4 ft) in new construction. In restricted spaces only, the minimum width should not be less than 915 mm (3 ft).

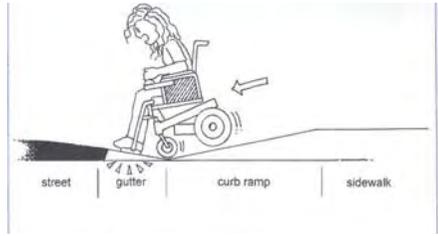
Significant **changes of grade** as the pedestrians travel from the down slope of the ramp to the up slope of the gutter can cause wheelchair users to fall forward (See Figure 26) and should be 13 percent or less. Counterslope should not exceed 5 percent.

Curb ramp alignment should be perpendicular to the curb face. The ramp needs to be aligned within the crosswalk with a straight path of travel from the top of the ramp to the roadway to the curb ramp on the other side.

¹ **Detectable warnings** (See Figure 27) across the lower part of the ramp are required. Ramps make it difficult for pedestrians with vision impairments to detect the transition between the sidewalk and the street. Detectable warnings should have a visual contrast with the adjacent walking surfaces. (See Section 9)

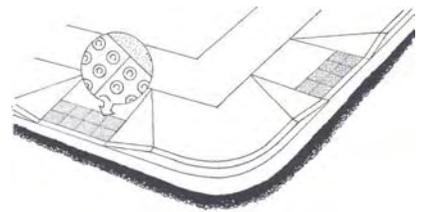
- **Transition points** between adjacent curb ramp surfaces should be flush. Even a 13 mm (0.5 in) change in level combined with a change in grade can complicate access for wheelchair users. Curb ramp lips are not allowed by ADAAG.
- **Sidewalk approach width** should have a minimum of 1.2 m (4 ft). (See previous discussion in Section 3, Sidewalk Corridors.)
- **Level landing** at the top and bottom of the curb ramp should be 1.2 m x 4 ft) and the cross slope should not exceed 2 percent in any direction. This is necessary to allow wheelchair users to maneuver off the ramp

Figure 26



A wheelchair can bottom out at areas of rapid change of grade (greater than 13 percent). The wheelchair can be pitched forward or thrown backwards.

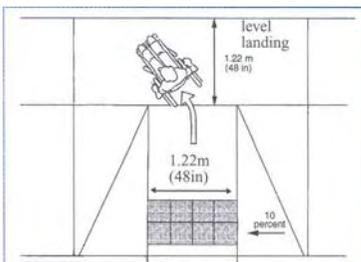
Figure 27



GOOD DESIGN

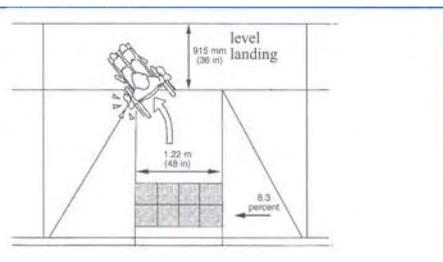
A 610 mm (2 ft) strip of detectable warnings shall be installed at the bottom of a curb ramp to indicate the transition from the sidewalk to the street.

Figure 28



The 1.2 m (4 ft) width of this curb ramp provides sufficient turning space for this wheelchair user. The maximum slope of the flares at this curb ramp should be 10 percent. Measured at the face of the curb.

Figure 29



The 915 mm (3 ft) width of this landing forces this wheelchair user to travel over a portion of the flare to maneuver onto the narrow landing. For this reason, the maximum slope of the flare should not exceed 8.3 percent and should be blended at the top apex. The ramp width should be widened up to 1.2 m (4 ft) to allow for a tighter turn onto the landing.

and onto the path of travel within the pedestrian zone. (See **Figure 28**). If space is limited, the absolute minimum level landing width should not be less than 915 mm (3 ft). (See **Figure 29**). However, in such a case, wheelchair users may have to travel over a portion of the flare in order to move off the ramp onto the path of travel. To compensate, the warping of the slope at the top area of the *flare* should be blended for easier travel across, and the ramp width should not be less than 1.2 m (4 ft). The maximum slope of the flare should not exceed 8.3 percent if the landing is between 0.9m-1.2m(3 ft-4 ft).

Table 2. Ramp length for perpendicular curb ramps based on ramp slope

Change in Elevation	Ramp Length for 7.1 Percent Slope	Ramp Length for 8.3 Percent Slope
203 mm (8 m)	4.0 m (13.1 ft)	3.2 m (10.7 ft)
178 mm (7 in)	3.5 m (11.4 ft)	2.8 m (9.3 ft)
152 mm (6 m)	3.0 m (9.8 ft)	2.4 m (7.9 ft)
127 mm (5 in)	2.5 m (8.2 ft)	2.0 m (6.6 ft)
101 mm (4 in)	2.0m (6.5 ft)	1.6 m (5.3 ft)

This table assumes that the sidewalk corridor has a 2 percent slope and that the corner is level. The length is for the ramp only and does not include sidewalk width required for level landing.

Curb ramp length is determined by the vertical height of the curb between the roadway and the sidewalk. Assuming the cross slope of the corridor is constant at 2 percent, the formula for determining ramp length is:

$$\text{ramp length} = \frac{\text{curb height}}{(\text{ramp slope/percent} - \text{sidewalk corridor cross slope/percent})}$$

Table 2 calculates the minimum ramp length required for a 7.1 percent ramp and an 8.3 percent ramp, based on the height of the required vertical change.

Additional good practice curb ramp design:

- Align the curb ramp within the marked crosswalk, so there is a straight path of travel to the curb ramp on the other side.
- Provide adequate drainage to prevent the accumulation of water and debris on or at the bottom of the ramp.
- Minimize ramp length by lowering the sidewalk to reduce the curb height. Applicable in areas with narrow sidewalks.

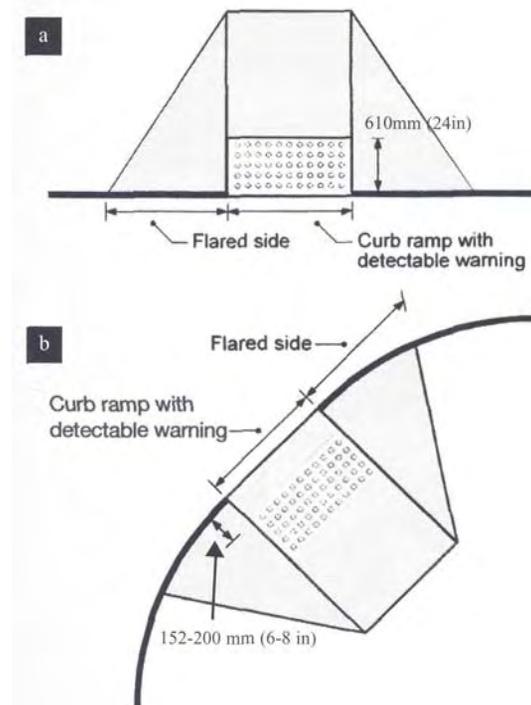
9 Providing Information to Pedestrians:

Pedestrians with vision impairments rely on nonvisual audible and tactile cues to travel. Cues in the environment include the sound of traffic, presence of curb ramps, verbal messages and audible tones in pedestrian signals, and detectable warnings.

To accommodate the information needs of all pedestrians, it is important to provide information in formats that can be assimilated using more than one sense. Pedestrian information includes pedestrian signage, Accessible Pedestrian Signals (APS) - audible tones, verbal messages, and vibrotactile information, and detectable warnings.

Detectable warnings (See Figure 30) are a standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of potential hazards.

Figure 30



Curb ramp designs showing 610 mm (24 in) detectable warning (U.S. Access Board-Detectable Warnings: Synthesis).

Detectable warnings shall consist of a surface of truncated domes aligned in a square grid pattern (See **Figure 31**):

- Base diameter of 23mm-26 mm (0.9in-1.4in).
- Top diameter of 50-60 percent of base diameter.
- Height of 5 mm (0.2 in).
- Center-to-center spacing of 41 mm-61 mm (1.6 in-2.4 in).
- Visual contrast of light-on-dark or dark-on-light with adjacent walking surfaces.

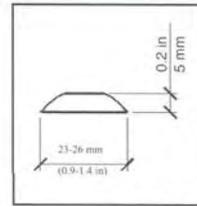
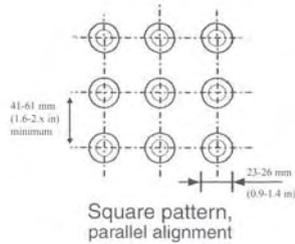
ADAAG Appendix, Section A, 29.2 recommends that the materials used provide a contrast of at least 70 percent.

$$\text{Contrast} = [(B1- B 2) / B1] \times 100$$

B1 = light reflectance value of lighter area (LRV)

B2 = light reflectance value of darker area (LRV)

Figure 31

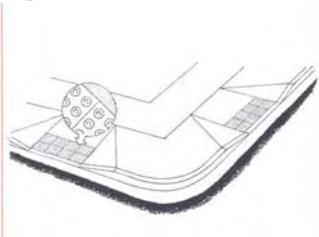


height and diameter of truncated domes

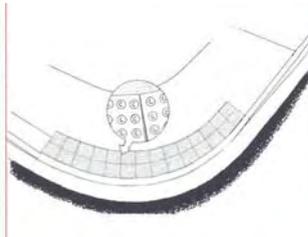
Truncated domes aligned so that wheels may pass between them arc easier for some wheelchair users to negotiate (Bentzen, Barlow, & Tabor, 2000.)

Detectable Warning Design Applications

Figure 32

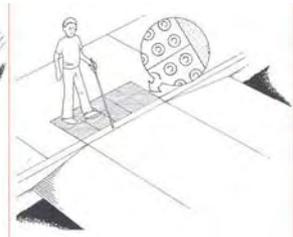


A 610 mm (2 ft) strip of detectable warnings shall be installed at the bottom of a curb ramp to indicate the transition from the sidewalk to the street.



A 610 mm (2 ft) strip of warnings shall be installed at the border of a depressed corner to identify the transition between the sidewalk and the street.

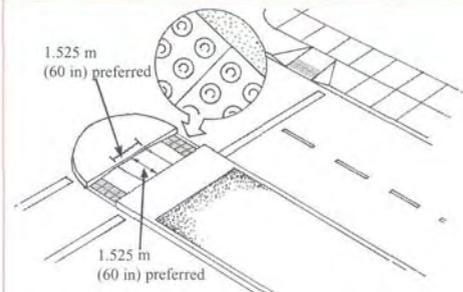
Figure 34



A 610 mm (2 ft) strip of warnings shall be installed at the edge of a raised crosswalk to identify the transition between the sidewalk and street.

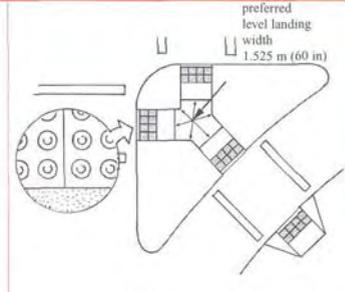
Detectable warnings shall be placed at the bottom of curb ramps (**See Figure 32**) and other locations such as depressed corners (**See Figure 33**), raised crosswalks and raised intersections (**See Figure 34**), borders of medians and islands (**See Figures 35 and 36**), and at the edge of transit platforms and where railroad tracks cross the sidewalk to warn people with visual impairments of potential hazards. Detectable warnings must be installed across the full width of ramps, and 610 mm (2 ft) in length up the ramp. The detectable warning

Figure 35



A ramped median should have a level landing that is 1.5 m (5 ft) level landing.

Figure 36

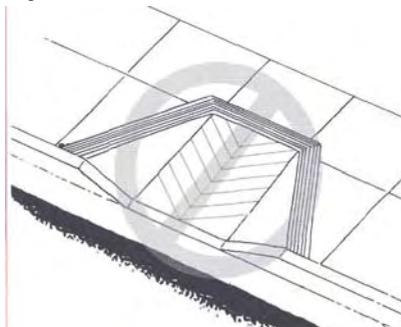


Ramped islands shall include detectable warnings and have a level landing.

should be set back 152 mm-200 mm (6 in-8 in) from the bottom of the curb (**refer to Figure 30 b above**). This allows wheelchair users to gain momentum before traveling over the truncated domes. It provides pedestrians with vision impairments additional time to react to the detectable warning or advanced warning before they reach the street. Smooth surfaces should be provided adjoining the detectable warning to maximize contrast. Bricks and other textured surfaces affect the ability of the pedestrian to detect the truncated dome warnings.

Grooves do not provide a detectable warning and pedestrians can easily confuse them with sidewalk expansion joints or cracks in the sidewalk (**See Figure 37**). They are not allowed as a detectable warning by ADAAG.

Figure 37



Potential Problem:
Grooves are not the equivalent of a detectable warning because they are not detectable underfoot.

10 Accessible Pedestrian Signals:

Accessible Pedestrian Signals:

The implementing regulation under Title II of the ADA requires that all facilities constructed or altered after January 1992 be designed and constructed to be accessible to people with disabilities.

Audible tones and speech messages can provide standard information about the status of the signal cycle (WALK, DON'T WALK). Information on the location, direction of travel, and the name of the street to be crossed can also be included. Infrared or Light Emitting Diodes (LED) transmitters can send speech messages to personal receivers. In addition to providing information in multiple formats, the physical design, placement, and location of the pedestrian signal device need to be accessible to pedestrians with vision and mobility impairments.

Accessible Pedestrian Signal (APS)

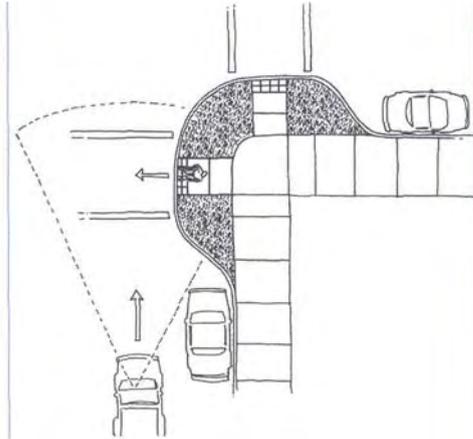
- Locate the push button as close as possible to the curb ramp without interfering with clear space.
- The device should be operated from a level landing.
- Mount the device no higher than 1.0 m (3.5 ft) above the sidewalk.
- The control face of the button shall be parallel to the direction of the marked crosswalk.
- One button per pole, each separated by 3 m (10 ft) is preferred.
- Place the device no closer than 760 mm (2.5 ft) to the curb, and no more than 1.5 m (5 ft) from the crosswalk.
- The button should be a minimum of 50 mm (2 in) in diameter to be easily operated by pedestrians with limited hand function. Avoid activation buttons that require conductivity (unusable by pedestrians with prosthetic hands).
- The force to actuate the button should require a minimum amount of force no greater than 15.5 N or 3 lbf to activate.

(For more information on Accessible Pedestrian Signals visit the Web sites at <http://www.mutcd.gov>, www.access-board.gov and www.accessforblind.org)

11 Pedestrian Crossings:

Designing an effective pedestrian crossing involves the correct layout of pedestrian elements including: information (signs, accessible pedestrian/traffic signals, markings), turning radius, visible crosswalks (including raised crosswalks), adequate crossing times, medians (See **Figure 35**), refuge islands, corner island (See **Figure 36**), curb ramps with detectable warnings, and curb extensions (See **Figure 38**). It also involves careful consideration of adequate sight lines, traffic patterns, and traffic signal phasing. Other techniques such as restrictions on right turns, pedestrian lead times, and traffic calming measures will benefit all pedestrians. Regulations that prohibit parking at the corner can also improve blocked sight lines.

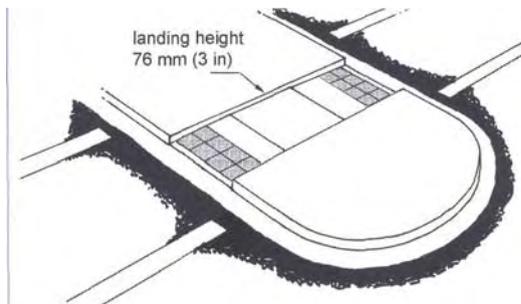
Figure 38



Curb extensions improve visibility between pedestrians and motorists and make it easier to install perpendicular curb ramps with level landing. Regulations that prohibit parking at the corner can also improve blocked sight lines

Medians: Medians generally reduce crossing exposure and allow pedestrians to negotiate vehicle traffic one direction at a time. Medians should be curbed or barrier medians to physically separate pedestrians and motorists rather than painted flush. Furthermore, all medians should be accessible to pedestrians. The nose of the median should be extended beyond the crosswalk (See **Figure 39**). If a cut through (See **Figure 40**) is provided, it should be at least 1.8 m (6 ft) long and 1.5 m (5 ft) wide. This allows 2 wheelchair users to pass each other. In addition the edges of the cut through must be perpendicular to the street being crossed.

Figure 39



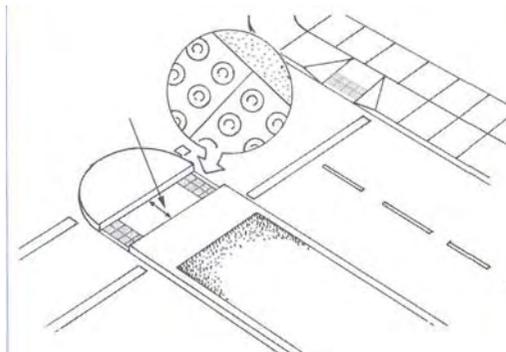
GOOD DESIGN: The height of this median does not exceed 76 mm (3 in). This design allows for the construction of shorter curb ramps and a longer level landing.

Ramped medians (See **Figure 35**), should have a curb ramp at either end and a level landing at least 1.5 m x 1.5 m (5 ft x 5 ft). For all medians, cut through or ramped, a 0.6 m (2 ft) strip of detectable warnings should be located at the entrance and exit.

Corner Island: The design guidance for the island itself is similar to those of the median. The island should be raised and designed with curb ramps (See **Figure 36**) or a pedestrian cut-through (See **Figure 41**). If a cut-through design is selected, it should provide at least 1.5 m (5 ft) of clear space in all directions. In addition, a 0.6 m (2 ft) strip of detectable warning should be included at every exit point on the island.

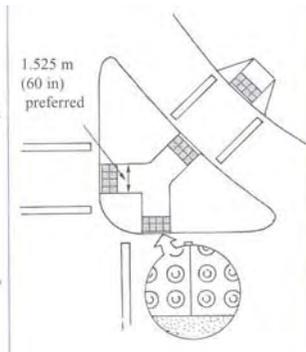
Ramped Corner Island (See **Figure 36**): The design should include curb ramps that are at least 1.5 m (5 ft) wide (preferred), 1.5 m x 1.5 m (5 ft x 5 ft) level landing and detectable warnings.

Figure 40



Cut-through medians should be at least 1.525 m (60 in) wide and should include 610 mm (24 in) strips of detectable warnings at both ends.

Figure 41



Corner islands with cut-throughs should be at least 1.525 m (60 in) wide at all locations and include 610 mm (24 in) strips of detectable warnings