5 Designing Pedestrian Facilities

5.1. Introduction

The viability and safety of pedestrian travel depends on well-designed roadways and pedestrian facilities. Basic design features can affect the ability of the public right of way to accommodate persons afoot or in wheelchairs.

National and state policies address the need not only to consider, but also to include pedestrian facilities as part of urban and suburban roadway projects. "Consideration" must include, at a minimum, the presumption that pedestrians will be accommodated in the design of new and improved urban and suburban transportation projects. Federal transportation policy calls for the incorporating pedestrian facilities in all new or reconstructed urban and suburban projects unless one of three exceptions holds true. One exception, for example, is if pedestrians are not allowed on the roadway because it is a freeway. The decision not to include pedestrian accommodations should actually be the exception and not the rule. This policy of "incorporation" or "mainstreaming" has recently been supported by a newer national effort called "complete streets." The basic tenets are the same, but the user groups are broadened to include all roadway users, including transit users, bicyclists, pedestrians, motorists and people with disabilities. Wisconsin's version of Complete Streets legislation can be found at *Section 84.01(35)* of the State Statutes.

Pedestrian routes must be designed to accommodate pedestrians of all ages and abilities. The Americans with Disabilities Act (ADA) requires that pedestrian facilities and routes be accessible to pedestrians with mobility, visual, cognitive and other types of impairments. Following ADA, the U.S. Access Board has developed specific accessibility guidelines, known as the ***Americans with Disabilities Act Accessibility Guidelines*** (ADAAG), for the design of certain pedestrian facilities. The Americans with Disabilities Act Accessibility Guidelines are enforceable by law. Facilities must comply with the Americans with Disabilities Act Accessibility Guideline requirements. ***Wisconsin State Statute 9090.66*** mandates additional accessibility requirements for the design of pedestrian facilities. These additional requirements are enforceable by law and must be followed. The U.S. Access Board has developed ***accessibility guidelines for the design of public right of ways (PROWAG)***. Currently, these guidelines serve as a set of recommended standards but they may soon become law.

This chapter presents both legal requirements and recommended standards for the design of roadways and pedestrian facilities. Throughout this chapter, the term "shall" is used to identify design requirements as mandated by the Americans with Disabilities Act Accessibility Guidelines or Wisconsin State Statute. These requirements are enforceable by law and require compliance. The term "should" is used to identify Wisconsin Department of Transportation (WisDOT) or U.S. Access Board standards that are not enforceable by law, but serve as recommended practices.

Today, roadway design engineers understand they must balance the needs of all users. In the past, engineers often designed roadways from the centerline out. Roadways were widened for additional travel lanes, with little room left for pedestrian facilities. Designing roadways and streets has become more complex as additional requirements and considerations are involved, such as historic preservation, environmental regulations, landscaping, context sensitive design, bicycle and pedestrian accommodations, and accessibility. How the balance between roadway design and pedestrian facilities is found will often depend on the scope of the project, functional classification of the roadway, and the area in which it is located. Examples of this balance include:

- A tight turning radius will be more acceptable on a neighborhood street than on an arterial street.
- Placing sidewalks on both sides of a street would be standard treatment on a reconstruction project, but not on a street that is scheduled for a maintenance project.

This chapter complements the American Association of State Highway and Transportation Officials (AASHTO) *Policy on Geometric Design of Highways and Streets*. Additionally, it describes WisDOT's policies and guidelines for new and reconstructed facilities. This chapter is divided into two major parts:

- Roadway design as it relates to pedestrian travel
- Pedestrian facility design

5.2. Part 1: Roadway Design

5.2.1. HOW ROADWAY DESIGN AFFECTS PEDESTRIAN TRAVEL

Roadway design affects not only the safety and comfort of motorists, but also the viability and safety of pedestrian travel. Roadways must be designed with pedestrians in mind since pedestrians share the right of way with motorists. Occasionally, pedestrian travel routes are completely separated from roadways or pedestrians are prohibited from the roadway. In these rare cases, pedestrian needs still must be considered at any point where pedestrian routes and roadways intersect to permit pedestrian travel across roadways.

While large natural and man made features such as rivers and freeways create obvious pedestrian barriers, all roadways create barriers for pedestrian travel. High traffic speeds, high traffic volumes, large roadway widths, and long waits at intersections all are pedestrian barriers when they adversely affect pedestrian travel. Such barriers often encourage or force pedestrians to take unnecessary risks. For example, a long wait to cross a street often leads to persons trying to cross during a shortened gap in traffic. A well-designed roadway system can mitigate or avoid many common pedestrian barriers.

The following sections detail pedestrian barriers and the impact of roadway design on pedestrian travel, and they offer strategies to recognize and mitigate barriers whenever possible.

Attributes of roadway design covered in this section include:

- The "barrier effect" on pedestrian route continuity
- Roadway design speed
- Roadway width
- Intersection design—curb radii
- Intersection design—special intersections
- Sight distances and sight lines
- Motorist/pedestrian separation

5.2.1.1. The "barrier effect" on pedestrian route continuity

Natural and man-made physical features often create dangerous and challenging obstacles for pedestrians. These barriers disrupt the connectivity of the walking environment and force pedestrians to take inconvenient routes or dangerous detours, use other modes of transportation, or forgo trips altogether. In some situations, the barriers may be on a smaller scale such as gaps in sidewalks, vegetation growth over sidewalks, or the lack of curb ramps.

The creation of pedestrian barriers should be avoided whenever possible. Often, due to logistical and financial constraints, avoiding large barriers is infeasible. When pedestrian barriers cannot be avoided, one should plan for mitigating the negative effects to the maximum extent feasible.

Roadway system connectivity is maintained with bridges, overpasses, underpasses and tunnels. These structures must also include adequate and accessible pedestrian facilities. Pedestrian overpasses or underpasses can provide full connectivity or help pedestrians avoid unusually congested or high-conflict locations. Because of the high cost of constructing these grade-separated facilities, they should be considered where other more standard or less costly solutions are not practical or acceptable.

Designers can take several steps to address barrier issues:

- Incorporate sidewalks into the design of new bridges or create separate pedestrian facilities to dramatically decrease the barrier effect (Exhibit 5-1).
- Create separate pedestrian overpasses and underpasses across freeways and expressways, in addition to roadway crossings, to create continuous pedestrian routes.
- Design interchange and non-interchange roadway crossings to safely and conveniently accommodate pedestrians.

Typically, bridges have a useful life of up to 75 years, making a decision on whether to include pedestrian facilities very important for not only the short-term, but the long-term as well. A sidewalk on a bridge that is not used frequently for the first five years may be well used for the next 70 years. In cases where it is uncertain if pedestrian facilities will be needed on a bridge, it is important engineers design the bridge to not preclude the incorporation of pedestrian facilities when the bridge is re-decked.

Mitigation of barriers is essential for creating continuous pedestrian routes. Unlike motor vehicles, pedestrians cannot be expected to travel a quarter mile or more from their direct route to avoid barriers such as expressways, freeways, railways, hilly terrain or rivers.

Not only can major barriers cause significant problems for pedestrians, small-scale barriers like gaps in the sidewalk network can have similar impacts. Gaps can require pedestrians to walk through vegetation, uneven surfaces or mud. A discontinuous sidewalk network may require pedestrians to climb over obstacles or walk in the street, and can make pedestrian trips longer, less convenient or more dangerous. Because sidewalk construction usually occurs during adjacent construction and is limited to the boundaries of that construction, the system is often missing sidewalk segments or whole blocks of sidewalks. For this reason, designing for pedestrian facilities is an integral part of all new construction or major reconstruction, even where sidewalks connecting the project to the rest of the community do not yet exist. Many communities have assessed the continuity of their sidewalk system and created specific sidewalk construction projects to fill the gaps.

Exhibit 5-1: Where a river bisects a community, a bridge can help to mitigate the barrier effect on pedestrians.

5.2.1.2. Roadway design speed

High vehicular speeds can create a dangerous barrier for pedestrians needing to cross the right of way. Studies indicate that faster moving vehicles increase the risk that motorist-pedestrian crashes will result in pedestrian fatalities. Reduced motorist speeds provide more opportunity for pedestrians and motorists to see and react to one another.

Selecting an appropriate design speed is one of the most important elements in roadway design. Motorists tend to drive at the speeds they feel comfortable. A roadway's engineered design speed and surrounding land use is often more important in determining vehicular speed than the posted speed limit. The design speed should be appropriate for the specific street being planned, including consideration of adjacent land uses, anticipated motorist speeds, topography, potential levels of pedestrian activity, and the roadway's functional classification.

WisDOT recommends designing urban arterial streets that have developed frontage and traffic control devices to encourage running speeds no greater than 30 to 45 mph in most cases. Consistent design speeds help maintain smooth motorist flow; however, high volumes of cross-street pedestrian traffic and other factors may require reduced speeds in certain areas. When planning arterial street improvements and design speed, engineers should consider physical constraints and the anticipated motorist speeds during off-peak periods, which are typically higher than

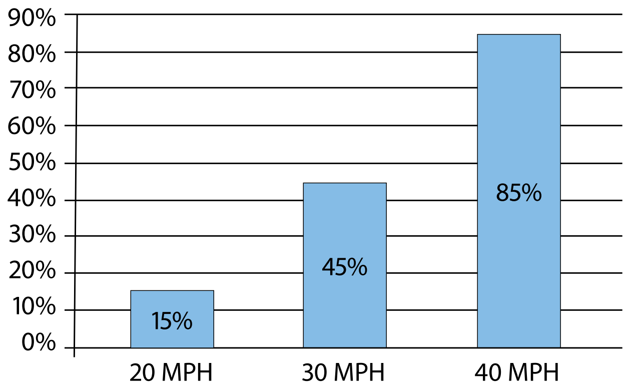


Exhibit 5-2: Probability of a pedestrian fatality, if struck by a motor vehicle, increases with vehicular speed.

peak periods. In advance of areas with potentially increased pedestrian activity, the roadway's design speed should be changed gradually over a sufficient distance to permit motorists to change speed.

Pedestrians and bicyclists are considered priority users on local residential streets. ***Wisconsin State Statute 346.57*** establishes 25 mph as the default speed limit for these streets. Designing local residential streets to encourage motorist speeds that do not exceed 25 mph is essential for motorist compliance. As shown in Exhibit 5-2, the risk of a motorist-pedestrian crash resulting in a pedestrian fatality increases significantly at speeds above 25 mph. For more information on selecting appropriate design speeds, see AASHTO's ***Policy on Geometric Design of Highways and Streets***.

Engineered design speed, streetscape characteristics, and the posted speed limit work together to influence the actual motorist speed on a roadway. Where there is no legislatively mandated speed limit, the posted speed limit for arterial streets should be determined through an engineering study. ***The Traffic Engineering Handbook*** indicates that the 85th percentile motorist speed and other factors, such as presence of driveways, heavy pedestrian use and the presence of school zones, should be considered when determining an appropriate posted speed limit. See ***WisDOT Speed Management Guidelines*** for additional information.

If motorist speeds on an existing roadway are too high for the neighborhood environment and the level of pedestrian activity across the roadway, designers should modify the roadway's design speed and roadway geometrics to encourage lower speeds. This can be accomplished by using:

- Reduced lane widths
- Signal progressions to match the desired motorist speed
- Various traffic management and calming techniques (discussed in ***Section 5.2.1.8.***)

Simply lowering the posted speed limit below the 85th percentile motorist speed on an existing roadway, without additional measures, will have little or no effect on actual prevailing motorist speeds. Some authorities try to reduce prevailing speeds with consistent enforcement of the posted speed limits. However, without 24-hour enforcement, such efforts usually have only a temporary effect.

5.2.1.3. Roadway width

Often, designers select the number and widths of roadway lanes solely to serve motorist demands at a desired level of service. Designers should also consider the effects of roadway width on pedestrians. Wide roadways create greater pedestrian crossing distances and encourage higher vehicular speeds. Simply stated, wider roadways are more difficult for pedestrians to cross and inherently less safe. In most cases, undivided arterials of six lanes or more, with or without parking, are not safe for pedestrians. When wide arterial streets are situated in environments where there are few parallel options for pedestrians and additional motor vehicle traffic is directed to the arterial street, the problem is exacerbated. On rural roadways with low motorist volumes and few intersecting trails or streets, the effect of roadway width on pedestrian travel still needs to beconsidered in some locations such as near schools, on existing transit routes and on likely transit routes.

On wide roadways, designers can use three basic methods to reduce roadway width and shorten pedestrian crossings:

- Reduce the number of lanes
- Reduce the width of each lane
- Reduce the effective length of the crossing

Reduce the number of lanes. Some four-lane undivided roads may be re-striped as three-lane roads, with one lane for through traffic in each direction of travel and a center left turn lane (Exhibit 5.3). This method can also provide space to add sidewalks and bicycle lanes on both sides of the road. Another alternative to reduce lanes is to use two or more parallel streets, either as

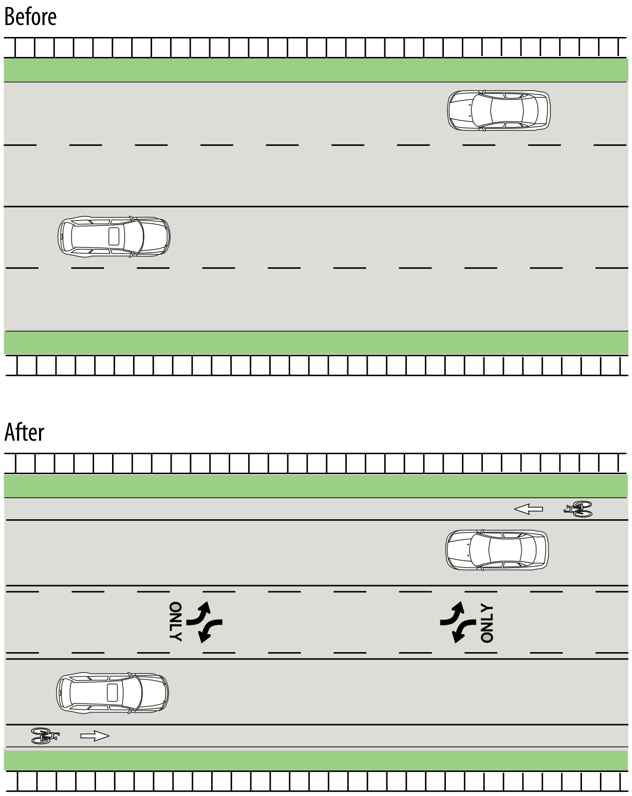


Exhibit 5-3: A four-lane undivided road can be reconfigured as a three-lane road with a center turn lane to reduce lane widths and the number of lanes.

two-way streets or as one-way couplets, instead of funneling all traffic onto one community-splitting wide arterial street. Before reducing the number of roadway lanes or rerouting roadway traffic, a traffic analysis should be conducted to determine the effects of lane reduction or rerouting. (See ***FDM Section 11-5-3*** for more information).

Reduce the width of each lane. Changing roadway lane widths in developed areas involves balancing the safety, efficiency and mobility needs of motorists, bicyclists and pedestrians. Site-specific considerations strongly influence this balance. The choice of lane width should address any site-specific conditions.

In some locations, wide lanes are needed to accommodate large vehicles such as trucks and buses. For example, federally-designated long truck routes require at least one 12-foot lane. Wide lanes also increase the level of service for motorists. Narrow lanes of 10 to12 feet can decrease risks to pedestrians by encouraging lower vehicular speeds. Furthermore, narrow lanes decrease the crossing distances of pedestrians, may provide space to accommodate bicycle lanes and parking lanes, and may reduce waiting times for motorists during pedestrian signal phases. AASHTO's ***Policy on Geometric Design of Highways and Streets*** generally permits lane widths on urban streets from 10 to 12 feet. On multi-lane arterials, wider curb lanes and narrower median lanes may be the most efficient use of available roadway width. For further information on the selection of appropriate lane widths, see AASHTO's ***Policy on Geometric Design of Highways and Streets*** and WisDOT's *Facility Design Manual* (FDM) ***Section 11-20-1*** and ***Section 11-35-1***.

Reduce the effective length of the pedestrian crossing. Bulb outs, curb extensions, smaller turning radii and other devices physically decrease the length of the pedestrian crossing. Additionally, raised medians can be introduced to create pedestrian refuge islands. These options are discussed throughout the remainder of this chapter.

5.2.1.4. Intersection design-curb radii

Curb radii are an important consideration in intersection design. When considering curb radii at both signalized and unsignalized intersections, the needs of pedestrians must be balanced against the needs of motorists and large vehicles. The safety, operations, and convenience of both pedestrians and motorists, including truck, bus, and other heavy vehicle drivers, must be considered.

In general, pedestrians benefit from smaller curb radii. Smaller curb radii can:

- Decrease the crossing distance for pedestrians (Exhibit 5-4)

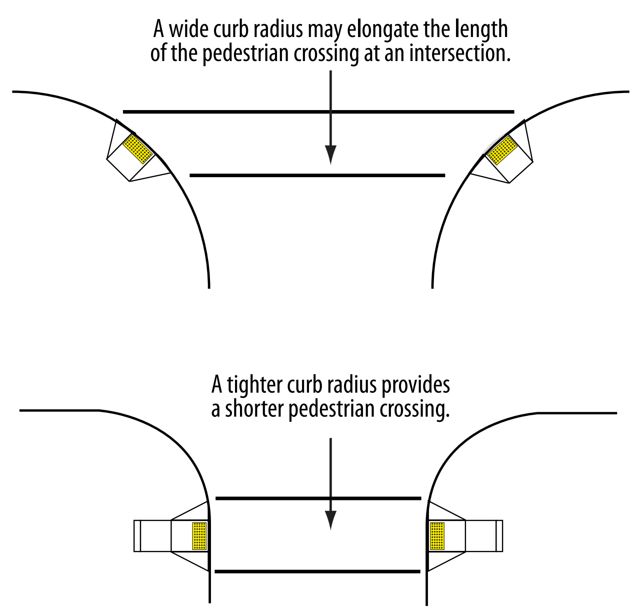


Exhibit 5-4: Pedestrian crossing distances for wide turning radii are longer than when using a tight radii.

- Lower the speed of turning motorists
- Decrease exposure risks for people on foot or in wheelchairs
- Increase the corner storage space for pedestrians
- Improve motorists' line-of-sight toward pedestrians and make it easier for pedestrians to see motorists

However, smaller curb radii can also create problems. For example, smaller curb radii may:

- Slightly decrease highway capacity at the intersection because it takes longer for drivers to make the turn
- Create problems for drivers of larger vehicles, especially in situations where they cannot encroach upon other lanes to make a turn
- Result in motorists driving over the curb or encroaching upon the pedestrian space

When planning street corner radii, designers should consider both the actual radius of the street corner and the effective turning radius of the vehicle type on which the design is based. The effective turning radius is the radius needed for motorists to clear any adjacent parking lanes, bike lanes, or shoulders and to align themselves with their new travel lanes. Exhibit 5-5 illustrates both the actual and effective radii. Using the effective turning radius allows a smaller actual curb radius than required for motorists turning from curb lane to curb lane. On a roadway with parking lanes, a smaller actual curb radius can be provided because the effective curb radius envelopes the parked vehicles.

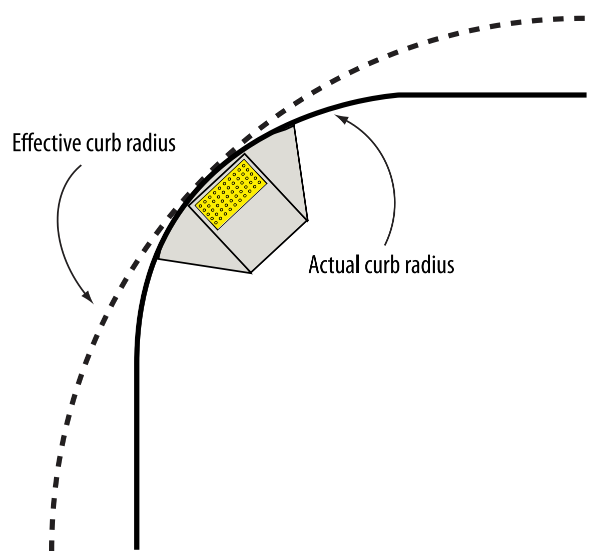


Exhibit 5-5: The actual curb radius differs from the effective curb radii which include the extra space needed to make the turn.

Avoiding larger corner radii and building the tightest corners possible is usually a sound objective for promoting pedestrian safety and access. The main disadvantages of large radii corners is that they invite faster right turns from smaller vehicles (smaller than the trucks that the intersection was designed for) from a major street onto a minor street, as well as faster "rolling stops" from the minor street onto the major street. Some very generous corners can effectively act as right turn lanes creating unknown lane configurations. Large corner radii also require the stop bar, and often the crosswalks and curb ramps, to be placed farther back away from the major street, which may make pedestrians less visible to motorists. Often motorists will ignore stop bars set back far from the intersection and pull up to the intersection. Finally, additional right of way and maintenance costs will often be higher since the intersections are larger.

Curb radii should be designed for the largest vehicle that typically—rather than occasionally—makes a specific turning maneuver. Defining the design vehicle that typically uses an intersection is related to the surrounding land use, the existence of a truck route, and often the roadway's functional classification. On major arterials, the radius should be designed to allow turning motorists to use all of the available roadway width in the direction of travel. If the receiving street is a local or collector street occasionally used by large vehicles, these occasional vehicles can encroach into the opposing travel lane to make a turn, preventing the need for a large curb radius. This situation often occurs when a school bus, moving van, fire truck or oversized delivery truck makes a turn at the intersection of a local and collector street.

Where the turning volume of large vehicles is small, designing a *15 to 25 foot* curb radius is typically sufficient. Where the turning volume of large vehicles is high, such as next to a warehouse, mall, or distribution center, the maximum curb radius should be increased to *25 to 35 feet* and the stop bar should be set further back on the receiving street to allow drivers of large vehicles enough room to complete a turn. When curb radii are increased into this range, the operational justification should be documented rather than routinely granting a more generous radius. The minimum curb radius at intersections is 5 feet to allow for effective street sweeping. For further information on curb radii for special situations, see AASHTO's *Policy on Geometric Design of Highways and Streets*.

5.2.1.5. Intersection design—special intersections

5.2.1.5.1. Freeway and expressway ramps

The intersection of expressway and freeway ramps with urban or suburban streets, particularly those that are unsignalized, create unique challenges and dangers for pedestrians. Often, on an exit ramp, a motorist's attention is focused on merging into the local road system rather than anticipating pedestrians crossing the street. On an entrance ramp, a motorist's attention is focused on accelerating and merging with motorists already on the expressway.

To minimize motorist-pedestrian conflicts at freeway and expressway ramps, well-designed pedestrian facilities (including sidewalks, crosswalks and curb ramps) should be provided. Significantly slowing motorist speeds or requiring motorists to stop before merging onto a freeway or after exiting a freeway in areas where there is pedestrian use greatly reduces the potential for motorist-pedestrian conflicts. Stop signs, yield signs, stop bars or signals can be used at some locations to allow pedestrians the opportunity to cross. At unsignalized ramp-street intersections, pedestrian crossing warning signs can be used to alert motorists and pedestrians of the potential conflict area.

Expressway and freeway intersections should be designed to increase pedestrian visibility and alert motorists that they have entered a different driving environment. Both motorist and pedestrian visibility can be improved by providing a right-angle intersection where entrance and exit ramps meet cross streets. Where diamond-type interchange ramps intersect with local streets, accessible islands can be installed between the right and left turning movements to provide a crossing island for pedestrians.

Finally, expressway and freeway ramps should have appropriate design speeds. In urban and suburban situations, exits preferably should meet the cross-street at a 90 degree angle with a stop condition. Angles from 75 to 105 degrees (15 degrees off of 90 degrees) are permissible if a 90 degree angle cannot be done. At the point of pedestrian crossings, the turning radii of interchange ramps should be consistent with the design speed of the land access road and not the design speed of the freeway or expressway (Exhibit 5-6). Large ramp radii at the point of pedestrian crossings, in conjunction with long right-turn slip lanes, encourage higher-than-necessary vehicular speeds at pedestrian crossings.

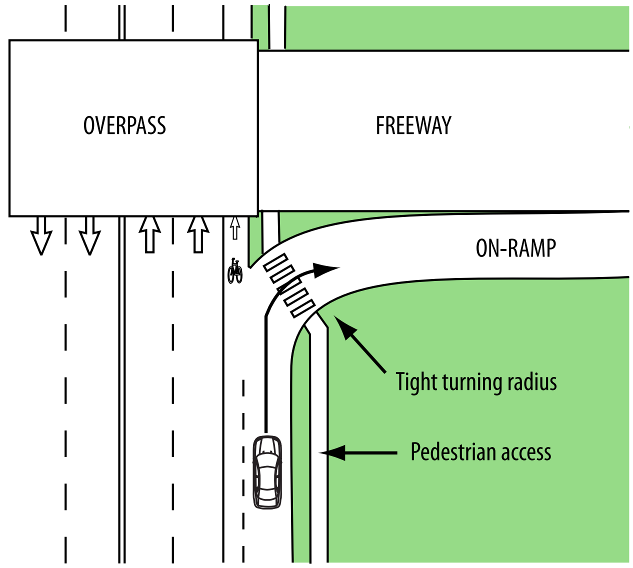


Exhibit 5-6: A tight radius that causes traffic to slow or stop before merging onto an entrance ramp is best for pedestrian safety.

5.2.1.5.2. Channelized right-turn slip lanes

Channelized right-turn slip lanes are occasionally used at both signalized and unsignalized intersections (more common for state highway intersections). At signalized intersections, designers may use channelized right-turn slip lanes to allow right-turning motorists to bypass the traffic signal, help reduce motorist congestion, or improve sight distances for right-turning motorists to allow them to safely accept smaller gaps in traffic. At unsignalized intersections, designers may use channelized right-turn slip lanes to provide motorists with smoother turning maneuvers.

Channelized right-turn slip lanes have negative effects on pedestrians. For example, channelized right-turn slip lanes promote faster motorist turning speeds, and unimpeded vehicular movement, and they focus driver attention on the turning movement, creating a safety hazard for pedestrians. Right-turn slip lanes also decrease the pedestrian waiting area at the abutting corner and limit drivers' sight lines of pedestrians who are waiting to cross. Channelized right turn slip lanes are especially problematic for pedestrians with visual impairments who have difficulty perceiving gaps in traffic. These lanes may also be confusing for pedestrians with cognitive disabilities.

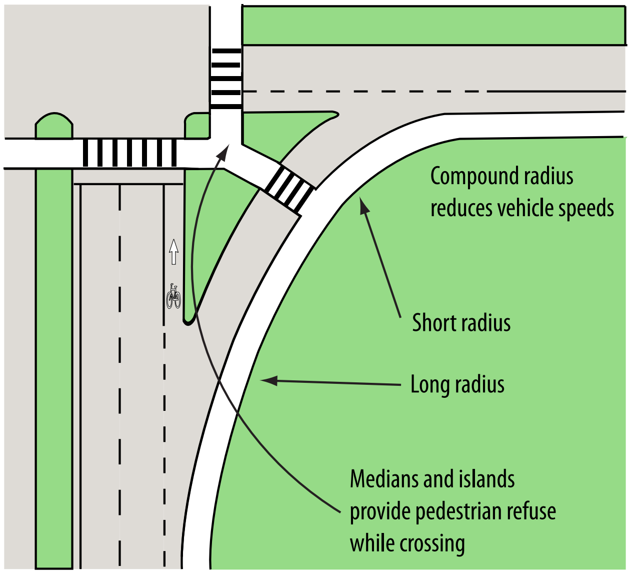


Exhibit 5-7: A channelized right-turn slip lane with a compound radius can slow turning vehicles and increase visibility for pedestrians and motorists.

Good design can improve pedestrian safety by reducing vehicle speeds and increasing pedestrian visibility at channelized right-turn slip lanes. When designing a channelized right-turn slip lane, the turn lane should be kept as narrow as the turning path of the design vehicle. It should typically not exceed 14 feet in the radius portion of the turn lane and should enter the receiving roadway at an angle as close to 90 degrees as the effective turning radius will allow (Exhibit 5-7). A right-turn slip lane with a compound radius may be used to increase both pedestrian visibility and the sight lines for merging motorists. National Cooperative Highway Research Program (NCHRP) Project 3-78A is determining appropriate geometric design and traffic control guidelines for channelized right-turn slip lanes and roundabouts to better accommodate pedestrians with visual impairments. More information on this project is available from the ***NCHRP Web site***.

Wherever a channelized right-turn slip lane is used, a raised triangular "pork chop" shaped island is often provided to separate the channelized right-turn slip lane from the "through" motorist lanes. Properly designed, this pork chop island can benefit pedestrians by reducing crossing distances, increasing the visibility of crossing pedestrians, and giving pedestrians a vertically separated refuge. (See ***Section 5.3.4.2.2.*** for more information on pork chop islands.)

5.2.1.5.3. Roundabouts

Modern roundabouts are an alternative to signals at intersections. A roundabout's primary purpose is to provide an intersection that enables near constant vehicle movement but slows vehicular speed, which reduces the severity of crashes and improves safety. Research suggests fewer motorist-pedestrian conflicts and crashes may occur at properly designed roundabout intersections compared to typical intersections. Roundabouts can also:

- Increase intersection capacity for motorists
- Reduce delays for motorists
- Lower the operating and maintenance costs of an intersection
- Improve a streetscape

In general, any intersection, whether urban or rural, that meets the criteria of a four-way stop condition or a traffic signal also qualifies for evaluation as a modern roundabout (see ***FDM 11-25-3***).

While roundabouts have certain desirable characteristics for all users, including pedestrians in general, they can be problematic for some pedestrians. For example, because pedestrians can only cross roundabouts during gaps in traffic or upon motorists yielding to them (similar to crossing other unsignalized intersections), pedestrians may find it difficult to cross a roundabout with insufficient traffic gaps and vehicles that fail to yield. Furthermore, pedestrians with visual or cognitive impairments may have difficulty understanding the layout of a roundabout and determining the appropriate time to cross. NCHRP Projects 3-65 and 3-78A are determining appropriate geometric design and traffic control guidelines to accommodate all pedestrians at roundabouts, including those with visual impairments. Recommendations from these projects will likely be incorporated into various design requirements and guidance if safety solutions can be identified.

Appropriate design can improve pedestrian safety and comfort at roundabouts. The curved entrance to a roundabout will require drivers to reduce their speed at the entrance to about 15 to 25 mph. Yield signs at roundabouts are the primary traffic control mechanism for entering motorists. The skip-dash pavement marking is typically used in conjunction with yield signs at roundabout entry locations.

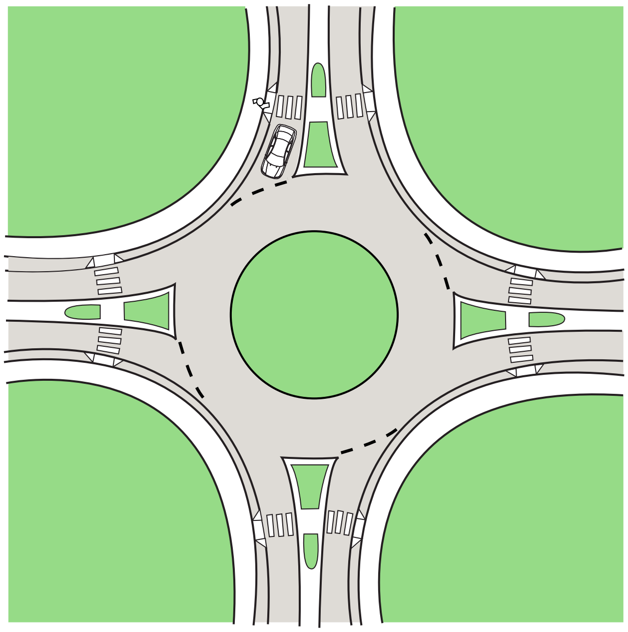


Exhibit 5-8: Roundabout design having one car length between the crosswalk and yield bar allows pedestrians to cross behind yielding traffic.

The design and markings at a roundabout should enable pedestrians to identify the designated crosswalk locations and discourage pedestrians from crossing through the roundabout's center island where they are prohibited. Furthermore, splitter islands at roundabouts must be accessible, detectable, and large enough to handle pedestrian traffic, including wheelchair users. Crosswalks to splitter islands should be offset a minimum of 20 feet—approximately one car length—from the yield line for each of the approach intersections (Exhibit 5-8).

Parking should always be prohibited near roundabout entrances and exits. If parking is provided next to a roundabout, it should be set back 75 feet or more from the yield line. This distance typically provides enough visibility for both pedestrians and motorists, while also allowing pedestrians to cross behind the first motorist entering the roundabout.

Multi-lane roundabouts usually have slightly higher operating speeds than single-lane roundabouts and longer crossing distances for pedestrians. As a result, these roundabouts often create more problems for pedestrians. If there is uncertainty of the need for a multi-lane roundabout for the design year, designers can plan and design a single-lane roundabout so that it can be more easily rebuilt as a multi-lane roundabout in the future. Typically, single lane roundabouts are more easily managed by pedestrians. See ***FDM Chapter 11, Section 26*** and FHWA's ***Roundabouts: An Informational Guide*** for more information on both single and multi-lane roundabout design.

5.2.1.6. Sight distances and sight lines

Sight distances include stopping sight distances, intersection sight distances, decision sight distances, and passing sight distances. While it is important for motorists to have adequate sight distances, it is equally important for pedestrians to be able to see everything on or adjacent to the roadway and have enough time to react to potential conflicts. Both motorist and pedestrian sight distances are key considerations at all intersections and are particularly important at crosswalks and trails that intersect a roadway mid-block. Sight distance issues must be addressed during both the intersections's initial design phase and throughout its operational life.

A 90-degree intersection angle has potentially optimal sight lines for pedestrians and motorists. WisDOT recommends designing intersection legs to intersect at an angle as close to 90 degrees as practical, and not less than 70 degrees.

Several conditions may reduce sight lines, including:

- Significant grades at intersection approaches
- Landscaping
- Parked cars
- Utility poles
- Traffic control devices
- Street furniture
- Signs
- Signal control boxes

Features added after an intersection's construction or reconstruction might also cause sight obstructions. When these features cannot be relocated, curb extensions or parking restrictions can be used to create clear pedestrian paths or sight lines.

Parked vehicles near intersections or mid-block crosswalks can limit the ability of motorists and pedestrians to see one another. The position of parked vehicles in relation to a waiting pedestrian can determine motorist and pedestrian visibility. For instance, if a vehicle is parked 20 feet away from the crosswalk, an adult standing on the curb may only see or be seen by a vehicle 60 feet down the road without the line of sight passing over or through a vehicle. Larger vehicles, such as sport utility vehicles (SUVs), vans or trucks, may block sight lines even more as people may not be able to look over or through them. Children and people using wheelchairs may not see or be seen if any parked vehicle blocks visibility between them and motorists.

Adding curb extensions is one solution to poor sight lines (Exhibit 5-9). Without curb extensions, pedestrians may need to step into the intersection to see around parked vehicles to cross safely. However, curb extensions may not be practical in all locations where parking is permitted. Additional curb extension design information is included later in this chapter (see *Section 5.3.4.2.3.*).

The extension of the no-parking zone is another solution to improve poor sight lines. State law requires that no vehicle shall be parked closer than 15 feet from a crosswalk or 15 feet from an intersection in the absence of marked or unmarked crosswalks. On streets with 20 to 30 mph speed limits, a minimum no-parking zone of 20 feet (measured from the uncontrolled intersection or crosswalk, if one exists) is recommended. A no-parking zone of 30 feet should be used (measured from the intersection or crosswalk, if one exists) where signals, stop signs, and yield signs are in use. Distances where parking is prohibited may need to be extended beyond the cited measurements wherever sight lines are insufficient. See ***FDM Section 11-10-5*** for sight distance tables. Where practical, no-parking zones should be elongated on intersection approaches with higher speed limits. For example, where the posted speed limit is between 35 and 45 mph, a no-parking zone should extend 50 feet from the intersection or crosswalk, if one exists on each intersection approach. In areas where the speed limit exceeds 45 mph, on-street parking should be prohibited.

5.2.1.7. Motorist/pedestrian separation

To increase both the comfort and safety of pedestrian travel, a roadway's design should allow for adequate separation of motorists and pedestrians. Generally, as a minimum, it is desirable to have four to five feet of separation between traffic lanes and pedestrian walking areas under most situations. When this separation is reduced to less than three feet, a sloped or vertical curb (depending on the speed) should be used.

Pedestrians and motorists can be separated both vertically and horizontally. Vertical separation generally involves the use of a curb to clearly define

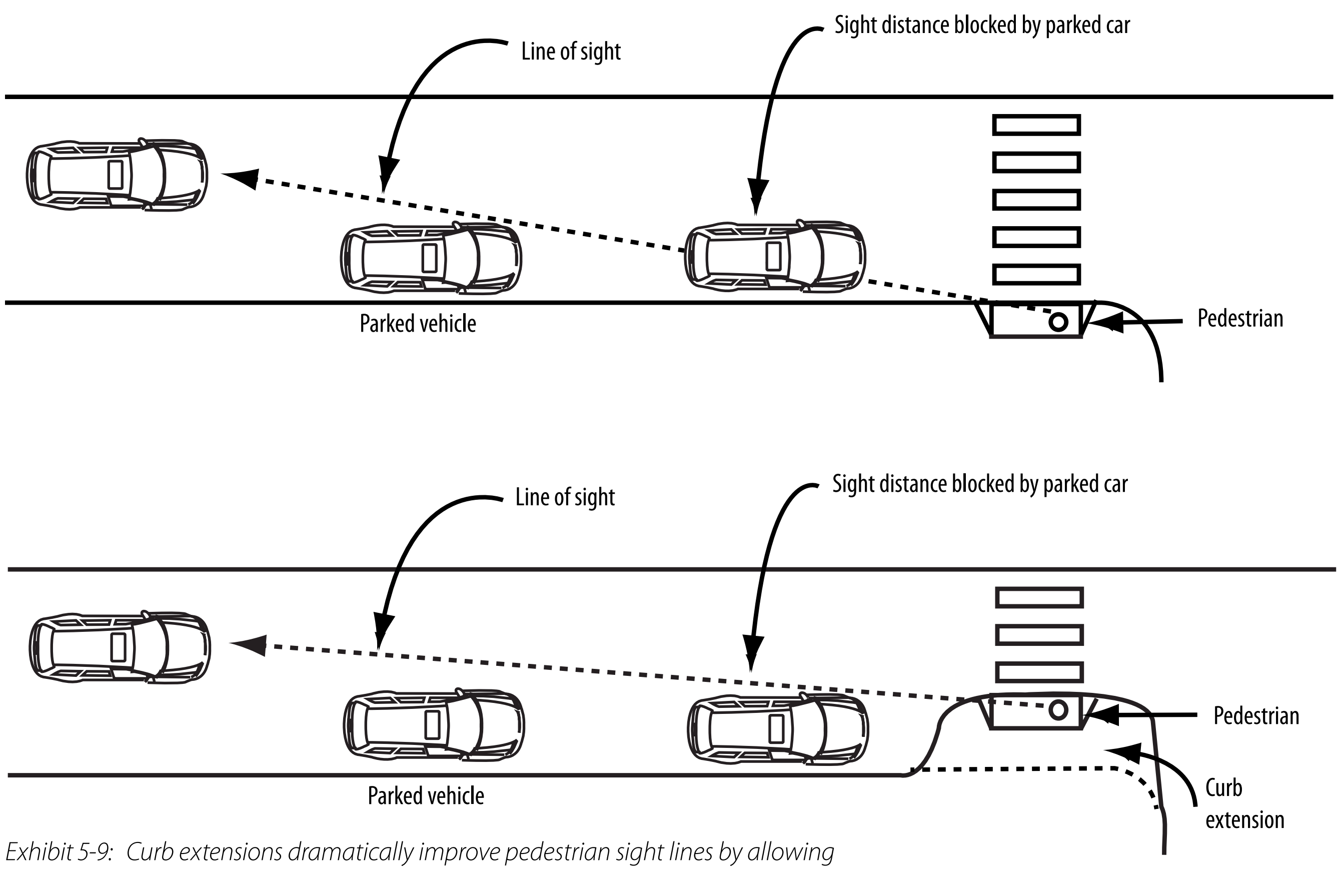


Exhibit 5-9: Curb extensions dramatically improve pedestrian sight lines by allowing both pedestrians and motorists to see beyond parked cars.

Exhibit 5-10: In Wisconsin, horizontal separation between the sidewalk and the roadway provides needed space for snow storage.

and distinguish between the areas intended for motorists and those intended for pedestrians. If a roadway's posted speed limit is 25 mph or below, curbs can improve safety for all travelers. Curbs usually are not recommended on roadways with posted speed limits above 40 mph or in some types of developments. (See ***FDM Section 11-20-1*** for more information on where curbs are appropriate.) If curbs are used on roadways with posted speed limits over 45 mph, additional separation between the traffic lane and the curb is necessary.

Horizontal separation of motorists and pedestrians involves the use of parking lanes, bike lanes and shoulders. Furniture zones or terraces (as discussed later in ***Section 5.3.1.2.1.***) are often combined with curbs to provide both horizontal and vertical separation between motorists and pedestrians. One additional benefit of horizontal separation is the space it provides for storing snow (Exhibit 5-10).

Combining different types of vertical and horizontal separation features to the streetscape can enhance pedestrian safety and comfort. The following is a list of combined separation features that can be incorporated into a roadway's design from the street centerline to the property line. The combinations are depicted in Exhibit 5-11, from the most separation to the least separation.

- Option A: Traffic lanes, bike lane, parking lane, vertical curb, 4' to 6' terrace/furniture zone, walking area.
- Option B: Traffic lanes, parking lane, vertical curb, 4' to 6' terrace/furniture zone, walking area

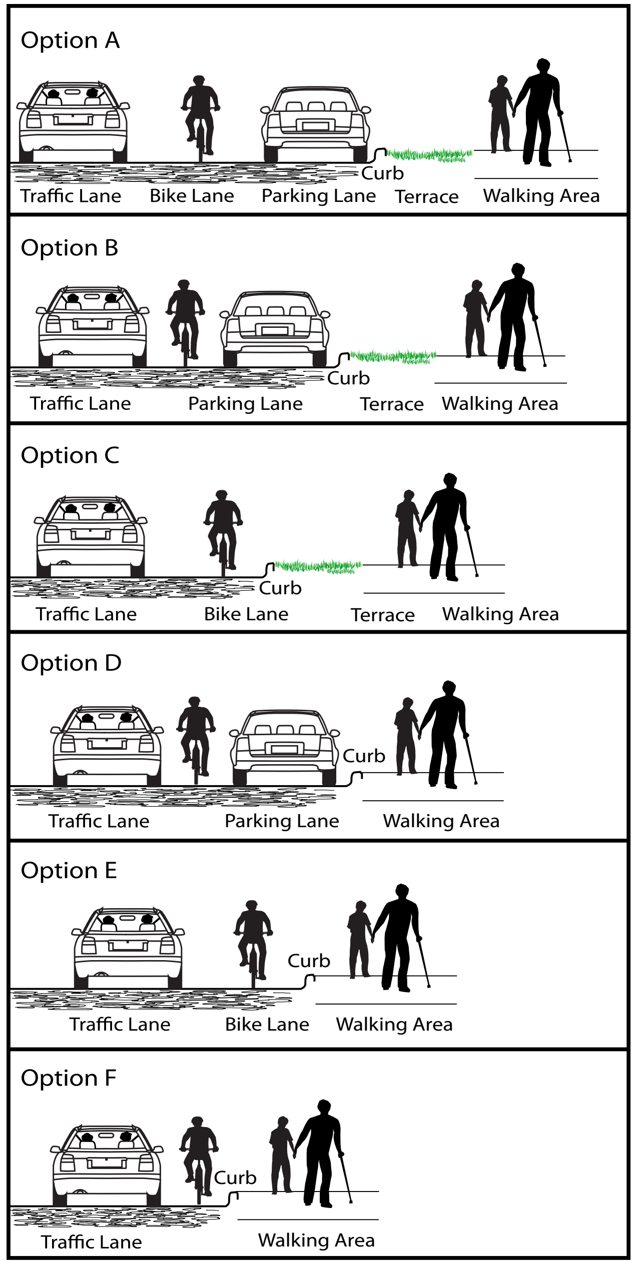


Exhibit 5-11: Combinations of features used to separate motorists and pedestrians.

- Option C: Traffic lanes, bike lane, vertical curb, 4' to 6' terrace/furniture zone, walking area.
- Option D: Traffic lanes, parking lane, vertical curb, walking area
- Option E: Traffic lanes, bike lane, vertical curb, walking area
- Option F: Traffic lanes, vertical curb, walking area

In Exhibit 5-11, the upper options (A, B and C) are the best standards and fully expected on new construction projects. Reduced separation is evident in the options as one moves down the list. These options may be the viable solutions for retrofit projects where right of way limitations and other constraints are prevalent. On arterial and most collector streets, bike lanes or shoulders should be provided where feasible. On bridges and overpasses, pedestrian walking areas are often directly adjacent to traffic lanes. In these situations, a protective physical barrier between the sidewalk and the traffic lanes may be required at certain speeds and traffic volumes to increase pedestrians' comfort level and reduce the risk of motorist-pedestrian crashes. (See ***FDM Section 11-35-1*** and the ***Section 5.3.6.*** in this chapter for more information on grade-separated crossings and the conditions under which physical barriers are required.)

5.2.1.8. Traffic calming techniques

Traffic calming techniques are used mostly on local street systems, with the intention of changing driver behavior. These techniques also improve pedestrian safety and comfort. Traffic calming techniques incorporate engineered physical structures directly into a roadway's design. They are intended to be mostly self-enforcing rather than regulatory measures. Traffic calming techniques include both speed control measures that alter vehicular speed, and volume control measures that limit the number of vehicles on a roadway or decrease cut-through traffic. The use of stop signs is not considered a traffic calming technique.

Successful traffic calming measures are seldom applied at one single location or on one street. The best approach involves developing a community-wide program and process for implementing networks of improvements. It is important to look at a neighborhood as a whole and develop a neighborhood-wide traffic control plan so traffic problems will not simply be shifted from one street to the next. Additionally, traffic-calming techniques are most effective when used in conjunction with other well-designed pedestrian facilities, such as sidewalks and marked crosswalks.

Traffic calming techniques are used most commonly on residential streets, often at the request of residents concerned with safety and quality of life. However, in some communities, traffic-calming techniques have also been used successfully on collector or arterial streets, often to slow traffic in such places as neighborhood business districts or downtowns.

This section does not provide detailed design guidance, but rather to introduce the topic of traffic calming techniques and discuss how typical calming measures can be designed to enhance the pedestrian environment. If traffic-calming measures are implemented inappropriately, they may create problems and hazards for pedestrians and bicyclists. Similarly, without close cooperation with maintenance departments and emergency services to assure safe access, calming designs may cause more problems than they solve. The following sections describe some common traffic calming techniques.

5.2.1.8.1. Speed control measures

Neighborhood traffic circles. Neighborhood traffic circles are circular islands placed in the middle of neighborhood intersections (either uncontrolled or stop-controlled) (Exhibit 5-12). These devices effectively reduce vehicle speeds

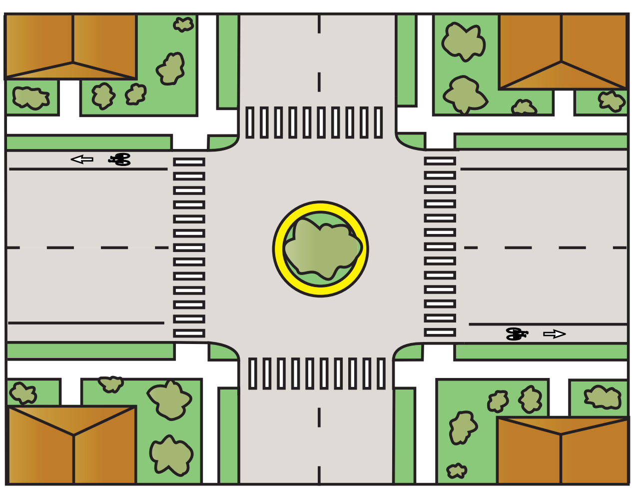


Exhibit 5-12: Neighborhood traffic circles are circular islands placed in the middle of neighborhood intersections (either uncontrolled or stop-controlled).

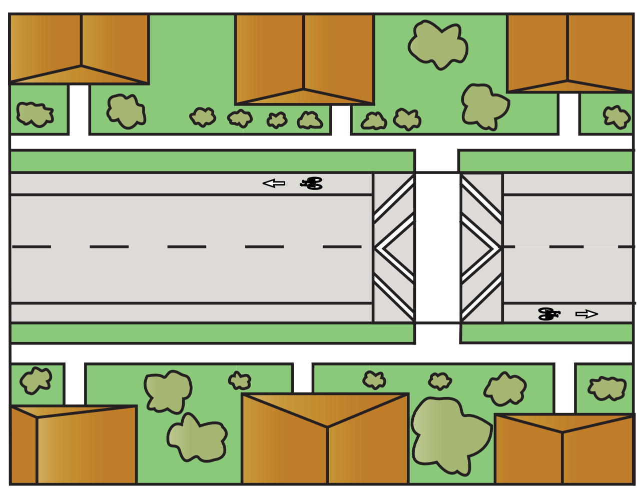


Exhibit 5-13: Speed humps are raised strips of roadway that have a more gradual slope than speed bumps.

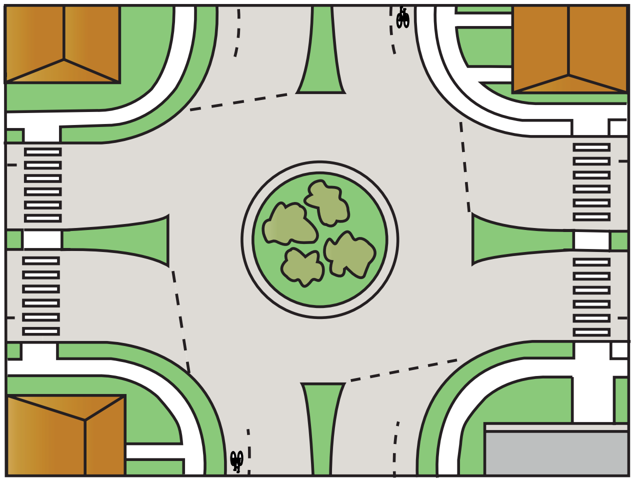


Exhibit 5-14: Roundabouts are similar to neighborhood traffic circles as they contain a circular central island and can lead to lower vehicular speeds.

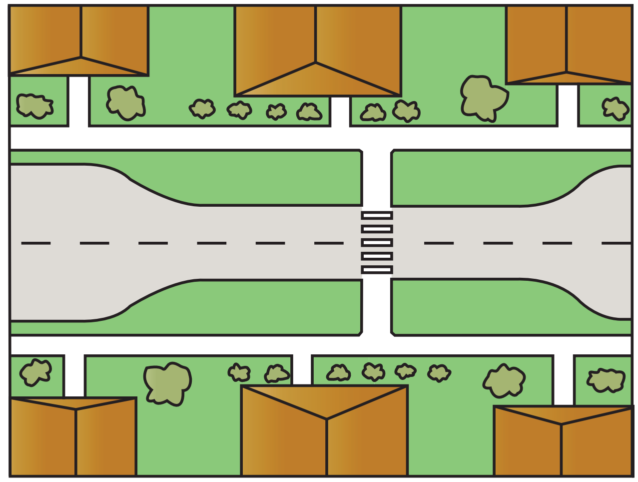


Exhibit 5-16: Chokers or squeeze points narrow the street over a short distance to a single lane.

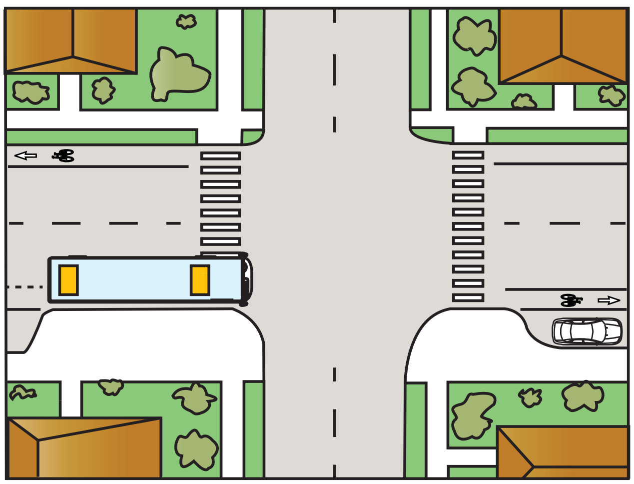


Exhibit 5-15: Curb extensions create smaller turning radii and perceived lane narrowing to reduce the speed of through and turning vehicles.

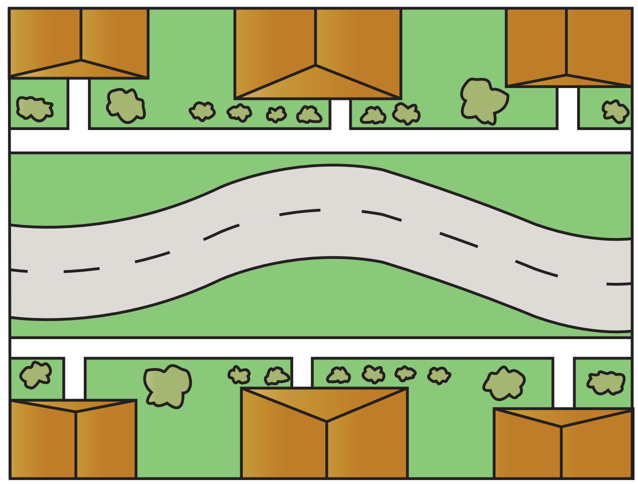


Exhibit 5-17: Chicanes are curved streets that may include staggered obstacles such as expanded sidewalk areas, planters, street furniture or parking bays.

by forcing a lateral shift in the motorist's path of travel. Neighborhood traffic circles can create problems if they force the motorist's path of travel into pedestrian crosswalks. Additionally, they may create problems for pedestrians with visual, cognitive and mobility impairments because they can lead to irregular motorist behavior. When making left-hand turns at neighborhood traffic circles, motorists frequently turn before the circle instead of driving counterclockwise around the circle. To limit this action, neighborhood traffic circles should not be placed at locations with high volumes of left-turning motorists. Signage with arrows may be helpful in directing traffic. If neighborhood traffic circles are landscaped, the landscaping cannot obstruct motorists' or pedestrians' sight lines.

Speed humps. Speed humps are raised strips of roadway that have a more gradual slope than speed bumps, which tend to be used to slow traffic at driveways and parking lot entrances rather than in roadways. Speed humps can include marked crosswalks (Exhibit 5-13) and are sometimes called speed tables. These devices effectively reduce vehicle speeds by forcing a vertical shift in motorist's travel. Speed humps can be problematic to vehicle drivers and passengers with neck and back problems if they cause a jarring effect on the vehicle. To minimize this problem, speed humps should have a gradual slope to allow motorists to proceed over the speed hump at or near the posted speed limit.

Roundabouts. Roundabouts are similar to neighborhood traffic circles as they contain a circular central island and can lead to lower vehicular speeds (Exhibit 5-14). However, roundabouts have a more complex design than neighborhood traffic circles and contain yield control of all entering traffic, channelized approaches and splitter islands. Most engineers do not consider roundabouts a traffic calming measure, but instead an intersection control type. See *Section 5.2.1.5.3.* for a more in-depth discussion of roundabouts, including information about roundabout design.

Curb extensions. Curb extensions create smaller turning radii and perceived lane narrowing to reduce the speed of through and turning vehicles (Exhibit 5-15). They are also referred to as bulb-outs or neckdowns. Curb extensions create shorter pedestrian crossings, increase pedestrian visibility and increase the space available for curb ramps. See *Section 5.3.4.2.3.* for more information about the design of curb extensions.

Chokers. Chokers or squeeze points narrow the street over a short distance to a single lane (Exhibit 5-16). Motorists must slow down and, occasionally, negotiate with on-coming traffic. Channels are often provided outside the squeeze point for bicycle access.

Chicanes. Chicanes are curved streets that may include staggered obstacles such as expanded sidewalk areas, planters, street furniture or parking bays (Exhibit 5-17). They are designed to shift the traffic stream side-to-side. The extent to which motorists decrease their speed depends on the treatment's design speed, the frequency of the shifts, and how far the motorist must shift.

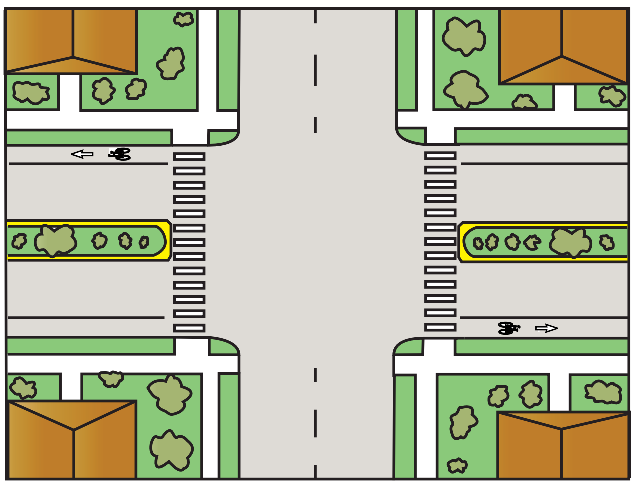


Exhibit 5-18: Medians are often used on major streets to eliminate left turns into local streets and cross traffic.

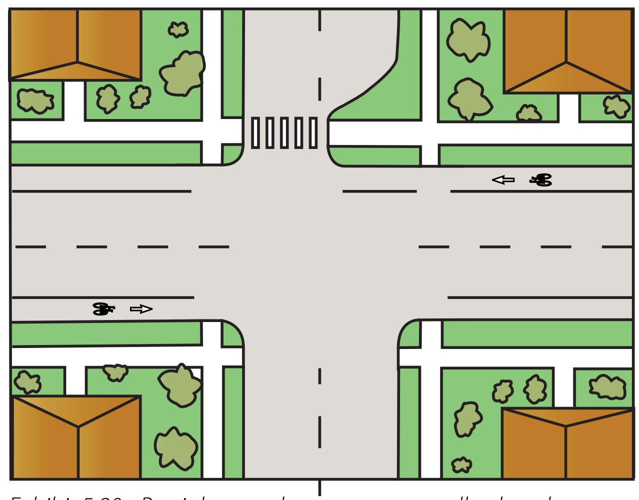


Exhibit 5-20: Partial street closures are generally placed at intersections and prohibit one direction of motor vehicle travel.

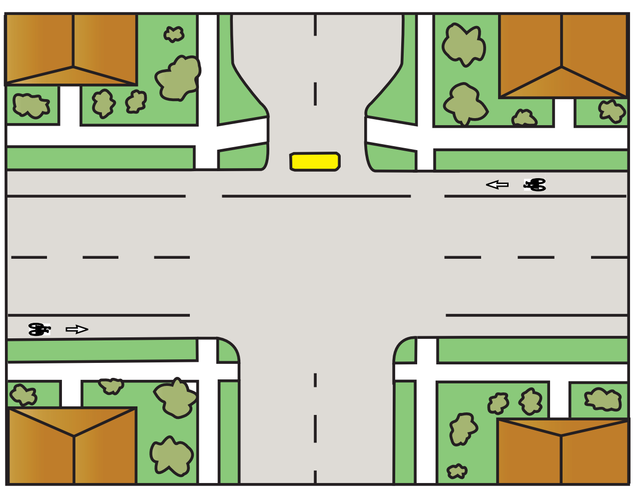


Exhibit 5-19: Street closures block motor vehicle traffic entirely.

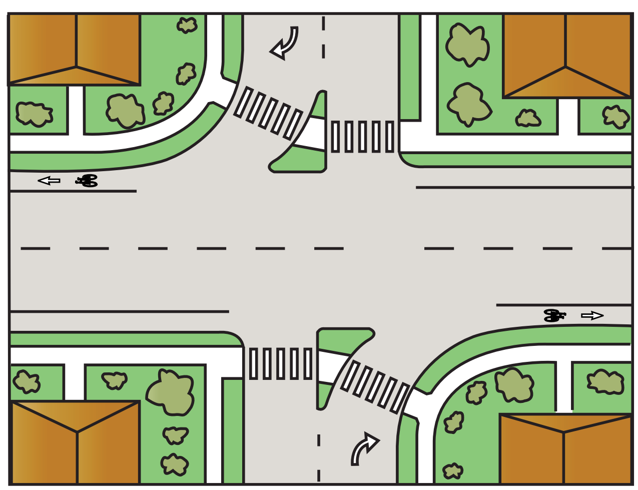


Exhibit 5-21: Diverters are diagonal barriers placed at intersections to force all motorists to turn right or left.

5.2.1.8.2. Volume control measures

Medians. Medians are often used on major streets to eliminate left turns into local streets and cross traffic (Exhibit 5-18). Curb ramps or level cut-throughs must be provided wherever medians intersect crosswalks (see *Section 5.3.4.2.1.* for more information on median design). Medians are also used on local streets to narrow street widths resulting in slower speeds for motorists.

Street closures. Street closures block motor vehicle traffic entirely (Exhibit 5-19). While not as common as less severe treatments, they are occasionally used where cut-through traffic creates significant problems. Street closures are sometimes installed at mid-block. If street closures are used, channels that allow pedestrians and bicyclists to pass through should be provided. Typically, street closures are considered a last resort measure since their impact can be significant on circulating traffic and may simply relocate traffic problems to other streets.

Partial street closures. Partial street closures are generally placed at intersections and prohibit one direction of motor vehicle travel. Bicyclists are allowed to ride past in either direction or may be provided with a channel. The barrier may be supplemented with "Do Not Enter" regulatory signs.

Diverters. Diverters are diagonal barriers placed at intersections to force all motorists to turn right or left. Unlike street closures, motorists do not have to turn around. Partial diverters only block particular movements. They typically force motorists to turn right rather than go straight or turn left.

5.3. Part II: Pedestrian Facility Design

The viability and safety of pedestrian travel depends not only on the design of pedestrian facilities but also on good roadway design. Pedestrian facilities are the physical infrastructure that allows for or promotes walking and forms of pedestrian movement (such as the use of wheelchairs and strollers) as a mode of travel. Pedestrian facilities include structures such as sidewalks, crosswalks and curb ramps. This section provides both legal requirements and recommended guidelines for the design of several different types of pedestrian facilities:

- Sidewalks
- Shoulders and rural cross-sections
- Curb ramps
- Pedestrian crossings
- Intersections—signals
- Pedestrian facilities on grade-separated crossings
- Grade-separated crosswalks
- Lighting
- Streetscapes and "context sensitive design/community sensitive design"
- Parking
- Meeting the pedestrian needs of public transportation users
- Trails
- Other techniques

5.3.1. SIDEWALKS

5.3.1.1. The purpose of sidewalks and general considerations

Sidewalks are essential for creating an accessible, interconnected and visually appealing walking environment. Sidewalks can increase the social liveliness of a community by offering a place for neighbors to interact and for children to play. By encouraging walking, sidewalks promote fitness, exercise and the general health of a community. Perhaps most importantly, sidewalks increase the safety of pedestrian travel because they form a network physically separate from motorists. In areas without sidewalks, the risk of motorist-pedestrian conflicts increases substantially. A 1996 study found locations with no sidewalks are more than twice as likely to have motorist-pedestrian collisions as sites with sidewalks.

Sidewalks are especially important to persons with disabilities, who account for nearly one-fifth of the U.S. population. Walking and transit are often their only means of independent travel. Low-income households and households without motor vehicles often depend on a well-designed pedestrian travel system, of which sidewalks are a critical component. Sidewalks are important to older adults who may develop sensory or cognitive disabilities that interfere with their ability to drive safely. Currently, seniors age account for more than 13 percent of Wisconsin's total population. Pedestrians, particularly those involved in crashes, are disproportionately seniors, children, and individuals with visual impairments.

Sidewalks should be placed on both sides of a street, particularly on transit and school bus routes, and near typical trip origins or destinations. Sidewalks on both sides of the street maintain the continuity of the walking system and can increase the level of pedestrian traffic. Alternatively, sidewalks on only one side of a street weaken overall system connectivity, threaten pedestrian safety, reduce mobility and impair accessibility. Where sidewalks are installed on only one side of the street, pedestrians are required to unnecessarily cross the street to meet their travel needs, particularly along transit and school bus routes. In limited circumstances, such as along cul de sacs, sidewalks on only one side of the street may be acceptable or temporarily appropriate. Where one side of a street is undeveloped, at minimum, there should be sidewalks on the developed side of the street. Sidewalks should be constructed on the undeveloped side of a street as soon as development begins.

5.3.1.2. Specific design parameters for sidewalk corridors

5.3.1.2.1. Corridor widths

The sidewalk corridor, or what is referred to throughout Wisconsin State Statute as "the sidewalk," is the distance from the edge of the roadway to the edge of the public right of way established for pedestrian use. The sidewalk corridor can typically be divided into four distinct parts:

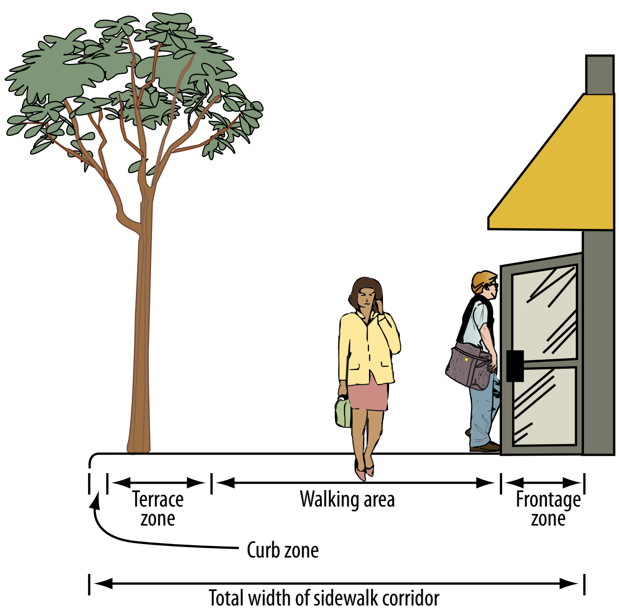


Exhibit 5-22: The four parts of a typical sidewalk corridor.

- Curb zone
- Terrace/furniture zone
- Walking area
- Frontage zone

Exhibit 5-22 illustrates a typical sidewalk corridor. A description and width standard for each part of the sidewalk corridor is discussed below.

Curb zone. A curb clearly uses vertical separation to distinguish the areas intended for motorist use from those intended for pedestrian use, and prevents drivers from driving onto the sidewalk corridor. The curb zone includes the curb, which facilitates roadway drainage and acts as a cue for visually impaired pedestrians. The curb zone is generally 6 inches wide.

Terrace. The terrace, which is often called the "furniture zone" in commercial areas and central business districts, is the area between the curb zone and the pedestrian walking area. The terrace increases pedestrian comfort and safety by providing separation between motorists and pedestrians, and can provide a snow storage area and splash protection distance between the walking area and the roadway. In residential areas, the terrace usually consists of a simple strip of lawn that may contain mailboxes, trees, and landscaping. In commercial areas and central business districts, the terrace is often paved. In these areas, the terrace takes on a greater significance by acting as an area for sidewalk furniture and other maintenance objects that would otherwise impede pedestrian travel.

Terraces provide space for numerous items, including curb ramps, streetlight poles, trash pick up, newspaper boxes, fire hydrants, bike racks, and traffic signs. The terrace should be clear at intersections in order to maintain maximum sight lines for both motorists and pedestrians. WisDOT recommends a typical terrace width of 4 to 6 feet. Four feet is the recommended width of the terrace if it includes planted trees and is used for snow storage. A 7-foot terrace will allow the curb ramp to rise to a level area just an inch above a 6-inch vertical curb. The terrace should slope away from the sidewalk toward the street. The standard slope of 4 percent is recommended. Greater slopes are permitted and often necessitated to account for grade differences between the sidewalk and the curb. In rare situations, a step may be used to accommodate significant grade differences. In this case, there should be a flat one-foot distance between the step and the sidewalk.

Walking area. The walking area, also called the pedestrian zone, is the area of the sidewalk corridor designated for pedestrian travel. Straight and direct walking areas are preferred over weaving and meandering walking areas, as they are more efficient and convenient for pedestrians and easier to navigate by the visually impaired. The walking area should be free of all obstacles and obstructions (See ***Section 5.3.1.2.7.*** for more information). The standard width for a typical walking area is five feet, while the standard width for a curbside walking area (a walking area immediately adjacent to the curb) is six feet. See ***FDM Section 11-25-30*** for more information. Central business districts should have a walking area next to a terrace with a minimum width of six feet to accommodate higher levels of pedestrian traffic. Walking areas shall have a minimum width of four feet to meet the ADAAG requirements for accessible routes. Walking areas with widths between four and five feet shall include passing areas of at least five feet by five feet every 200 feet or less. Clearance between objects should be 4 feet. This can be reduced to 3 feet for a length of 2 feet provided these narrowings are infrequent and a separated by at least 100 feet from each other.

Frontage zone. The frontage zone is the area between the walking area and the adjoining property line. In commercial areas and central business districts, the frontage zone allows pedestrians to avoid building fronts, walls and doorways that swing out into the zone. In residential areas, the frontage zone allows pedestrians to avoid trees and fences and allows municipalities additional maneuvering space when maintaining sidewalks. A minimum width of one foot for typical frontage zones and a slightly increased width for frontage zones in a central business district are recommended. Doors from adjacent businesses should not open directly to the walking area. The frontage zone may be eliminated if the walking area is adjacent to an open or landscaped space, such as a lawn. Even in this situation, a six-inch to 12-inch frontage zone will allow a municipality to work on the sidewalk without seeking permission from the adjacent property owner.

5.3.1.2.2. Cross slope

The cross slope of a walking area is the slope measured perpendicular to the pedestrian direction of travel. While cross slopes facilitate drainage, they may also create impediments to safe pedestrian travel. Wheelchair users exert considerably more energy when negotiating steep cross slopes. Additionally, steep cross slopes pull wheelchair users toward the roadway and increase the risk of tipping over. This is especially problematic where sidewalks traverse driveways. Walking areas shall have a maximum cross slope of 2 percent. At corners, walking areas shall have maximum slopes of 2 percent in both perpendicular travel directions. Because cross slopes of less than 2 percent create drainage problems, WisDOT recommends that walking areas have cross slopes of exactly 2 percent with very tight tolerances. In order to achieve this, the terrace slope or the curb height can be increased slightly.

5.3.1.2.3. Grade/running slope

The grade of a walking area, also called the running slope, is the gradient measured parallel to the pedestrian direction of travel. Walking areas with steep grades create problems for all pedestrians, especially during adverse weather conditions. Extreme grades drain pedestrian energy and the battery reserves of pedestrians using electric mobility devices. Pedestrians with mobility impairments avoid steep sidewalk grades if they know alternative routes. A few cities have developed and publicized routes showing sidewalk grades to help people identify safer routes.

In most cases, the maximum grade for sidewalks and other walkways shall be 5 percent. A sidewalk can have a grade between 5 percent and 8.3 percent if level landings are provided every 2.5 feet of vertical change. When matching the grade of an adjacent street, which is between 5 percent and 8.3 percent, level landings are still recommended. When the grade of the adjacent street exceeds 8.3 percent, the adjacent sidewalk shall match roadway grade. In these locations, flat landings/rest strips can be provided at regular intervals. When the running grade of the sidewalk exceeds 5 percent and also exceeds the grade of the adjacent roadway, rest intervals are required for every 2.5 feet of vertical change. When designing sidewalks on hilly streets, certain trade-offs may be inevitable. To establish a level landing area behind a curb ramp, the sidewalk's grade may need to exceed the prescribed thresholds for a short distance. Whenever these trade-offs are necessary and deviations from standards are taken, clear documentation of those actions—and the reasons for them—is strongly recommended.

5.3.1.2.4. Surface material

The surface treatment of the walking area has a significant impact on the facility's overall accessibility, safety and comfort level. In accordance with ADAAG, the walking area surface shall be stable, firm and slip resistant. The surface should also be smooth and continuous. Surfaces should be uniform in color and texture to aid pedestrians with visual impairments.

Portland cement concrete and asphaltic concrete pavement are the preferred surface treatments for the walking area. Portland cement concrete is typically used in urban areas and provides a smooth, long-lasting, and durable finish that is easy to grade and repair. A broom finish in the concrete can increase its slip-resistance, an important consideration under ADAAG. Asphaltic concrete has a shorter life expectancy but may be appropriate in less traveled areas such as rural areas or in park settings. Occasionally, crushed aggregate is used as a surface treatment for less traveled walkways, but may require a higher level of maintenance to preserve accessibility. Walking areas constructed with crushed aggregate that do not stay firm during the thaw cycle or remain very wet are a questionable surface type and may not meet federal accessibility requirements for all seasons.

Exhibit 5-23: Combining a concrete walking area with brick edging can create a stable and attractive sidewalk corridor.

Bricks, cobblestone and pavers should not be used as surface treatments for the walking area. Undesirable characteristics of these surface treatments include:

- Higher installation and maintenance costs
- Frequent buckling, which may be especially problematic in freeze-thaw cycles
- Irregular surfaces that create tripping hazards for pedestrians, especially seniors or pedestrians using assistive devices.
- Uncomfortable surfaces that are problematic and often jarring for wheelchair users with spinal injuries
- Greater difficulty in detecting truncated domes for pedestrians with visual impairments

If bricks, cobblestone or pavers are used as a surface treatment for walking areas, they should be installed in such a way as to avoid settling or eventual dislodging of the materials.

As a somewhat better alternative to traditional bricks and pavers, designers may consider imprint molds in colored concrete to create the visual appearance of bricks and pavers. This technique has the advantages of traditional materials without many of the maintenance disadvantages associated with bricks and pavers. These techniques are not completely without problems. Many of the imprints, especially those in concrete, may still cause unacceptable levels of jarring to wheelchair users. Colors may fade and it may be difficult to replicate the original pattern and color following sidewalk repairs and utility cuts.

As a recommended alternative, designers may consider a concrete main walking area combined with brick edging (Exhibit 5-23). The brick edging can hold street furniture, lights, trees, poles, and other streetscape amenities. For example, in a central business district, a 14-foot sidewalk width might include a 6-foot concrete sidewalk with a total of 8 feet decorative brick edging treatments for the terrace and frontage zones.

5.3.1.2.5. Driveways and sidewalks

Motorist access across a sidewalk not only degrades the quality of the pedestrian environment, it also increases the potential for motorist-motorist and motorist-pedestrian conflicts. When providing access to adjacent property, the number of motorist access points across the pedestrian path should be minimized.

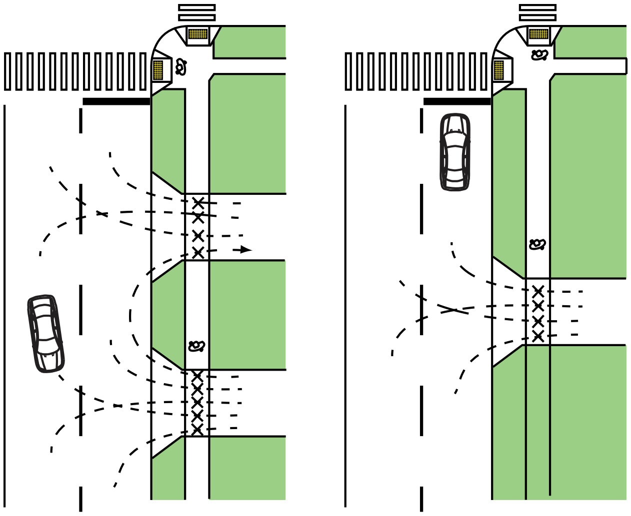


Exhibit 5-24: Limiting motorist access across a sidewalk reduces points where conflicts can occur between motorists and pedestrians.

Exhibit 5-25: Side flares and cross slopes can be problematic for some pedestrians. In this example, an easement is provided for pedestrians to maneuver around the flare.

Commercial driveways generally have higher motorist volumes than other driveway types and have the greatest potential for conflicts between motorists and pedestrians. Multiple-unit apartment and condominium buildings can have motorist volumes that approach those of commercial driveways. The number of high-volume driveways and their proximity to each other has a direct effect on the quality of the pedestrian environment. Limiting and consolidating multiple or undifferentiated driveways reduces the number of conflict points (Exhibit 5-24). Managing motorists' access can also redirect motorists to intersections with appropriate control devices. AASHTO's *Policy on Geometric Design of Highways and Streets* and the WisDOT *Access Manual/ TRB Access Management Manual* provide further information on the benefits of access management.

Residential driveways to individual homes pose less potential conflict to pedestrians than high-volume driveways because of lower use rates. On residential driveways, there should be enough driveway length beyond the public right of way to prevent parked vehicles from blocking sidewalks.

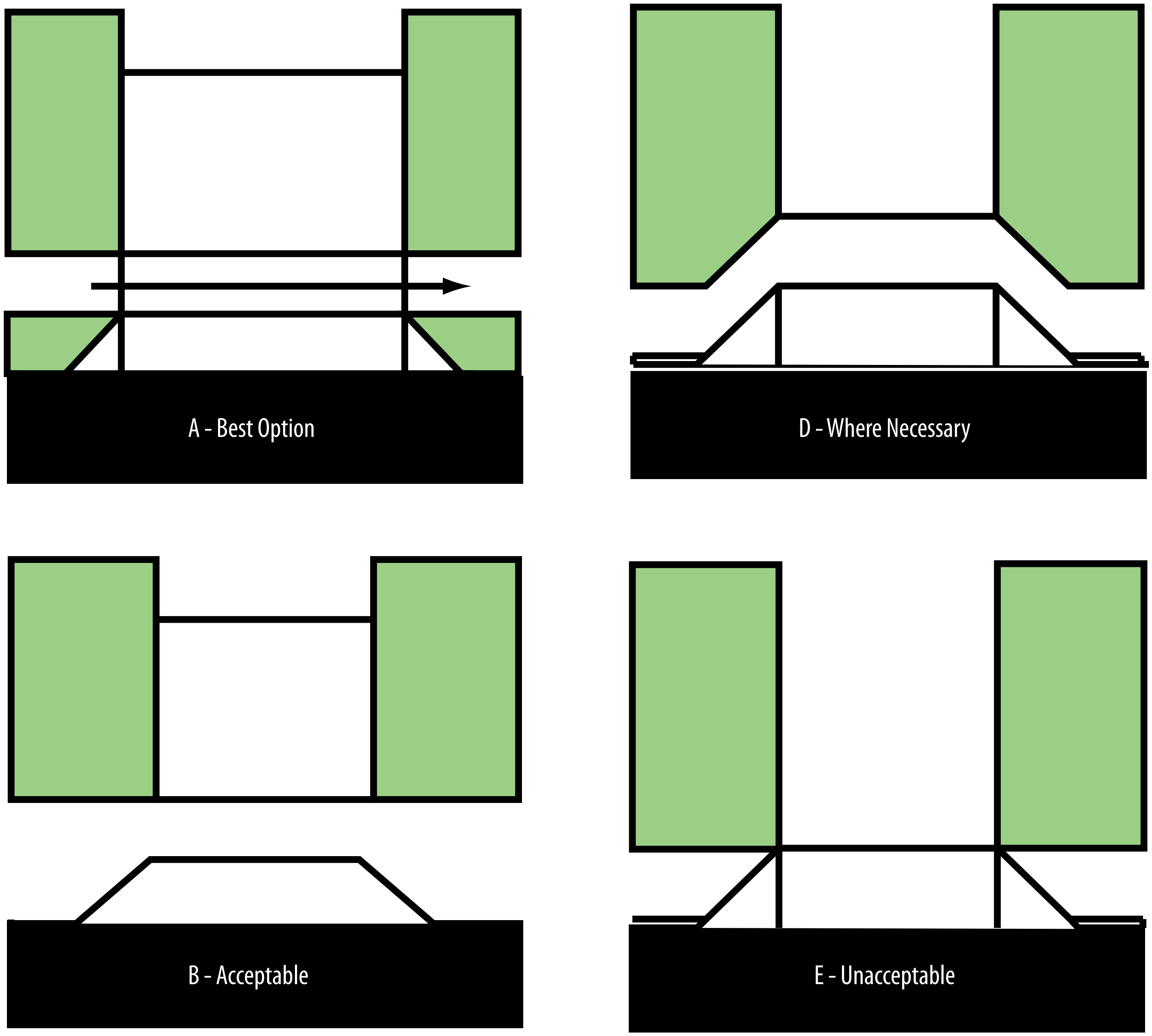
Wherever a driveway crosses a pedestrian walking area, the driveway must conform in width, cross slope, and grade to the design requirements for walking areas to meet ADA requirements. The ADA requires that a relatively flat travel surface be provided for people who use wheelchairs, strollers or other mobility devices. If local driveway requirements conflict with ADA requirements, ADA requirements are to take precedence.

WisDOT does not recommend unramped curb returns for driveways. Side flares and cross slopes at driveway aprons may cause a drive wheel, caster or leg tip to lose contact with the surface causing the pedestrian to fall (Exhibit 5-25). Cross slopes in new construction shall not exceed 2 percent.

There are four basic driveway designs that meet ADA accessibility requirements. Each design maintains a level, or nearly level, surface by either maintaining a four-foot minimum path width or providing a four-foot area adjacent to the main walk without exceeding a 2 percent cross slope. In reconstruction work at some locations, WisDOT recommends increasing the driveway slope in the driveway apron to allow for an adjacent level five-foot walking area. Designers should consult the standards of local agencies concerning driveway apron slopes. Exhibit 5-26 illustrates the four acceptable driveway designs and an example of a driveway design that is not acceptable.

Option A, *which is the recommended driveway design*, utilizes a wide terrace to greatly improve the safety of the driveway access area for both pedestrians and motorists. The driveway slope and the driveway apron are fully placed in the terrace to allow the adjacent walking area to be continuous and level. Wide terraces allow more turning area for entering and exiting motorists. The terrace immediately adjacent to a driveway should be free of trees, tall landscaping and other obstructions that could limit the sight distances of pedestrians and motorists.

Option B narrows the walking area at the point where the walking area intersects the driveway. This allows additional space for the driveway slope. In Option B, the narrowed walking area shall maintain a minimum width of four feet.



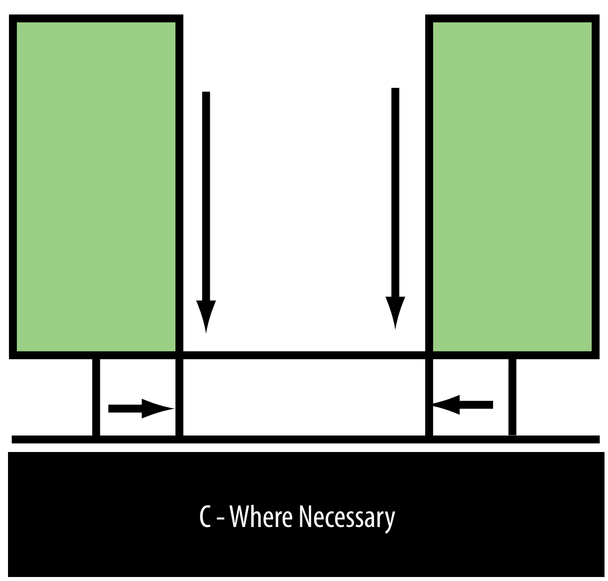


Exhibit 5-26: Driveways that cross the pedestrian walking area have a range of configurations, from the best design to unacceptable design.

Option C, also referred to as the parallel ramped driveway crossing, may be considered in areas where the sidewalk corridor is too narrow for either Option A or Option B. Where the distance from the edge of the sidewalk to the face of the curb is insufficient to provide a cross slope of 2 percent, Option C uses an appropriately designed ramp on either side of the driveway. This lowers the walking area to near street-grade at the driveway crossing. The driveway slope is located behind the walking area. This driveway design may encourage higher vehicular turning speeds, may cause pedestrians with mobility impairments additional difficulties, and may cause pedestrians with visual impairments to mistake the driveway crossing for a curb ramp. Because of these potential problems, Option C should only be used if other, safer options are not technically feasible and should be limited to low-volume residential driveways.

Option D, the jogged driveway crossing, wraps the walking area around the driveway slope with the use of two triangular tapers. Public agencies may need to purchase or obtain an easement from the adjacent property to provide the additional space required for Option D. This driveway design can be difficult for pedestrians with visual impairments to follow and may be impractical at some sites due to physical constraints. This option should be used in limited circumstances when other, safer options are not technically possible.

Option E is never acceptable because it requires the pedestrian to traverse the cross slopes of the driveway.

Wherever a parking garage exit driveway crosses a walking area, motorists need sufficient sight distance to see pedestrians. Exiting drivers should be reminded that they must yield to pedestrians at these locations. "Stop" or "Yield" signs can be supplemented with mirrors, electronic animated eyes, displays, audible signals or flashing lights. These signs and signals should be directed to gain the attention of motorists rather than pedestrians. Using audible or visible signals that require pedestrians to yield to motorists at driveways is confusing and inappropriate.

Driveways with high motorist volumes are often designed as intersections with curb returns, curb ramps and marked crosswalks. Unless high-volume private-access driveways are signalized, WisDOT recommends the standard driveway treatments described above to clearly indicate the pedestrian right-of-way. If an intersection-type design is used at a driveway, designers should apply guidelines for intersection design discussed in ***Section 5.2.1.4***.

5.3.1.2.6. Side slopes and vertical drops

Steep side slopes or vertical drops adjacent to a walking area can create an uncomfortable and potentially unsafe situation for pedestrians. There are two ways to mitigate this situation – horizontal separation or a barrier, such as a railing or fence.

Exhibit 5-27: Providing fencing along a walking path with a steep side slope of 1:1 or greater is strongly recommended.

Typically, 4:1 grades sloping downward do not require wider shoulders or railings. Wherever there is at least five feet of gradual horizontal separation (6:1 side slope) between the walking area and a steep side slope, no additional treatment is required. The inability to meet either of these provisions may require a railing or fence.

A railing or fence is **required** when the sidewalk is adjacent to a vertical drop of more than one foot, the grade exceeds 2:1, and there is limited horizontal separation (less than five feet) between the walkway and the drop-off (Exhibit 5-27). When deciding on an appropriate treatment for other steep side slope conditions, designers should consider the following conditions:

- What is located at the bottom of the steep side slope or vertical drop?
- Is the drop-off vertical or sloped?
- How far down is the steep slope or vertical drop?
- Can a shoulder with modestly steep grades (2:1 to 3:1) be provided for a relatively minor drop (less than five feet)? It should be noted that a one- or two-foot shoulder in addition to a sloping downward grade of at least 3:1 is preferred to a five-foot shoulder next to an otherwise very steep slope.
- How steep is the slope of the down slope?

If the bottom of the drop is water or a hard surface, railings are recommended. A grassy landing at the bottom of a steep side slope is less problematic. Typically, 4:1 grades sloping downward do not require flat shoulders or railings. However, a six-inch shoulder is still recommended even if it increases the down slope a slight amount.

Retaining walls have steep vertical drops. A barrier is necessary if pedestrians, bicycles or children are likely to be within five feet of the top of the wall. A barrier must be installed at the top of any wall that is over one-foot tall, if the top of the wall is adjacent to a sidewalk, trail, parking lot or stairway landing. Walls located farther from human or vehicular activity may be higher before a barrier is considered necessary. In any case, a barrier must be provided if it is determined to be necessary, regardless of the wall's height. The barrier on top of a wall could be a fence, beam guard or railing. The selection, location and installation details of a proposed barrier should be coordinated with the structural designer. The aesthetics of any barrier, especially in urban areas where the wall and barrier are located adjacent to private property, may also be considered.

5.3.1.2.7. Obstructions and other pedestrian obstacles

To maximize pedestrian accessibility, the walking area should be clear of all potential obstructions. The following subsection describes common obstructions and pedestrian obstacles, and discusses solutions to these obstacles.

Changes in level. Abrupt vertical rises between adjacent surfaces within the walking area are changes in level. There are many causes of changes in level, such as tree roots pushing up under the walking area or frost heaving and settling the walking surface. Changes in level can create tripping hazards for pedestrians, especially pedestrians with visual or mobility impairments. According to ADAAG standards, changes in level between ¼ and ½ inch should be beveled, with a maximum slope of 50 percent (Exhibit 5-28). Changes in level above ½ inch should be patched or restored to a maximum grade of 8.3 percent and should conform to ADA ramp guidelines (See Chapter 4, Section 405 of ADAAG).

Exhibit 5-28: Changes in level can create tripping hazards. Any changes in level between ¼ and ½ inch should be beveled.

Sidewalk displacement is common in Wisconsin due to frost heaves and tree roots. Although reducing changes in level are recommended when displacement reaches ½ inch, it is not expected that the entire stock of a community's sidewalk system be in compliance. It is more likely for municipalities, as a common and acceptable practice, to follow an annual maintenance program that will bring sub-areas of a community into compliance. Each area is brought up to standard with permanent repairs on a rotational basis. Consideration may be given to stricter standards or more frequent reviews for areas with heavy pedestrian traffic such as areas around busy downtowns, stadiums and venues. Eventually, the maintenance program will return to the initial neighborhood and the cycle will repeat itself. A maintenance program cycle does not relieve a community from responding to hazardous tripping conditions and making temporary repairs to sidewalks in other parts of the community.

Protruding objects. Objects that extend into the walking area, terrace or frontage zones are especially unsafe for pedestrians with visual impairments. Objects that are protruding between the heights of 27 inches and 80 inches from a wall or a post shall not protrude horizontally more than four inches if they can be approached from the side, and not more than 12 inches if they can only be approached from the front. If an object is mounted between two posts or poles that are separated by more than 12 inches, the lowest edge of the object shall have a maximum height of 80 inches. Common objects in the pedestrian right of way to position properly

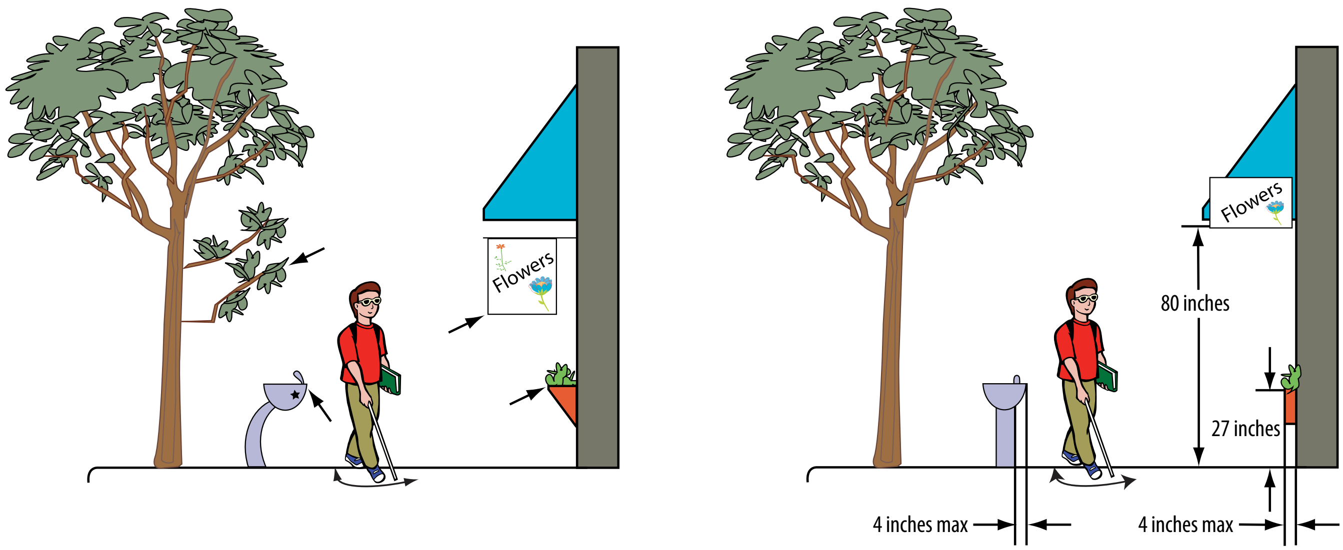


Exhibit 5-29: Objects protruding into the terrace and frontage zone may create problems for pedestrians with vision impairments and are subject to placement restrictions.

include transit stop signs, drinking fountains, business signs, railroad crossing gate apparatus and counterweights. Exhibit 5-29 shows protruding object conflicts and placement distances for objects.

Ground-level obstacles. Offsets, gaps or openings in drainage grates, tree grates, manhole covers, hatches, valves, vaults and other utility coverings, particularly those with parallel bars can all fall into this category. These obstacles can catch parts of wheelchairs, strollers, walkers, shoes, and canes, causing pedestrians to fall. Valve boxes, pull boxes, vault covers, sanitary clean-out covers, manhole covers, water curb boxes and other access features are often needed for operation and maintenance reasons.

Often ground level utility features are located in the sidewalk. They may be associated with changes in slope or "warps" to accommodate them in the sidewalk and may promote premature cracking or failure of the sidewalk. The best solution is to not locate any of these features in the walking area. If maintenance features must extend into the walking area, they must be installed flush and level with the surrounding surface (Exhibit 5-30). A four-foot wide walking area still must be provided, absent of any obstacles. The same requirements for changes in level discussed above apply to these objects.

Exhibit 5-30: Where maintenance features are located in the walking area of a sidewalk or path, they must be flush and level.

Exhibit 5-31: The curb box protrudes into the walking area after frost heaving, creating a tripping hazard.

Exhibit 5-32: Maintenance features can instead be encircled by a frost sleeve to prevent frost heaving.

Exhibit 5-33: Tree grates that extend into the walking area are subject to design standards.

Frost heaving is a typical reason that maintenance features become pedestrian obstacles and tripping hazards. The tops of the features rise with the sidewalk but do not always drop back down into their appropriate position when the sidewalks recess in the spring. The use of frost sleeves has been a successful method of solving the problem of frost heaving. Exhibit 5-31 depicts a curb box in the walking area that was lifted from frost heaving, while Exhibit 5-32 shows an appropriately flush curb box contained within a frost sleeve.

Grates in the walking area shall be designed so that openings do not allow the passage of a ½-inch sphere. Elongated openings shall be orientated so that the long dimension is perpendicular to the dominant direction of travel. Exhibit 5-33 provides an example of a well-designed grate.

Overhead objects. Guy wires and utility tie-downs should not be located in or across the walking area at heights below eight feet . Guy wires located parallel to the walking area should be covered with a yellow or other highly visible plastic guard. Clearance to overhead objects (signs, tree limbs, etc.) must be at least seven feet.

Stairs. For the construction of new sidewalk routes, avoid constructing only stairs or steps for primary access, since they are difficult or impossible to negotiate by pedestrians with mobility impairments. Where stairs currently exist, an alternate accessible route that does not deviate greatly from the principal route, should be constructed whenever possible. Providing access where there are existing stairs can be accomplished, in part, by including the problem sites in the "transition plan." Steps may be provided in addition to an accessible route for any project. Steps or stairs shall follow current ADAAG requirements (See Chapter 5, Section 504 of ADAAG). Local building codes may also regulate stair construction in detail.

In order to provide an accessible route in complex situations, a feasibility study can be conducted to analyze all of the components required in construction. Flexible design and reasons for a less-than-ideal accessible route should always be documented. In unique cases where it is infeasible to provide an accessible route, stairs are preferred to an overall lack of access. Documentation should be provided for justification.

On properties with little or no setback from the sidewalk, there are cases with existing stairs that extend out into the walking area. In these cases,

Exhibit 5-34: Where buildings abut the sidewalk and have existing stairs for entrance, a 4-foot walking area should be maintained.

the stairs should not be allowed to extend further into a four-foot wide walking area (Exhibit 5-34).

Street furniture. As noted above, obstructions such as street furniture, trees, newspaper boxes, and utility poles should be placed together in the terrace in a spot that does not restrict the sight lines of either motorists or pedestrians. Improperly placed objects can create obstacles for pedestrians with visual impairments or those using strollers, walkers, wheelchairs or other mobility devices. All street furniture should be placed outside of the walking area and should contrast in color with the walking area to increase their visibility. Additionally, street furniture should not be placed too close to on-street parking. Two feet is the recommended distance for street furniture to be placed away from the curb. Street furniture, such as benches, telephone poles, or streetlights, can be placed at the end of a row of parking rather than in the middle of parking spaces.

5.3.1.2.8. Street trees and planting strips

Street trees are an excellent buffer between the roadway and walking area. Street trees are aesthetically pleasing, offer shade to pedestrians, and may contribute to traffic calming. When deciding where to locate trees, avoid:

- Obstructing the view between an approaching motorist and pedestrians or motorists attempting to cross or enter the street
- Interfering with overhead utilities, roadside furniture, and opening car doors
- Allowing tree canopies to hang below a vertical height of seven feet
- Planting trees with large trunks and tree root systems that spread out near the surface of the ground

Tree selection. A landscape architect or arborist can identify preferred tree types for the local climate and terrain. Appropriate tree selection can reduce tree maintenance and increase longevity. The appropriate type of tree should have root patterns that are not likely to eventually cause the sidewalk to heave and shift vertically or damage the foundations of nearby structures.

Tree grates. When planting street trees within an urban sidewalk corridor, the trees and their grates should be placed outside of the walking area. A minimum of four feet should be provided for the pedestrian walking area. Tree grates can vary in size depending on the type of tree and the width of the sidewalk corridor. Tree grates should be a minimum of four feet by four feet, or have at least 16 square feet of open area. Where the terrace is narrow, a rectangular grate can be used. Tree grates adjacent to the walking area must not interfere with the accessibility needs of all potential users. Tree grates should have drainage gaps that are flush with the sidewalk pavement and narrow enough to prevent high-heeled shoes, strollers, wheelchairs, canes, and other mobility devices from becoming lodged in them. See the previous subsection on ground-level obstacles for additional guidance on the design of tree grates.

Plantings. In addition to street trees, terrace plantings can enhance the comfort level of people walking along a sidewalk. Plantings offer pedestrians an increased sense of security, while also protecting them from roadside spray from rain or snow. Terrace plantings can also act to direct pedestrians to appropriate crosswalk locations. Most trees and plants are inappropriate for median plantings. Local microclimate, soil conditions, the width of the median, the amount of automobile exhaust, and visibility codes all dictate proper terrace plantings.

Regardless of where the planting is, it is imperative to consider visibility through plantings. A tall tree near a driveway will provide more visibility for motorists to see oncoming wheelchair users and pedestrians than a continuous row of bushes or tall prairie plantings. Some localities have jurisdiction over sight triangles through plantings on private property and will take the necessary action to maintain good sight lines. Low growing, well-maintained plantings are encouraged. They should be no higher than two feet and should not encroach on the walking area or the roadway to maintain good visibility for both pedestrians and motorists.

Designers should consult *FDM Section 11-20-1* to determine the clear recovery area policies before making a final recommendation of buffer width and buffer tree locations.

5.3.1.2.9. Streetscape

The streetscape is an aesthetic consideration of roadway design that involves the visual appeal of the street's entire public right of way. It is an important network in the urban fabric that assists in defining a sense of place. Streetscapes are important environments for pedestrians as well as automobiles. A well designed sidewalk corridor can have a positive effect on the overall streetscape. For example, properly placed street trees in the terrace can enhance the streetscape by providing color contrast, vertical height and an edge. Street furniture and sufficient motorist/pedestrian separation can make a right of way appear more inviting and comfortable. Appropriately placed public art can enhance a streetscape. Building facades provide the visual texture to frame the street. When designing the sidewalk corridor, designers should be mindful of the sidewalk corridor's impact on the overall streetscape. See *Section 5.4.* for more information on community sensitive design.

The design and elements of a good streetscape create distinction from the approaching environment. For pedestrians, the distinction is important because it signals to motorists that a speed reduction is required. Light spacing decreases, visual cues increase, and the land use changes. The combined effect indicates to motorists that they are entering a new environment.

5.3.1.2.10. Lighting for sidewalks

Both street lighting and pedestrian-level lighting can improve the visibility, safety, and security of the sidewalk corridor. See *Section 5.3.7.* in this chapter for more detailed information on lighting the sidewalk corridor.

5.3.2. WALKWAYS ON SHOULDERS AND RURAL CROSS-SECTION HIGHWAYS

Like sidewalks in urban areas, sidewalks in rural areas must be adequately separated from vehicular travel lanes. Often, rural areas lack sidewalks. Where sidewalks do not exist, pedestrians use shoulders as walkways. However, Wisconsin State Statute *340.01(54)* and *340.01(58)* does not define roadway shoulders as legal sidewalks or pedestrian facilities. Even though roadway shoulders are not legal pedestrian facilities and cannot legally be designated as pedestrian access routes, the occasional pedestrian that uses a shoulder as a walkway benefits from a wide paved shoulder. Because some pedestrians may not prefer to walk on gravel, pedestrians prefer a paved shoulder to a gravel shoulder. Gravel shoulders and combinations of paved and gravel shoulders still benefit the occasional pedestrian. Laws and statutes may prohibit pedestrians from certain roadways such as Interstates. In these circumstances, pedestrian needs should not be a consideration in determining shoulder widths.

In places where pedestrians are commonly using the shoulders, a separate walking facility is needed. Attempting to solve the problem through shoulder widening and paving may be an inappropriate response. A separate walkway may be a better way to resolve the issue, especially in transitional areas where residential and commercial development create a demand for pedestrian facilities.

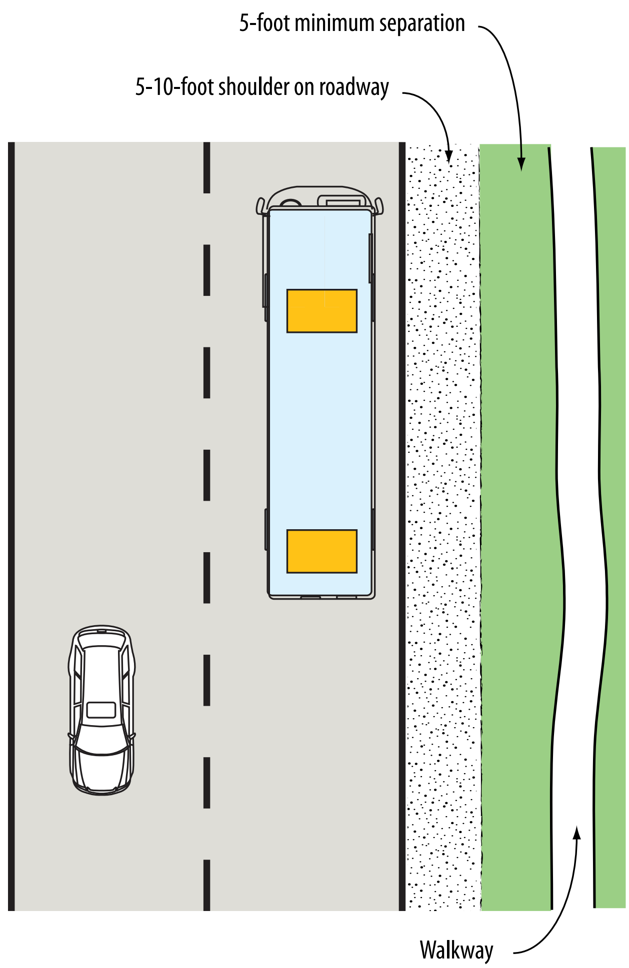


Exhibit 5-35: Walkways may be needed alongside rural roads where full sidewalks are not yet feasible.

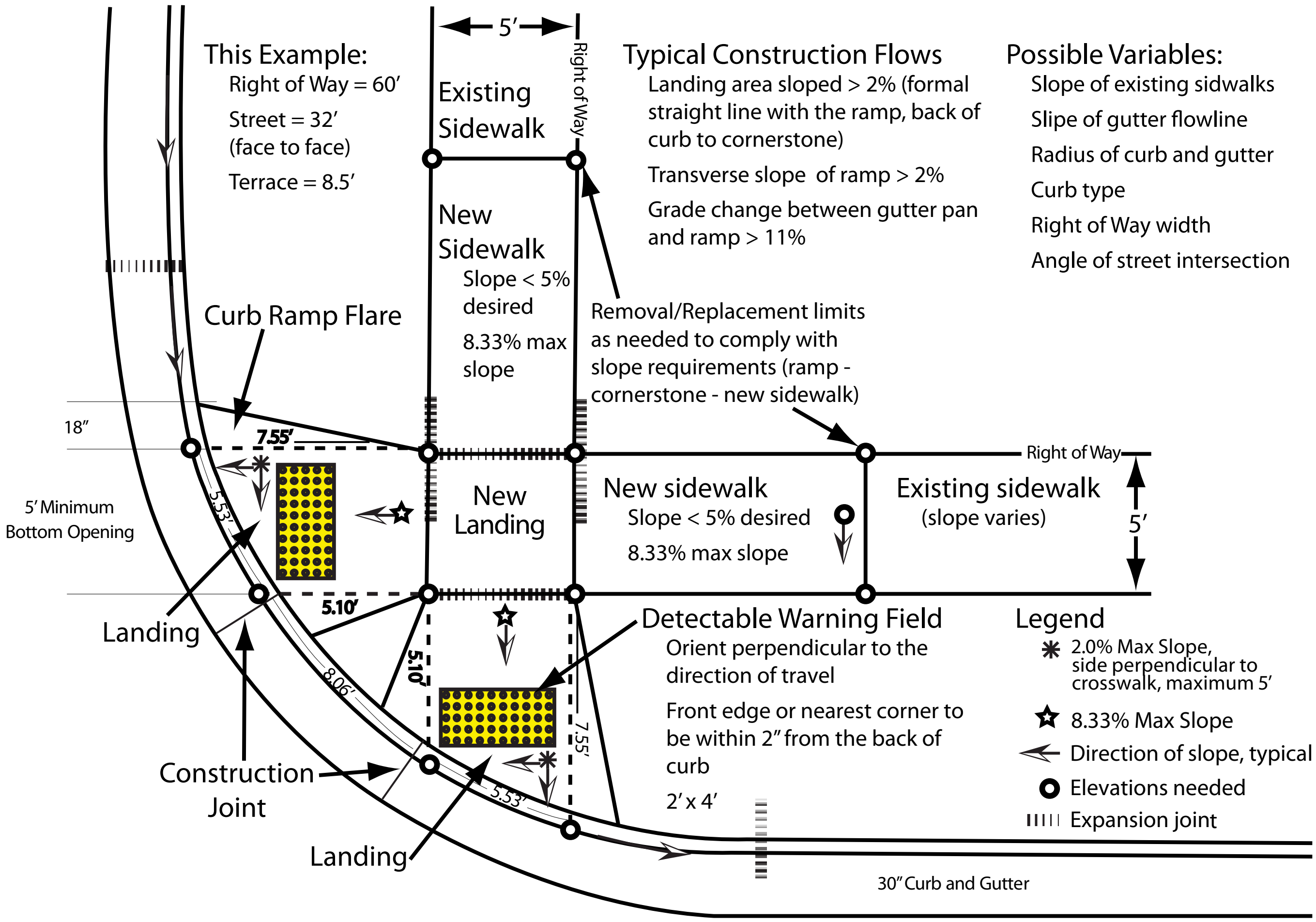


Exhibit 5-36: Far from simplicity, numerous design elements are accounted for in a well-constructed curb ramp.

Shoulder widths generally differ on state, county, city/village and town roads. The FDM determines width standards for state highways as well as shoulder cross slope and width standards for local, collector and arterial roads. Most roads are required to have a shoulder between three and ten feet. The walkway should be located a minimum of five feet from the edge of where the standard shoulder would be located, even if the current shoulder is not up to standard. This provides room for the shoulder to be updated to the standard.

In situations where sidewalks are not feasible, Exhibit 5-35 shows how a walkway may be provided alongside a rural cross section if there is a five-foot separation between the shoulder and walking area. The roadway's functional class will determine how much shoulder should be provided, with a minimum of five feet of separation between the shoulder and the walkway.

5.3.3. CURB RAMPS

Pedestrians with mobility impairments rely on curb ramps to effectively navigate the interface between sidewalks and roadways. Curb ramps also benefit pedestrians with strollers, delivery carts, and rolling luggage. However, curb ramps are problematic for pedestrians with visual impairments because they blur the transition point between the sidewalk and the roadway. Federal law requires all curb ramps to contain truncated domes to increase their detectability. Curb ramps and detectable warnings are required

Designing for mobility devices

Standard wheelchairs are 4 feet long, and some scooters used for mobility can be up to 4.3 feet long. Manual chairs and scooters are typically 2 feet wide, though some large wheelchairs can be up to 3 feet wide. For these reasons, it is important to maintain a landing of 5 feet by 5 feet so mobility devices users can turn around to change directions.

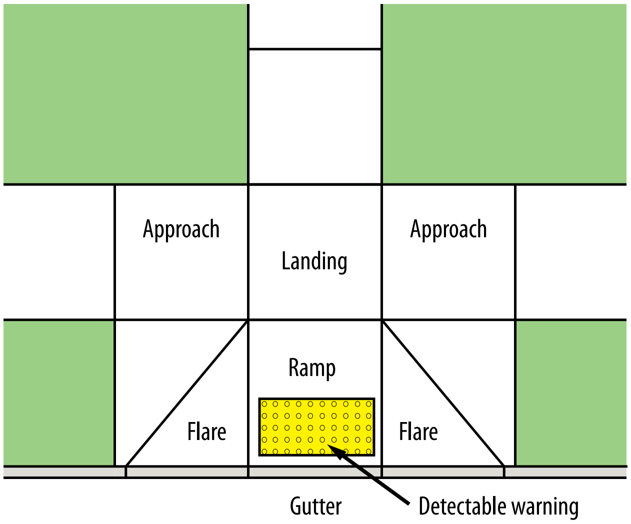


Exhibit 5-37: The six main components of standard curb ramp design.

on all new facilities and as retrofits on all projects from resurfacing on up, regardless of private or public ownership and funding source. Truncated domes are discussed later in this section. A well-constructed curb ramp takes into account numerous design elements (Exhibit 5-36).

In accordance with ADAAG, curb ramps shall be provided at the intersections and mid-block crossings of all newly constructed or altered roadways wherever crosswalks (either marked or unmarked) are present. Based on court decisions, pavement overlay projects of greater than 1 ½ inches are considered roadway alterations and require curb ramp installations in coordination with ADAAG standards. If a curb ramp is provided at one corner of an intersection or mid-block crossing, generally companion ramps should be provided at the other corners of the crossing as per the FDM. Exceptions are provided in ***FDM Section 11-25-30***; these exceptions are consistent with ADAAG. Curb ramps should not only be used in conjunction with sidewalks, but shall also be provided where shared-use trails and transportation facilities intersect roadways. To ensure their year-round accessibility, curb ramps should be promptly cleared of snow during the winter months (see Chapter 6, Maintenance of Pedestrian Facilities, and Chapter 7, Pedestrian Work Zone Safety, for more information).

5.3.3.1. Design specifications for curb ramps

Proper curb ramp design is important for pedestrians either continuing along a sidewalk path or attempting to cross the street. Most curb ramps consist of six main components (Exhibit 5-37): approaches, landings, ramps, gutters, flares, and a detectable warning. Curb ramps shall be constructed to have flush transition points between these five components that are free from abrupt change. Although a 1-inch lip was once recommended between the gutter and the ramp to increase detectability for pedestrians with visual impairments, current guidelines require a smooth and even transition from the ramp to the gutter. Uneven and non-flush transitions between any of the curb ramp's five components create tripping hazards for pedestrians and act as potential barriers for pedestrians with mobility impairments. The following subsections provide design parameters for each of the five curb ramp components.

Approach. The approach is the interface between the curb ramp and the sidewalk corridor. The approach should meet the same design requirements as a typical sidewalk corridor including maintaining a standard five-foot wide walk surface with a cross slope no greater than 2 percent.

Landing. Landings provide a level area with a cross slope of 2 percent or less in any direction for wheelchair users to wait, maneuver into or out of a ramp, or bypass the ramp altogether. Landings should be 5 feet by 5 feet and shall, at a minimum, be 4 feet by 4 feet.

Existing facilities do not always have landing areas because of right of way restrictions or obstructions. New construction or major

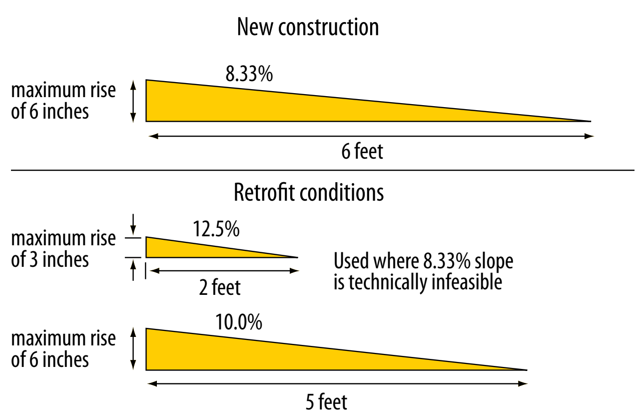


Exhibit 5-38: Ramp grade specifications for new construction and retrofit applications.

reconstruction should provide landing areas that meet the guidelines presented above. In addition, landings or level cut-throughs shall be provided at raised medians or crossing islands adjacent to channelized right-turn slip lanes.

Ramps. The ramp provides the sloped connection between the sidewalk and the roadway. The grade of a ramp shall not exceed 8.33 percent, which equates to one inch of rise per one foot of length (Exhibit 5-38). Ramp grades should be a minimum of 2 percent for drainage purposes. Ideally, curb ramps should be designed with a maximum grade of 7.1 percent to allow for construction tolerances. The cross slope of the ramp shall not be greater than 2 percent. A cross slope greater than 2 percent can create problems for pedestrians by compounding the problems associated with the ramp's steep grade. WisDOT recommends a cross slope of exactly 2 percent to facilitate drainage.

In rare situations when ramps are being retrofitted into existing intersections, curb ramp slopes may be increased between 8.33 percent and 10 percent when the maximum rise is six inches, and slopes may be increased between 10 percent and 12.5 percent when the maximum rise is 3 inches. Written justification and documentation are essential when this is done. See Exhibit 5-38.

The standard ramp width for a newly constructed curb ramp is 5 feet, or the width of the walking area, whichever is greater. This measurement does not include the widths of the flared sides. For existing curb ramps, WisDOT allows a minimum ramp width of four feet only if conditions prohibit a wider ramp. Existing curb ramps with a width

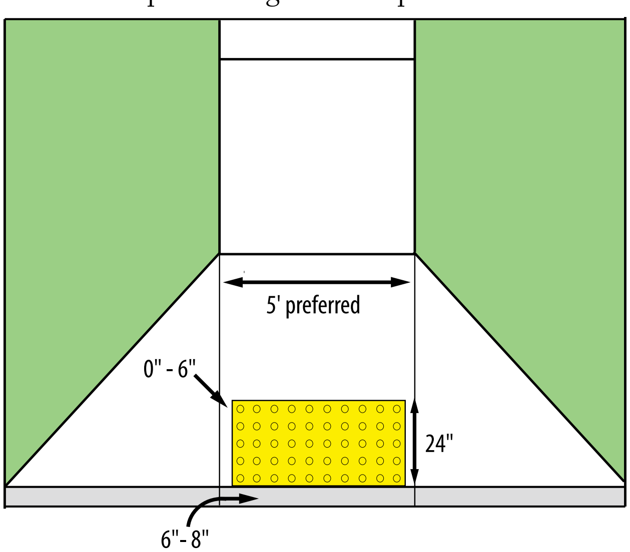


Exhibit 5-39: Proper placement and size parameters for detectable warnings.

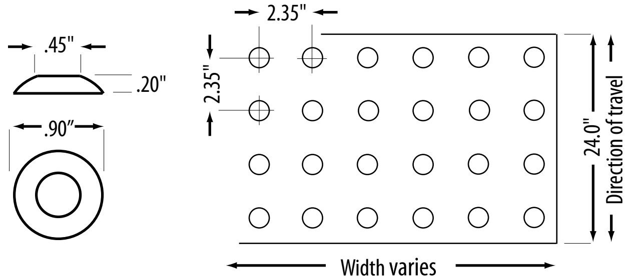


Exhibit 5-40: Size and height specifications for truncated domes.

smaller than four feet must be replaced. A transition plan will help a community identify noncompliant curb ramps and create a timetable for their replacement. See the Planning Chapter for more information on transition plans.

Detectable warnings. All new and reconstructed curb ramps shall include truncated domes to signal to pedestrians with visual impairments where the transition from the sidewalk to the roadway occurs. Existing ramps that do not already contain detectable warning fields should include truncated domes during any sidewalk or roadway alterations. Transition plans should include an update for retrofitting detectable warnings on existing curb ramps in the community.

Truncated domes shall cover the width of the curb ramp with zero to six inches gap allowed on each side (as measured perpendicular to the pedestrian direction of travel) and have a length of two feet (as measured parallel to the pedestrian direction of travel). Truncated domes should be placed six to eight inches from the face of the curb and shall provide color contrast with the ramp surface (Exhibit 5-39). WisDOT requires yellow, white or natural patina (rust) colored truncated domes on all state- or federally-funded projects. While darker colors that provide a color contrast with the ramp surface are allowed under federal rules, WisDOT does not recommend them because darker colors do not provide a sufficient contrast with the ramp surface at night or in other low-light conditions.

Each raised section within the truncated dome should have a bottom diameter of 0.9 inches, a top diameter of 0.4 inches, and a height of 0.2 inches. Raised sections within the truncated dome should have a center-to-center spacing of 2.35 inches. Domes should be arranged in straight lines and not offset with each other (Exhibit 5-40).

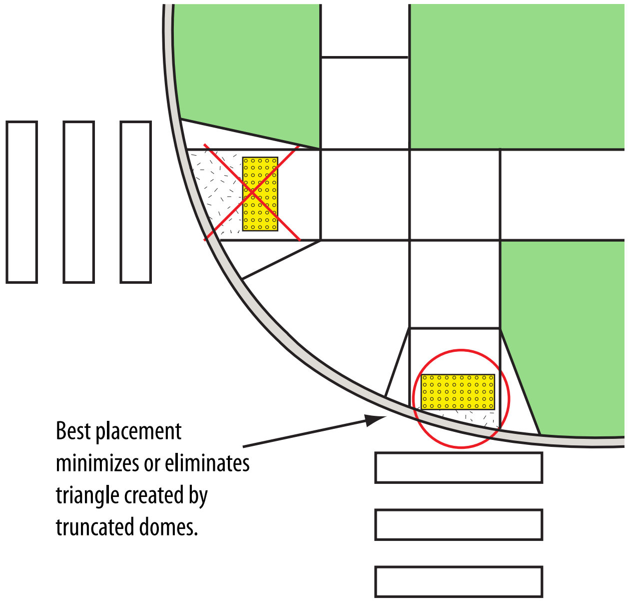


Exhibit 5-41: Truncated dome panels should be arranged to minimize the triangle created at the base of the curb ramp.

Detectable warnings installed in the curb ramp should be placed to minimize the triangle created at the base of the curb ramp (Exhibit 5-41). In cases where the detectable warning can be placed directly adjacent to the gutter, no triangle will be created. Detectable warnings are intended to provide a tactile equivalent of the visible curb line. A detectable warning placed too far from the street edge because of a large curb radius may compromise effective crossing analysis.

Gutters. To facilitate roadway drainage, gutters require a counter slope at the point where the curb ramp meets the street. This counter slope must meet certain requirements. The counter slope shall not exceed 5 percent as per ADAAG. Having at least a 2 percent counter slope for the gutter is critical to prevent water accumulation and the problems associated with freezing. The algebraic difference in slope between the gutter and the adjacent ramp shall not exceed 11 percent (Exhibit 5-42), as per ***FDM Section 11-25-30***. The change in angle shall be flush, without a lip, raised joint, or gap. Lips or gaps between the curb ramp slope and the counter slope can catch caster wheels or crutch tips and cause pedestrian injuries.

Flares. Curb ramp flares are the graded transitions from a ramp to the surrounding sidewalk. Flares are not part of an accessible route and are typically steeper than the ramp with significant cross slopes. For pedestrians with visual impairments, flares may be one of the cues used to identify a curb ramp and upcoming street edge. If the landing width is less than 5 feet, the slope of the flare may not exceed 8.33 percent. In all cases, the flare slope shall not exceed 10 percent.

Flares should only be installed where the ramp edge abuts pavement. In locations where the ramp edge abuts grass or other landscaping, and in locations where pedestrians cannot walk across the ramp sides of the curb ramp, a returned curb can be installed instead of flares. Straight returned curbs are a useful orientation cue for pedestrians with visual impairments (Exhibit 5-43). A return curb should not be used where there is no grass terrace.

5.3.3.2. Types of curb ramps

There are four major types of curb ramps: perpendicular, parallel, diagonal and built-up. These four curb ramp types differ in both their structural design and their placement relative

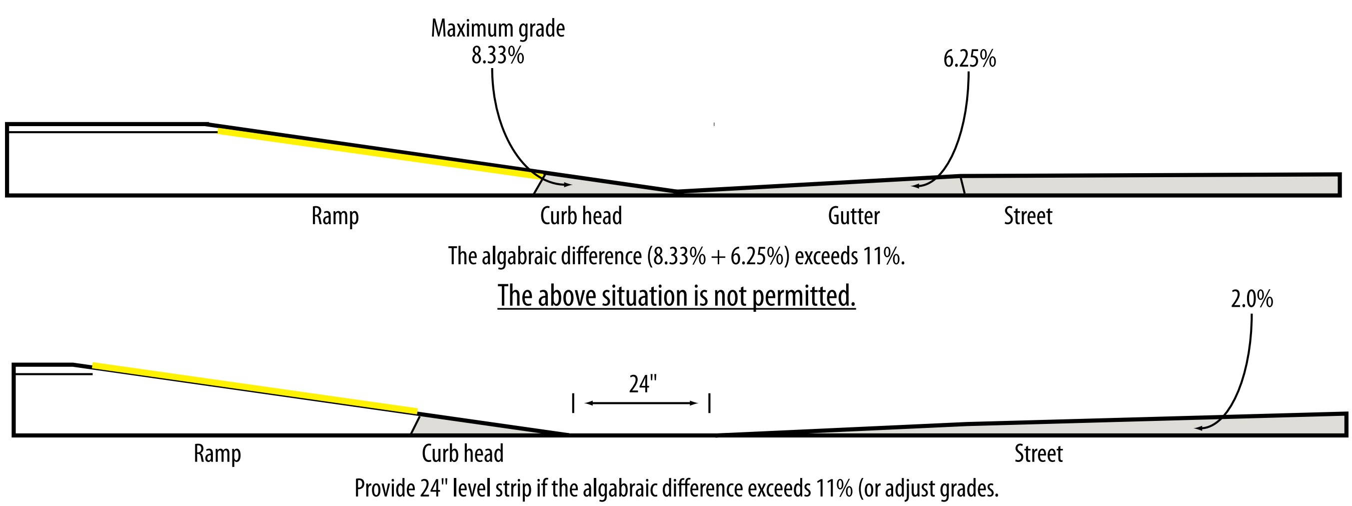


Exhibit 5-42: Gutter counter slope requirements.

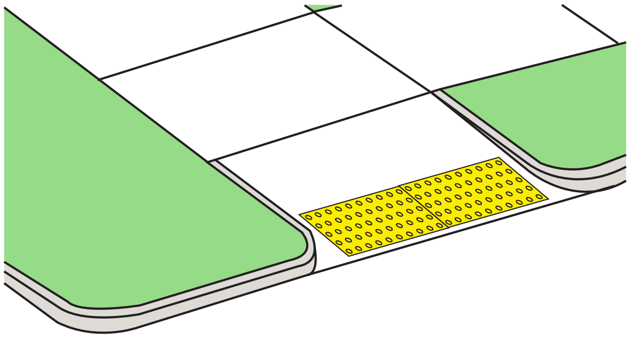


Exhibit 5-43: A return curb may be used where grassy terraces exist.

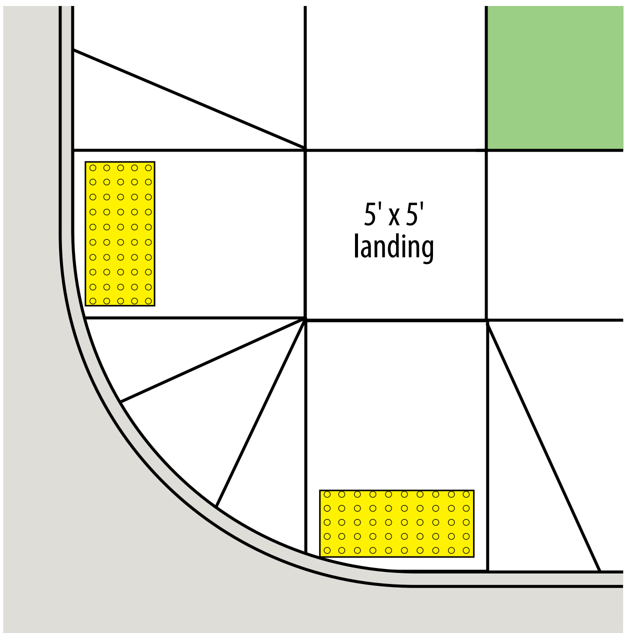


Exhibit 5-44: Two perpendicular curb ramps sharing a 5-foot square landing. The flares are the triangular looking graded transitions on either side of the ramps.

to the sidewalk and roadway. WisDOT also distinguishes between Type I and Type II ramps. A curb ramp is classified as a Type I ramp if it is diagonal to the crossing and is the sole ramp at an intersection corner. A Type II ramp is one of two ramps at an intersection corner.

Determining the appropriate type of curb ramp for a specific crossing affects both pedestrian accessibility and safety. When choosing the type of curb ramp for a particular crossing, designers should consider adjacent sidewalk and terrace width, the curb height, the corner radius, and the topography of the street corner. The following section describes the four major types of curb ramps and placement considerations for each type.

5.3.3.2.1. Perpendicular ramp (usually Type II ramp)

In general, WisDOT recommends the use of perpendicular curb ramps at pedestrian crossings. Other types of curb ramps should be considered in locations where perpendicular curb ramps are not feasible.

Perpendicular ramps are generally perpendicular to the tangent section of the street and allow pedestrians to enter the roadway perpendicular to vehicular travel. If a perpendicular ramp is not at a 90-degree angle to the street (not necessarily the curb), it will create difficulties for pedestrians transitioning from the street. Perpendicular ramps should also be parallel with the crosswalk and fully contained within the crosswalk extended. If marked crosswalks are used in conjunction with perpendicular ramps, the crosswalks should be marked to provide a continuous connection to the ramp.

At intersection corners, two separate perpendicular ramps should be provided, one for each direction of pedestrian travel. A five-foot square landing must be provided at the top of each ramp to allow space for pedestrians to turn, maneuver or bypass the ramp (Exhibit 5-44). A perpendicular ramp without an adequate landing forces pedestrians to travel over the ramp flares, which typically have steep cross slopes that are inaccessible to pedestrians with mobility impairments.

Site-specific characteristics occasionally create problems for installing perpendicular ramps. For example, a sidewalk corridor may be too narrow to incorporate two perpendicular ramps at an intersection. Moreover, the curb radius of an intersection corner may be too large to both align a perpendicular ramp at a 90-degree angle relative to the curb and keep the perpendicular ramp parallel with the crosswalk. In these situations, designers should not automatically opt for a different type of curb ramp, but should consider a compromise of design solutions for incorporating perpendicular ramps.

If the sidewalk corridor is too narrow to accommodate the length of a curb ramp with the required maximum slope, or if there is not enough space to accommodate an adequate landing, designers should consider the following possible solutions:

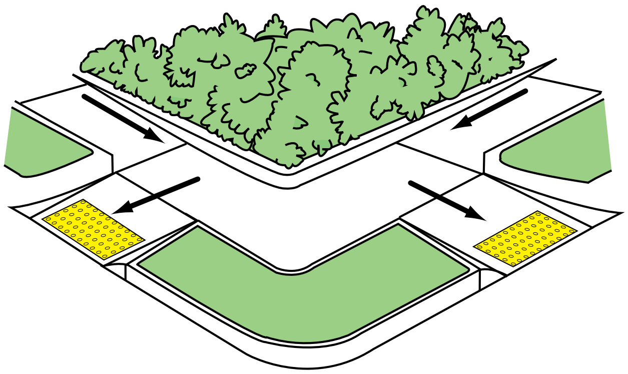


Exhibit 5-45: Gradually lowering the curb and sidewalk height on the approaches to the corner lowers the elevation of the landing and allows for shorter ramps.

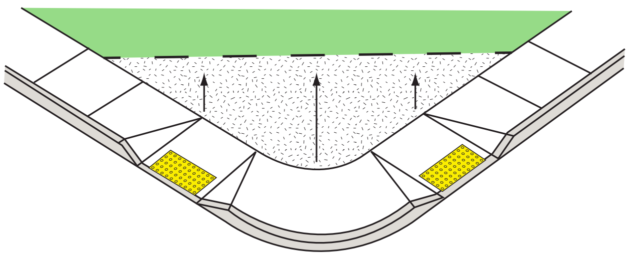


Exhibit 5-46: Acquisition of easements can provide the space needed to accommodate ramp landings.

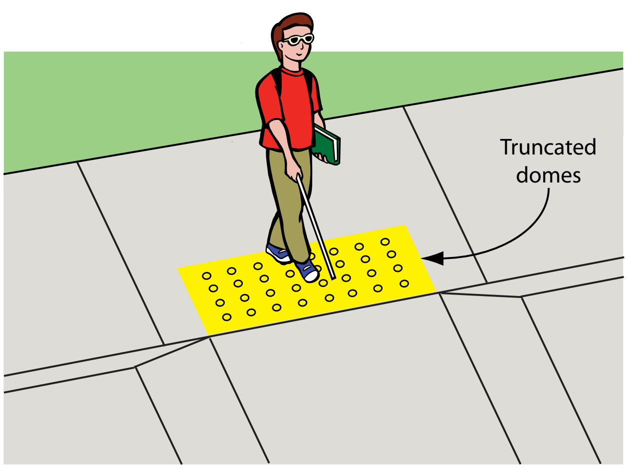


Exhibit 5-47: A raised crosswalk, with appropriately placed truncated domes, can eliminate the need for a ramp.

- Gradually lower the curb and sidewalk height on the approaches to the corner. This lowers the elevation of the ramp landing and allows for shorter ramps (Exhibit 5-45). However, this design forces pedestrians who are continuing on the sidewalk to negotiate multiple grades.
- Purchase or obtain an easement from the adjacent property to provide additional right of way adjacent to the sidewalk corridor. This additional right of way can be used to accommodate the ramp landing (Exhibit 5-46).

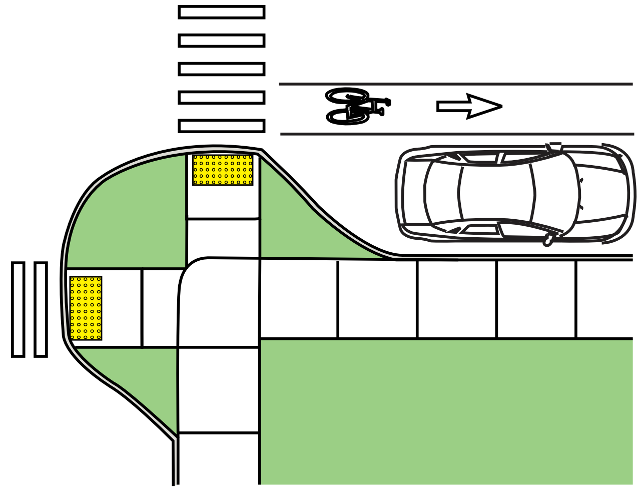


Exhibit 5-48: Curb extensions can create the space required for ramp slopes and level landings.

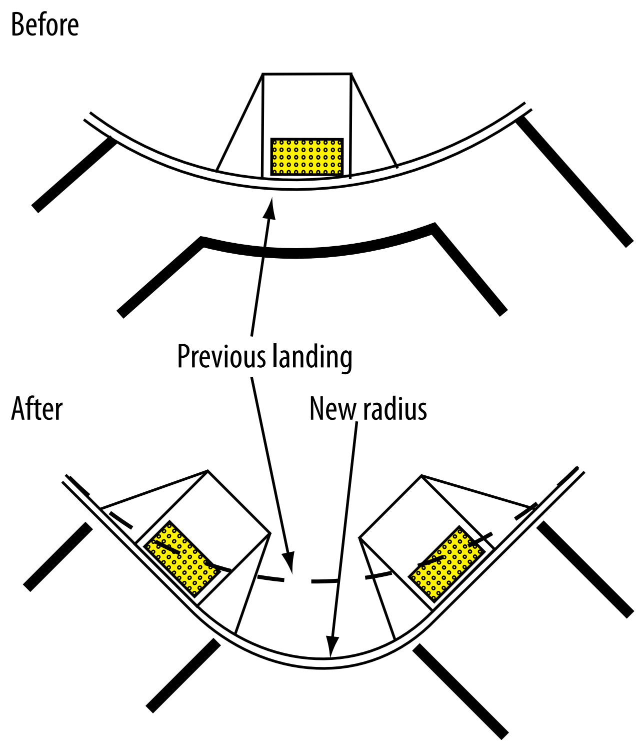


Exhibit 5-49: The curb radius can be reduced to allow space for two perpendicular curb ramps.

- Install a raised crosswalk. This option may be feasible on lower volume roadways. Raised crosswalks require shorter ramps and, in some cases, may eliminate the need for ramps if the raised crosswalk is level with the walking area (Exhibit 5-47). However, raised crosswalks can create problems for pedestrians with visual impairments, can be expensive, and can cause drainage problems and discomfort for some motorists and bicyclists if not properly designed. Raised crosswalks must include truncated domes on both ends.

Exhibit 5-50: The curb ramp is perpendicular to the roadway with a minimized triangle between detectable warnings and crosswalk.

- Add a curb extension to create the additional sidewalk space needed to install a standard ramp. Curb extensions are commonly installed on roadways where curb parking exists. In addition to providing additional space for curb ramps, curb extensions shorten the crossing distance for pedestrians, improve sight distance for both pedestrians and motorists, and prevent motorists from parking in the crosswalk area (Exhibit 5-48).
- Reduce the curb radius to provide enough space to construct perpendicular ramps (Exhibit 5-49). This option may only be available on local streets where a large vehicle turning radius is not required.

If the curb radius of an intersection corner is too large to align a perpendicular ramp at a 90-degree angle relative to the curb and keep the perpendicular ramp parallel with the crosswalk, designers should consider a possible alignment solution to incorporate perpendicular ramps. This includes aligning the ramp parallel to the crosswalk, creating a triangular area at the base of the ramp (Exhibit 5-50). To avoid a difficult access point to the ramp, this triangular section should not exceed 2 percent in any direction; otherwise, the caster wheels of a wheelchair will lose contact

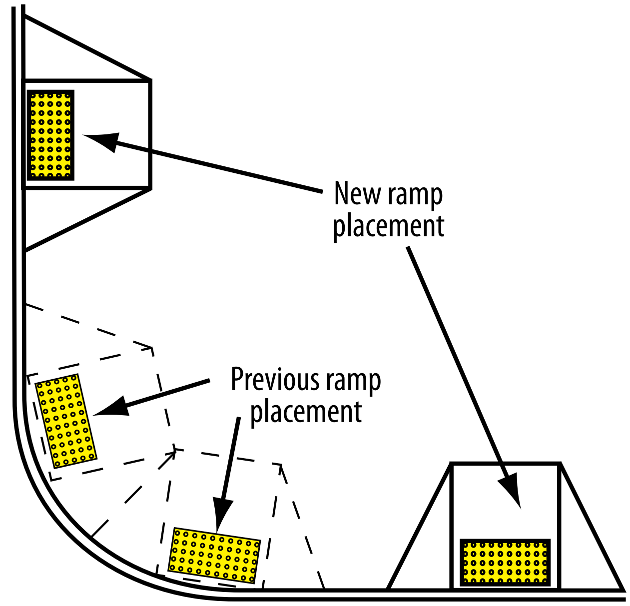


Exhibit 5-51: Moving curb ramps farther from the intersection can allow them to be placed perpendicular to the curb.

with the surface. The ramp should end prior to the triangular area. If the short side of the triangular area exceeds five feet, consider the following:

- Move ramps and crosswalks farther away from the apex of the curve to avoid the curb radius of the corner (Exhibit 5-51).
- Offset the ramps up to 10 feet from a line that would have been established had the ramps been placed as a direct extension of the sidewalks (Exhibit 5-52). This allows the ramps to be placed closer to the tangent sections of the corner. Offsetting the ramps by more than 10 feet however may cause orientation problems for pedestrians with visual impairments or make it difficult for pedestrians to be seen by turning motorists. Consider using a single diagonal

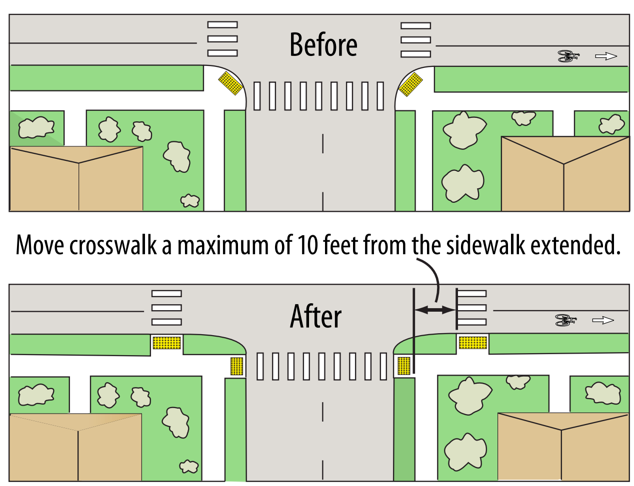


Exhibit 5-52: Moving the crosswalks away from the intersection can allow for better alignment of curb ramps.

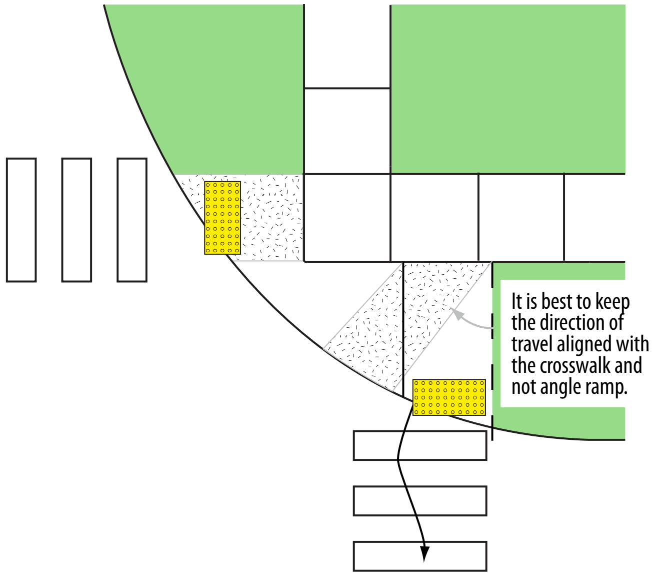


Exhibit 5-53: Combining solutions can give better results when designing perpendicular ramps on a project.

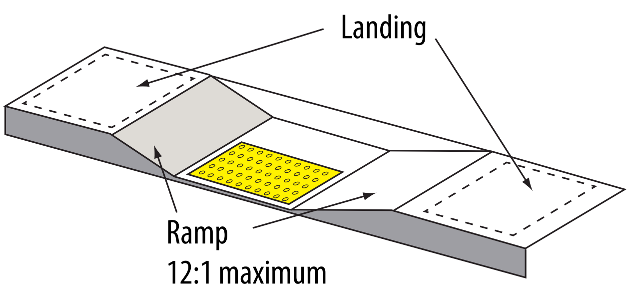


Exhibit 5-54: A parallel ramp has two level landings, one on each side of the ramp.

ramp as a last resort to avoid having to move the ramps further than 10 feet. Crosswalks should be marked in line with the ramps.

- Tighten the radius of the corner, where possible, to provide better placement of the curb ramps.
- Stagger the detectable warning fields.

The design solutions listed above can often be used in combination with each other to achieve positive results. For example, at an intersection with a large curb radius, a designer may reduce the radius of the corner and move the curb ramp farther away from the intersection (Exhibit 5-53).

Occasionally, designers will find that, even in light of the above design solutions, site-specific characteristics make it impossible to install two perpendicular curb ramps at each corner of an intersection. For example, in retrofit projects at existing intersections, the location of drainage inlets may make separate perpendicular ramps for each crosswalk impractical. In these cases, designers should consider installing a different type of curb ramp at the pedestrian crossing.

5.3.3.2.2. Parallel ramp

The next preferred ramp type is a parallel ramp. This ramp consists of two ramps, both parallel to the direction of travel and both containing a level landing at its top that leads down to one street-level landing (Exhibit 5-54). Parallel ramps are typically installed where the available space between the curb and property line is too tight to permit a typical perpendicular ramp. Parallel ramps work especially well at mid-block crossings. They can also be installed either in pairs or singularly at intersection corners.

Parallel ramps are constructed by bringing the entire sidewalk down to a street-level landing immediately adjacent to the intersection crosswalk. The landing must be a minimum five feet by five feet square to ensure that foot rests on wheelchairs do not get caught on either ramp. The landing should have a 2 percent drainage slope toward the gutter. Additionally, truncated domes must be installed at the curb line. The detectable warning should be parallel to the roadway.

5.3.3.2.3. Diagonal ramp (usually Type I ramp)

Diagonal ramps, which usually serve two adjacent crosswalks, are single perpendicular curb ramps located at a corner's apex. They are not a recommended curb ramp design because they require pedestrians to move away from the direction of travel, toward the intersection, prior to entering a crosswalk. The movement redirects the pedestrian's orientation across the path of through-motorists or turning motorists. Diagonal ramps may also create problems for pedestrians with visual impairments by aiming them away from the crosswalk. Diagonal ramps are especially problematic at intersections with small turning radii or intersections without nearby on-street parking. Because of the disadvantages of diagonal ramps, two perpendicular or parallel ramps should be included in new construction where space is available rather than a single diagonal ramp. Existing diagonal ramps should be replaced with two perpendicular ramps when streets are reconstructed or alternatively curb extensions should be added. The transition plan should include changing from diagonal to perpendicular ramps, where possible.

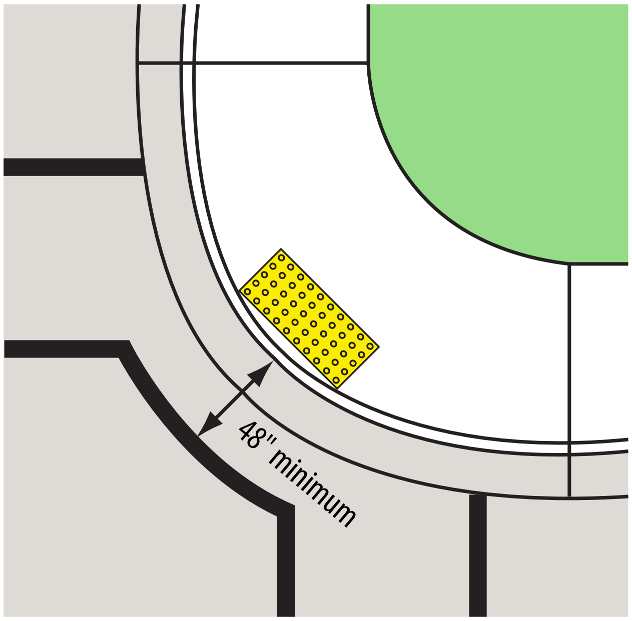


Exhibit 5-55: A standard diagonal curb ramp must have a minimum of 48 inches of clear area at the base. This allows pedestrians enough space to maneuver between the crosswalk and the curb ramp.

If there is no alternative to installing a diagonal ramp, designers must take several steps to increase the diagonal ramp's safety and accessibility. Additional clear level space shall be provided at the base of the diagonal ramp to connect it to the crosswalk. As shown in Exhibit 5-55, the additional clear space shall:

- Extend 48 inches from the bottom edge of the ramp, preferably from the curb joint
- Be parallel to the curb
- Be outside all vehicular travel lanes
- Have a grade no greater than 2 percent in all directions

This additional clear level space must be provided even if the adjacent crosswalk is unmarked. If the adjacent crosswalk is marked, the additional clear level space must be contained within the marked crosswalk. Diagonal ramps shall also have a level landing at the top. Landings should be five feet by five feet and shall, at a minimum, be four feet by four feet.

5.3.3.2.4. Built-up ramps

Built-up ramps, which are most commonly used in parking lots, extend beyond the curb and into the gutter and roadway. Some built-up ramps may begin sloping in the sidewalk corridor and only extend to the edge of the gutter. When used on sidewalks, built-up ramps can create problems for both pedestrians and motorists. For example, built-up ramps increase pedestrian exposure to traffic and create drainage problems. Furthermore, a parking lane must protect built-up ramps. Because of the problems associated with built-up curb ramps, they should only be used if other types of curb ramps are not feasible.

5.3.4. PEDESTRIAN CROSSINGS

Pedestrian crossings occur at mid-block locations and at roadway intersections. Pedestrians have the legal right of way at crosswalks. Pedestrians may also legally cross roadways at other locations as long as they yield the right of way to motorists. Well-designed pedestrian crossings create an interconnected and continuous network of sidewalks and trails, and allow pedestrians to safely and comfortably cross roadways. Crosswalks must be frequent enough to allow pedestrians to cross roadways at regular intervals and should always be present near residential neighborhoods, schools, parks, shopping areas, employment centers and other typical pedestrian generators. This section provides guidelines and recommendations for creating safe and effective pedestrian crossings.

5.3.4.1. Crosswalks

Crosswalks are defined as pedestrian crossings where motorists must legally yield the right of way to crossing pedestrians. As stated in Wisconsin State Statute 340.01(10), crosswalks exist at all intersections where sidewalks are present, even if the crosswalks are unmarked. Intersection crosswalks are legally considered prolongations of their contiguous sidewalks. Crosswalks can also exist at mid-block locations. However, unlike crosswalks at intersections, mid-block crosswalks must be marked. Crosswalks, wherever possible, should be lined up to form a natural extension of the sidewalk corridor.

Crosswalks should meet the same ADA requirements as sidewalk corridors. For example, crosswalks should have a maximum cross slope (equivalent to the roadway grade) of 2 percent and a maximum grade (equivalent to the roadway cross slope) of 8.3 percent.

5.3.4.1.1. Intersection crosswalks

Turning motorists pose a large threat to pedestrians at intersection crosswalks. In Wisconsin between 2005 and 2007, 48 percent of reported vehicular crashes involving pedestrians occurred at an intersection. At signalized and unsignalized

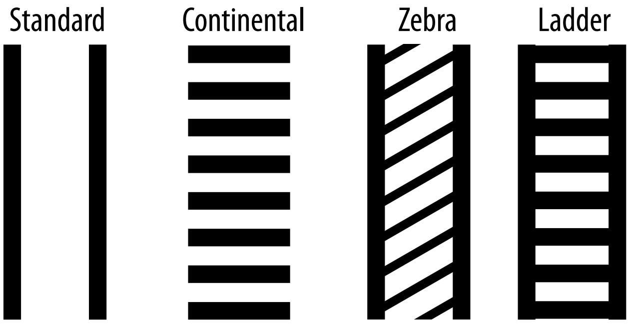


Exhibit 5-56: Common styles of crosswalk markings used in Wisconsin.

intersections, steps should be taken to ensure that motorists turn slowly and that motorists and pedestrians have advantageous sight distances.

Intersection crosswalks can be marked or unmarked. Marked crosswalks are beneficial because they inform motorists and pedestrians that they are in, or are approaching, the pedestrian right of way. Marked crosswalks also can be used to advise pedestrians of the best place to cross the street. Marked crosswalks are best used in combination with other treatments such as traffic signals, reduced speeds, signs, and pavement striping, color, or height changes. Under certain conditions, marked crosswalks may be used to supplement an existing or new traffic control feature.

The MUTCD permits four primary styles of crosswalk markings (Exhibit 5-56):

- Continental style: consists of a series of unconnected white longitudinal bars placed perpendicular to the pedestrian direction of travel and positioned to avoid the wheel paths of vehicles. The bars should be 1 to 2 feet wide and be placed 1 to 5 feet apart. The continental style is the most visible crosswalk marking style for motorists and is often the preferred option for higher pedestrian volumes.
- Standard style: consists of two solid white transverse lines not less than 6 inches wide, but often as wide as one-foot. The 2009 MUTCD allows up to 2 feet wide.
- Zebra style: similar to the standard style in that it consists of two solid white transverse lines. However, unlike the standard style, the two solid white transverse lines are connected at regular intervals by solid white diagonal bars. The bars should be 1 to 2 feet wide and be spaced 1 to 2 feet apart.
- Ladder style: combines the continental style and the standard style.

Exhibit 5-57: Contrasting colors can be used to demarcate the crosswalk, but white crosswalk lines should still be used in addition.

Refer to the MUTCD or the Wisconsin Manual of Traffic Control Devices (WMUTCD) for more information on styles of crosswalk markings.

For all styles of crosswalk markings, the marked crosswalk should typically be 6 feet to 8 feet wide. The minimum acceptable width for a crosswalk is 6 feet. The marked crosswalk should be wider (10 feet or greater) in special situations such as connecting a shared-use path, accommodating pedestrians within a pedestrian mall, or where pedestrian volumes are high. The marked crosswalk should completely contain curb ramps and other sloped areas within it, excluding any flared sides. The crosswalk lines should extend the full length of the crosswalk at unsignalized or uncontrolled crosswalks, in school zones, or areas where there is a substantial pedestrian presence, special emphasis styles of crosswalk markings should be considered such as the continental or zebra styles to increase visibility. The continental style is often recommended because it is most visible to motorists. However, it is also regarded as more expensive to maintain. High-contrast markings may also aid pedestrians with visual impairments. The MUTCD has not yet developed guidance for use of these types of markings however.

Exhibit 5-58: On busy roadways where pedestrians may have to complete a two-stage crossing, raised medians should be provided as a safe place to wait and check for traffic.

Several types of pavement marking materials can be used to mark crosswalks. Water-based paint is often used due to its low initial cost. Epoxy, pre-formed plastic, and thermoplastics offer increased durability over water-based paint but may produce slipping hazards under certain conditions and as wear sets in. When choosing a pavement marking material, designers should be aware of the advantages and disadvantages of each type of material. Occasionally, colored crosswalk design treatments are used to improve aesthetics and promote traffic calming (Exhibit 5-57). Materials used in these treatments must be non-slip and visible. Paver systems should be avoided, since they may shift, settle or induce a high degree of vibration in caster and drive wheels or wheelchairs. Textured treatments may be used to define a crosswalk but should not be used on the walking path.

Marked crosswalks may be inappropriate at some pedestrian crossings unless used in conjunction with other treatments. For example, marked crosswalks generally should not be installed by themselves within an uncontrolled environment where the posted speed limits are greater than 40 mph. The Federal Highway Administration's ***Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations*** study found that on multilane roads with traffic volumes above about 12,000 vehicles per day, having a marked crosswalk alone (without other substantial improvements) was associated with a higher pedestrian crash rate (after controlling for other site factors) compared to an unmarked crosswalk. Raised medians provided significantly lower pedestrian crash rates on multilane roads, compared to roads with no raised median, contributing significantly to the safety of intersections with marked crosswalks. Older pedestrians had crash rates that were high relative to their crossing exposure. Exhibit 5-58 shows a marked crosswalk in conjunction with a raised median on a busy roadway. The raised median provides a safe place for the pedestrian to check for traffic before finishing the crossing.

For additional information on marked crosswalks, as well as standards and guidance for various crosswalk improvements (including signs, signals, and other devices), refer to the MUTCD guidelines for marked crosswalks. For crosswalk markings on state highways, see WisDOT ***Traffic Guidelines Manual 3-2-17.*** This policy establishes guidance for markings and restricts the marking of crosswalks on state highway streets to roadways with posted speeds of less than 45 mph.

Solid white stop bars that are 1 to 2 feet wide (18 inches for state highways) should be installed across approach lanes at stop or signal-controlled legs of an intersection. This ensures that motorists and pedestrians can see each other from all approaches to an intersection. Stop bars are appropriate in rural and urban areas to indicate the point behind which motorists are required to stop for crosswalks or other traffic control devices.

Stop bars should be placed no less than 4 feet in advance of and parallel to the nearest crosswalk line. Setting the stop bar to the left lane farther back than the stop bar of the right lane or setting stop bars farther back altogether can help ensure that motorists in adjacent lanes do not block other motorists' views of crossing pedestrians. Installing a sign, such as "Stop Here for Crosswalk", can supplement the setback stop bar and improve sight distances between pedestrians and motorists. In locations with large numbers of pedestrians or high volumes of truck or bus traffic, designers should consider either locating the stop bar 10 feet or more in advance of the crosswalk or increasing the width of the crosswalk.

5.3.4.1.2. Crosswalk closures

Legal but often unmarked crosswalks exist as extensions of sidewalks at intersections. The crossing should be evaluated for closure if site conditions, safety concerns or other conditions identified under *Section 349.185(2)*, Wis. Stats., exist. If a crosswalk closure is determined to be appropriate, the crossing must be signed properly and a barrier such as a railing must be installed to alert pedestrians with visual impairments and other users that crossing is not permitted.

Other options for closing a crosswalk where there is a through street terrace width of 3 feet or more include:

- A 4-inch to 6-inch curb, with tapered ends, across the end of the side road sidewalk extended, or a raised planter with perimeter curbing, with standard signs installed on a post in back of the concrete pedestrian curb.
- Less preferable are low growth plantings (18-inch maximum height at maturity) or a terrace mound. The terrace mound is approximately 6 inches high and across the end of the side road sidewalk extended. The mounding option is acceptable on state and federally funded projects if WisDOT determines other options are not feasible.

If there is less than a 3-foot terrace, or if the sidewalk is adjacent to the back of the curb, the crossing should be closed by first moving the sidewalk back from the through street back of the curb as it approaches the intersection and then using one of the options described above. This option may require the purchase of right of way, depending on available space. If right of way is not available and the sidewalk and furniture area is narrow, it may be acceptable (with approval from WisDOT if funding with state dollars) to install a raised curb along with a "pedestrian crossing closed" sign.

For more information, see ***FDM Section 11.25.30.1.1.***

Mid-block crosswalks are most effective:

» Where already a substantial number of people make mid-block crossings

» Where new development is expected to generate mid-block crossings

» When pedestrians are highly unlikely to cross the street at the nearest intersection

» Where adjacent intersections have a high volume of traffic and/or large turning volumes that make it difficult to cross

» Where the space between intersections exceeds 660 feet

» Where adequate sight distance exists and motorists expect pedestrians to cross

5.3.4.1.3. Mid-block crosswalks

Designated mid-block crosswalks help people get to their destinations more directly, conveniently and safely. Unlike intersection crosswalks, mid-block crosswalks must be marked (see *Section 5.3.4.1.1.* for accepted styles of crosswalk markings). Because motorists do not generally expect mid-block crosswalks, mid-block crosswalks must be carefully considered and designed with clearly visible signs and markings as shown in Exhibit 5-59. Various design features such as pedestrian signals, signing and curb extensions can help pedestrians identify where to safely cross mid-block. Medians and crossing islands are recommended at mid-block locations to further improve pedestrian safety (see *Section 5.3.4.2.1.* for more information on medians.) Some mid-block crosswalks may be raised above the road grade, to increase the pedestrians' visibility to motorists and to decrease vehicular speed. Raised crosswalks can be used on local streets that have low speeds and do not serve as an emergency route. Raised crosswalks require detectable truncated dome warnings at the curb lines.

Several factors influence the appropriate placement of mid-block crosswalks, including:

- Pedestrian volume
- Motorist volume
- Roadway width
- Motorist speed
- Vehicle type
- Desired paths for pedestrians
- Adjacent land uses

Exhibit 5-60: In-street pedestrian signs are used to alert motorists of pedestrian crossings.

Mid-block crosswalks are more appropriate on streets with long blocks or streets with alleys that cross the roadway. Mid-block crosswalks should be considered where large pedestrian volumes are expected to cross the roadway or where substantial pedestrian generators are located between intersections. For example, pedestrians may need a mid-block crosswalk to access stores located across the street from a university or where a multi-use trail facility crosses a roadway. Mid-block crossings may also be appropriate when a parking lot is located on a long block across from a factory or business or where a busy transit route has a mid-block stop.

Motorists and pedestrians must be able to clearly see mid-block crosswalks and easily understand their design. Mid-block crosswalks should have appropriate signs and additional lighting to inform motorists that pedestrian will be crossing the roadway. An in-street pedestrian sign may be used in the roadway at a mid-block crosswalk (Exhibit 5-60). Refer to the MUTCD Section 2B.10-12 for sign placement criteria. The ***WisDOT Traffic Guidelines Manual*** also has criteria that must be followed if the sign for the crossing is on a state highway.

Mid-block crosswalks may need additional motorist control measures, especially at higher-speed locations. These measures could include yield to pedestrian signs, medians (crossing islands), flashing beacons, street lighting, traffic calming features, or in rare situations, traffic signals to provide additional notice to slow or stop motorists prior to the crosswalk. In some locations yield lines (triangles that extend across all approach lanes) can be installed at least 5 feet—but preferably 20 feet to 50 feet—in advance of and parallel to the nearest crosswalk marking to prevent motorists from encroaching into the pedestrian crosswalk space. Yield lines also improve the pedestrian's ability to see around taller vehicles. Overhead pedestrian crosswalk signs on span wires or mast arms can improve motorist awareness of a mid-block crosswalk. At locations with extremely high pedestrian volume during certain times of the day, designers may consider installing a signalized crosswalk with pedestrian actuation after reviewing the MUTCD warrants for this

Exhibit 5-59: Mid-block crosswalks should have highly visible pavement markings and appropriate signage to alert motorists.

Exhibit 5-61: Curb extensions and parking restrictions should be incorporated into the design of a mid-block crosswalk in conjunction with on-street parking.

application. In areas with on-street parking, mid-block crosswalks should include crosswalk markings, advance signing, a curb extension or more extensive parking restrictions (Exhibit 5-61).

Mid-block crosswalks often create challenges for pedestrians with visual impairments. They may have difficulty locating mid-block crosswalks and determining an appropriate time to safely cross. A signalized crosswalk with a locator tone may be used to help pedestrians with visual impairments to navigate the crosswalk.

Mid-block crosswalks are likely to be inappropriate where either motorists or pedestrians have limited sight distances that cannot be improved, where motorist volumes and speeds are high, or in uncontrolled environments with speeds greater than 40 mph. In such circumstances, mid-block crossings increase the potential for motorist-pedestrian crashes.

Regardless of these circumstances, it may be unrealistic to expect pedestrians to make a long trip to the corner crosswalk if the corner is far away and their destination is across the street. For example, will teenagers walk to an eatery directly across the street from their school by going to the nearest intersection at the end of the 800-foot block or will they choose to cut through shrubs mid-block?

5.3.4.2. The length of pedestrian crossings

The length of a pedestrian crossing is a factor in its accessibility. Short pedestrian crossings are safer and more accessible because they decrease pedestrian roadway exposure time and the potential of motorist-pedestrian conflicts. Long pedestrian crossings decrease pedestrians' perceived safety and convenience, and add unduly to pedestrian and motorist delay. At signalized intersections, reducing the length of a pedestrian crossing can usually improve the intersection's efficiency. Pedestrian crossing lengths are often the controlling factor for dictating the minimum green time required for the associated vehicular phase. For this reason, reducing the length of a pedestrian crossing at an intersection approach can, under certain conditions, actually increase that street's capacity since it increases the intersection's capacity.

Methods to decrease the length of pedestrian crossings include:

- Constructing medians (crossings islands) (*Section 5.3.4.2.1.*), corner (pork chop) islands (*Section 5.3.4.2.2.*), or curb extensions (*Section 5.3.4.2.3.*) where appropriate
- Reducing the lane width of a roadway (*Section 5.2.1.3.*)
- Reducing the turning radii of a roadway (*Section 5.2.1.4.*)

5.3.4.2.1. Medians

Medians, which are sometimes referred to as crossing or safety islands or refuges, are raised or painted continuous longitudinal spaces that separate the two main directions of motorist movement in the street. Medians at intersections can greatly facilitate pedestrian crossings at signalized and non-signalized intersections. At intersections, medians are beneficial since they provide a waiting area for pedestrians who are unable to completely cross the street during a single crossing phase, such as persons age 65 and older, families with young children, and people with disabilities.

Depending on the signal timing, medians should be considered at signalized intersections where the crossing distance exceeds 48 feet. After the addition of a median, signal timing should still accommodate pedestrians to cross the street in a single stage. Adding a median does not justify signal timing for a two-stage crossing. Medians should be considered at signalized intersections with short crossing distances where there is a special need or condition, such as nearby senior housing or a medical clinic.

At unsignalized intersections, medians are especially beneficial as they allow pedestrians who are crossing a roadway to negotiate one direction of motorist traffic at a time. Medians provide a space for pedestrians who have crossed the first part of the street as they assess whether it is safe to cross the second part.

Median width, as measured parallel to the pedestrian direction of travel, can vary considerably. Medians should always be wide enough to fully accommodate an appropriately designed street-level cut-through or ramped median crossing. In all cases, a newly constructed median should not be less than 6 feet wide from face of curb to face of curb. A minimum 6-foot wide median is required to separate the pedestrian waiting area from the face of the curb and to provide ample space for multiple pedestrians, wheelchair users or bicyclists. The median width should be increased based on anticipated pedestrian usage and crosswalk level of service criteria. Existing 4-foot medians should be widened to 6 feet or more in reconstruction projects.

Medians 8 feet or wider can better accommodate bicyclists, users of wheelchairs, users of other mobility devices, strollers, and groups of pedestrians. Where allowed, designers may narrow travel lanes to 11 feet—or even 10 feet in constrained conditions—to provide more space for the median and to lower motorist speeds. Where it is not practical to widen the median, the crossing or cut-through width (as measured perpendicular to the pedestrian direction of travel) can be increased to provide more space for pedestrians and bicyclists within the median.

Two types of medians treatments exist. The median may have a cut-through where the crosswalk passes through the median or a painted crosswalk adjacent to the median nose. Exhibit 5-62 defines these two styles of medians and their elements. At signalized intersections, the signal timing should accommodate a one-stage crossing. If a crossing is designed as a two-stage crossing for operational reasons, the crosswalk shall directly intersect (cut-through) the median to create a safe place for pedestrians to wait between stages of crossing.

At both signalized and unsignalized intersections, cut-through medians are preferred to painted medians (where the crosswalk abuts the median nose) since they improve pedestrian visibility and allow for a greater physical separation of motorists and pedestrians. In order to be accessible to pedestrians with mobility impairments, all raised medians shall contain either a street-level cut-through (Exhibit 5-63) or ramps on each side

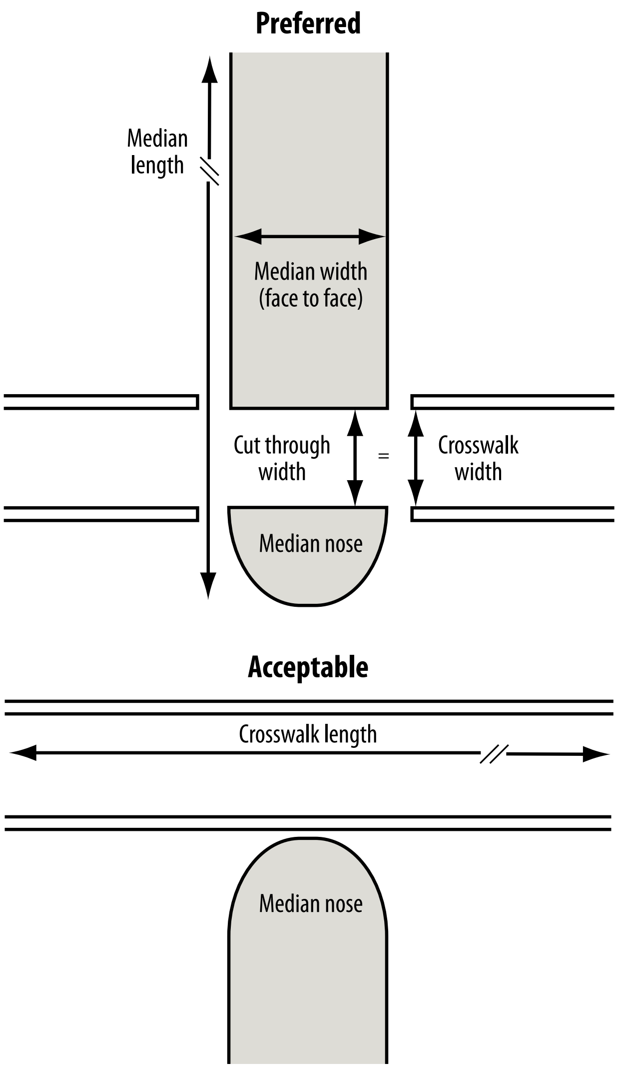


Exhibit 5-62: Median elements defined on the two styles of medians used for a pedestrian crossing: a cut through (top) and a painted median abutting the crosswalk (bottom). Painted medians should only be used for a single stage crossing.

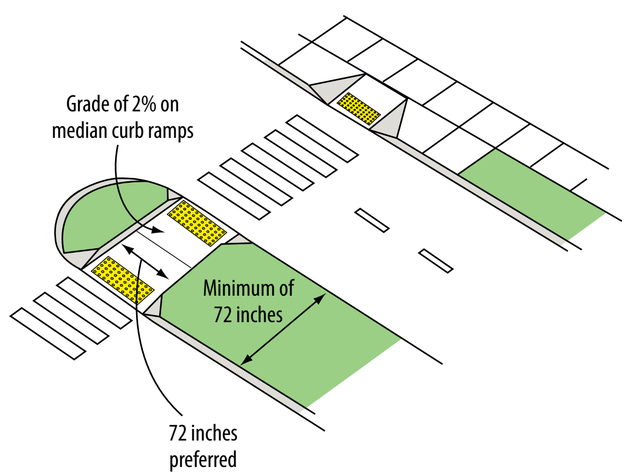


Exhibit 5-63: Specifications for a typical cut through on a roadway median. (Preferred)

leading to an elevated level landing (Exhibit 5-64) where the crosswalk intersects the median.

When a median contains a street-level cut-through, the street-level cut-through should be at least 6 feet wide or wider where the crosswalk is wider. A minimum grade of 2 percent is strongly recommended to facilitate drainage. If the median contains ramps on each side leading to a level landing, the ramps shall not exceed a grade of 8.33 percent. The level landing shall be at least 5 feet wide by 5 feet long, but in most cases it will be the same width as the cut-through in the median. If an adequately sized landing cannot be provided due to space limitations, the landing may be lowered to approximately half the height of the median curb to allow for shorter ramps. To assist pedestrians with visual impairments in identifying the edge of the roadway, both street-level cut-throughs and ramped median crossings shall contain truncated domes at each end and be separated from one another by at least 2 feet. A street-level cut-through and a ramped median crossing require regular maintenance, such as sweeping and snow removal.

In some cases, angling crosswalks 10 to 15 degrees toward the direction of traffic through a median is recommended to help pedestrians see and increase their awareness of motorists on the roadway they are about to cross. By using a slight angle, people who are blind or visually impaired will not be disadvantaged by the angling effect.

Medians provide opportunities to incorporate landscaping within the roadway. Well-landscaped medians with small trees, low shrubs or colorful native plants can decrease vehicular speed and improve the streetscape. However, landscaping must not decrease visibility and should allow motorists from all approaches to easily detect pedestrians. Vegetation should not be planted adjacent to the intersection nose or mid-block crossing if it will affect the visibility of pedestrians or motorists. It is essential to regularly maintain and prune all types of landscaping.

The median nose should be designed to slope up to a vertical height of 6 inches and then desirably extend horizontally before reaching the intersecting crosswalk as seen in Exhibit 5-65 (a). If distance is limited, the median nose may be designed to simply slope up to a vertical height of 6 inches before reaching the intersecting crosswalk Exhibit 5-65 (b). If space is severely limited, the median nose may be designed to slope up to a vertical height of 3 inches before reaching the intersecting crosswalk Exhibit 5-65 (c). The end of the median nose can be painted to increase its visibility to motorists.

If the crosswalk is placed beyond the median's end, the end treatment of the median should

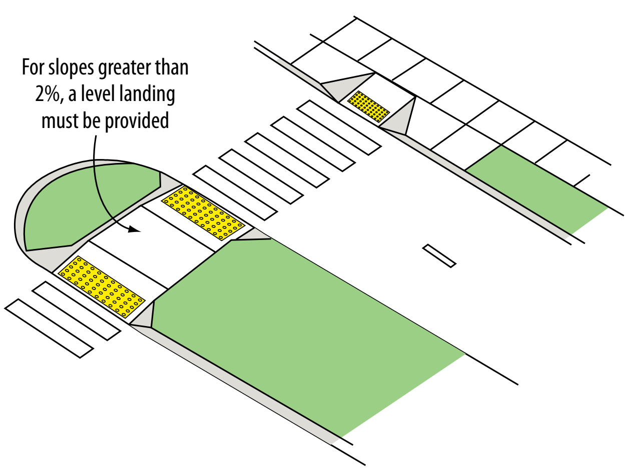


Exhibit 5-64: Specifications for a ramped median with a level landing.

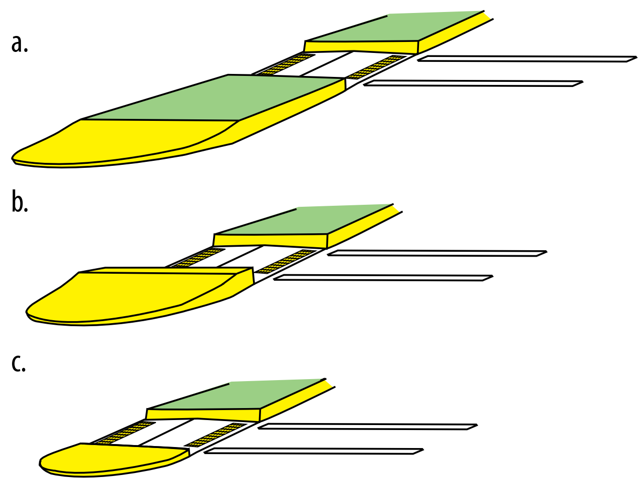


Exhibit 5-65: Median noses vary in length and width affecting the placement and design of the cut-through.

Exhibit 5-66: To avoid interference with the crosswalk, the median nose is depressed.

not encroach onto the crosswalk. For example, a median nose should not extend into a crosswalk. Occasionally, median noses are depressed, especially at signalized intersections, to avoid interference with a crosswalk (Exhibit 5-66). A crosswalk should be placed beyond the median's end only if the crosswalk is designed as a single-stage crossing.

When needed, it is possible to retrofit a median into an existing roadway. It may be feasible to extend a median along the entire stretch of roadway that requires pedestrian crossings at intervals. In other situations, space constraints may result in medians being provided only at intersections. There are several options for creating the space necessary to provide a safe pedestrian crossing at a median where space is constrained. As shown in Exhibit 5-67, the travel lanes can be narrowed to decrease traffic speeds and provide space for a median. Another option is to shift the lanes and narrow the terrace at the approach to the intersection.

5.3.4.2.2. Corner (pork-chop) islands

Corner islands are raised triangular spaces located at some intersections between a channelized right-turn slip lane and the through travel lanes. Corner islands can be used as a pedestrian waiting area to reduce pedestrian crossing distances across the through street (Exhibit 5-68). However, right-turn slip lanes and corner islands can also create unique problems for pedestrians. Right-turn slip lanes are often discouraged because of inherent pedestrian safety issues with turning vehicles. (See ***Section 5.2.1.5.2.*** for more information on the design

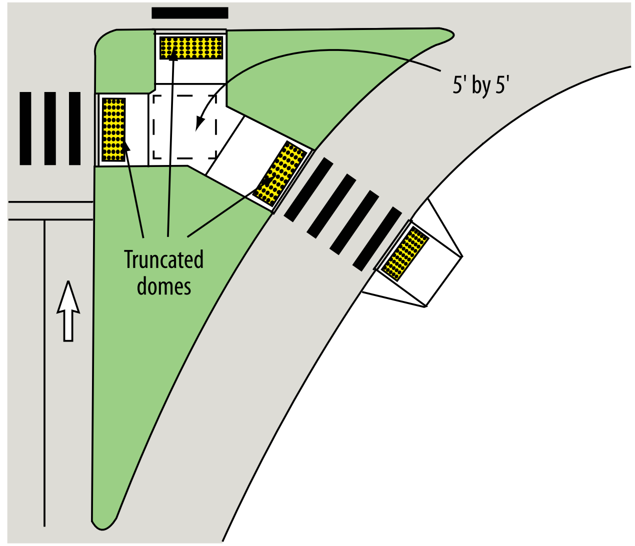


Exhibit 5-68: A pedestrian cut-through at a corner island reduces overall crossing distances but should be designed to minimize motorist pedestrian conflicts.

and safety of right-turn slip lanes.) To minimize motorist-pedestrian conflicts at right-turn slip lanes, pedestrian crosswalks should be at 90-degree angles across right-turn slip lanes. The crosswalk that traverses a right-turn slip lane should be located at an appropriate sight distance for both the pedestrian and driver. The location of the stop bar for the right-turn slip lane may affect the placement the crosswalk.

Like medians, corner islands that intersect with crosswalks must contain either street-level cut-throughs or ramps leading to a central level landing. If a corner island contains a street-

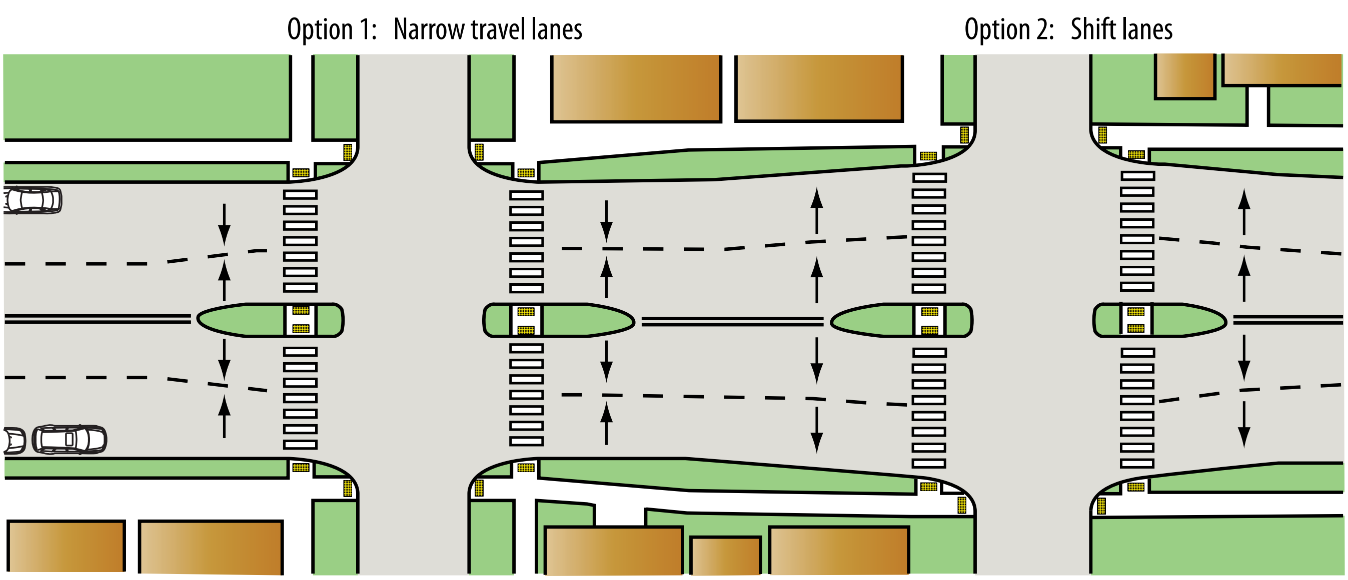


Exhibit 5-67: It may be desirable to retrofit medians onto streets where pedestrian crossings are difficult. Narrowing or shifting the travel lanes can create the space provided for the median and create a visual cue advising motorists to slow down.

level cut-through, the street-level cut-through should be at least 5 feet wide. If the corner island contains ramps leading to a level landing, the ramps should be 5 feet wide and shall not exceed a grade of 8.33 percent. The level landing should be 5 feet wide by 5 feet long. Both street-level cut-throughs and ramped median crossings must contain truncated domes wherever they abut the roadway so that pedestrians with visual impairments can identify the edge of the roadway. The placement and requirements for truncated domes on curb ramps applies to corner islands.

5.3.4.2.3. Curb extensions

Curb extensions can have a multitude of benefits if implemented properly. They can reduce the pedestrian crossing distance on roadways with curb parking, improve sight distances for pedestrians and motorists, prevent motorists from parking in crosswalk areas, signal pedestrian's intent to cross, and create adequate space for curb ramps and landings where the existing sidewalk space is too narrow (Exhibit 5-69). In general, curb extensions should extend the width of the parking lane, approximately 6 feet to 8 feet from the curb face to allow for parallel parking. A wider curb extension is necessary for angled parking. If the street leg is narrow, if parking is not permitted, or if the curb extension would interfere with a bicycle lane, curb extensions may not be needed or desirable on every leg of an intersection.

Curb extensions may also make snow plowing more difficult because the extensions are not always obvious after heavy snowfalls. Low-level landscaping in planting strips or boxes can be used on curb extensions to increase the aesthetics of the area and to increase the visibility of the curb extensions to approaching motorists and snowplow drivers (Exhibit 5-70). Traffic signs or bus stops can also be placed on curb extensions to increase visibility.

5.3.4.3. Pedestrian crossings at skewed intersections

Skewed intersections occur where two or more roadways intersect at angles other than 90 degrees. In addition to creating significant operational problems for motorists, skewed intersections present several challenges to pedestrians. Skewed intersections increase the time pedestrians are exposed to traffic and provide unclear orientation cues for pedestrians with visual impairments.

Skewed intersections can increase pedestrian-motorist conflicts by both reducing sight distances for some users and encouraging higher turning speeds of motorists. Design features such as curb extensions, crossing islands, or special traffic control devices may be appropriate to mitigate challenges created by skewed intersections. Pedestrians with visual impairments will benefit from audible pedestrian signals (APS) at skewed intersections.

Designers should avoid creating skewed intersections. Where practical, existing skewed intersections should be reconstructed to eliminate or minimize the skew. Modern roundabouts provide one solution to the problems caused by skewed intersections (See *Section 5.2.1.5.3.* for more information on roundabouts). If skewed intersections are unavoidable, then crosswalk placement at the skewed intersection becomes especially important to reduce some of the pedestrian

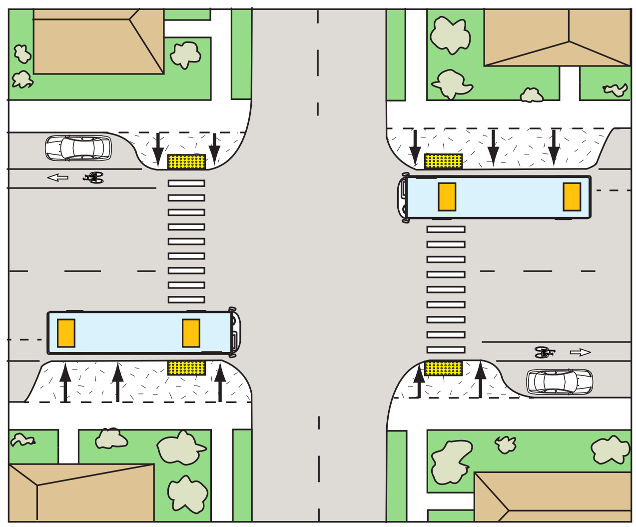


Exhibit 5-69: Adding curb extensions can reduce the pedestrian crossing distance and provide space for bus stops and curb ramps.

Exhibit 5-70: Since curb extensions stretch the width of the parking lane, signage or street furniture must be placed on the curb extension to alert drivers and plows.

challenges listed. At skewed intersections, crosswalks may be located perpendicular to the roadway or in line with the skew of the intersection. Crosswalks can also be placed somewhere in between a completely perpendicular placement and a completely skewed placement (Exhibit 5-71). There is no single placement solution appropriate for every circumstance.

Crosswalks placed perpendicular to the roadway at skewed intersections create the shortest crossing distance for pedestrians and provide pedestrians with good visibility of approaching motorists and bicyclists. However, perpendicular crosswalks may be counter intuitive for both pedestrians and motorists, and may be more difficult for pedestrians with visual impairments to locate. Perpendicular crosswalks are placed away from the intersection in a place where turning motorists and bicyclists may not expect crossing pedestrians.

Crosswalks that are placed in line with the skew at skewed intersections align with the approach sidewalk. This placement leads to the longest overall walking distance for crossing pedestrians. Skewed crosswalks expose pedestrians to motorists and bicyclists for a longer period of time.

In many cases, the best placement for a crosswalk is somewhere between a completely perpendicular crosswalk and a completely skewed crosswalk. At skewed intersections, pedestrians often cross at a location other than the marked crosswalk if the crosswalk is not placed where they feel safe and comfortable. The proper crosswalk placement can be achieved by envisioning the natural path a pedestrian will take and analyzing the various turning movements to create optimal visibility, meet motorist and pedestrian expectations, and provide reasonable crossing distances.

5.3.4.4. Pedestrian crossings at rail intersections

Light rail vehicles, surface commuter rail systems, streetcars, and freight rail lines frequently cross roadways and sidewalk corridors at grade. Pedestrian crossings at railroads must be designed in accordance with ADAAG requirements and in coordination with the local transit or railway authority.

The crossing must be level and flush with the top of the rails at both the outer edge of each rail and between the rails to avoid situations in which wheelchair casters rotate and drop into the flange way gap after hitting the top of a rail. Flange way gaps must not exceed 2.5 inches or 3 inches for tracks that carry freight. The pedestrian crossing should be as close as practical to perpendicular with the railroad tracks (Exhibit 5-72).

The pedestrian crossing must also have clear sight lines and good visibility so that pedestrians can see approaching trains. One effective and low-cost solution for railroad companies is to increase the visibility of rail vehicles with a very high contrast front end of the train by using a high-intensity light. Where railways cross sidewalks or trails, truncated domes must be installed on the sidewalk to alert pedestrians with visual impairments of the crossing. Truncated domes should be placed 15 feet back from the rail crossing as measured from the nearest rail. This 15-foot measurement is important for keeping waiting pedestrians outside of the

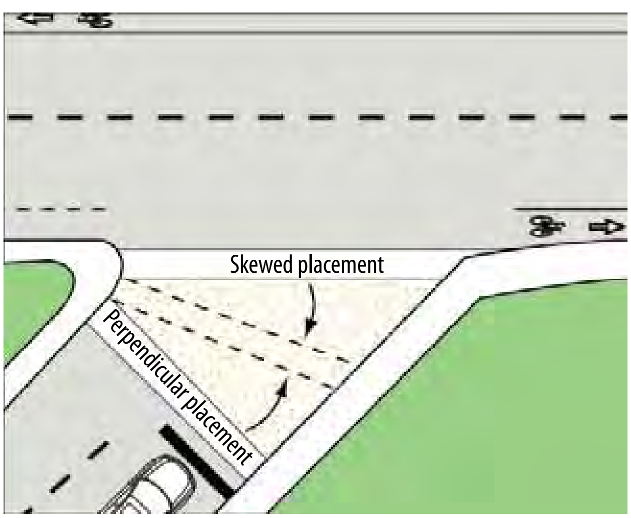


Exhibit 5-71: Best placement for a crosswalk at a skewed intersection is often between skewed and perpendicular.

Exhibit 5-72: If necessary, the walking area should curve to avoid crossing railroad tracks at an angle less than perpendicular.

train envelope. Where there is a gate present, the detectable warning should be located 1.5 feet from the arm. Exhibit 5-73 shows where the detectable warning should be located. Consideration should also be given to the placement of the cross arm and its counterbalance used over the roadway relative to the sidewalk or path. The sidewalk or path should be placed so as to provide enough separation for the gate parts not to interfere with the accessible pedestrian path while up or lowered. See FDM Standard Detail Drawing 8D5 for more information.

In locations with more than one track, rail vehicles may travel in more than one direction. Rail vehicles stopped close to the pedestrian crossing may block pedestrians from seeing trains approaching from the other direction. Informational signs can be used to warn pedestrians of this threat. In addition, fencing or landscaping can be used to guide pedestrians to the safest crossing point. Designers may consider installing pedestrian-only crossing gates or other audible and visible warning devices. (See Exhibit 5-74)

5.3.5. SIGNALIZED INTERSECTIONS

At most signalized intersections and some mid-block crossings, pedestrian signaling devices help pedestrians determine the safest and most appropriate time to cross the roadway. The placement and timing of pedestrian signaling devices at an intersection is closely interrelated to the placement and timing of traffic signaling devices. Signaling often depends on, or influences, the overall intersection design. For example, the placement of pedestrian signal heads may depend on the placement of traffic signal poles, which may depend on or determine the skew of the intersection, the location of medians, and the position of stop bars. Designers must keep this complex interrelationship in mind at all times. While this section only discusses best practices concerning pedestrian signaling devices, it is important to realize that these best practices both depend on and are influenced by the overall design of an intersection or mid-block crossing.

Signalized intersections with pedestrian signal devices do not always guarantee pedestrian safety. For example, pedestrians face conflicts at signalized intersections due to turning vehicles (especially left-turning vehicles), inattentive or reckless motorists, and their own failure to cross at the appropriate locations or obey the appropriate signaling devices. Pedestrians with disabilities often face additional challenges at signalized intersections because they cannot access all of the available crossing information. Accessible pedestrian signals are pedestrian signal devices that benefit pedestrians with certain kinds of disabilities by providing additional forms of crossing information, such as visual, audible or vibrotactile signals. This section provides guidelines and recommendations for designing several types of pedestrian signals.

The amount of time a pedestrian has to clear an intersection from the start of the WALK phase relates to the distance to be covered and an assumed standard walking speed. Guidance in the 2009 MUTCD indicates that the pedestrian clearance time should be sufficient to allow someone crossing in the crosswalk who left the curb or shoulder at the end of the WALK phase to travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median designed for pedestrians to wait safely. Where pedestrians who walk slower than 3.5 feet per second or pedestrians who use wheelchairs routinely use the crosswalk, a walking speed of less than 3.5 feet per second should

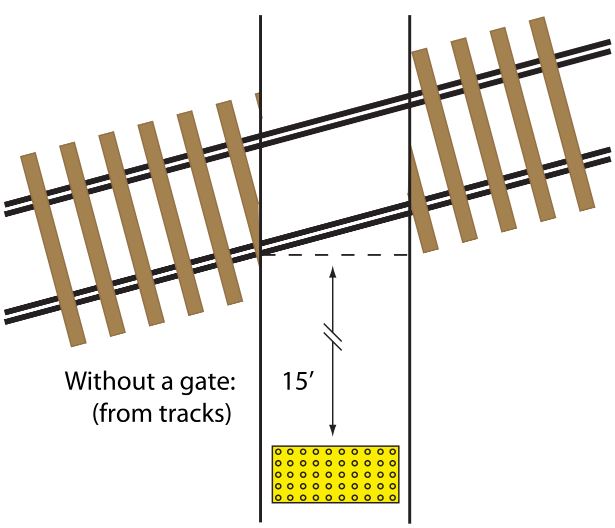


Exhibit 5-73: Proper placement of detectable warnings at a rail crossing.

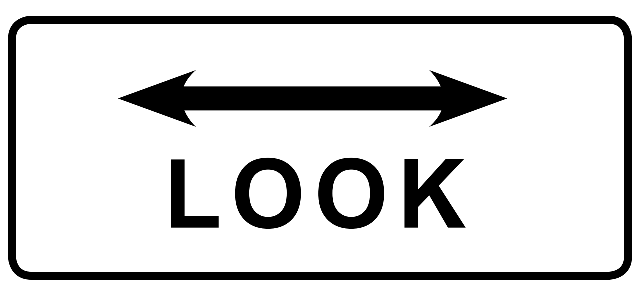


Exhibit 5-74: Signs at railway crossings can remind pedestrians to look both ways before crossing.

be considered in determining the clearance time. A walking speed of up to 4.0 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where an extended push button has been installed to provide slower pedestrians an opportunity to request and receive more time to cross. Passive pedestrian detection may also be used to automatically adjust the pedestrian clearance time based on a pedestrian's actual walking speed or actual clearance of the intersection. See the 2009 MUTCD Section 4E.06, Pedestrian Intervals and Signal Phases, for additional information.

There are three phases of pedestrian crossings for signal devices:

- WALK phase: Instructs pedestrians when it is appropriate to begin crossing the roadway. The duration of the WALK phase shall be a minimum of 4 seconds. Pedestrians begin their movement into the crosswalk during this phase.
- Pedestrian change interval: Occurs when the sign is flashing DON'T WALK. It instructs pedestrians who approach the intersection not to begin crossing and allows pedestrians who are already in the roadway to complete their crossing.
- DON'T WALK phase: Instructs pedestrians they need to complete their crossing because the signal phase is about to change.

Pedestrian signal heads are mounted on the far side of crosswalks on either signal light poles or their own poles and provide pictorial or written symbols to inform pedestrians of each phase. Pictorial symbols are now required since they are easier to understand by children, non-English speakers, and pedestrians with cognitive impairments.

In addition to the visual cues provided by the pedestrian signal head, a fixed time signal device provides audible cues that inform pedestrians with visual impairments of the WALK phase. This feature is the most significant part of Accessible Pedestrian Signals (APS). This audible cue can also act as a guiding beacon to help direct pedestrians with visual impairments across the roadway. An APS signal emits a sound such as a voice, ticking, tone or birdcall with an automatic volume adjustment control up to 5 decibels above the intersection's ambient noise to identify the WALK phase. Additionally, the APS should have an automatic volume adjustment control that emits a sound of 2.5 decibels above the intersection's ambient noise level to help people locate the push button. Different sounds may be used to indicate different crossing directions (such as North/South and East/West). However, without strict standardization and well-orientated streets, using different sounds can cause confusion for pedestrians with visual impairments. In addition to audible cues, vibrotactile cues can be used at accessible pedestrian signals to provide a more diverse range of information. The U.S. Access Board recommends APS systems for inclusion at all intersections with new pedestrian signal systems. APS system installation on signalized intersections occurs on state highways when there is a request from a person with a disability or there is an identified need.

Table 5-1: Pedestrian delay and likelihood of noncompliance

Level of service	Pedestrian delay (seconds)	Likelihood of noncompliance
A	< 10	Low
B	≥ 10–20	Low
C	> 20–30	Moderate
D	> 30–40	Moderate
E	> 40–60	High
F	> 60	Very high

5.3.5.1. Fixed time pedestrian signal devices

Fixed time signal devices use pedestrian signal heads to automatically signal walk phases on a full-time basis. These signals do not require pedestrian activated push-button to produce a "walk" condition.

5.3.5.2. Pedestrian actuated signal devices

A pedestrian actuated signal device uses a pedestrian signal head to signal the same three phases of pedestrian crossings as fixed time signal devices. However, unlike fixed time signal devices, pedestrian actuated signal devices require pedestrians to press a push button in order to activate the WALK phase. These signal devices are commonly used at intersections where pedestrian crossings are infrequent and fixed pedestrian signaling will significantly add to the inefficiency of intersections. When pressed, the push button should activate the WALK phase as quickly as produced by a motor vehicle response so pedestrians do not become impatient and cross during non-WALK phases. Quick responses are difficult to consistently provide at many intersections since signals are often synchronized with other signals and minimum phase times are required for traffic at other legs of the intersection. However, at other intersections, pedestrian activated signals may give a better level of service to occasional pedestrian traffic than fixed time signals. Some features within pedestrian activated signals can be used to provide a slightly longer extended walk time for pedestrians. Table 5-1 lists level of service criteria from the *Highway Capacity Manual* for pedestrians at signalized intersections based on pedestrian delay. It is important to consider the implications of wait time for pedestrian activated signals to gauge the likelihood of noncompliance.

Like fixed time pedestrian signals, pedestrian actuated signal devices are most commonly installed when signals are placed at intersections according to warrants for motor vehicle traffic volumes. They are also installed if they meet a pedestrian volume or school crossing warrant contained in the MUTCD. The minimum pedestrian volume warrant states that a traffic signal (with pedestrian indicators) may be warranted when the pedestrian volume crossing the priority street at an intersection or midblock location during an average day is either 100 or more crossing for each of any four hours or 190 or more crossings during any one hour.

Pedestrian actuated signal devices may also be considered at

- Complex or irregularly shaped intersections
- Intersections experiencing high volumes of turning traffic
- Signalized intersections where traffic sounds are sporadic or masked by ambient noise
- Intersections that have vehicular actuation of the traffic signals
- Intersections with complex signal phasing
- Major corridors leading to areas of fundamental importance such as post offices, courthouses, hospitals, and schools
- Exclusive pedestrian phase areas, such as motorists stopped in all directions
- Locations requested by people with vision impairments

Push buttons can have a locator tone so that pedestrians with visual impairments can position themselves and receive non-verbal cues for crossing the street. Push buttons are subject to restrictions on placement (Exhibit 5-75). Adjacent push buttons must be separated by at least 10 feet in order to be distinguishable by pedestrians with visual

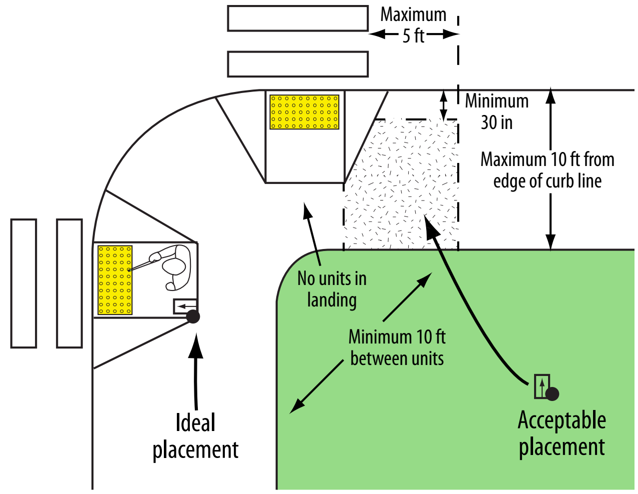


Exhibit 5-75: Push buttons are subject to placement restrictions. This diagram shows ideal as well as acceptable placement.

impairments. In order to be accessible to pedestrians with mobility impairments, push buttons must:

- Be located within 5 feet of the crosswalk extended and within 6 feet of the edge of the curb, shoulder, or pavement
- Be parallel to the their respective crosswalk
- Have a maximum reach length of 18 inches
- Have a maximum height of 48 inches (42 inches is desirable)
- Be located next to a level area—preferably the level landing at the top of a curb ramp—and should never be positioned behind a guardrail, vegetation or grass. The level area must be large enough to allow wheel-chair users and other pedestrians with mobility impairments to access the push button without being in any sloped portions of the curb ramp.

When mounted on a pole, push buttons should be perpendicular to the crosswalk. Push buttons should be large with a maximum activation force requirement of 5.0 pounds of force so pedestrians with limited hand function can operate the signal. During winter months, snow must be promptly cleared and appropriately stored to ensure the push button's year-round accessibility.

At locations where crosswalks intersect a median or a refuge island, an additional pedestrian actuated signal device can be placed on the median or refuge island for use by pedestrians unable to completely cross the street during a single crossing phase, such as seniors, families with young children, and people with disabilities. Push buttons on medians and refuge islands are subject to the same accessibility requirements as push buttons on intersection corners. Placing an additional pedestrian actuated signal device on a median or refuge island does not on its own justify signal timing that forces pedestrians to complete their crossing in two distinct stages. WisDOT avoids the use of two-stage pedestrian crossings. However, if two-stage pedestrian crossings are used, separate pedestrian signal heads are required for each stage of the crossing. When there is more than one pedestrian signal head, they must be carefully placed relative to each other to prevent pedestrians at the first stage of the crossing from using the second stage signal.

5.3.5.3. Signals at mid-block crossings

Signals are occasionally used at mid-block pedestrian crossings. In locations where vehicle speeds are high, signalization may be the only practical means of helping pedestrians complete a mid-block crossing unless the crossing is part of a signal-timing scheme. It is best not to allow urban area roadways to achieve high corridor speeds especially when land use supports higher densities. As speed increases, it is more difficult to help pedestrians safely cross the street. If a pedestrian crossing is needed, the designer must increase the number of devices used to alert the motorist. Refer to the MUTCD to evaluate the conditions under which pedestrian signals are warranted at mid-block crossings. The use of a pedestrian hybrid signal may be a viable option at this type of crossing. See ***Section 5.3.5.4.*** for more information on pedestrian hybrid signals.

5.3.5.4. Other designs and innovations

Recent advances in pedestrian signaling device technology have increased the efficiency and safety of signalized intersections and mid-block crossings. Often, the technology makes pedestrian crossings more accessible to pedestrians with certain impairments. This section describes some of these recent advances.

Hybrid Signals (aka HAWKs). A pedestrian hybrid signal, also called a "HAWK" – **H**igh intensity **A**ctivated cross **W**al**K**, is a special type of signal used to warn and control traffic at an unsignalized location with a marked crosswalk is new to the 2009 MUTCD. When not activated, the signal is dark, allowing motorists to pass through freely. The HAWK signal is activated by a pedestrian push button. When activated, the overhead signal advances through four phases:

1. Flashing yellow to gain the attention of motorists.
2. Solid yellow to advise drivers to prepare to stop.
3. Solid red, which requires drivers to stop before the crosswalk. During this phase, the pedestrian is shown a "Walk" indicator.
4. Alternating red signal during which the driver may proceed through the intersection after having come to a complete stop and the pedestrian has safely crossed. During this phase, the pedestrian is shown a flashing "Don't Walk" with a countdown time that indicates the time left to cross during this phase.

At the completion of stage 4, the signal returns to a dark condition and traffic may again move freely.

Pedestrian countdown signals. New new in the 2009 MUTCD is the standard that all pedestrian signal heads used at crosswalks where the pedestrian change interval (commonly known by the flashing DON"T WALK or UPRAISED HAND symbols) is more than seven seconds shall include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval. Countdown displays may also be used where the pedestrian change interval is seven seconds or less. Where countdown pedestrian signals are used, the countdown shall always be displayed simultaneously with the flashing UPRAISED HAND symbolizing DON'T WALK. This requirement shall be implemented when new pedestrian signal heads are installed or when an existing system of pedestrian signal heads is replaced. See 2009 MUTCD Section 4E.07, Countdown Pedestrian Signals, for more information.

Infrared or LED transmitters. Infrared or LED transmitters are devices that transmit messages to personal receivers. Transmitters can be mounted near crosswalks on traffic poles, buildings, or other practical streetscape objects. Pedestrians with visual impairments who carry a personal receiver can obtain information from the transmitter concerning the status of the crossing phase, the name and location of the street to be crossed, and the direction of intended travel. This technology only works in areas where a municipality has created and maintained a computer system and database to allow for the information exchange.

Audible signals with information. Unlike infrared or LED transmitters, crossing information may be provided without a transmitter. When audible signals with information are used, the signal itself provides information such as direction of travel and street location. The signal phase is announced when pressing the push button. This information is available to all pedestrians within hearing range rather than only pedestrians with special transmitters. This increases the availability of the information, and eliminates the cost and exclusiveness of the transmitters.

Pedestrian-activated roadway lights. When pedestrian-activated roadways lights are used, the lights are embedded within the roadway on each side of the crosswalk. The lights are activated by a pedestrian push button. Once activated, the lights flash for an amount of time equal to the pedestrian clearance time. Pedestrian-activated roadway lights are intended to increase the visibility of pedestrians during low-light conditions.

Lead pedestrian interval (LPI). Some pedestrian actuated signal devices contain a Lead Pedestrian Interval (LPI). LPIs activate the "Walk" phase of a pedestrian crossing a few seconds prior to activating the parallel vehicular green signal. LPIs allow pedestrians to enter a crosswalk before turning vehicles arrive. LPIs may decrease conflicts between left-turning vehicles and crossing pedestrians.

Part time no-turn-on-red. Prohibiting motorists from making right-hand turns at a red light can increase the safety and comfort of pedestrians. This technique can be limited to certain times of the day, particularly those times with heavy pedestrian traffic. A blank out sign can be used so that the "no turn on red" is displayed for vehicular traffic. A pedestrian can push a button to activate the sign or it may be automatically timed so it is visible to traffic only at rush hour periods.

Exclusive pedestrian phase. Intersections with an exclusive pedestrian phase stop all directions of traffic simultaneously to allow pedestrians to cross the roadway in conventional crosswalks or diagonally. While exclusive pedestrian phases increase pedestrian safety, they decrease overall intersection efficiency.

Microwave sensors. Microwave sensors aimed at the crosswalk can sense slower-moving pedestrians and can add several seconds to the WALK phase to aid these pedestrians in completing a crossing. Microwave sensors allow for shorter standard WALK phases while allowing longer WALK phases to accommodate the occasional slower-moving pedestrian.

5.3.6. GRADE-SEPARATED CROSSINGS

Pedestrian movements are often segregated from cross-traffic on grade-separated crossings, and include pedestrian facilities built as part of grade-separated roadways including facilities on bridges or under bridges. Grade-separated crossings can also include separate pedestrian underpasses and overpasses, which are usually shared with bicyclists. Obvious places for grade-separated pedestrian facilities are across facilities with topographic displacement (such as freeways, interstates, arterials, rivers and railroads) where there is significant pedestrian volume or a lack of suitable alternative crossings nearby. Grade-separated crossings in urban areas may also be considered if the roadway meets signal warrants, but a signal cannot be installed for technical reasons. Grade-separated crossings should be considered on rural roadways and trails if the roadway speed is 40 mph or higher and ADT is 3,500 or higher. In very rare cases, grade separations are retrofitted at intersections or in mid-block locations, and are more common with trails crossing busy roadways than crosswalks at conventional intersections.

Connectivity of walkways is just as critical to pedestrians as a connected system of roadways is for motorists. In urban and suburban areas, public agencies should always make provisions to include well-designed pedestrian facilities as part of all new and reconstructed grade-separated crossings. In rural areas, pedestrian facilities should also be considered. Without the adequate spacing and placement of crossings, pedestrians are more likely to cross highways at grade-level, creating safety and accessibility problems.

5.3.6.1. Bridges and tunnels with pedestrian access

With respect to grade separations, roadway bridges are the most common way for pedestrians to cross streets and highways. Grade-separated roadways often have sidewalks that carry pedestrian traffic over or under major highway barriers. The crossing may be at an interchange or involve a bridge crossing at a non-interchange location. Space is typically at a premium on grade-separated crossings. Adequate pedestrian facilities along crossings are often designed with less horizontal separation from travel lanes than along the approaching roadways. Sidewalks are often limited to the space between the traffic lanes and a wall or railing.

On grade-separated crossings, a protective barrier between the sidewalk and the traffic lanes is required for state highway projects under certain conditions to reduce the risk of motorist-pedestrian crashes and increase pedestrians' perceptions of safety. If the posted speed limit exceeds 45 mph, a 32-inch minimum parapet or barrier shall separate traffic lanes from pedestrian walking areas. If the posted speed limit is 45 mph, parapets or barriers may need to be provided depending on site-specific considerations such as warranting criteria, the location and length of the structure, adjacent roadway character, and pedestrian volume. When the posted speed limit is below 45 mph, barriers do not necessarily need to be provided, but may be warranted in some cases (Exhibit 5-76). Refer to ***FDM Section 11-35-1*** for more information on barrier types and placement considerations on grade-separated crossings.

Exhibit 5-76: On bridges with higher speeds, substantial traffic volume or significant curvature, it may be necessary to include a jersey barrier between the walking area and the roadway.

Railings prevent motorists, pedestrians or bicyclists from veering off bridges. AASHTO's ***Standard Specifications for Highway Bridges*** specifies geometric, design load, and maximum allowable material stress requirements for the design of railings in various situations. Barriers or railings should be designed so no part of the curbed sidewalk extends closer to the roadway than the front of the barrier.

The width of the walking area on a bridge or through an underpass should be 1-foot wider than the walking area connecting it to each side of the crossing. Pedestrians should not be forced to walk within 1-foot of a wall. WisDOT's standard width for a curbside walking area on a bridge or as a curbside sidewalk underneath a bridge is 6 feet.

When building a bridge or underpass, consider including room for future sidewalks even if sidewalks currently are not needed. One strategy is to include an oversized shoulder on a bridge so that a sidewalk can be added later. Designing the supporting structure to more easily provide additional width when the bridge is redecked is another option.

Walking areas underneath bridges are problematic if the walking area is located between the abutment wall and supporting columns or pillars next to the roadway. If the length of the underpass exceeds 100 feet, large columns or pillars create blind spots or voids which can threaten pedestrian safety and security. Where practical, bridge underpasses should be designed either with a clear span from abutment to abutment or with centered columns. Where designs place columns on either side of the roadway, the walking area should be built between the columns and the roadway. Where designs must locate columns adjacent to the curb, the walking area behind the columns should be designed as wide as practical.

The ratio of bridge height to its length influences how intimidating the structure will seem to people on foot. The longer the bridge, the higher its ceiling height should be. Depending on the length of the underpass and its roof height, 24-hour vandal proof lights above the walking area

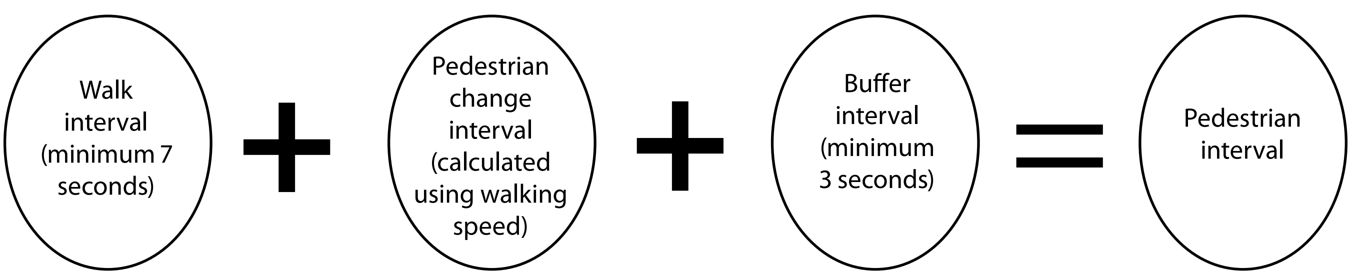


Exhibit 5-76: Calculating pedestrian interval at a signalized intersection.

may be needed to increase actual and perceived security. Lighting is often provided for roadway users underneath bridges. This lighting can be oriented to also provide adequate lighting for pedestrians using adjacent sidewalks. See ***Section 5.3.7.*** for additional information on lighting.

Drainage/cross-slope considerations are especially important on bridges. Bridge underpasses should be designed to drain so passing motorists do not splash standing water onto pedestrians.

Because sidewalks require less vertical clearance than roadways, sidewalks under bridges do not need to be constructed to the same grade as the adjacent roadway, especially in situations where the roadway grade is greater than the maximum allowed sidewalk grade (Exhibit 5-77). However, constructing sidewalks above the roadway grade requires railings along the roadway edge and may raise security concerns. Railing should not obstruct the pedestrian view of the roadway or surrounding area.

If pedestrians are not permitted in a long tunnel, space should be provided for an emergency walkway. Stranded motorists, maintenance crews and emergency personnel should be able to use the emergency walkway when the need arises. The emergency sidewalks also create additional separation between motorists and the tunnel walls and lights. Emergency walkways should be 4 feet wide as long as they are temporarily widened to 5 feet every 200 feet.

Exhibit 5-77: Where the sidewalk is located above the roadway grade, a railing must be provided.

5.3.6.2. Pedestrian overpasses and underpasses

Grade-separated pedestrian facilities are constructed to completely separate the travel paths of pedestrians from the travel paths of motorists. Grade-separated overpasses and underpasses can be designed and connected to pedestrian and bicycle networks and can improve pedestrian safety when appropriately located and designed. Grade-separated pedestrian facilities can be quite expensive, may be considered unattractive, and in rare cases, may even decrease personal safety if not properly located and designed.

Grade-separated pedestrian facilities are most appropriate in situations with:

- The potential for moderate to high pedestrian demand to cross a freeway, expressway or arterial
- Large numbers of pedestrians separated from schools, shopping centers, and recreation facilities by high-speed or high-volume roadways
- High motorist volumes or high motorist speeds
- Topographic compatibility

Grade-separated overpasses and underpasses may be beneficial where one or more of these conditions exist in conjunction with well-defined pedestrian origins and destinations (Exhibit 5-78). Some examples include a residential neighborhood across a busy street from a school, a parking structure across from a university, a high volume multi-use trail that intersects a street, a parking structure near a stadium or busy athletic field, or an apartment complex near a shopping

Exhibit 5-78: Rational placement of grade-separated facilities considers connecting well-defined pedestrian origins and destinations as well as continuity of regional bikeways and trail systems.

Exhibit 5-79: An accessible ramp is required to connect the grade-separated pedestrian facility to the sidewalk, but stairs may also be constructed to provide more direct access.

mall. Grade-separated facilities can also provide continuity for regional bikeways and trail systems.

Research has found that pedestrian use of underpasses and overpasses depends on walking distances and the convenience of the facility. For example, 95 percent of pedestrians would likely use an underpass and 70 percent would likely use an overpass if it took the same amount of time as it did to cross at grade. However, if it took 50 percent longer to use an overpass or underpass than to cross at grade, very few pedestrians would use the facilities. It may be difficult to get pedestrians to use an overpass or underpass if they see the proposed pedestrian route as inconvenient or do not perceive the risk of crossing at grade. Barriers, such as fences or hedges may be placed along the at-grade crossing to give visual cues to pedestrians to use the grade-separated crosswalk. However, proper placement should be the first choice.

Grade-separated crossings must meet several design requirements including being accessible to all pedestrians. If pedestrians must change elevation to use an overpass or underpass, access ramps must meet ADAAG ramp requirements. Stairs are allowed and may provide more direct access, but may be provided in addition to ramps, not instead of ramps (Exhibit 5-79).

Protective screening:
Several types of screening material are available, such as aluminum, fiberglass and plastic sheeting, and chain link type fencing.

Grade-separated pedestrian overpasses and underpasses should include barriers or railings. The crossing should have adequate widths based on perceptions of safety and pedestrian volumes. Lighting may also be necessary to increase pedestrians' sense of safety and security. Potential or perceived safety and security problems often discourage pedestrians from using underpasses and overpasses, particularly at night. Where possible, overpasses may be designed to accommodate access for emergency vehicles.

Because pedestrian overpasses and underpasses are expensive to construct, they are usually considered after exhausting lower cost options. For example, it may be less expensive to provide sidewalks on existing bridges or bridges in the planning phase.

Grade-separated overpasses or underpasses have advantages and disadvantages. Overpasses require more vertical separation to provide clearance for large trucks or trains. Underpass vertical clearances are approximately half the height of an overpass (10 feet), dependent on the length of the underpass. Underpasses also require shorter ramps and less right of way than overpasses. However, underpasses can be more expensive to construct if the roadway needs to be elevated, utilities need to be relocated, or drainage creates a problem.

5.3.6.2.1. Pedestrian overpasses

Pedestrian overpasses are typically bridge structures over major highways or railroads. Where the major highway or railroad is depressed, the bridge can be

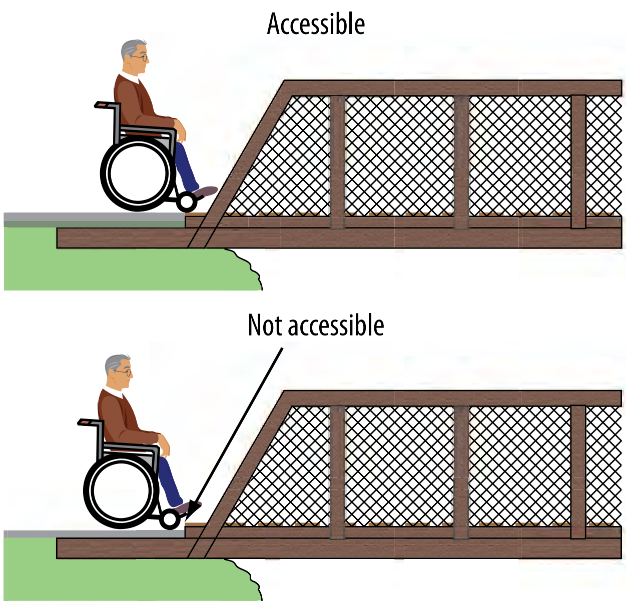


Exhibit 5-80: A level transition must be provided between the walking area and the overpass to provide accessibility to pedestrians with mobility impairments.

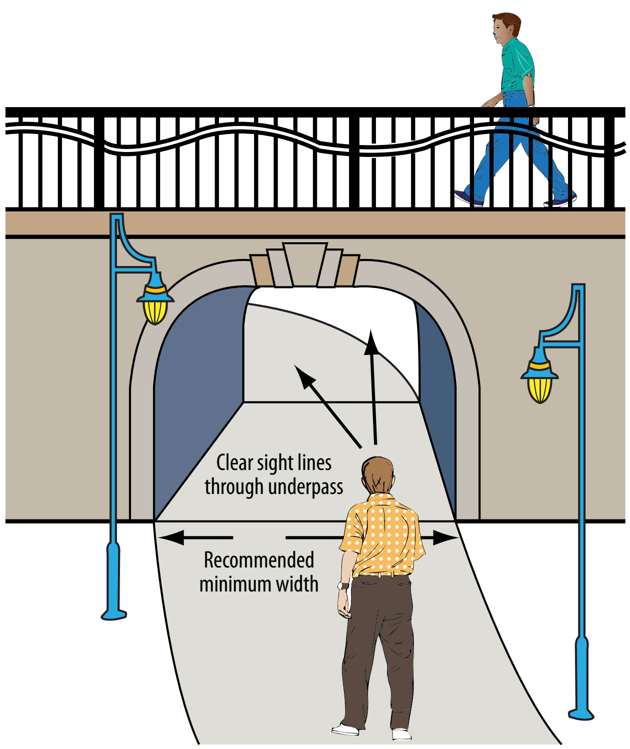


Exhibit 5-81: Underpasses should have sufficient width, lighting and clear sight lines to promote pedestrian comfort and security.

at ground level. In many cases, pedestrians need stairs and ramps to access the overpass. Overpasses with ramps must meet ADAAG ramp criteria with a grade of 5 percent or less. A maximum grade of 8.33 percent can be used, but a level landing for every 30 feet of ramp segment is required along the ramp. Handrails are also required on both sides

When conducting a lighting evaluation:

- Review current conditions
- Establish locations for additional lighting to benefit pedestrian safety
- Locate light available from other sources
- Identify where tree trimming is needed to maintain effective illumination
- Evaluate nighttime pedestrian activity levels

of the structure. Many pedestrians with mobility and stamina disabilities may not be able to use ramps that rise more than a total of 5 feet. Stairs may supplement, but not replace, a ramp. There must always be a level transition between the roadside sidewalk and the overpass (Exhibit 5-80).

The minimum inside clear width of a pedestrian overpass is 8 feet. If the contiguous sidewalks are wider than 8 feet, it is recommended that the pedestrian overpass should be 1 to 2 feet wider. If the overpass is enclosed to prevent debris from falling onto the highway below, the bridge should be 2 feet wider than the sidewalk leading up to it in order to counteract the visual tunnel effect and provide a feeling of security. If the overpass is very long, it should be widened further to compensate for the visual perception of narrowness. If the overpass is a shared facility with bicycles, the minimum width is 12 feet. All pedestrian overpasses should have protective screening on both sides.

Elevated walkways and skywalks are additional facilities that can be used by pedestrians to cross over a roadway. These facilities may be freestanding or connected to adjacent buildings. When enclosed, they are often called skywalks. They are typically built at least one story above ground level to connect buildings at mid-block and are especially beneficial in extreme weather. Their impact on pedestrian safety and flow is limited if they are only accessible during the limited business hours of the buildings they connect. Some cities have discouraged building skywalks where they would disrupt important architectural views or could greatly reduce street level activity. Skywalks do not negate the need for accessible sidewalks at street level.

5.3.6.2.2. Pedestrian underpasses

Pedestrian underpasses include tunnels and openings under bridge structures. Underpasses generally contain ramps that lead down to a below-grade passageway. In some cases, the underpass is at ground level and the roadway is elevated (Exhibit 5-81). If the road is not elevated, the end of the underpass should be flared out to provide clear sight distances to and through the underpass. The drainage system should be carefully designed to prevent flooding.

Underpasses should be wide enough to be inviting. The longer the tunnel, the wider it should be to give pedestrians a feeling of security when approaching and when passing other pedestrians within it. WisDOT advises a minimum width of 12 feet, but wider widths encouraged for lengths over 60 feet. These widths also accommodate bicyclists on shared-use facilities. ADA requirements for grade percentages are the same as overpasses (see ***Section 5.3.6.2.1.***).

The longer the underpass, the higher its ceiling should be. While an 8-foot vertical clearance is appropriate for short tunnels, longer tunnels may require a 10-foot vertical clearance or more to maintain a feeling of openness and security. A vertical clearance of 10 feet should be provided if equestrians might use the underpass. If people driving emergency or maintenance vehicles will use the tunnel, a higher vertical clearance should be provided. Where snowmobiles share the underpass, it is helpful to consider the special height and width clearance needs for snowmobile grooming equipment.

Underpasses have additional security and maintenance needs, thus their design needs to consider accommodating emergency and security vehicles. The underpass should be periodically monitored for graffiti and debris removal. Underpasses should be designed so that police officers can see all the way through them from the street, without leaving their vehicles. Vandal resistant lighting should be installed and maintained. Proper lighting of underpasses can improve security for pedestrians. AASHTO's ***Roadway Lighting Design Guide***, which guides the selection of locations for fixed-source lighting and presents design guidance for their illumination, includes a section on the lighting of tunnels and underpasses.

5.3.7. LIGHTING

Pedestrian facilities should be adequately lit to maximize pedestrian safety, comfort and security. Low-light conditions reduce how well motorists can see pedestrians. Thirty-two percent of all pedestrian crashes in Wisconsin occur during low-light conditions such as dusk, dawn, or in the dark, however, 57 percent of all pedestrian fatalities occur during these same conditions. In lit areas, the percentage of fatalities was proportionate to the percentage of pedestrian crashes. In unlit areas, the percentage of fatalities was five times higher than the percentage of pedestrian crashes occurring in unlit conditions. This is a strong indicator of the increase in severity of crashes occurring in unlit conditions.

Well-lit facilities enhance the security and atmosphere for pedestrian users. They benefit from seeing and being seen by motorists, especially at crossing points. Lighted areas improve safety and encourage people to use areas at night. Increasing the number of pedestrians reinforces the general safety of the area and reduces the opportunities for crime to occur. Appropriate street lighting can also be used to provide a sense of neighborhood continuity or preserve the character of a historic district. The style of lighting fixtures can be integrated into an overall design to compliment streetscape elements.

Facility lighting is important in every season. In Wisconsin, there are considerably fewer daylight hours during the winter months. In winter, many individuals travel to and from work and run errands primarily when it is dark outside. A nighttime evaluation can be conducted to survey the need for additional pedestrian lighting. In areas with heavy tree growth, lighting should be assessed during the summer months when foliage blockage is greatest.

5.3.7.1. Street lighting

Lighting that illuminates the roadway adjacent to a walkway has beneficial impacts on a pedestrian seeing and being seen. Where there is a mid-block crossing, it is especially important to have proper illumination because motorists may not expect a pedestrian crossing. The best type of lighting focuses on the walkway and shines down on it rather than away from it. This minimizes glare into the surrounding neighborhood. Street lighting should not be relied upon as the only light source to illuminate pedestrian activity. It may need to be supplemented with additional lighting.

Crosswalks traversing roadways at mid-block and at street intersections should be provided with illumination in addition to the roadway lighting. In designing a crosswalk lighting system, selecting an appropriate luminaire and luminaire height are critical. Since the object of interest is vertical, the intensity distribution should have a horizontal component. If all the light from the luminaire is directed downward, the vertical profile of the pedestrian is not adequately illuminated (Exhibit 5-82). The luminous intensity distribution from the luminaire must provide the required luminous intensity in the geometry required. If the luminaire cannot produce the required intensity, it is not suitable for use in a crosswalk installation. If placing a luminaire in the median is not an option, a wide throw luminaire (Type III) might be used from the roadway edge to light other lanes.

Many agencies have historically installed a single luminaire directly over the crosswalk as shown in Exhibit 5-83. While this provides high pavement luminance at the crosswalk, it does not adequately illuminate the pedestrian. The luminaires should be located such that the vertical luminance makes the pedestrian visible at a sufficient distance. Based on the assessment performed to select the luminaire, the luminaire should be located so that it provides 20 vertical lux at the crosswalk. Where there are wide roadways, additional consideration

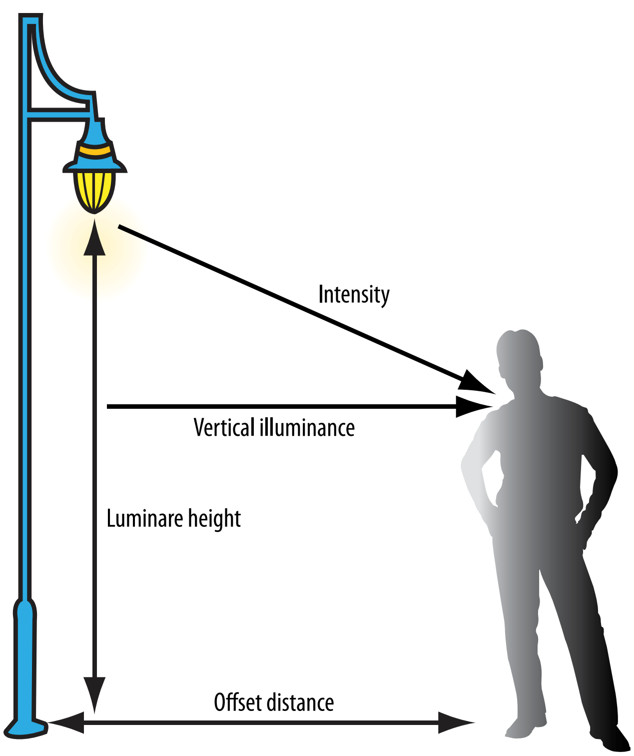
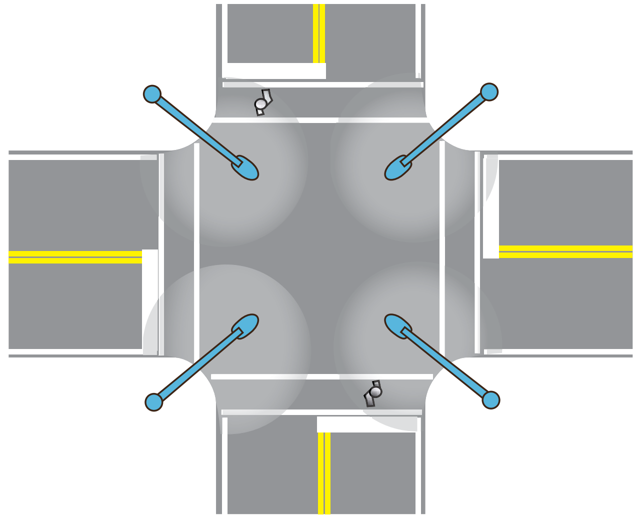
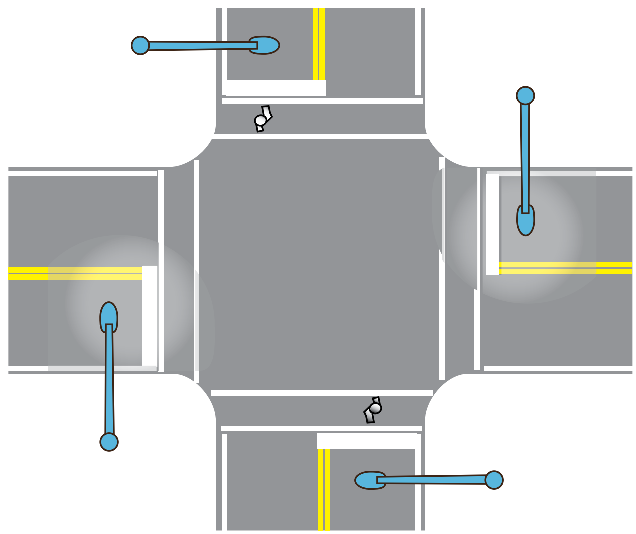


Exhibit 5-82: The basics of pedestrian lighting.



Traditional intersection lighting



Improved intersection lighting

Exhibit 5-83: In traditional luminare placement, the lighting does not adequately illuminate the pedestrian. The improved intersection lighting makes the pedestrian visible from a sufficient distance.

for lighting must be given. It is possible that two approach luminaires will be required to provide the required luminance level across the entire roadway. A luminaire located in the center median may be required for the design.

Where there is a mid-block crossing, it is especially important to have proper illumination to help motorists recognize a crossing point where they may not expect one. For mid-block crossings a vertical luminance of 20 lux in the mid-block crosswalk, measured at a height of 5 feet from

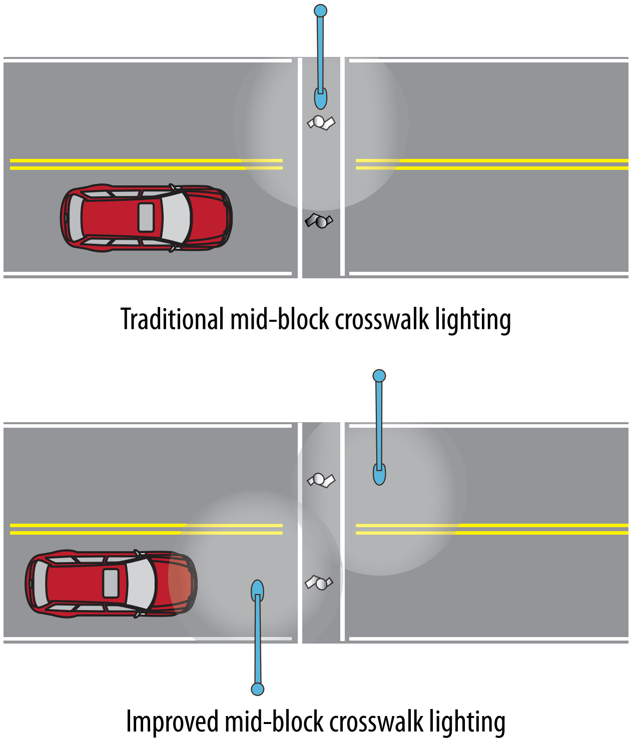


Exhibit 5-84: Traditionally luminaries are placed directly over the crosswalk at a mid-block crosswalk. Better visibility of the pedestrian can be managed by placing the luminare before the crosswalk.

the road surface, provided adequate detection distances in most circumstances. The choice of illumination for a mid-block crossing considers the same issues as other crosswalk lighting including glare, light color, light intensity and focus of light onto the pavement. Exhibit 5-84 shows desirable placement of luminaries at mid-block crosswalks.

Crosswalks that have high ambient lighting in the background may benefit from a higher vertical luminance. These areas would include crosswalks close to shopping areas, adjacent to transit stations, and in central business districts. While no specific research has been performed to address this issue, a vertical luminance level of 30 lux is considered a conservative estimate of the lighting level required for adequate visibility.

Exhibit 5-85: Pedestrian level lighting fixtures are placed to illuminate the walking path.

5.3.7.2. Pedestrian-level lighting

Where there are shopping and entertainment districts or special areas with high pedestrian traffic, additional comfort and safety is obtained by providing pedestrian-level lighting in addition to the street lighting (Exhibit 5-85). Pedestrian-level lighting can also be installed in areas where it is desired to create a sense of intimacy and place. Fixtures are usually placed 12 to 15 feet above the walking area. Focal point lighting may be used to illuminate items of special visual interest. Fixtures can be decorative or functional and can provide illumination to works of art or signage. They can be built directly into buildings and structures where applicable. Pedestrian-level lighting also adds a level of ambience unattainable by using medium-mount or high-mount fixtures.

The preferred pedestrian-level lights are mercury vapor and metal halide. LEDs are increasingly being employed because of their low energy usage. Low-pressure sodium lights may be energy-efficient, but create undesirable color distortion. High-pressure sodium lights produce less distortion and are a better alternative to low-pressure sodium lights.

5.3.7.3. Lighting for separate pedestrian facilities

Pedestrian pathways, walkways on separate rights of way or easements, underpasses and overpasses typically require lighting in addition to that of nearby roadways. In all cases, lighting should be placed to provide a uniform quantity of illumination. Having bright and shadowed areas requires the eye to adjust to changes in light and can affect the sight and safety of the pedestrian. Persons with vision impairments may have difficulty transitioning between poorly lit and well-lit areas. Lighting consistency also helps pedestrians visually identify objects. Vertical surface luminance is summarized in Table 5-2. It is recommended that all lighting designs conform to the luminance requirements shown in Table 5-2. Pedestrian facilities require their own lighting if they are not adjacent to an illuminated roadway. For pathways, lighting should be extended to sufficiently cover beyond the immediate pathway, at least 6 feet on either side of the pavement. In rural and suburban areas, designers might consider the benefits of solar lighting for the pedestrian facility (Exhibit 5-86).

Special consideration for illumination should also be given to areas where there is a concentration of pedestrian activities that take place during dusk or the evening hours, such as places of worship, shopping/entertainment corridors, schools, community centers, and transit stops. Local guidelines should be consulted since many municipalities have ordinances and standards that relate to outdoor lighting.

In pedestrian or shared-use underpasses, 24-hour lighting should be especially considered for longer underpasses. For short underpasses, lights may be positioned to provide adequate levels of nighttime illumination without the need for light fixtures attached to the structure. Vandal-resistant fixtures should be used at low-levels or in areas prone to vandalism.

Exhibit 5-86: Solar lighting can be used on shared-use paths to provide acceptable luminance levels.

For a more detailed discussion of lighting, including the effects of pavement type, refer to the Illuminating Engineering Society of North America's Lighting Handbook. For further information and guidance on roadway lighting levels and lighting information, refer to AASHTO's ***Roadway Lighting Design Guide***.

5.3.8. MEETING THE PEDESTRIAN NEEDS OF TRANSIT USERS

The location of stops for buses and street running rail vehicles should be chosen for pedestrian safety and convenience as well as its impact upon safe traffic flow. Essential elements include:

- Roadway design (***Section 5.2.***)
- Sidewalk design (***Section 5.3.1.***)
- Pedestrian crossings (***Section 5.3.4.***)
- Transit stop location and design (***Section 5.3.8.1.***)

Table 5-2: Luminance level for pedestrian facilities in lux[1]

Facility	Type	Minimum average horizontal levels	Average vertical levels for pedestrian security[2]	Uniformity ratio
Sidewalk	Commercial	10	22	4:1
	Intermediate	6	11	4:1
	Residential	2	5	4:1
Pedestrian pathway[3]	All	5	5	5:1
Shared-use pathway	All	43	54	

Source: Illuminating Engineering Society of North America. *Lighting Handbook*. 9th Edition.
[1]For approximate value in foot-candles, multiply by 0.1.
[2]For pedestrian identification at a distance; values are given at 6 feet above walkway.
[3]Assumes facility is separate (not receiving roadway lighting).

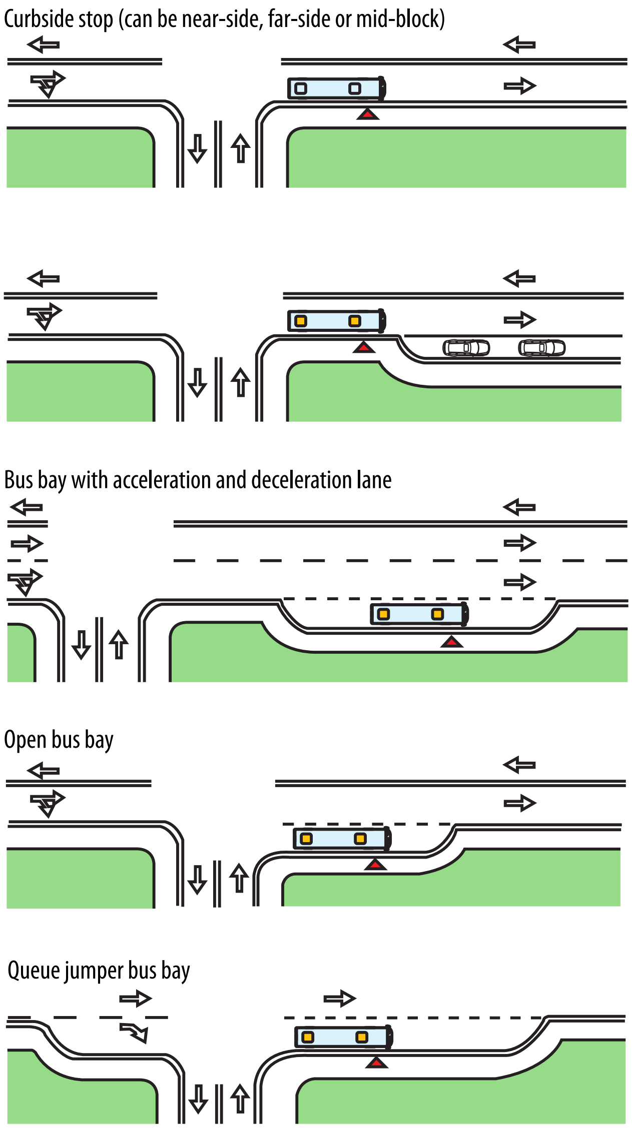


Exhibit 5-87: Many options exist for placement of transit loading zones.

5.3.8.1. Transit stop location and design

5.3.8.1.1. Landing Pads

ADA guidelines (ADAAG 10.2.1) require a landing pad be located at all stops to allow pedestrians to enter and exit the bus safely without entering the roadway. This is particularly important in rural or suburban areas without a pedestrian network. The landing pad shall have a firm, stable surface free of obstructions. Pads can be constructed from asphalt or concrete. They shall have a minimum length of 8 feet (from curb, or roadway edge if no curb), and a minimum width of 5 feet (in the direction parallel to the roadway) to allow a wheelchair user to turn around. It must be connected to the adjacent sidewalk network if there is one by an accessible route (as defined in this guide in *Section 5.3.1.2.1.* through *Section 5.3.1.2.7.*). In all cases, landing pads should be connected to the nearest corner or crosswalk with an accessible route.

5.3.8.1.2. Stop shelters and waiting areas

A range of amenities can be installed in the pedestrian zone for waiting passengers. When placing shelters and seating, designers should consider all the guidelines previously discussed in this chapter for maintaining an accessible path and a safe and welcoming pedestrian environment. Shelters and seating should be located to maximize pedestrian safety and access. They should be placed with:

- Clear access to crosswalks
- Clear connection to the existing pedestrian network, whether sidewalks or other facilities
- Clear sight lines for pedestrians, vehicle drivers, and transit operators
- Consideration for how the stop and go movements of the transit vehicle will interact with the flow of other traffic
- Consideration for the number of transit vehicles servicing the site

Bus stop checklists. Bus stop checklists can be used to inventory conditions at stops and pedestrian access to a stop. This list can be used to develop an action plan to address changes to improve safe access and use. Typical checklist contents include:

- Presence of sidewalks and other pedestrian access (including connectivity)
- Access for people with disabilities (curb ramps, detectable warnings, 4-foot minimum walking area not obstructed by the shelter, access to/from shelter/pad for wheelchair users, etc.)
- Location of bus stop (near vs. far side, accessible path from pedestrian facility to stop – if any)
- Roadway crossing treatments (marked crosswalks, pedestrian signals, pedestrian signal timing, lighting, etc.)
- Bus stop characteristics (seating, shelters, signage, visibility for drivers and waiting passengers, etc.)

The Resource chapter includes two examples of two checklists.

Stop placement along a block. Bus stops can be located in a variety of places along a block. Common placements include curbside, at a nub or other protrusion, bus bay or queue jumper (Exhibit 5-87).

Table 5-3: Summary of bus stop location advantages and disadvantages					
Near-side		Far-side		Mid-block	
Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Minimizes distance when traffic is heavy on the far side of the intersection Minimizes distance between crosswalks and stop Keeps intersection available to assist in transit vehicle pulling away from curb Prevents double stopping by transit vehicle—passengers can access vehicle at a red light Provides transit vehicle operators the opportunity to look for oncoming traffic	Increases conflicts with right turning vehicles May result in stopped transit vehicles obscuring sight lines for traffic control devices or crossing pedestrians May obscure sight distances for cross vehicles stopped to the right of the transit vehicle May block traffic travel lane during peak periods due to multiple queuing of transit vehicles May increase sight line distances for crossing pedestrians May result in pedestrians crossing illegally in front of transit vehicle to get operator's attention	Minimizes conflicts between right turning vehicles and transit vehicles at the stop Provides additional right-turn capacity by making the curb lane available Minimizes sight distance problems for drivers on approaches to intersection Encourages pedestrians to cross behind the transit vehicle or at the intersection crossing in front of the transit vehicle Requires shorter deceleration distances for transit vehicles Creates gaps in the traffic flow when transit vehicles re-enter the flow at signalized intersections	May block intersections during peak periods due to queuing of transit vehicles May obscure sight distances for crossing vehicles May increase sight distance problems for crossing pedestrians May interfere with transit vehicle flow and traffic flow due to transit vehicles stopping at far side for a red light May increase the risk of rear end crashes since drivers do not expect transit vehicles to stop again after clearing a red light	Minimizes sight distances problems for pedestrians and vehicle drivers May make pedestrian areas less crowded since pedestrians can spread out in either direction Allows passengers to access transit vehicles close to the crosswalk	Requires maximum length for no parking area of all bus stop location options Requires pedestrians to cross street at mid-block (this may be addressed with proper mid-block crossing treatments as discussed in section 5.2.4.1.2 Increases the walking distance for passengers crossing at the intersection if no safe mid-block crossing is available

Source: U.S. Department of Transportation, Federal Highway Administration. ***Pedestrian Safety Guide for Transit Agencies***.

Curbside stops are the most common. No changes are required to the roadway to accommodate the stop. Its advantages include its simplicity, low cost, ease of installation and flexibility. Whether to locate curbside stops at the nearside, far side or at mid-block depends on the pedestrian and vehicle conditions on a particular block. Table 5-3 reviews some advantages and disadvantages of curbside stops.

Transit stops near roundabouts are most similar to mid-block stops. Stops should be located approximately 75 feet back from marked crosswalks at the roundabout. Examples of the curbside, nub, bus bay, and que-jumper stop types are depicted in Exhibit 5-87.

A nub or other protrusion bus stop occurs when a parking lane exists for almost the entire length of the block except for a protrusion that allows the transit vehicle to stay in the travel lane. These transit stops can be used when there is adequate space in the right of way and the sidewalk can be altered to bulb out. The design can be used with on-street parking. It results in minimal delay for the transit vehicle and improves pedestrian movements at the intersection. Traffic backup behind the transit vehicle may occur (especially at a near side stop) and vehicle drivers may make unsafe lane changes to go around the transit vehicle. Costs are associated with constructing the bulb out.

There are two types of bus bay stops: a bus bay with room for acceleration/deceleration and an open bus bay. Both types of bus bays may be used when there is no on-street parking, traffic volume is high (exceeding 250 vehicles per hour at peak), traffic speeds are 40 mph, or when there is a transit vehicle layover.

A bus bay with acceleration and deceleration space gives space for the transit vehicle to slow down from travel lane speeds as it approaches the stop as well as speed up to travel lane speeds as it pulls away from the stop. This type of stop has several advantages including minimal disruption of vehicle travel lanes and additional separation between passengers and travel lanes. There are also several disadvantages such as elimination of on-street parking, potential difficulty for transit vehicles to merge with traffic, construction-related costs, and the alteration of the sidewalk and roadway.

An open bus bay is located at the near side of an intersection rather than at mid-block. It has all the advantages of the mid-block bus bay, and it enables the transit vehicle to use the intersection to decelerate. It also has the same potential disadvantages of a bus bay with an acceleration and deceleration lane.

Queue jumper bus bays are similar to a nearside bus bay but with a smaller bus bay also on the opposite side of the intersection. The queue jumper bus bay has the same advantages as the other types of bus bays, but it allows transit vehicles to bypass traffic queues at a signal. It may delay right turning vehicles, has some additional construction costs, and alters the roadway and sidewalk. Queue jumper bus bays may be used in the same circumstances as the other types of bus bays.

A transit stop may be located at a pork chop island. The stop may be located on the island itself or on the main sidewalk adjacent to the right turn lane. Both of these stop locations are undesirable because of the difficulty in meeting stop accessibility requirements, the difficulty of snow removal on the pork chop island, and the added conflicts in the right turn lane of either transit riders or the transit vehicle itself. It is preferable that these types of stops be retrofitted to eliminate the safety and maintenance problems. Stops can be relocated 75 to 100 feet back from the pork chop island or to the far side of the intersection.

5.3.9. INDEPENDENT PEDESTRIAN CORRIDORS

Walking facilities exist in other forms besides the traditional sidewalk. When connected with the sidewalk system, independent corridors can significantly enhance the entire pedestrian network. This guide discusses three major types of independent walkways: shared-use paths (trails), greenways and mid-block walkways. All of these pedestrian corridors must be accessible to pedestrians with disabilities. Paths and greenways should accommodate maintenance and security vehicles.

5.3.9.1. Shared-use paths

Paths are the most common type of independent pedestrian corridor. Shared-use paths (multi-use trails) may be built in urban, suburban and rural areas. They can be used to connect points of interest and to increase pedestrian connectivity in areas with poor pedestrian linkages. Paths should be flexible enough to deviate from the exact route of a road to avoid hazards, to provide more direct pedestrian access to key destinations, or to take advantage of scenic routes. Shared-use paths are commonly constructed in rail corridors and parks, or along rivers or lakes. Paths should offer pedestrians separation from motorists. It is common for paths to be completely separated from roads, or have a set back from roads separated by a green area, ditch, swale or trees.

A common multi-use arrangement for paths is when pedestrians and bicyclists share a path. Although many trails are referred to as “bike paths or trails,” their use is intended for both pedestrians and bicyclists. Shared-use paths must meet both pedestrian accessibility requirements and design requirements for bicycles. The connecting pathways and access routes leading to and from a shared-use path must also meet pedestrian accessibility requirements. The guidelines discussed in this section are intended to cover paths functioning primarily as transportation facilities. Additional information on bike-only and shared paths may be found in the ***Wisconsin Bicycle Facility Design Handbook***.

Path basics. Most paths contain three basic components: trail heads, path corridors and path elements. Trail heads are the locations where pedestrians can access or exit the path. The trail head can provide useful information concerning the facility’s length, width, grade, cross slope and path elements. A map of the path system is often provided at the trail head. The path corridor is the actual travel path along a trail and extends from the beginning of the path to the ending destination. Path elements include features such as benches, restrooms and drinking water fountains. The three basic path components should be combined to create a unified and accessible path. The following subsections provide guidelines and requirements for designing several types of paths.

Design of paths. Paths need to comply with different aspects of ADA guidelines depending on the path’s primary function. If a path functions largely as a sidewalk because of its location, the places it serves, or a predominance of pedestrian use, it should be designed as a sidewalk using the requirements in the Section 1.3.5. of this guide. Shared-use path overpasses and underpasses shall follow the ***Public Rights of Way Accessibility*** *Guidelines* (PROWAG) draft

*Exhibi**88-5 t**: Well-placed drainage grates are located outside of the walking area so they do not interfere with pedestrian travel.*

guideline requirements. Paths located within their own right of way should comply with the *proposed Public Rights of Way Accessibility Guidelines (PROWAG)*.

Common surfacing materials for shared-use paths include asphalt, concrete or crushed aggregate. Each of these surface materials has advantages and disadvantages. Problems exist for crushed aggregate paths in winter and spring seasons since they do not maintain their stability during freeze and thaw cycles. While crushed aggregate may be more economical than concrete or asphalt, it is inaccessible to inline skaters and seasonally inaccessible to wheelchair users. Crushed aggregate also requires regular maintenance to maintain a consistent surface. If a shared-use path is being designed for use similar to a sidewalk—year round use, heavy pedestrian and bicyclist use – its surface material should be asphalt or concrete. Crushed aggregate may be appropriate for shared-use paths with a recreational focus – not cleared in winter, snow mobile use in winter.
All path surfaces must be firm, stable, and slip-resistant regardless of the surface material.

Path surfaces should not contain changes in level (such as abrupt vertical rises between adjacent surfaces) within the path corridor. Changes in level between ¼ and ½ inch should be beveled with a maximum slope of 50 percent. Changes in level above ½ inch should be ramped

Exhibit 5-89: Designated use lane on multi-use paths keep pedestrian traffic separated from cyclists who travel at faster speeds.

Exhibit 5-90: A protective edge along a trail must have a minimum height of 42 inches.

and should meet ADAAG ramp guidelines. Where possible, openings such as drainage grates or flange way gaps should be located outside of the walking area (Exhibit 88-5).

Paths have a maximum running grade of 5 percent, except if located in a highway corridor. The maximum grade for pathways in a highway corridor can exceed 5 percent for short segments and/or can match the grade of the adjacent roadway. For paths that follow the PROWAG requirements, length restrictions and rest intervals are necessary when the running grade exceeds 5 percent. All path segments with grades greater than 5 percent but not

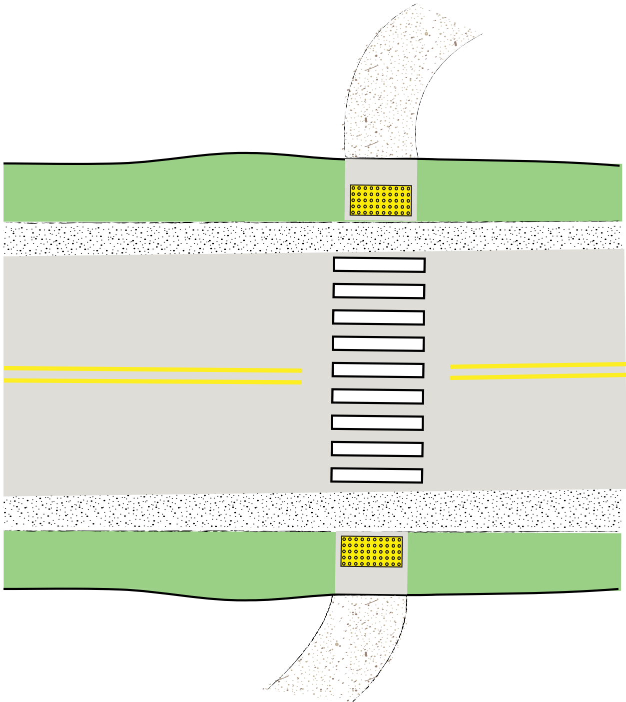


Exhibit 5-91: As as option, a concrete pad provides a surface for truncated domes where a recreational trail crosses a roadway.

more than 8.3 percent shall have a rest interval every 200 feet. All segments with grades greater than 8.3 percent but not more than 10 percent should have a rest interval every 30 feet. The combined length of all path segments with grades over 8.3 percent should account for less than 30 percent of the path's total length. Rest intervals can be designed at grades as great as 5 percent, although lesser grades are strongly recommended. High-grade segments of the path corridor should be free of all other potential impediments such as severe cross slopes or changes in level. The transition from high-grade segments of the path corridor to more level segments should be gradual instead of abrupt.

Paths should have a minimum width of 10 feet with an additional two feet of graded area provided on both sides. Paths with very limited use may have a minimum width of 8 feet, while trails with higher volumes of users should have widths between 12 and 14 feet. Distinct lanes can be delineated for users who travel at different speeds to prevent conflicts (Exhibit 5-89). While cross slopes are required for adequate drainage, severe cross slopes create barriers for pedestrians with certain types of disabilities. The path corridor should have a maximum cross slope of 2 percent if paved and 5 percent if unpaved.

Objects between the heights of 2.3 feet and 6.7 feet (protruding into the trail corridor should not protrude horizontally more than 4 inches. Objects protruding more than 4 inches must maintain a minimum vertical clearance of 10 feet. All forms of edge protection along trails, such as railings, must have a minimum height of 42 inches (Exhibit 5-90).

ADA compliant curb ramps should be provided at shared-use path access points. Detectable warnings should be provided immediately behind the curb. If there is a walking surface that is not separated from a vehicular way by a curb or another element that defines the pedestrian area from the vehicular area, the boundary between the area shall be defined by a continuous detectable warning (per ADAAG accessibility guidelines). If the path surface is crushed aggregate or gravel, a concrete pad can be added with the detectable warnings (Exhibit 5-91).

Paths should be properly integrated into the existing network of roads and sidewalks. Paths should cross roadways at a 90-degree angle. Push button signals and high visibility roadway markings should be used at crossing locations where high volume roadways and pathways intersect. Yield and stop signs on the path may be appropriate when crossing higher volume and high speed roads.

5.3.9.2. Rail trails

Many people are familiar with rail-trails—shared-use paths developed along railroad corridors. Over 20 rail-trails are located in Wisconsin. Some of these rail-trails were converted from their former use as a railroad corridor, while others are located alongside active rail corridors.

5.3.9.2.1. Rails-to-trails

Rails-to-trails are shared-used paths located along unused or abandoned rail corridors. These paths are created with the understanding that the rail line may become active rail lines in the future. Most are designed for pedestrians and bicyclists and are often long distance trails. Using abandoned rail routes for pedestrian underpasses and overpasses is one way to mitigate the barrier effect of pedestrian route continuity and establish connections for recreational trails. The Elroy-Sparta State Trail, located in southwestern Wisconsin, was the first abandoned rail corridor in the United States to be converted into a recreational trail.

Exhibit 5-92: Some communities have had success incorporating pedestrian pathways alongside rail corridors, although considerable coordination with the rail company is necessary.

5.3.9.2.2. Rails-with-trails

As trail popularity increases and communities look for innovative solutions to incorporate trails into their communities, rails-with-trails (RWT) have become increasingly popular. RWTs are located adjacent to or within an active railroad corridor (Exhibit 5-92).

Many successful RWTs show the ability of trains and trails to co-exist. For example, the LaCrosse River State Trail serves as a 34-mile connector between the Elroy-Sparta State Trail and the Great River Trail. Freight and passenger trains run on adjacent rail line over a dozen times a day.

No national standards or guidelines direct RWT setbacks and separations between the active rail lines and the trails. Guidance must be gathered from design standards for other types of facilities such as shared-use paths, pedestrian facilities, railroad facilities, and crossings over railroad rights of way. RWTs must be designed to meet the operational needs of the railroad and the safety of the trail user.

Refer to FHWA's ***Rails with Trails: Lessons Learned*** for guidance on the development, design, and operational aspects of RWT projects.

5.3.9.3. Greenways

Greenways are open spaces established along natural corridors. They have historically served as pedestrian linkages between neighborhoods, natural areas, and parks. Recently, many have been opened up to bicyclists as well. Greenways are often designated as parkland or corridors of protected open space. Milwaukee County was a national leader in establishing parkways (greenways) along creeks and rivers.

Conservation component. Greenways are maintained and managed for conservation, transportation and recreational purposes. They are used to protect environmentally sensitive land along rivers, streams and wetlands. They also preserve open space and natural corridors. The establishment of a greenway may also create corridors for the movement of wildlife and act as a potential buffer for storm water control.

Design of greenways. Greenway paths can be designed for exclusive use by pedestrians or as shared-use paths. Generally, greenways should be designed for shared-use using the design guidance for paths (***Section9.1.3.5.***). This guidance reflects ADA standards described in *Designing Sidewalks and Trails for Access*. Greenways designed for exclusive use by pedestrians can use the design guidance for sidewalk standards (***Section1.3.5.***) or PROWAG.

Like trails, greenways benefit from having multiple pedestrian access points and limited street and driveway crossings. This reduces the potential number of conflict points and increases the level of comfort for greenway users.

5.3.9.4. Mid-block walkways

Mid-block walkways are a continuation of the sidewalk system. Mid-block walkways are often provided in areas with especially long blocks to achieve better pedestrian access to trip generators.

Exhibit 5-93: Mid-block walkways can provide a continuation of the sidewalk systems to create better access for pedestrians.

Mid-block walkways are often combined with a mid-block crossing to form an uninterrupted extension of the independent pedestrian corridor (Exhibit 5-93). Many mid-block walkways are found in urban areas where there is a long block or group of sizeable buildings disrupting the established grid pattern of roads and sidewalks.

Design of mid-block walkways. Of the three types of independent pedestrian corridors described in this guide, mid-block walkways are typically designed to serve only pedestrians, not both pedestrians and bicyclists. However, they may be designed to path standards or be widened to better accommodate shared use.

The minimum width of mid-block walkways is 6 feet. Providing a minimum 10-foot easement allows a 2-foot clearance on both sides. Additional width is important for maintaining the path and storing snow. Neighbors often construct fences along these walkways. This visually narrows the walkways and provides less effective room, especially at shoulder height. Additional real estate or easement width is required if the walkways are designed as shared-use paths. If the walkway is to be built to a trail standard, designers shall follow ADA PROWAG guidelines as well as bicycle-related standards.

5.3.10. ON-STREET PARKING

On-street parking is either angled or parallel to the roadway. Parallel parking is considered the standard choice for roadways under 45 mph. Table 5-4 identifies parking restrictions that should be used from the curb to the start/end of parallel parking.

Angle parking is commonly used in low-speed residential, mixed use and commercial areas when parking demand is greater than that provided by parallel parking. It is more difficult to see around angle-parked cars than parallel-parked cars. For this reason, a larger parking restriction from the parked cars to the intersection is required. The size of the restricted

Table 5-4: Parking restrictions based on roadway speed

Speed zone	Parking restriction
20–30 MPH	20 feet from curb
35–45 MPH	50 feet from curb
45 MPH or higher	Prohibited

Exhibit 5-94: Park and ride facilities may provide connections between different modes of transportation.

area depends on the angle at which the cars are parked and the direction to which pedestrians are looking. See *Section 5.2.1.6.* for a description of how sight lines affect pedestrian travel.

5.3.10.1. Community or regional parks/special events

On weekends and during special events, community or regional parks may attract large numbers of visitors. Generally, the parking provided for the park cannot accommodate the number of visitors generated by some of these events. This may create the need for additional on-street parking in high traffic areas. Pedestrians may find themselves in a precarious situation—crossing the roadway in between parked cars and creating a potential safety hazard. One solution is to erect a fence alongside the area to channel pedestrian to a single crossing point or intersection. Parking restrictions could also be placed on the opposite side of the street when parking is allowed adjacent to the recreational facility. This eliminates individuals from crossing the roadway to access parked vehicles.

5.3.10.2. Park and ride facilities

Designers provide for the safe passage of pedestrians within park and ride lots. Some park and ride facilities are utilized to provide connections with other transportation modes. Pedestrians often connect on foot or via transit with these facilities to make connections to carpools, vanpools, passenger rail service and long distance transit. Park and ride facilities should provide safe access to the facility and sheltered waiting areas (Exhibit 5-94). They should also be well lit.

Exhibit 5-95: Using CSD principles, a community can assert its character in public works projects..

5.4. Community Sensitive Design

Community sensitive design (CSD), sometimes called context sensitive design, strives to preserve and enhance a sense of place when building or expanding public works projects (Exhibit 5-95). It is intended to create the opportunity for project selection and design to fit the character of a community rather than be a one-size-fits-all approach to transportation planning.

WisDOT formally adopted CSD in 2002 by incorporating its principles into the FDM. ***FDM Section 11-3-1*** states:

It is WisDOT policy to use a community sensitive design approach to enhance excellence in transportation project development and resulting solutions. CSD is the art of creating public works projects that function safely and efficiently, and are pleasing to both the users and the neighboring communities. The goal of CSD is to leave a lasting public works legacy that will stand the test of time.

Community sensitive design is a collaborative interdisciplinary approach that includes early involvement of all stakeholders to ensure that transportation projects not only provide safety and mobility, but are also in harmony with communities and the natural, social, economic, and cultural environments.

In accomplishing this, a variety of design, construction and safety standards must be met, along with environmental considerations. Design exceptions to standards may be used, where appropriate and necessary. These must be documented and approved, and must contain a thorough analysis of the consequences and trade-offs.

5.4.1. FLEXIBILITY OF DESIGN CRITERIA

FDM criteria should be used in preliminary designs. The design must meet the safety and mobility needs of users and soften impacts to community and environmentally sensitive areas.

Exceptions to the FDM design criteria can be made if needed to reduce negative impacts. However, the use of less-than-minimum design specifications should be rare and only for unique situations where even minimum specifications will cause excessive negative impacts to community or environmentally sensitive areas.

The elements of flexible design criteria in the streetscape addressed in this Guide include:

- Lane widths (***Section 5.2.1.3.***)
- Intersections (***Section 5.2.1.5.***)
- Barriers/separation (***Section 5.2.1.7.***)
- Sidewalks (***Section 5.3.1.***)
- Shoulders (***Section 5.3.2.***)
- Curb ramps (***Section 5.3.3.***)
- Pedestrian crossings (***Section 5.3.4.***)
- Grade separated crossings (***Section 5.3.6.***)
- Transit facilities (***Section 5.3.8.***)
- Independent pedestrian corridors (***Section 5.3.9.***)
- Parking (***Section 5.3.10.***)

5.4.1.1. Developing a public involvement plan

An important aspect of CSD is to involve the public early in the design process and develop a public involvement plan. Preparation of a public involvement plan involves creating a detailed and sequential list of designated public contacts. Members of the concerned community must have the opportunity to be involved in the project in a planned and orderly manner that is consistent with CSD philosophy. The public involvement plan must be updated as intentions change. Public involvement meetings should be conducted during each phases of the design process: Planning, Scoping, Investigation, and Determination. They should also be conducted before beginning the Final Design and Construction phases.

WisDOT's facilities development process includes public involvement opportunities early and often. The process includes coordination with and extensive outreach to internal and external stakeholders in the development of policy changes. Designers shall use guidance in ***FDM Chapter 6*** on WisDOT-funded projects. This guidance may also be useful for non-WisDOT projects.

Integrating the principles of CSD into a public works project is more of an art than a science. No two projects are alike, and no engineering formula guarantees successful project development. A successful project should accomplish all of its stated objectives.