

# 8

# PEDESTRIAN CROSSINGS

## CHAPTER

## Pedestrian Crossings

Designing an effective pedestrian crossing involves the correct layout of a variety of elements including:

- Information/signs, signals and markings;
- The turning radius;
- Crosswalks;
- Crossing times;
- Medians;
- Refuge islands and slip lanes;
- Curb ramps;
- Sight lines;
- Traffic patterns; and
- Onset of signal phases.



**Figure 8-1.** Pedestrian crossings should be designed to be accessible to all pedestrians.

A pedestrian crossing is defined as any location where the pedestrian leaves the sidewalk and enters the roadway. At a pedestrian crossing, the pedestrian's path of travel crosses the motorist's path of travel. Pedestrian crossings include midblock crossings and street intersections. At midblock crossings, pedestrians generally encounter traffic moving in two directions. At signal phasing, traffic is usually moving in multiple directions because of turning vehicles. Overpasses and underpasses route pedestrians above or below vehicular traffic and therefore are addressed as variations in the design of the sidewalk corridor and are included as part of Chapter 4.

A design that carefully considers each of these elements is the first step in the creation of an effective pedestrian

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crossing. Equally important, however, is the way in which these elements are combined. Sometimes variations in the design will be necessary in order for elements to be combined appropriately. More complicated pedestrian crossings, including roundabouts, skewed intersections, and streets with rail tracks are discussed in this chapter and in Chapter 9.

### 8.1 Barriers to pedestrian access

Pedestrians are at risk whenever they cross the roadway. The degree of risk depends on the complexity of the vehicular and pedestrian traffic patterns and the effectiveness of supplementary information provided regarding the crossing location, direction, and duration. At street intersections, turning vehicles and the speed at which they travel pose the greatest threat to pedestrians because the motorist's attention is focused primarily on other motorists.

In addition to the geometric design of the intersection, pedestrian safety also

relies heavily on the information that is provided to pedestrians (e.g., signs or signals). All pedestrians, including people with vision impairments, need the same information at an intersection. Providing vital information in multiple, accessible formats (e.g., visual, auditory, tactile) also benefits all pedestrians since information is better recognized and remembered if it is understood by multiple senses. Generally, the more complex the crossing, the more important it is to have accessible information about the crossing location, direction, and duration. More detailed information about accessible pedestrian information is provided in Chapter 6.

#### 8.1.1 Movement barriers

A movement barrier is anything that restricts an individual's ability to physically move along or within the sidewalk and crosswalk environment. The greatest movement barriers for pedestrians at pedestrian crossings are:

- Long crossing distances;

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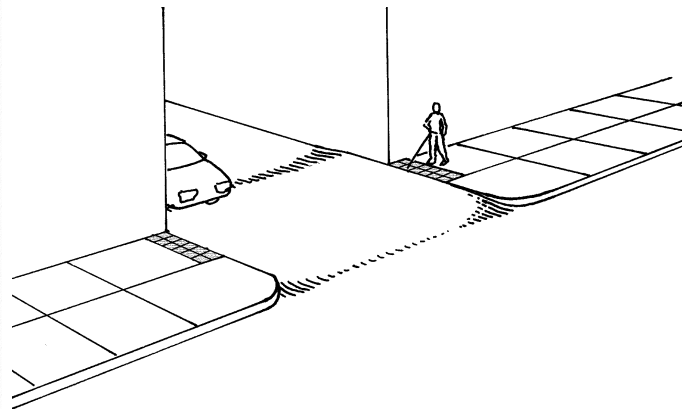
- Short signal timing;
- Medians and islands without ramps or cut-throughs;
- Curbs without curb ramps;
- Curb ramps without level landing;
- Pedestrian actuated signal devices that are difficult to activate or in hard to reach locations; and
- Lack of information during pedestrian signal phase.

### 8.1.2 Information barriers

Information barriers restrict an individual's ability to utilize information contained within the sidewalk environment. The greatest information barriers for pedestrians at crossing locations are:

- Conditions that make it difficult to identify the boundary between the sidewalk and street;
- Blocked sight lines;
- Signal devices (including actuated) that do not provide accessible information;
- Lack of accessible information about the pedestrian crossing location, direction, or interval;
- Crosswalk locations that are only detectable by sight;
- Vehicular actuation mechanisms that make the onset and duration of signal phases unpredictable without accessible pedestrian signal information;

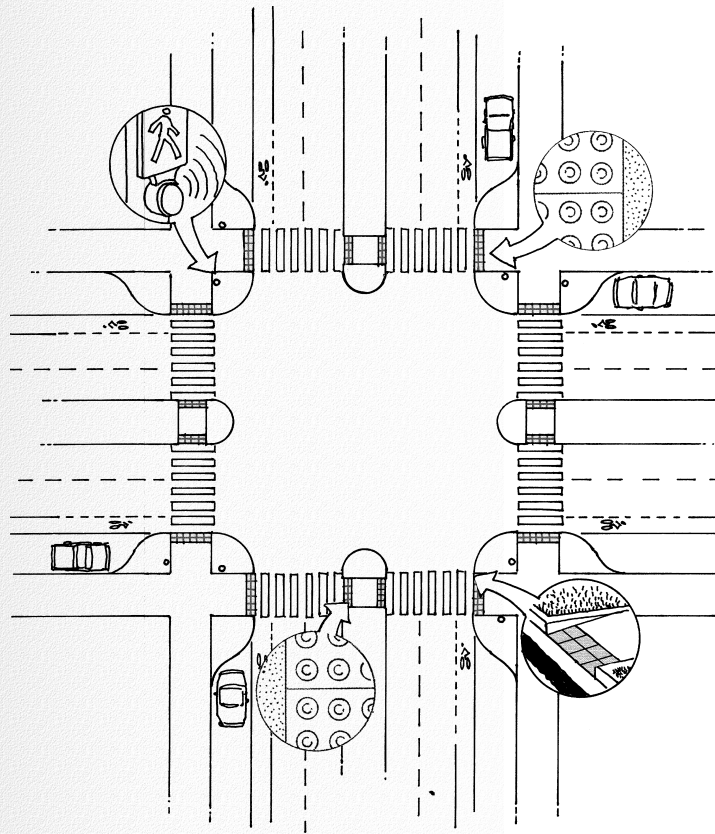
**Figure 8-2.** Crossing an alley is difficult for people with vision impairments if the motorist's sight lines are short and the crosswalk is raised to enhance access for people with mobility impairments. Detectable warnings are critical whenever the crosswalk is flush with the curb.



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**Figure 8-3. GOOD DESIGN:** At wide intersections, pedestrian access can be enhanced through a variety of features including ladder marking of crosswalks, perpendicular curb ramps, curb extensions with landscaping, detectable warnings, medians, and accessible pedestrian signals.

- Exclusive pedestrian phases (i.e., motorists stopped in all directions), without accessible pedestrian signal information for people with vision impairments to determine the crossing phase;
- Motorists making right turns during a red light;
- Nonsignalized slip lanes or roundabouts that permit a continuous flow of vehicular traffic;
- Rectilinear or unusual geometrics in the design of the intersection where the crossing location and correct direction of travel is not clear;
- Small signage or pedestrian signals at intersections with long crossing distances; and

- Short WALK intervals that do not provide pedestrians with slower starting times sufficient time to verify that the WALK interval has begun.

### 8.1.3 Design solutions

Techniques that can help improve pedestrian conditions and access at intersections are outlined in the following list and expanded in the subsequent sections:

- Install a center median to provide a refuge for slower pedestrians;
- Install accessible pedestrian signals to assist in providing people with vision impairments enough time to cross the street;
- Increase crossing times so that people who walk slowly will have sufficient time to cross before the signal indication changes;

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- Increase the crossing times so that people who delay the start of their crossing to confirm the WALK interval will have sufficient time to cross before the signal indication changes;
- Restrict right turns on red;
- Enhance the visibility of the crosswalk markings or consider a raised crosswalk with detectable warnings (truncated domes) at both ends;
- Reduce crossing distances and increase visibility through the construction of curb extensions;
- Reduce traffic speed;
- Clarify the pedestrian crossing area by installing raised crosswalks with detectable warnings (truncated domes) installed at both ends;
- Provide pedestrian lead time and an accessible pedestrian signal so pedestrians, including those with

vision impairments, can assert themselves in the crosswalk before motorists start making right and left turns;

- Provide midblock signalized crossing with accessible pedestrian signal opportunities at busy intersections to encourage people to cross where there are fewer potential points of conflict between pedestrians and motorists;
- Provide a curb extension to decrease crossing distances and increase pedestrian visibility; and
- Add traffic and pedestrian signal indications if they do not already exist.

In addition, if commercial facilities are primarily located on one side of a very busy street, public transportation, such as buses, should drop people off on the commercial side of the street whenever feasible to reduce the number of crossings.

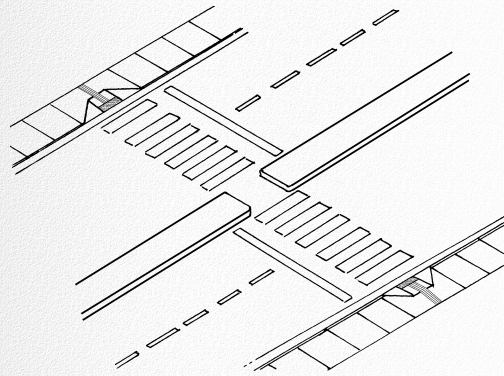
### Case Study 8-1

Eagle Point, Oregon, improved access to its downtown intersections by moving utility poles, constructing new sidewalks, and implementing other accessibility features.

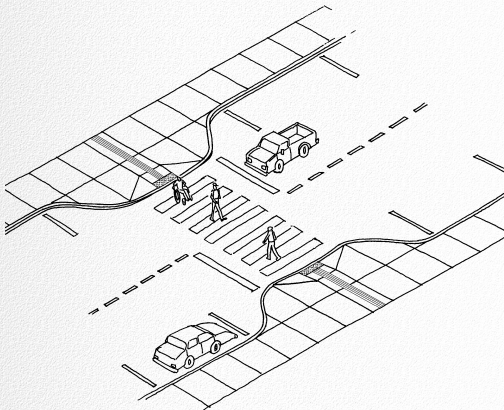
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**Figure 8-4.** Medians improve pedestrian access at midblock crossings by allowing pedestrians to negotiate traffic in only one direction at a time.



**Figure 8-5.** Curb extensions and highly visible crosswalks improve pedestrian access at midblock crossings.

## 8.2 Midblock crossings

Midblock crossings are locations between intersections where a marked crosswalk has been provided. Midblock crossings are often installed in areas with heavy pedestrian traffic to provide more frequent crossing opportunities. They may also be added near major pedestrian destinations, such as schools, where people might otherwise cross at unmarked locations.

Midblock crossings may or may not be regulated. In many situations, midblock crossings are easier for pedestrians to use because traffic is flowing in no more than two directions. However, midblock crossings present some design challenges because motorists often do not expect pedestrians to be crossing at a midblock location. In addition, midblock crossings are difficult for pedestrians with vision impairments to locate; if signalized, pedestrians with vision impairments are often unable to identify when it is their turn to cross because their customary cue,

the surge of traffic in the street beside them, isn't present. If not signalized, they are often unable to tell when there is a gap in traffic or whether all approaching cars have stopped (the sound of one idling car can mask the sound of approaching cars).

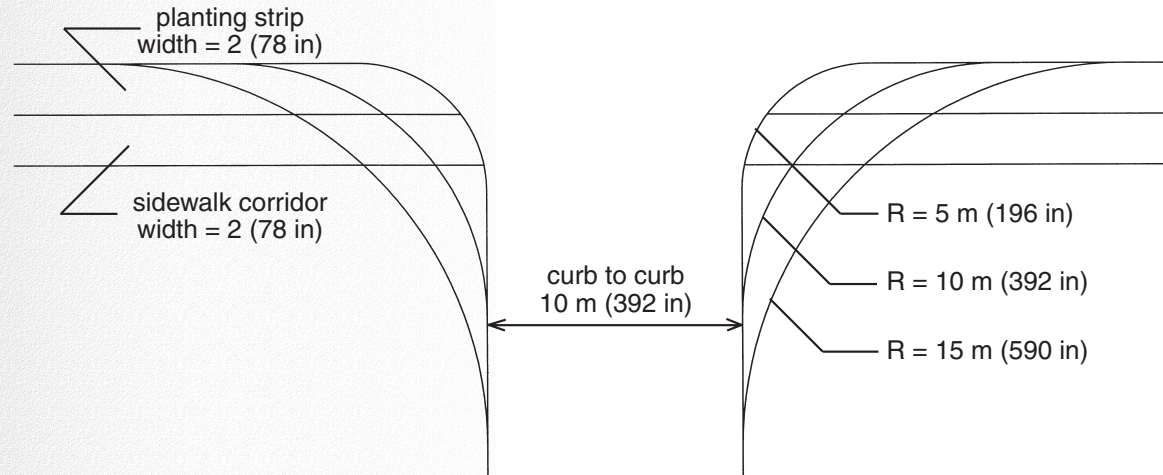
A variety of strategies can be employed to identify midblock crossings to people with vision impairments. If the crossing is signalized, an accessible pedestrian actuated signal device with a locator tone should be provided. Another strategy is to include raised directional wayfinding surfaces across the width of the sidewalk (perpendicular to the sidewalk path of travel). This alerts the pedestrian with visual impairments to the midblock crossing, and they are able to follow the directional surface to the curb on the other side of crossing. In the United States, relatively few midblock crossings incorporate raised directional surfaces, although they are more widely used in other countries, including Japan and England.

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**Table 8-1**



| Turning Radius             | Crossing Distance*           | Increased Crossing Distance** |
|----------------------------|------------------------------|-------------------------------|
| 5 m<br>(16.4 ft = 196 in)  | 10.8 m<br>(35.4 ft = 424 in) | 0.8 m<br>(2.6 ft = 30 in)     |
| 10 m<br>(32.8 ft = 392 in) | 15.7 m<br>(51.5 ft = 617 in) | 5.7 m<br>(18.7 ft = 223 in)   |
| 15 m<br>(32.8 ft = 392 in) | 22 m<br>(72.2 ft = 866 in)   | 12 m<br>(39.4 ft = 472 in)    |

### 8.3 Turning radius

Designing intersections with smaller turning radii slows traffic speeds and allows perpendicular curb ramps to be positioned parallel to the crosswalk path of travel, as well as perpendicular to the curb (Section 7.2.1). In addition, smaller turning radii significantly decrease crossing distances for pedestrians, as shown in Table 8-1. Smaller radii also enhance detection of the crosswalk and improve crossing conditions for people with vision impairments because there is a greater distinction between the perpendicular and parallel traffic flows.

Unfortunately, the turning radius at intersections has gradually increased in order to accommodate larger vehicles and more continuous traffic flow. Current practice dictates that the turning radius be determined by the types of vehicles that travel on the road and the intended speeds for drivers to make right turns. Larger trucks and buses benefit from larger turning radii because they have a longer wheelbase than smaller passenger vehicles.

\*Measured from the center of the paved portion of the sidewalk corridor  
 \*\*Based on a curb-to-curb distance of 10.0 m (32.8 ft)

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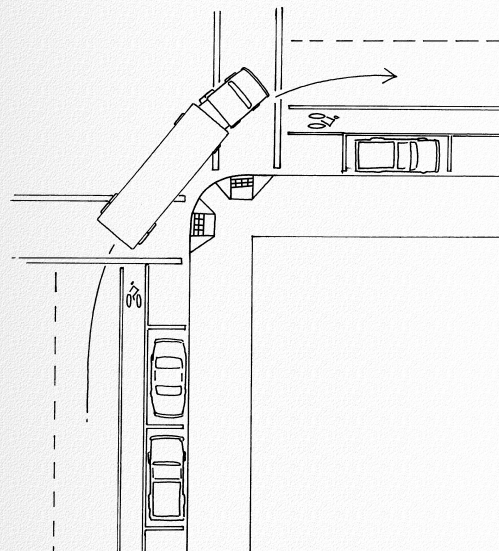
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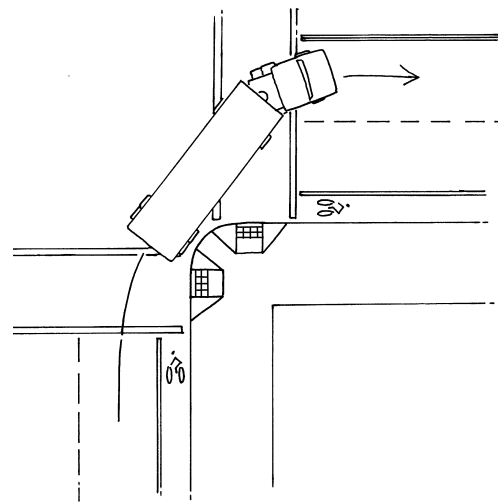
However, pedestrian access is significantly compromised at intersections with larger turning radii, for the following reasons:

- Cars can make right turns at higher speeds;
- Curb ramp designs may be compromised;

- Pedestrian crossing distances are increased (this also results in increased vehicle signal phasing delays and reduced roadway capacity from the delays);
- Less space is available on the corner for pedestrians to collect;
- Less space is available on the corner for utilities;
- It is more difficult for pedestrians, especially those with vision impairments, to claim the right of way when crossing;
- Greater numbers of conflicts arise between pedestrians and motorists; and
- Pedestrians are located outside of a driver's line of vision.



**Figure 8-6.** Adding bike and parking lanes increases the potential turning radius for oversized vehicles, while maintaining the benefits of smaller turning radii for pedestrians.



**Figure 8-7.** Allowing trucks to turn into the second lane of traffic increases the potential turning radius for oversized vehicles.

Minimum recommendations for turning radius are contained in A Policy on Geometric Design of Highways and Streets (AASHTO, 1996). However,



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designers rarely adhere to the minimum recommendation. Pedestrians would be better served if designers balanced the needs of larger vehicles with the needs of pedestrians.

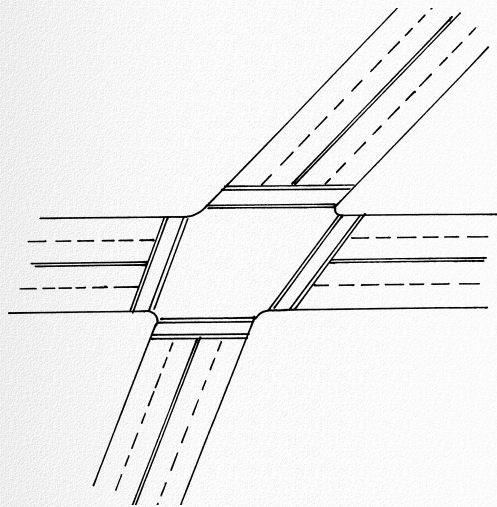
Whenever possible, creative designs should be used to minimize turning radii at an intersection. Alternatives to building intersections with large turning radii include:

**SOLUTION 1** — Add a parking lane to increase the relative turning radius of the corner.

**SOLUTION 2** — Allow trucks that cannot make it around a tight corner to turn into the out-of-lane roadway as necessary and put stoplines farther back from the intersection.

**SOLUTION 3** — Design intersections with right angles or as close to right angles as the site permits since skewed intersections inherently have some corners with wider turning radii.

**SOLUTION 4** — Consider a design that uses a compound curve. This design allows the use of larger turning radii where required and yet pedestrians still benefit from the positive aspects of tight corners wherever possible. For example, one corner section of the intersection may have a very large radius which then transitions to a much smaller radius at another corner. The combination of the initially large radius with the small radius on the opposite side of the crosswalk may benefit truck traffic at corners that they use most. At the same time, it forces other motorists making turns at smaller radii to slow down significantly as they turn.



**Figure 8-8.** Skewed intersections always have some corners with wide turning radii.

### 8.4 Right turn on red and turning vehicles

Right turns on red create a significant information barrier for individuals with vision impairments. Traffic sounds are a valuable orientation cue for people with vision impairments. Irregular sound

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patterns, such as cars pulling constantly through the intersection, can provide conflicting and unreliable information about the pedestrian crossing interval. Additional research is needed to establish guidelines for when right turn on red should be prohibited at intersections because of the negative impact it has on the safety of all pedestrians, especially those with vision impairments.

Turning traffic also has a significant impact on pedestrian travel in general. Motorists who are turning left have their concentration focused on the oncoming traffic. As a result, the attention paid to pedestrians in the crosswalk is decreased. The effect is compounded for drivers who are turning right on a red light. They are not only concentrating on identifying a suitable gap in automobile traffic traveling on a perpendicular path, they often pull into the pedestrian crossing area in order to improve their sight lines and decrease the distance required to merge. When this happens, pedestrians are forced to walk between cars or significantly delay the start of their crossing.

## 8.5 Crosswalks

Crosswalks are a critical part of the pedestrian network. A crosswalk is defined as “the portion of a roadway designated for pedestrians to use in crossing the street” (Institute of Transportation Engineers, 1998). Crosswalks are implied at all intersections whether or not they are marked. Midblock crossings include all marked crosswalks that do not occur at intersections. Midblock crossings are only created if a marked crosswalk is provided. The agency responsible for the roadway must ensure that all marked and unmarked crosswalks and midblock crossings are optimized for the safety and accessibility of all pedestrians.

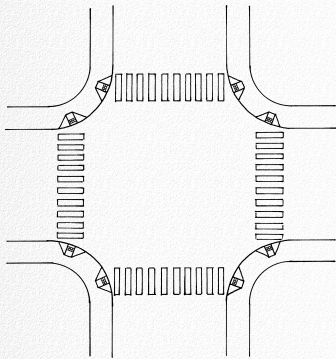
### 8.5.1 Crosswalk markings

Crosswalk markings, if provided, are used to define the pedestrian path of travel across the roadway and alert drivers to the crosswalk location. Marked crosswalks should be designed in accordance with the Manual of Uniform Traffic Control Devices (MUTCD). Although the MUTCD provides

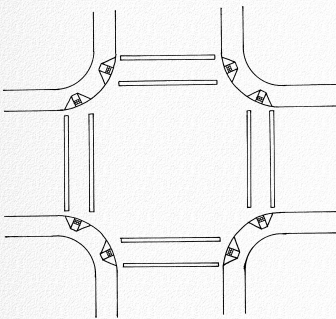
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**Figure 8-9. GOOD DESIGN:** Continental markings should be used at all pedestrian crossings because research has determined that they are most visible to motorists.



**Figure 8-10. ACCEPTABLE DESIGN:** Although crosswalks with parallel markings are permitted by the MUTCD, they are less visible to motorists than crosswalks with ladder striping.

options for crosswalk markings, the continental design is recommended because research indicates that it is the most visible to drivers (Knoblauch et al., 1988). The ladder design is created with white longitudinal lines at a 90 degree angle to the line of the crosswalk. The lines should be approximately 305 mm to 610 mm (12 in to 24 in) wide and spaced 305 mm to 610 mm (12 in to 24 in) apart (USDOT, 1988). The continental design can also be installed so that the primary paths for vehicular tires are between the crosswalk markings, which helps to reduce wear and maintenance. Use of the continental design for crosswalk markings also improves crosswalk detection for people with low vision and cognitive impairments. It is recommended that the continental design be used consistently to mark all crosswalks; otherwise the impact of less visible markings may be weakened by comparison.

### 8.5.2 Crosswalk research

In recent years, there has been much debate surrounding the safety implications

of marking crosswalks at uncontrolled intersections. Previous research results were contradictory in terms of whether pedestrian vehicle crashes were occurring with more, less, or the same frequency at marked and unmarked crosswalks. The contradictory findings can be attributed to limitations of the research project designs, which contained many confounding variables and small, potentially biased sample sizes and sites.

A large study entitled Evaluation of Pedestrian Facilities was completed by the Federal Highway Administration to address the limitations found in previous research (Zeeger, Stewart, & Huang, 1999). None of the sites in the study had traffic signals or stop signs on the approach to the crosswalk. The study examined the safety of marked and unmarked crosswalks and the impact of additional pedestrian treatments, such as signal indications, lights, and traffic calming measures. The study evaluated 1,000 marked crosswalks at uncontrolled locations or locations with no traffic control devices and 1,000 matched but unmarked sites

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in 30 geographically dispersed cities in the United States. Detailed information collected for each site included pedestrian crash history, pedestrian and traffic volumes, number of lanes, speed limit, type of median, type and condition of crosswalk markings, and crosswalk location. Results of the study indicated that:

- Higher pedestrian volumes, higher average daily traffic (ADT) rates, and a greater number of roadway lanes are related to a higher incidence of pedestrian crashes;
- Crosswalk location, speed limit, direction of traffic flow, crosswalk condition, and crosswalk marking pattern were not related to the incidence of pedestrian crashes;
- The presence of a median decreased the pedestrian crash risk;
- Marked crossings had a higher incidence of pedestrian crashes on multi-lane (4 or more lanes) roads with high ADTs;
- Marked and unmarked crossings had similar incidences of pedestrian crashes on all 2-, 3-, and multi-lane roads with lower ADTs;
- Pedestrians ages 65 and above were over represented in crashes; and
- The installation of marked crossings did not alter motorist behavior (e.g., stop or yield to pedestrians) or pedestrian behavior (e.g., crossing without looking).

According to the research, on smaller roadways with lighter traffic volumes, markings do not decrease the pedestrian crash risk; conversely, on large, high-volume roadways, the risk actually increases. However, Zegeer, Stuart and Huang (1999) indicated that the higher risk observed on multi-lane roadways with high ADT rates results from:

- An overall higher risk as the number of lanes or ADT rate increases regardless of markings;

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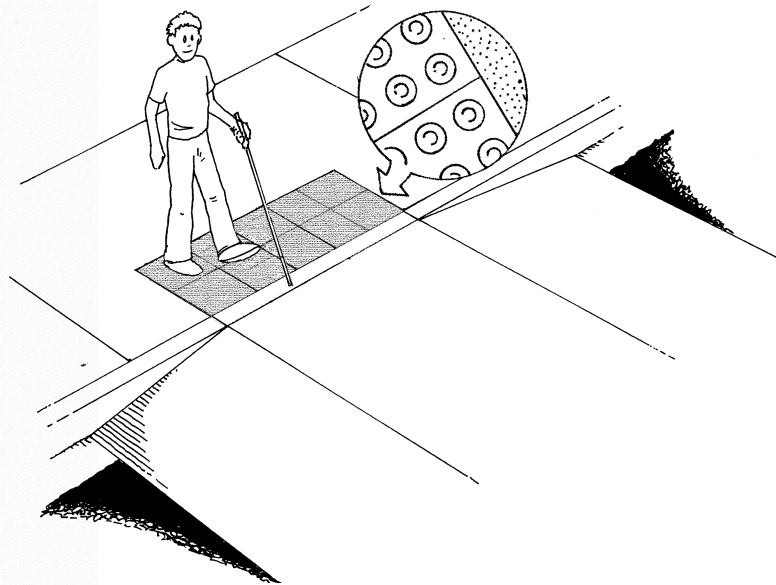
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**Figure 8-11.** Continental crosswalks combined with alternative measures, such as pedestrian actuated traffic controls, enhance pedestrian crossing.

- Recognition that multi-lane roadways with high ADT rates represent the most difficult scenarios for pedestrian crossings, and
- The fact that marked crossings draw pedestrians to cross in that location, particularly in areas where the crossing is perceived to be difficult.



**Figure 8-12.** Detectable warnings should be provided at the edge of a raised crosswalk to identify the transition between the sidewalk and the street for people with vision impairments.

### 8.5.3 Recommendations for enhancing pedestrian safety and access

Zegeer, Stuart, and Huang emphasized that the needs of pedestrians to safely cross streets cannot be ignored and that engineering and roadway treatments should be used to minimize the pedestrian crash risk. Based on these recommendations, it is not appropriate to always remove crosswalk markings from multi-lane roadways with high average daily traffic. Instead, the markings should be enhanced with appropriate additional pedestrian treatments such as signing, traffic calming, signalization, or other countermeasures.

Zegeer, Stuart and Huang (1999) offered a variety of recommendations based on the results of their research. Although the study was focused on safety issues, it is interesting to note that the majority of their recommendations for improving pedestrian safety would improve access for people with disabilities. Based on these research results and recommendations for enhancing access to pedestrian rights-of-way (U.S.

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Access Board, 1999a), the following recommendations are made for the design of pedestrian crosswalks:

- Design crosswalks as enhanced crossings that combine highly visible markings (ladder striping) with additional pedestrian treatments, such as shorter crossing distances, traffic calming, and medians;
- Design crosswalks so that all pedestrians can travel within the marked area throughout the entire crossing. Crosswalk designs should provide for a 1.22 m (48 in) clear space at the bottom of diagonal curb ramps;
- Avoid restrictions for pedestrians to cross on only one leg of an intersection unless a solid barrier and accessible information about the restricted crossing pattern is provided to pedestrians with visual impairments;
- Ensure that midblock crossings will be detectable by and accessible to pedestrians with vision impairments;
- Maintain crosswalk markings and consider additional treatments whenever a street is resurfaced;
- Do not install marked crosswalks without additional treatments, such as traffic calming and signing, on multi-lane roadways with high average daily traffic;
- Provide raised medians and curb extensions on multi-lane roads;
- Consider traffic signals and pedestrian actuated signal devices at difficult or problematic pedestrian crossings;
- Consider flashing signals and lights and advanced warning signs to increase the visibility of the crosswalk;
- Install traffic calming measures to reduce vehicle speeds (see Chapter 10);
- Increase the crossing time if the crossing is signalized;

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- Maintain the expected pedestrian travel pattern;
- Design corners with smaller turning radii; and
- Provide generous sight distances and unobstructed sight lines between vehicles and pedestrians.

### 8.5.3.1 Flashing signals

Pedestrian safety is maximized when drivers are aware of the crosswalk location and know when a pedestrian is attempting to cross. People who use wheelchairs are at a lower height than other pedestrians and may be more difficult for motorists to detect. People with vision impairments cannot establish eye contact with an approaching motorist, which may also decrease the probability that they will be seen or that the motorist will know that a crossing will be attempted. Flashing lights that are activated only when a pedestrian is attempting to cross can enhance crosswalk detection by motorists. The flashing lights, in conjunction with

advanced warning signs for the lights, can provide the motorists with more warning of the crossing. A variety of intermittent lighting styles may be used, including:

- Flashing traffic signals over the crosswalk;
- Imbedded flashing lights in the crosswalk surface; and
- Flashing signals to warn motorists if pedestrians are present.

Overhead flashing signals should be installed according to the MUTCD standards. The flashing in-pavement crosswalk lights are currently being tested for their effectiveness by FHWA as a new device and are not currently included in the MUTCD standards.

### 8.5.3.2 Reducing motorist speeds

Ultimately, the pedestrian in the roadway is dependent on the motorist's ability to detect the pedestrian with sufficient time to stop given the vehicle's



**Figure 8-13.** Imbedding lights in the asphalt at the edge of a crosswalk is an experimental method for making crosswalks more visible to motorists.

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speed. The faster a motorist is traveling, the longer the stopping distance will be. The required vehicle deceleration may be difficult for motorists to judge accurately, if the pedestrian is moving slower than expected. For example, a motorist may see a pedestrian start to cross from a distance and slow their vehicle so that it will approach the crosswalk after the pedestrian has finished crossing. However, if the pedestrian actually moves at a slower pace than anticipated, the motorist may not immediately recognize that greater deceleration or a full stop will be required. Likewise, pedestrians may not be able to judge vehicle approach speed and gap size effectively, especially at night.

Raised crosswalks (and other traffic calming devices) can reduce vehicle speeds and improve the crosswalk for individuals with mobility impairments because they eliminate the need to negotiate a curb or ramp. However, if raised crosswalks are installed, the edge of the street must be marked with detectable warnings so people with vision impairments can easily determine when they are leaving the

sidewalk and entering the street. Raised intersections are an alternative design but may not reduce vehicular speeds to the same extent. More detailed information on traffic calming techniques can be found in Chapter 9.

## 8.6 Crossing times

People's decision and reaction times before they start walking, as well as their walking pace, vary depending on several factors. Older pedestrians and pedestrians with vision or cognitive impairments may all require longer starting times to verify that cars have stopped. They may also have slower reaction times and slower walking speeds. Both powered and manual wheelchair users on level or downhill slopes may travel faster than other pedestrians. But on uphill slopes, manual wheelchair users have slower travel speeds. At intersections without accessible information to indicate the onset and direction of the WALK interval, people with vision impairments require longer starting times to verify that their



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pedestrian interval has started and it is appropriate to cross safely. Additional information about accessible pedestrian signals can be found in Chapter 6.

The MUTCD standard identifies a “normal” walking speed as 1.22 m/s (4 ft/s). However, research indicates that the majority of pedestrians walk at a speed that is slower than this and that 15 percent of pedestrians walk at speeds less than 1.065 m/s (3.5 ft/s) (Kell and Fullerton, 1982). The latter group includes a large proportion of people with ambulatory impairments and older adults. As the population ages, the number of pedestrians traveling at slower walking speeds is increasing. Therefore, it is recommended that the calculation of all crossing times be based on a walking speed of no more than 1.065 m (3.5 ft/s). The City of San Francisco calculates pedestrian crossing times based on a walking speed of 855 mm/s (2.8 ft/s).

In the past, transportation manuals have recommended longer crossing times at intersections with high volumes of older adults or people with mobility impairments.

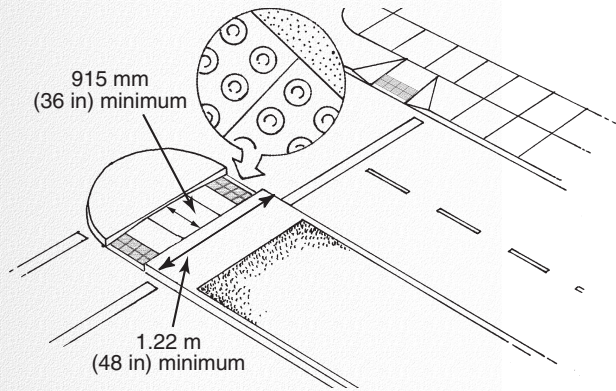
However, every intersection will be used by a variety of pedestrians including some individuals who walk slowly and others who walk quickly. Therefore, adjusting crossing times based on 3.5 ft/s should be considered at all intersections. Longer pedestrian signal cycles are strongly recommended at crossings that are unusually long or difficult to negotiate. Longer signal cycles are also recommended for crossings, such as those that provide access to a rehabilitation or senior center, where a higher proportion of the potential users may have a slower walking speed. Engineers are also encouraged to consider recent advancements in technology that can detect pedestrians in the crosswalk and extend the pedestrian interval as needed. Note that accessible pedestrian signals may be necessary since pedestrians who are blind may not know how the signals cycle.

If crossing times cannot be reduced, crossing distance should be decreased to benefit pedestrians who need more time to cross or who may require a rest or break during long or complex crossings.

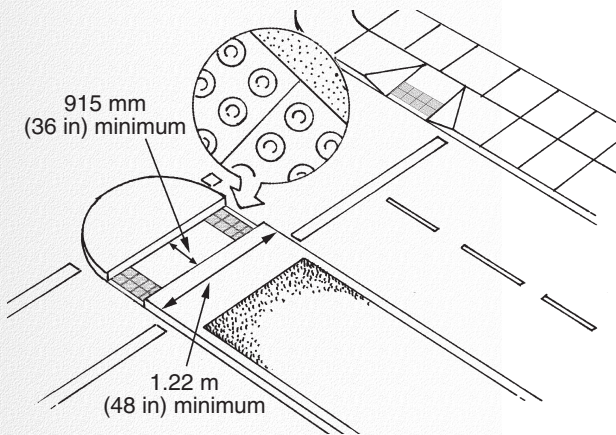
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**Figure 8-14.** A ramped median should have a level landing that is at least 915 mm (36 in) wide and 1.22 m (48 in) long.



**Figure 8-15.** Cut-through medians should be at least 915 mm (36 in) wide and should include 610 mm (24 in) strips of detectable warnings at both ends.

Crossing distances can be reduced by extending the sidewalk into the parking lane, by narrowing the existing lanes, or by providing medians to divide the crossing into two segments.

### 8.7 Medians

Medians are the portion of a divided roadway that separates traffic flows heading in opposite directions (US DOT, 1994b). At roundabouts, these are called splitter islands. Medians help pedestrians cross intersections by reducing the crossing distance from the curb to a protected area. This allows pedestrians to cross during smaller gaps in traffic. For this reason, medians are especially helpful for pedestrians who are unable to judge distances accurately. In addition, medians also help people with slow walking speeds to cross wide intersections during a

short signal cycle. Medians are also useful at irregularly-shaped intersections, such as sites where two roads converge into one (Earnhart & Simon, 1987). In commercial districts, medians provide pedestrians with valuable protection from oncoming traffic. In residential areas, they serve as traffic calming devices and green space.

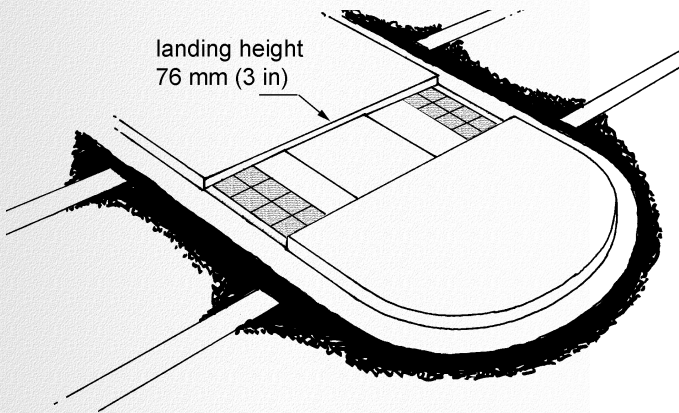
Whenever possible, medians should be raised to separate pedestrians and motorists. Raised medians make the pedestrian more visible to motorists and they are easier for people with vision impairments to detect. Raised medians should be designed with a cut-through at street level or a ramp. This provides pedestrian access to individuals who cannot travel over a curb. Detectable warning surfaces should be placed at the edge of both ends of the median in order for the streets to be recognized by pedestrians who are visually impaired. If the corner includes a pedestrian actuated control device, one should also be located at the median. (See Chapter 6.5 for more information.)

If a median is ramped (see Figure 8-14), the slope of the ramps must not

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**Figure 8-16. 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.

exceed 8.33 percent. In addition, a level area at least 915 mm (36 in) wide and 1.22 m (48 in) long is required. If space allows, a level area at least 1.525 m x 1.525 m (60 in x 60 in) is preferred. This is often difficult to achieve where the available space is restricted. One creative solution is presented in

Figure 8-16. Rather than raising the landing the full height of the median [e.g., a full 152 mm (6 in)], the landing is only raised 76 mm (3 in), which allows for much shorter ramp lengths and a longer landing. A 610 mm (24 in) strip of detectable warnings should be provided at the end of both curb ramps.

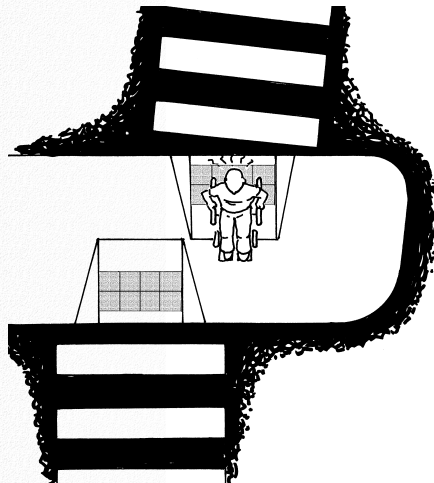
If the raised median is cut-through level with the street (see Figure 8-15), it should be at least 915 mm (36 in) wide and 1.22 m (48 in) long. If space permits, the length of the cut-through should

be increased to 1.53 m (60 in). A slight crowning of the asphalt (no greater than 5 percent) may be necessary for drainage. Cut-through medians should have a 610 mm (24 in) wide detectable warning at each end to identify the edge of the street.

### 8.8 Corner islands

In addition to medians, raised pedestrian refuge areas are sometimes installed between the independent right turn lane and the intersection through lanes. The right turn lane is often called a right slip lane because motorists are not expected to come to a complete stop at the intersection. Right slip lanes are designed to improve traffic flow by minimizing the drivers' need to stop at an intersection; therefore, driver speeds through the crosswalk tend to increase. To limit motorist speeds, a compound curve radius

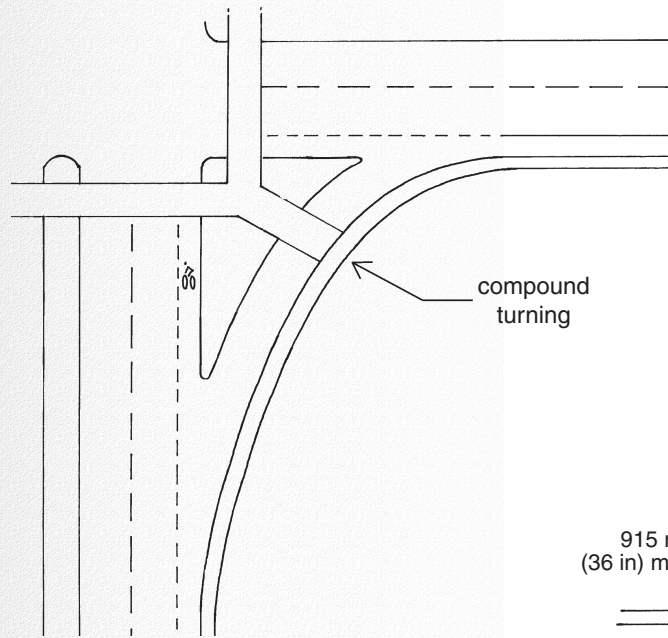
**Figure 8-17. PROBLEM:** Offsetting median ramps is a common mistake made by designers who do not understand the mobility limitations of wheelchair users. Providing a level landing is not sufficient if the landing does not connect to the subsequent ramp.



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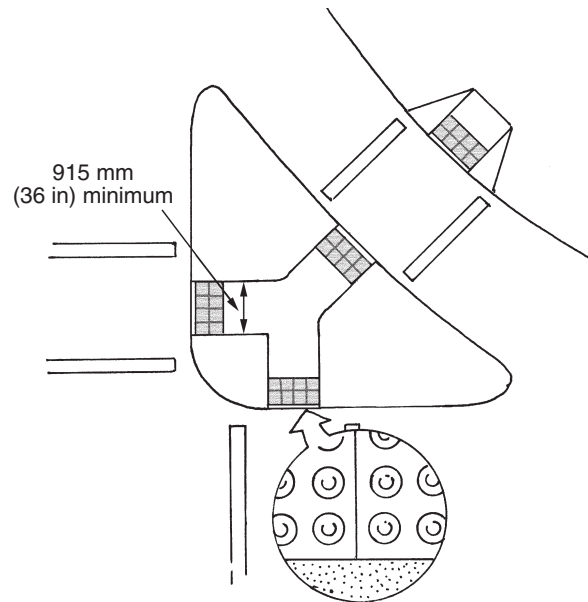
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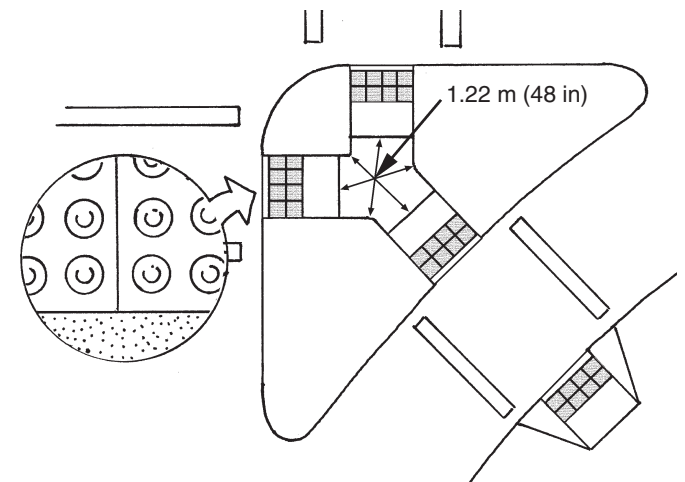
**Figure 8-18.** This corner island was installed at a corner with a compound curve radius. This design allows the use of larger turning radii where required, and pedestrians benefit from the positive aspects of a tight corner that forces drivers to decrease speeds.

should be used (see Section 8.3 for details). Even if vehicle speeds are somewhat controlled by the radius of the corner, a right turn slip lane still creates significant access barriers for pedestrians. For example:



**Figure 8-19.** Corner islands with cut-throughs should be at least 915 mm (36 in) wide at all locations and include 610 mm (24 in) strips of detectable warnings.

- Typical corner flow patterns are altered, which make it difficult for those with vision or cognitive impairments to detect and understand crossing locations;
- The area available at the corner for pedestrians waiting to cross is reduced and drivers' advance views of pedestrians waiting to cross is very short;



**Figure 8-20.** Ramped islands should include detectable warnings and have a level.

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- Traffic flow crossing cues for people with vision impairments are reduced because turning traffic masks the sounds of stop and go flows at the intersection; and
- Drivers often fail to yield the right-of-way to pedestrians waiting to cross, particularly individuals with vision impairments who cannot establish eye contact with the driver.

The benefits of right turn slip lanes are focused on improving the flow of vehicular traffic. However, given the significant drawbacks of right turn lanes separated by a corner island (see Figure 8-18) for pedestrians with and without disabilities, designers and engineers are challenged to develop alternate solutions that will not compromise access or safety. If a right turn slip lane is deemed necessary despite the drawbacks, the island should be raised and contain cut-throughs or ramps. In addition, design features

should be installed to control or calm the traffic, such as pedestrian-activated signals, or raised crosswalks with detectable warnings. If cut-throughs are used, they should be at least 915 mm (36 in) wide. If ramps are provided, they should be at least 915 mm (36 in) with a center landing of 1.22 m (36 in) and a maximum slope of 8.3 percent. Both ramps and cut-throughs should include a 610 mm (24 in) strip of detectable warnings at the island/street interface.

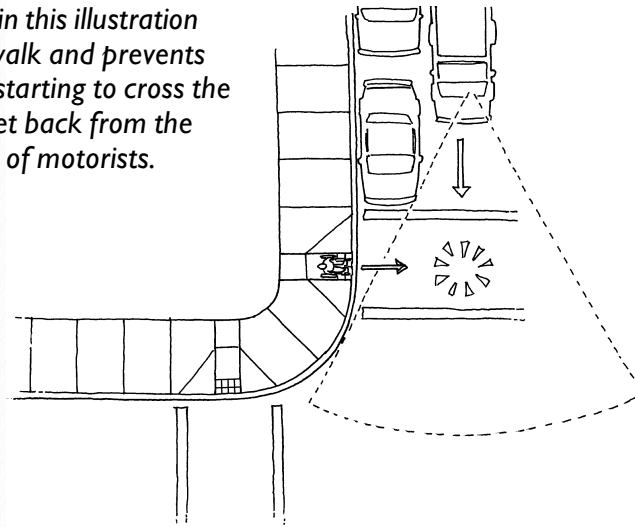
### 8.9 Improving sight lines at intersections

At pedestrian crossings, generous sight distances and unobstructed sight lines will allow motorists and pedestrians to detect each other in time to avoid collisions. Motorists also need appropriate sight distances to see traffic signals in time to stop. Sight lines should be designed so that the motorist can observe the movement of the pedestrian for a long enough period of time to accurately determine the pedestrian's speed. If the

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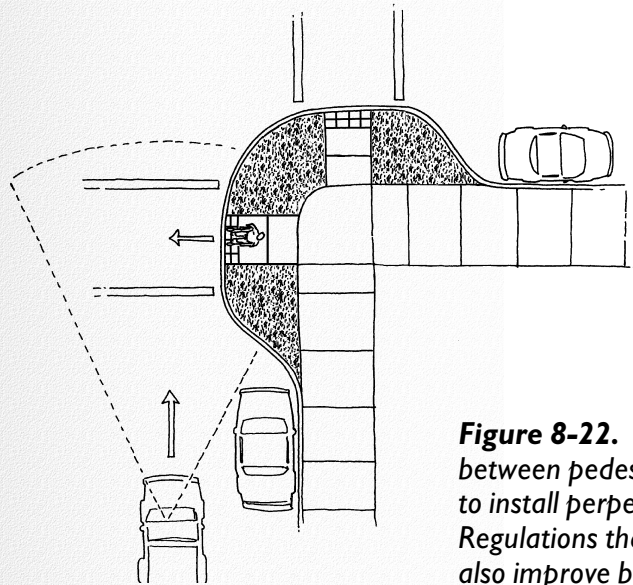
**Figure 8-21.** The parking lane in this illustration extends all the way to the crosswalk and prevents drivers from seeing pedestrians starting to cross the street. Parking lanes should be set back from the corner to increase the sight lines of motorists.



motorist has only a brief glimpse of the pedestrian, as at right turn slip lanes, and cannot observe the pedestrian's speed, he or she may overestimate the speed of slower pedestrians and not sufficiently slow his or her approach to the crosswalk.

While bollards, landscaping, benches, and bus shelters make pedestrian areas more inviting by calming traffic and providing amenities, they can also clutter the environment and limit the sight distance for motorists and pedestrians waiting to cross the intersection. Small children and people in wheelchairs are particularly vulnerable when sight lines are blocked. They may be unable to see over the obstacles and are at lower heights than drivers anticipate.

The best way to improve pedestrian visibility at an intersection is to install curb extensions to prevent parking at intersection corners and improve the visibility of pedestrians to motorists. Low landscaping or grass can be added to the curb extension to clarify the appropriate path of travel for individuals with vision impairments. In addition, the following steps should be considered:



**Figure 8-22.** Curb extensions improve visibility between pedestrians and motorists and make it easier to install perpendicular curb ramps with level landings. Regulations that prohibit parking at the corner can also improve blocked sight lines.

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- Trim vegetation, relocate signs and utilities, and eliminate visual clutter;
- Prohibit parking near the intersection corner;
- Provide raised medians and crosswalks; and
- Provide an advance stop line before a marked crosswalk on a multi-lane road.

### 8.10 Skewed intersections

Streets planned on a grid are generally easiest for pedestrians to negotiate because they result in intersections at 90 degree angles. Perpendicular intersections are easier to negotiate because the path of travel is clear and direct, and sight lines are good in all directions. Skewed intersections occur when streets cross at angles other than 90 degrees and create complicated scenarios for both pedestrians and drivers.

Skewed intersections should be avoided whenever possible during the planning stages of the development process. However, in some areas site constraints prevent the installation of perpendicular intersections. When skewed intersections are unavoidable, the intersection should be designed so that the angle between intersecting streets is as close to 90 degrees as possible. In addition, if major alterations are being done to an existing skewed intersection, transportation agencies should consider whether it is possible to reconfigure the intersection so that the crossings are more perpendicular.

At some skewed intersections, the crosswalks are moved back from the intersection to allow the crossing distance to be shorter and more perpendicular to the sidewalk. However, this design is only recommended if pedestrians with vision impairments can identify the unusual crossing location. People with vision impairments rely on predictable pedestrian travel paths to determine their crossing direction and location. Therefore,

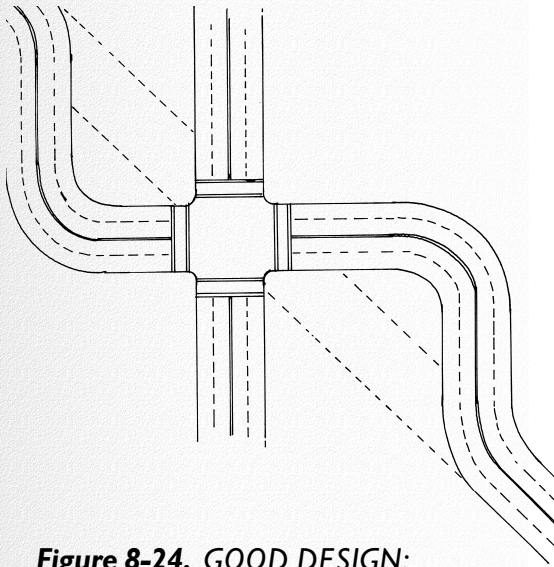


**Figure 8-23.** Skewed intersections create longer crossing distances, which significantly compromise pedestrian access.

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**Figure 8-24. GOOD DESIGN:** Transportation agencies should consider reconfiguring skewed intersections during alterations so that pedestrian crossings are perpendicular.

they are likely to experience difficulty locating crosswalk paths that are not aligned with the sidewalk path of travel. To enhance detection, a barrier or landscaping can be installed at the expected crossing location and an accessible pedestrian signal with a locator tone should be provided to identify the crosswalk location. Including raised directional surfaces (tiles to help locate the crosswalk) may also be useful for pedestrians with vision impairments. In addition to the drawbacks for pedestrians with vision impairments, other potential problems for this layout include:

- Pedestrians will use the most direct route to cross regardless of the crosswalk markings;
- Sight lines needed by turning motorists are decreased if the crosswalk is pushed too far back;
- Pedestrian visibility is decreased because they are crossing in a location that is different from what motorists expect;

- Motorists are often accelerating as they pass through the crosswalk;
- Cars may miss the stop line in advance of the intersection and have to stop suddenly in the middle of the crosswalk; and
- Cars may pull into the crosswalk to enhance their sight lines, which will block the pedestrian path of travel.

Permitting pedestrians to cross in the expected location is preferred to pushing the crosswalks back from the intersection, although this design increase the crossing distance. The following strategies are recommended to improve skewed intersections with this design:

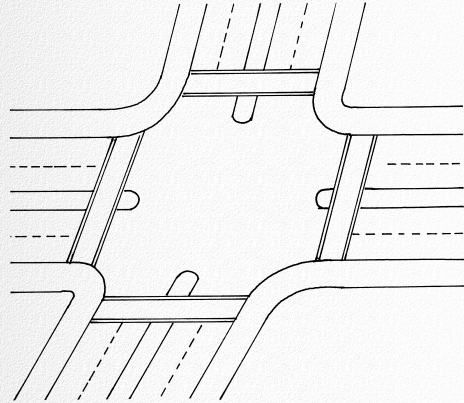
- Install curb ramps perpendicular to the curb;
- Provide longer crossing times and accessible pedestrian signals if the intersection is signalized;
- Provide marked crosswalks delineated with the continental pattern;



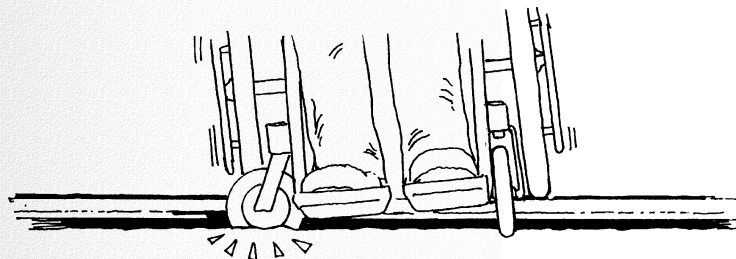
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**Figure 8-25. GOOD DESIGN:** When skewed intersections are unavoidable, crosswalks should be placed at the expected location, and accessible medians should be installed to break up the long crossing distances.



**Figure 8-26. PROBLEM:** Wheelchair casters may get stuck in railroad flangeways.

- Add medians with truncated domes to reduce crossing distances; and
- Consider installing intersection guidestrips which provide directional information for pedestrians with vision impairments. When intersection guidestrips are installed, it would be beneficial to inform the community of their presence so that pedestrians with visual disabilities know they are there and understand how they should be used.

### 8.11 Railroad crossings

Tracks for trains, light rail vehicles, or trolleys cross the streets of many urban communities as well as in rural areas. Railroad crossings have flangeway gaps that allow passage of the wheels of the train. The flangeway gaps are often large exceeding the 13 mm (0.5 in) limit for openings. Railroad

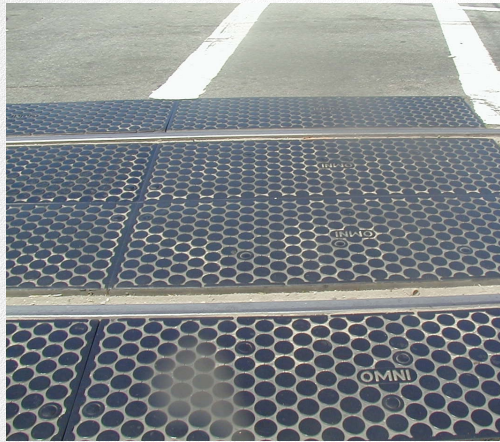
crossings are hazardous for all pedestrians and bicyclists. They are particularly hazardous to those who rely on wheeled devices for mobility. Wheelchair and scooter casters, as well as the tires of bicycles can easily get caught in the flangeway gap. In addition, rails or ties that are not embedded in the travel surface create a tripping hazard. Pedestrian safety and accessibility at railroad crossings can be enhanced by:

- Raising the approaches to the track and the area between the tracks to the level of the top of the rail creating flat level areas to cross. When casters on wheelchairs hit changes in level, they rotate and may drop into the flangeway gap;
- Utilizing a surface material that will not buckle, expand, or contract significantly (e.g., textured rubber railroad crossing pads) in all areas adjacent to the tracks so that the surface material will not interfere with railway function or degrade with use;

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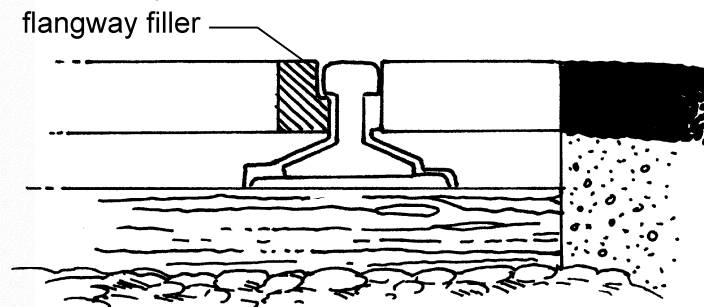
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**Figure 8-27.** Installing a rubber surface rather than asphalt around railroad flangeways reduces changes in level and other maintenance problems for pedestrians.

- Designing crossings so that the pedestrian paths of travel intersect the railroad track at a 90 degree angle, which minimizes problems with the flange-way gap width;
- Widening the crosswalk when a perpendicular crossing cannot be provided so that pedestrians have room to maneuver and position themselves to cross the tracks at a 90 degree angle;
- Installing detectable warnings similar to a transit platform if the railroad crosses the sidewalk; and
- Providing railroad crossing information in multiple formats, including signs, flashing lights, and audible sounds. The MUTCD requires railroad crossing signs whenever railroad tracks intersect the street.

The flangeway gap is essential to the function of the railroad system. Currently, a rubber insert is available to fill the flangeway gap for light rail tracks that have trains traveling at low speeds (e.g., approaching a transit stop). These “flangeway fillers” provide a level surface for pedestrians but deflect downward with the weight of the train. In this way, pedestrians can cross a “gap free” surface and rail function is unaffected. At the present time, there are no similar products on the market for high speed and heavy freight lines. Further research is needed to develop a product that works for all types of trains.



**Figure 8-28.** The “flangeway filler” eliminates the gap in the path of travel for pedestrians crossing railroad tracks. The filler, consisting of a rubber insert, will deflect downward with the weight of a train and does not affect railway function.