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Chapter 12 - Sidewalks and Bicycle Facilities

12A Sidewalks

12B Bicycle Facilities

General Sidewalk Requirements

A. Introduction

Sidewalks are an integral component of the transportation system. They provide a designated area, separated from the roadway, for pedestrians to use for both travel and recreation. Along roadways where pedestrians are present or anticipated, consideration should be given to constructing sidewalks on both sides of the road to minimize conflicts between vehicles and pedestrians.

Where sidewalks are provided, they must be constructed so they are accessible to all potential users, including those with disabilities. Design standards for pedestrian access routes are provided in Section 12A-2.

B. Sidewalk Classes

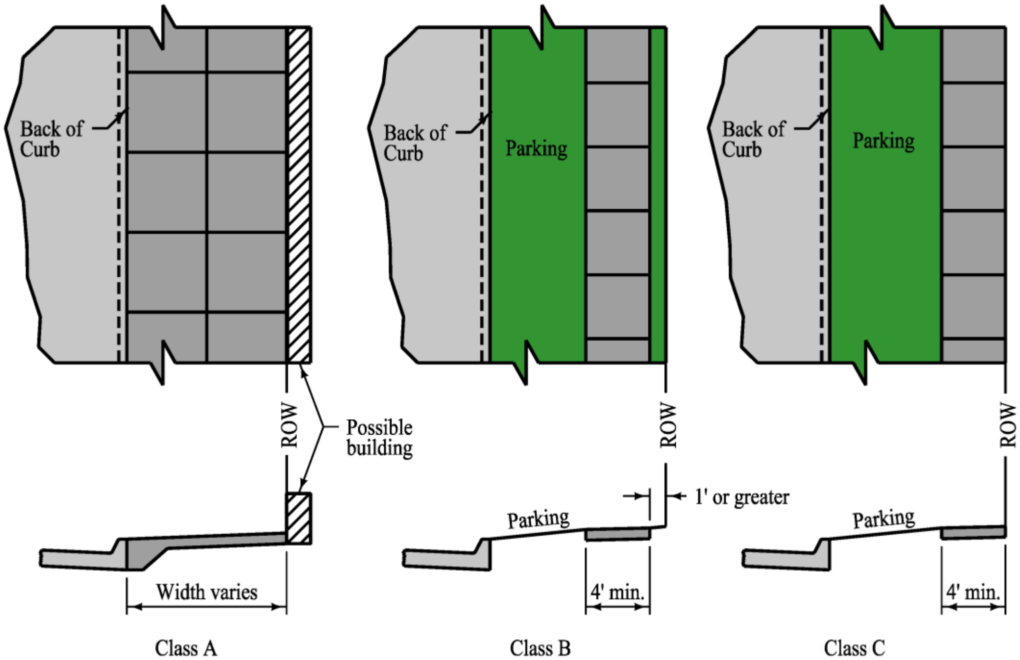
SUDAS identifies three classes of sidewalks, which are described below. Class B and C sidewalks provide a grass strip between the back of curb and the sidewalk, often referred to as the "parking."

1. **Class A:** Class A sidewalks begin at the back of curb and generally extend to the right-of-way line. These types of sidewalks are typical in downtown areas. Consideration must be given to the location of street signs, street lighting, utilities, mailboxes, snow storage, and other obstacles when utilizing Class A sidewalk.

2. **Class B:** Class B sidewalks are constructed with the back edge of the sidewalk 1 foot or more off of the right-of-way line.

3. **Class C:** Class C sidewalks have the back edge of the sidewalk on the right-of-way line.

Figure 12A-1.01: Classes of Sidewalk



C. Accessible Sidewalk Design

It has been common practice to place the responsibility for sidewalk ramp layout on the contractor or construction inspector. This has resulted in the sidewalk, curb ramps, driveway crossings, etc. being designed in the field, often with mixed accessibility results. As public right-of-way accessibility comes under greater scrutiny, it is increasingly important that newly constructed or altered sidewalks meet accessibility requirements. Therefore, sidewalks, curb ramps, and street crossings shall be included as part of the design process and the details of those designs shall be included in the contract documents as appropriate. Projects reviewed or let by the Iowa DOT will require use of S sheets according to the Iowa DOT Design Manual Section 1F-18.

D. Construction Requirements

1. **Sidewalk Thickness:** Sidewalks should be constructed of PCC with a minimum thickness of 4 inches. Where sidewalks cross driveways, the minimum thickness is 6 inches, or the thickness of the driveway, whichever is greater.

2. **Obstructions:** All obstructions are to be removed or relocated except for those that are impractical to move. In new development areas, these items should never occur, but in older, established areas, they will have to be addressed. In the case where the sidewalk is shifted to avoid an obstacle, use of a minimum 2:1 taper to and from the obstruction with a straight section adjacent to the obstruction should be considered. Flatter tapers may be used if space is available and user volume is high.

3. **Construction Tolerances:** Dimensions are subject to conventional industry tolerances except where dimensions are stated as a range, minimum, or maximum. Conventional industry tolerances include tolerances for field conditions and tolerances that may be a necessary consequence of a particular manufacturing process. Conventional industry tolerances do not apply to design work; see PROWAG R103.1. Designing features to the target values, rather than the allowable maximum or minimum, allows for appropriate construction tolerances and field adjustment during construction while maintaining compliance with PROWAG.

Accessible Sidewalk Requirements

A. Introduction

SUDAS and Iowa DOT jointly developed this section based on the July 26, 2011 "Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way." This section was developed in accordance with Federal regulations (23 CFR 652 and 28 CFR 35) and is the standard for use by all governmental entities in the State of Iowa. A local jurisdiction may elect to produce their own standards; however, these will require review and approval by FHWA and/or the United States Department of Justice.

Where sidewalks are provided, they must be constructed so they are accessible to all potential users, including those with disabilities. This section establishes the criteria necessary to make an element physically accessible to people with disabilities. This section also identifies what features need to be accessible and then provides the specific measurements, dimensions, and other technical information needed to make the feature accessible. The requirements of this section were developed based on the following documents:

1. **ADAAG:** The "Americans with Disabilities Act Accessibilities Guidelines" (ADAAG) was written by the US Access Board and adopted by the Department of Justice (DOJ) in 2010. This document includes a broad range of accessibility guidelines including businesses, restaurants, public facilities, public transportation, and sidewalks. These standards were originally adopted in 1991 and have been expanded and revised several times.

2. **PROWAG:** The July 26, 2011 "Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way" was written by the US Access Board and is also known as the Public Right-of-Way Accessibility Guidelines or PROWAG. PROWAG provides more specific information than the ADAAG for transportation facilities within the right-of-way including pedestrian access routes, signals, and parking facilities. The PROWAG requirements are currently in the development and adoption process and have not been officially adopted by the Department of Justice; however, the Federal Highway Administration has issued guidance that the draft version of the PROWAG "are currently recommended best practices, and can be considered the state of the practice that could be followed for areas not fully addressed" in the existing ADAAG requirements.

   Due to the widespread acceptance of the PROWAG, and their pending adoption in the future, the standards of this chapter are based upon the PROWAG requirements. The designer is encouraged to reference the complete PROWAG document for additional information (www.access-board.gov). References to the PROWAG in this section are shown in parentheses, e.g. (R302.7). Buildings and other structures not covered by PROWAG must comply with the applicable requirements of the ADAAG. For parks, recreational areas, and shared use paths, refer to other sections within this chapter.

B. Transition Plan

The ADA law passed in 1990 required public entities with more than 50 total employees to develop a formal transition plan identifying the steps necessary to meet ADA accessibility requirements for all pedestrian access routes within their jurisdiction by upgrading all noncompliant features. Recognizing that it would be difficult to upgrade all facilities immediately, the law provided the opportunity to develop a transition plan for the implementation of these improvements. Covered entities had until 1992 to complete a transition plan. In addition, any local public agency that is a recipient of US DOT funds must have a transition plan. For those agencies that have not completed a transition plan, it is critical that this process be completed. Although the transition plan may cover a broader scope, this section will only cover requirements within the public right-of-way.

Key elements of a transition plan include the following:

- Identifying physical obstacles in the public agency's facilities that limit the accessibility of its programs or activities to individuals with disabilities
- A detailed description of the methods that will be used to make the facilities accessible
- A schedule for taking the steps necessary to upgrade pedestrian access in each year following the transition plan
- Identification of the individual responsible for implementation of the plan

The document: *ADA Transition Plans: A Guide to Best Management Practices* (NCHRP Project No. 20-7 (232)) provides guidance for the development and update of transition plans. The document also assists communities in prioritizing required improvements for accessibility.

Public entities not required to have a formal transition plan are required to address noncompliant pedestrian access routes.

C. Definitions

Accessible: Facilities that comply with the requirements of this section.

Alteration: An alteration is a change that affects or could affect the usability of all or part of a building or facility. Alterations of streets, roadways, or highways include activities such as reconstruction, rehabilitation, resurfacing, widening, and projects of similar scale and effect.

Alternate Pedestrian Access Route: A route provided when a pedestrian circulation path is temporarily closed by construction, alterations, maintenance operations, or other conditions.

Curb Line: A line at the face of the curb that marks the transition between the curb and the gutter, street, or highway.

Cross Slope: The grade that is perpendicular to the direction of pedestrian travel.

Crosswalk: See pedestrian street crossing.

Curb Ramp: A ramp that cuts through or is built up to the curb. Curb ramps can be perpendicular, parallel, or a combination of parallel and perpendicular curb ramps.

Detectable Warning: Detectable warnings consist of small, truncated domes built in or applied to a walking surface that are detectable by cane or underfoot. On pedestrian access routes, detectable warning surfaces indicate the boundary between a pedestrian route and a vehicular route for pedestrians who are blind or have low vision.

New Construction: Construction of a roadway where an existing roadway does not currently exist.

Pedestrian Access Route: A continuous and unobstructed path of travel provided for pedestrians with disabilities within, or coinciding with, a pedestrian circulation path.

Pedestrian Circulation Path: A prepared exterior or interior surface provided for pedestrian travel in the public right-of-way.

Pedestrian Street Crossing: A marked or unmarked route, providing an accessible path to travel from one side of the street to the other. Pedestrian street crossings are a component of the pedestrian access route and/or the pedestrian circulation path.

Running Slope: The grade that is parallel to the direction of pedestrian travel.

PROWAG: The Public Right-of-way Accessibility Guidelines establish the criteria for providing a feature within the public right-of-way that is physically accessible to those with physical disabilities.

Scope of the Project: Work that can reasonably be completed within the limits of the project. This is not defined by the written project scope; however, it focuses on whether the alteration project presents an opportunity to design the altered element, space, or facility in an accessible manner.

Structurally Impracticable: Something that has little likelihood of being accomplished because of those rare circumstances when the unique characteristics of terrain prevent the incorporation of full and strict compliance with this section. Applies to new construction only.

Technically Infeasible: With respect to an alteration of an existing facility, something that has little likelihood of being accomplished because existing structural conditions would require removing or altering a load-bearing member that is an essential part of the structural frame; or because other existing physical or site constraints prohibit modification or addition of elements, spaces, or features that are in full and strict compliance with the requirements of this section. (2010 ADAAG 106.5)

Turning Space: An area at the top or bottom of a curb ramp, providing a space for pedestrians to stop, rest, or change direction.

D. Applicability

1. **New Construction:** Newly constructed facilities within the scope of the project shall be made accessible to persons with disabilities, except when a public agency can demonstrate it is structurally impracticable to provide full compliance with the requirements of this section. Structural impracticability is limited to only those rare situations when the unique characteristics of terrain make it physically impossible to construct facilities that are fully compliant. If full compliance with this section is structurally impracticable, compliance is required to the extent that it is not structurally impracticable. [2010 ADAAG 28 CFR 35.151(a)]

2. **Alterations:** Whenever alterations are made to the pedestrian circulation path, the pedestrian access route shall be made accessible to the maximum extent feasible within the scope of the project. If full compliance with this section is technically infeasible, compliance is required to the extent that it is not technically infeasible. [2010 ADAAG 28 CFR 35.151(b)] Alterations shall not gap pedestrian circulation paths in order to avoid ADA compliance.

Resurfacing is an alteration that triggers the requirement for curb ramps if it involves work on a street or roadway spanning from one intersection to another. Examples include, but are not limited to, the following treatments or their equivalents:

- New layer of surface material (asphalt or concrete, including mill and fill)
- Reconstruction
- Concrete pavement rehabilitation and reconstruction
- Open-graded surface course
- Microsurfacing and thin lift overlays
- Cape seals (slurry seal or microsurfacing over a new chip seal)
- In-place asphalt recycling

[DOJ/U.S. DOT Glossary of Terms and DOJ/U.S. DOT Technical Assistance; June 28, 2013]

Where elements are altered or added to existing facilities, but the pedestrian circulation path is not altered, the pedestrian circulation path is not required to be modified (R202.1). However, features that are added shall be made accessible to maximum extent feasible. The following are examples of added features:

- Installation of a traffic sign does not require sidewalk improvements; however, the sign cannot violate the protruding objects requirements.
- Installation of a traffic or pedestrian signal does not require sidewalk improvements; however, the signal must be accessible.
- Installation of a bench adjacent to the pedestrian access route would not require sidewalk improvements, but the bench cannot be placed in a manner that would reduce the sidewalk width below the minimum requirement.

3. **Maintenance:** Accessibility improvements are not required for work that is considered maintenance. Examples of work that would be considered maintenance include, but are not limited to, the following items.

- Painting pavement markings, excluding parking stall delineations
- Crack filling and sealing
- Surface sealing
- Chip seals
- Slurry seals
- Fog seals
- Scrub sealing
- Joint crack seals
- Joint repairs
- Dowel bar retrofit
- Spot high-friction treatments
- Diamond grinding
- Minor street patching (less than 50% of the pedestrian street crossing area)
- Curb and gutter repair or patching outside the pedestrian street crossing
- Minor sidewalk repair that does not include the turning space and curb ramps
- Filling potholes

If a project involves work not included in the list above, or is a combination of several maintenance items occurring at or near the same time, the agency administering the project is responsible for determining if the project should be considered maintenance or an alteration. If either of these two situations is determined to be maintenance, the agency administering the project must document the reasons for this determination. If the project is defined as maintenance, federal funding and Farm-to-Market funds cannot be used.

When a maintenance project modifies a crosswalk, installation of curb ramps at the crosswalks is recommended, if none already exists. The other accessibility improvements of this section are also recommended, but not required with such projects.

4. **Technical Infeasibility:** Examples of existing physical or site constraints that may make it technically infeasible to make an altered facility fully compliant include, but are not limited to, the following:
   - Right-of-way availability. Right-of-way acquisition in order to achieve full compliance is not mandatory, however, it should be considered. Improvements may be limited to the maximum extent practicable within the existing right-of-way.
   - Underground structures that cannot be moved without significantly expanding the project scope.
   - Adjacent developed facilities, including buildings that would have to be removed or relocated to achieve accessibility.
   - Drainage cannot be maintained if the feature is made accessible.
   - Notable natural or historic features that would have to be altered in a way that lessens their aesthetic or historic value.
   - Underlying terrain that would require a significant expansion of the project scope to achieve accessibility.
   - Street grades within the crosswalk exceed the pedestrian access route maximum cross slopes, provided an engineering analysis has concluded that it cannot be done without significantly expanding the project scope (for example, changing from resurfacing an intersection to reconstructing that intersection).

5. **Safety Issues:** When accessibility requirements would cause safety issues, compliance is required to the maximum extent practicable.

6. **Documenting Exceptions:** If the project cannot fully meet accessibility requirements because the accessibility improvements are structurally impracticable, technically infeasible, or safety issues, a document should be developed to describe how the existing physical or site constraints or safety issues limit the extent to which the facilities can be made compliant. This document should identify the specific locations that cannot be made fully compliant and provide specific reasons why full compliance cannot be achieved. It is recommended that this document be retained in the project file. For local agency projects administered through Iowa DOT, an “Accessibility Exceptions Certification” (Form 517118) with supporting documentation shall be signed by a registered professional engineer or landscape architect licensed in the State of Iowa and submitted to the Iowa DOT administering office. The certification shall be as prescribed by Iowa DOT Local Systems I.M. 1.080. For Iowa DOT projects, contact the Office of Design, Methods Section.

   Note: Documenting exceptions does not remove an agency’s responsibility to consider making accessibility improvements the next time the facility is altered because physical or site constraints and safety issues may change over time. The determination of exceptions and corresponding documentation needs to be made each time a facility is altered, based on the existing conditions and the scope of the proposed project.

7. **Reduction in Access:** Regardless of whether the additions or alterations involve the modification of the existing pedestrian circulation path, the resulting work cannot have the result of reducing the existing level of accessibility below the minimum requirements. For example, the installation of a bench cannot have the effect of reducing the width of the pedestrian access route to 3 feet (4 feet is the minimum). Likewise, the construction of an overlay cannot result in a street cross slope of more than 5%, nor have a lip at the curb ramp that exceeds 1/2 inch.

Pedestrian facilities may be removed if they are being re-routed for safety reasons, or terminated because they do not connect to a destination or another pedestrian circulation path.

8. **Addition of Pedestrian Facilities:** If a sidewalk exists on both sides of the street, curb ramps shall be installed on both sides when the street is altered. PROWAG does not require construction of pedestrian facilities where none currently exists, although the jurisdiction's transition plan may require them.

9. **Utility Construction:** If the pedestrian circulation path is disturbed during utility construction, the requirements of this section and Section 12A-4 shall apply.

E. Standards for Accessibility

The following section summarizes the design standards for the elements of an accessible pedestrian access route. The minimum and maximum values stated are taken from the PROWAG. Target values are also provided. Designing features to the target values, rather than the allowable maximum or minimum, allows for appropriate construction tolerances and field adjustment during construction while maintaining compliance with the PROWAG standards.

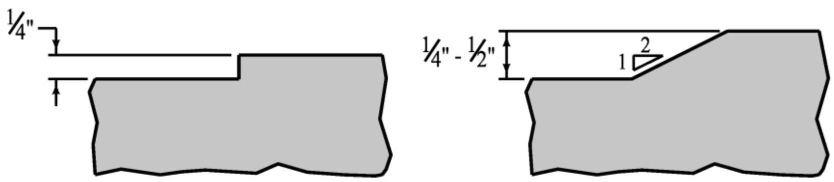
1. **General Requirements:** These requirements apply to all parts of the pedestrian access route.

   a. **Surfacing:** PROWAG requires all surfaces to be firm, stable, and slip resistant (R302.7). All permanent pedestrian access routes, with the exception of some Type 2 shared use paths (see Section 12B-2), shall be paved. When crossing granular surfaced facilities, consider paving wider than the pedestrian access route; see the shared use path section.

   b. **Vertical Alignment:** Vertical alignment (smoothness) shall be generally planar within the pedestrian access routes (R302.7.1). Although no definition for generally planar is provided, the Advisory statement for R302.7.1 indicates surfaces must be smooth and chosen for easy rollability and minimizing vibration for users of wheelchairs, scooters, and walkers. Surfaces that are heavily textured, rough, or chamfered and paving systems consisting of individual units that cannot be laid in plane should be reserved for borders and decorative accents located outside of and only occasionally crossing the pedestrian access route. Research has shown that bricks/pavers with no or narrow chamfers and narrow joint spacing between pavers can minimize vibration for all users. Bricks/pavers with sand bedding on natural soil should not be used in pedestrian access routes due to maintenance problems.

   c. **Changes in Level:** Changes in level, including bumps, utility castings, expansion joints, etc. shall be a maximum of 1/4 inch without a bevel or up to 1/2 inch with a 2:1 bevel. Where a bevel is provided, the entire vertical surface of the discontinuity shall be beveled (R302.7.2).

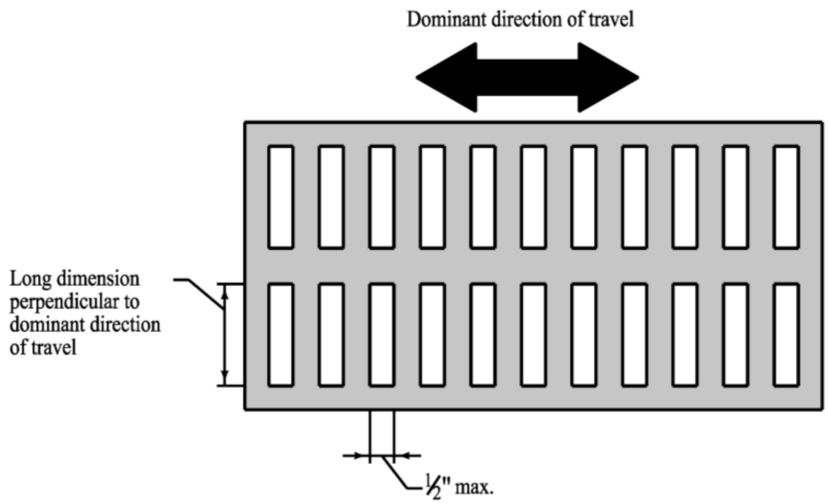
Figure 12A-2.01: Vertical Surface Discontinuities



d. **Horizontal Openings:** Horizontal openings shall not allow passage of a sphere more than 1/2 inch in diameter. Elongated openings in grates shall be placed so the long dimension is perpendicular to the dominant direction of travel. The use of grates within the pedestrian access route is discouraged; however, where necessary, the grate should be located outside of curb ramp runs, turning spaces, and gutter areas if possible. (R302.7.3)

It should be noted that none of the standard SUDAS/Iowa DOT intake grates meet the requirements for use within a pedestrian access route; therefore, a special design is required.

Figure 12A-2.02: Horizontal Openings



2. **Standard Sidewalk:** Sidewalks solely serving private residences are not required to follow these requirements.

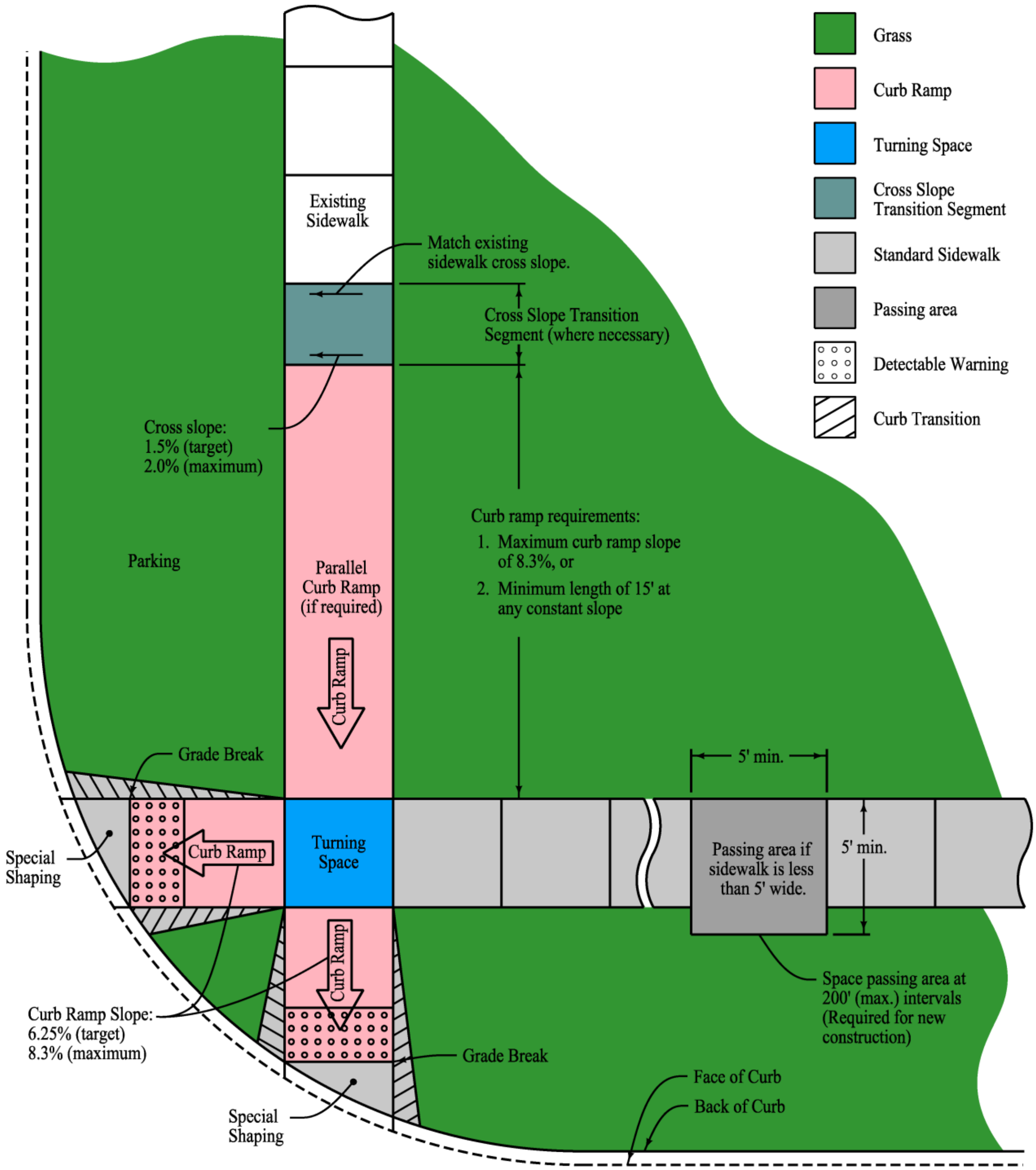
a. **Cross Slope:** The maximum cross slope is 2.0% with a target value of 1.5% (R302.6).

b. **Running Slope:** Sidewalks with a running slope of 5% or less are acceptable. However, where the sidewalk is contained within the street right-of-way, the grade of the sidewalk shall not exceed the general grade of the adjacent street (R302.5). For design, consider the general grade of the adjacent street to be within approximately 2% of the profile grade of the street.

c. **Width:** The minimum width of the pedestrian access route is 4 feet. Five foot sidewalks are encouraged and may be required by the Jurisdiction. Iowa DOT will design 5 foot sidewalks unless otherwise requested. (R302.3)

d. **Passing Spaces:** Where the clear width of the pedestrian access route is less than 5 feet, passing spaces are required at maximum intervals of 200 feet. The passing space shall be 5 foot minimum by 5 foot minimum. Passing spaces may overlap with the pedestrian access route. (R302.4). Driveways may be used as passing spaces, as long as the 2.0% maximum cross slope is not exceeded.

Figure 12A-2.03: Standard Sidewalk and Curb Ramp Elements

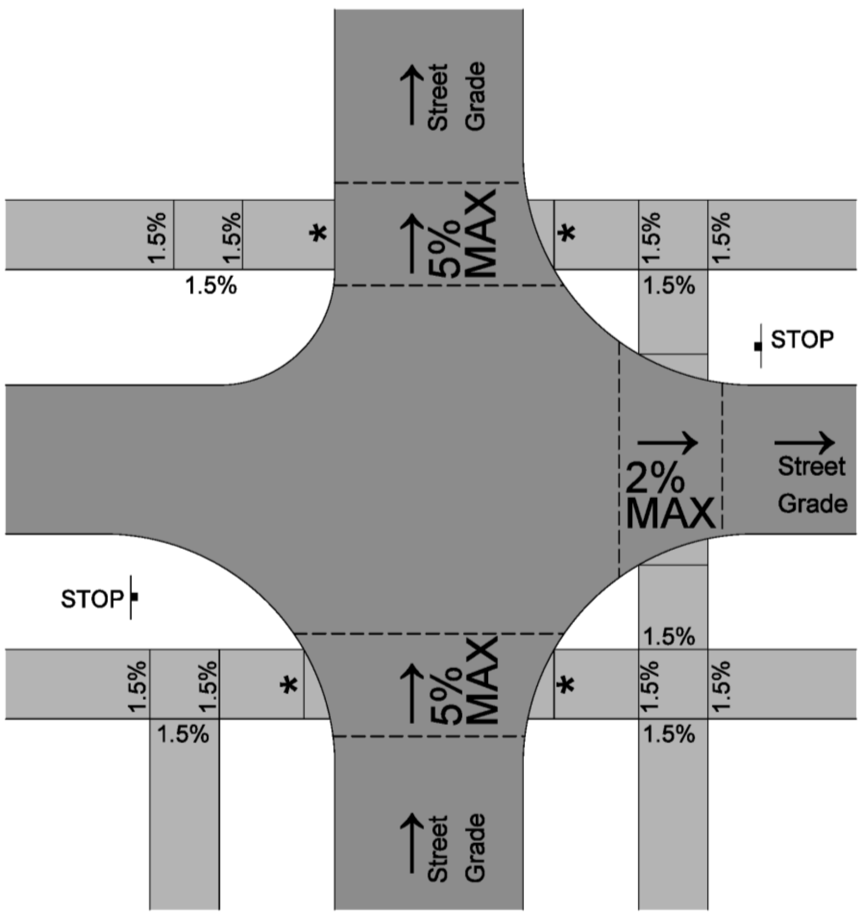


3. Pedestrian Street Crossings:

a. Cross Slope: The longitudinal grade of a street becomes the cross slope for a pedestrian street crossing. PROWAG has maximum limits for the cross slope of pedestrian street crossings, which vary depending on the location of the crossing and the type of vehicular traffic control at the crossing. These requirements, in effect, limit the longitudinal grade of a street, or require a "tabled crosswalk" at the intersection. (R302.6)

1) **Intersection Legs with Stop or Yield Control:** For pedestrian street crossings across an intersection leg with full stop or yield control (stop sign or yield sign), the maximum cross slope is 2.0% (maximum 2.0% street grade through the crossing).
2) **Intersection Legs without Stop or Yield Control:** For pedestrian street crossings across an intersection leg where vehicles may proceed without slowing or stopping (uncontrolled or signalized), the maximum cross slope of the pedestrian street crossing is 5.0% (maximum 5.0% street grade through the crossing).
3) **Midblock Pedestrian Street Crossings:** At midblock crossings, the cross slope of the pedestrian street crossing is allowed to equal the street grade.

Figure 12A-2.04: Example Street Intersection

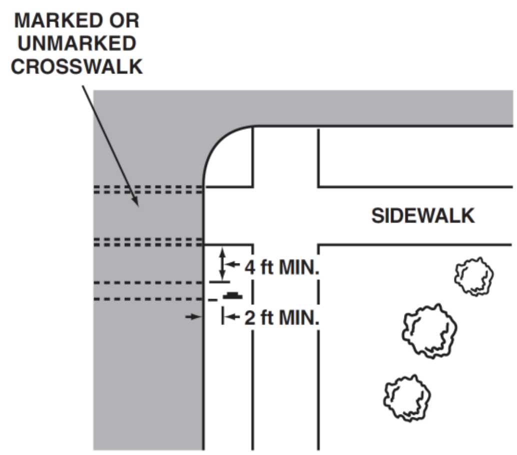


* Match pedestrian street crossing cross slope or flatter

b. Running Slope: The running slope of the pedestrian street crossing is limited to a maximum of 5.0% (maximum street cross slope or superelevation of 5.0%) (R302.5.1).

c. **Location:** Driver anticipation and awareness of pedestrians increases as one moves closer to the intersection. Therefore, curb ramps and pedestrian street crossings should be located as close to the edge of the adjacent traveled lane as practical. Where a stop sign or yield sign is provided, MUTCD requires the pedestrian street crossing, whether marked or unmarked, be located a minimum of 4 feet from the sign, between the sign and the intersection. It is recommended stop and yield signs be located no greater than 30 feet from the edge of the intersecting roadway; however, MUTCD allows up to 50 feet. Consult MUTCD for placement of curb ramps and pedestrian street crossings at signalized intersections.

Figure 12A-2.05: Pedestrian Street Crossing Location



Source: MUTCD, FHWA

d. **Medians and Pedestrian Refuge Islands:** Medians and pedestrian refuge islands in pedestrian street crossings shall be cut through level with the street or complying with the curb ramp requirements. The clear width of pedestrian access routes within medians and pedestrian refuge islands shall be 5.0 feet minimum (R302.3.1). If a raised median is not wider than 6 feet, it is recommended the nose not be placed in the pedestrian street crossing.

4. **Curb Ramps:**

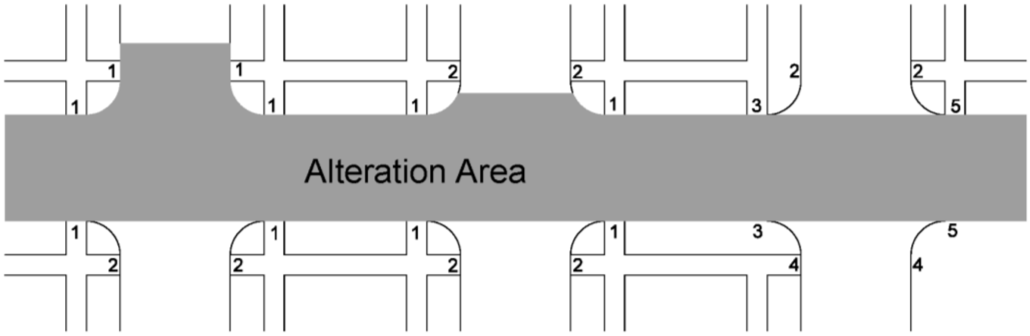
a. **General:** There are two types of curb ramps: perpendicular and parallel. Perpendicular curb ramps are generally perpendicular to the traffic they are crossing with the turning space at the top. Parallel curb ramps have the turning space at the bottom. Parallel curb ramps may be used where the sidewalk begins at or near the back of curb and there is little or no room between the sidewalk and curb for a perpendicular curb ramp.

A separate curb ramp is required at each pedestrian street crossing for new construction. Parallel ramps with a large turning space, as shown in Figure 12A-2.08, are allowed. For alterations, follow the new construction requirements if possible; however, a single diagonal curb ramp is allowed but not recommended where existing constraints prevent two curb ramps from being installed.

For transitions into and out of driveways, curb ramp requirements may be used.

For curb ramps within and near an alteration area, see Figure 12A-2.06.

Figure 12A-2.06: Curb Ramps for Alterations



1. Required.
2. Strongly recommended.
3. Required due to barriers in the path of travel between the sidewalk on one side of the street to the sidewalk on the other side of the street.
4. Recommended, but not required because it is outside the alteration area. Consider based on pedestrian usage, safety, and land development.
5. Install both sides or remove the existing one, based on pedestrian usage, safety, and land development.

b. Technical Requirements:

1) Cross Slope: The maximum cross slope is 2.0% with a target value of 1.5%; however, for intersection legs that do not have full stop or yield control (i.e. uncontrolled or signalized) and at mid-block crossings, the curb ramp cross slope is allowed to match the cross slope in the pedestrian street crossing section. See “pedestrian street crossings” for additional details. (R304.5.3)

2) Running Slope: Provide curb ramps with a target running slope of 6.25% and a maximum slope of 8.3%; however, curb ramps are not required to be longer than 15 feet, regardless of the resulting slope. (R304.2.2 and R304.3.2)

3) Width: The minimum width of a curb ramp is 4 feet, excluding curbs and flares. If the sidewalk facility is wider than 4 feet, the target value for the curb ramp is equal to the width of the sidewalk. (R304.5.1)

4) Grade Breaks: Grade breaks at the top and bottom of curb ramps must be perpendicular to the direction of the curb ramp run. Grade breaks are not allowed on the surface of curb ramp runs and turning spaces. (R304.5.2)

5) Flared Sides: For perpendicular curb ramps on Class A sidewalks, or configurations where the pedestrian circulation path crosses the curb ramp, PROWAG requires the flares along the sides of the curb ramp to be constructed at 10% or flatter. (R304.2.3) This allows pedestrians to approach the curb ramp from the side and prevents a tripping hazard. It is recommended to design these flares at a slope between 8% and 10%, which will clearly define the curb ramp from the sidewalk.

6) Clear Space: At the bottom of perpendicular curb ramps, a minimum 4 foot by 4 foot area must be provided within the width of the pedestrian street crossing, but wholly outside of the parallel vehicle travel lanes. (R304.5.5)

7) Turning Space: Turning spaces allow users to stop, rest, and change direction on the top or bottom of a curb ramp (R304.2.1 and R304.3.1).

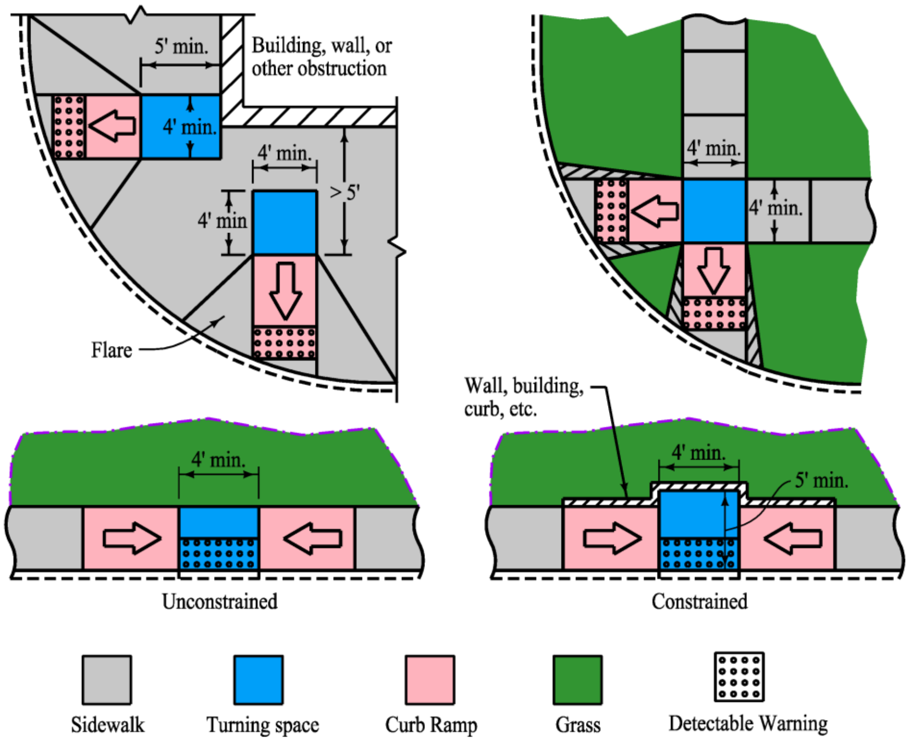
a) Placement: A turning space is required at the top of perpendicular curb ramps and at the bottom of parallel curb ramps.

b) Slope: The maximum cross slope and running slope is 2.0% with a target value of 1.5% (R304.2.2 and R304.3.2). When turning spaces are at the back of curb, cross slopes may be increased to match allowable values in the pedestrian street crossing section (R304.5.3).

c) **Size:** The turning space shall be a minimum of 4 feet by 4 feet. Where the turning space is constrained on one or more sides, provide 5 feet in the direction of the pedestrian street crossing.

8) **Special Shaping Area:** Transition area between the back of curb and the grade break. The longest side cannot exceed 5 feet.

Figure 12A-2.07: Curb Ramp Turning Spaces



c. Curb Ramp Design Considerations:

1) **Combination Curb Ramps:** For many intersection configurations, a perpendicular curb ramp will not provide enough length to establish the top turning space at the sidewalk elevation; in these situations, a parallel curb ramp is often required to transition from the turning space up to the sidewalk elevation. The use of a perpendicular curb ramp from the curb to the turning space in conjunction with a parallel curb ramp between the turning space and the sidewalk elevation is referred to as a combination curb ramp. When transitioning from a turning space to sidewalk elevation on a steep street, it is not necessary to chase the grade. As noted in the technical requirements above, a parallel curb ramp is not required to exceed 15 feet in length, regardless of the resulting curb ramp slope. In practice, the parallel curb ramp should be extended to the next joint beyond 15 feet.
2) **Cross Slope Transition Segment:** When connecting to existing construction that is out of cross slope compliance, the cross slope transition should be completed beyond the parallel curb ramp or turning space; this recommendation eliminates the need to list this curb ramp in the transition plan. It is recommended this cross slope transition take place at 1% per foot or less. Typically, this can be accomplished in a single panel.
3) **Parking Slope:** In situations where the length of the perpendicular curb ramp is insufficient to bring the turning space up to sidewalk elevation, consider lowering the sidewalk and flattening the parking slope.

5. **Blended Transitions:** A blended transition is allowed but not recommended. Design and constructability is difficult to meet compliance requirements. In lieu of a blended transition, a curb ramp or standard sidewalk should be used.

6. **Detectable Warnings:**

   a. **General:** Detectable warning surfaces are detected underfoot or with a cane by blind and low vision individuals. The warnings indicate the location of the back of curb. Detectable warnings also provide a visual queue to pedestrians with low vision and aid in locating the curb ramp across the street. For these reasons, the detectable warning shall contrast visually (light on dark or dark on light) from the surrounding paved surfaces (R305.1.3).

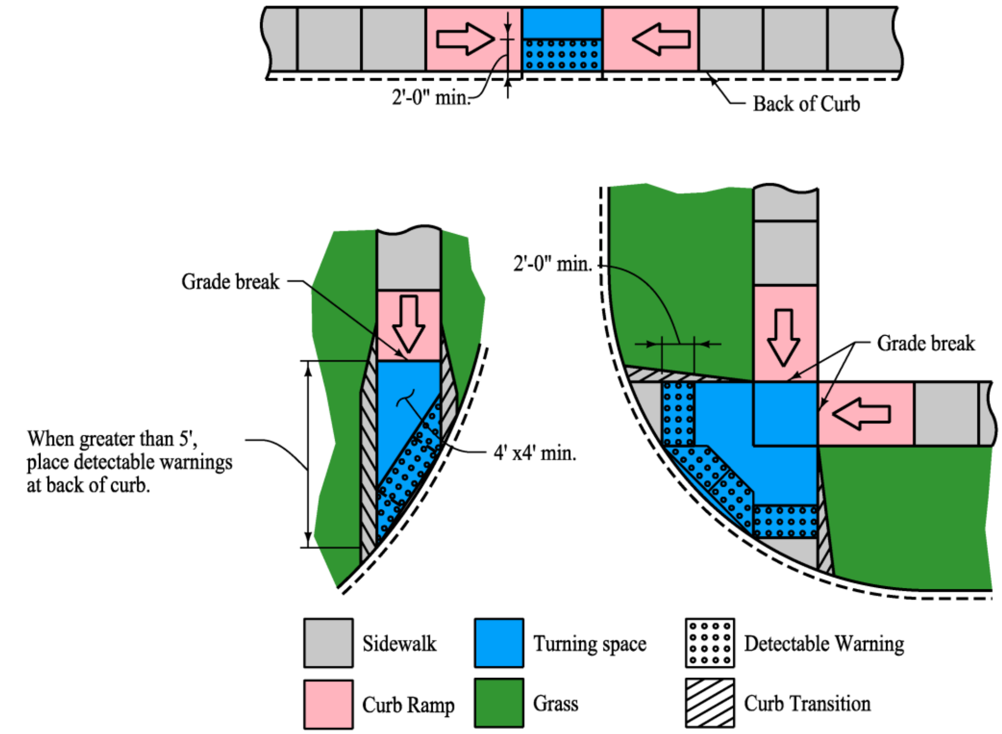
   b. **Location:** Detectable warnings shall be installed at all pedestrian street crossings and at-grade rail crossings (R208.1). Detectable warning surfaces should not be provided at crossings of residential driveways since the pedestrian right-of-way continues across the driveway. Where commercial driveways are provided with yield control, stop control, or traffic signals at the pedestrian access route, detectable warnings should be installed at the junction between the pedestrian access route and the driveway (Advisory R208.1).

   c. **Size:** Detectable warning surfaces shall extend a minimum of 2 feet in the direction of pedestrian travel and extend the full width of the curb ramp or pedestrian access route (R305.1.4).

   d. **Dome Orientation:** On curb ramps, the rows of truncated domes should be aligned perpendicular to the grade break so pedestrians in wheelchairs can track their wheels between the domes. On surfaces less than 5% slope, dome orientation is less critical.

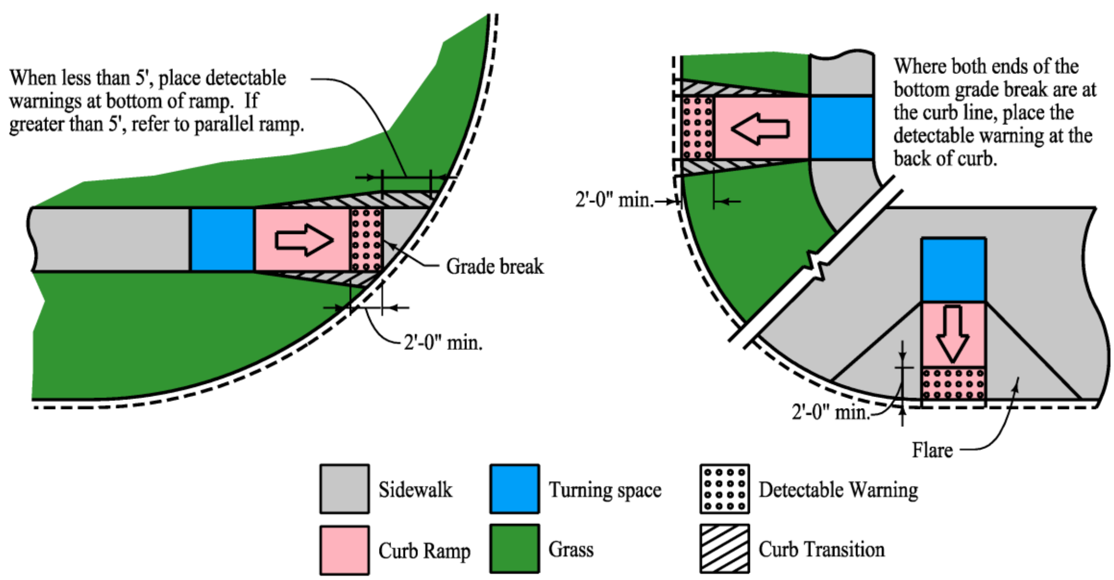
   e. **Parallel Curb Ramps:** On parallel curb ramps, detectable warning shall be placed on the turning space at the back of curb (R305.2.2).

Figure 12A-2.08: Detectable Warnings on Parallel Curb Ramps



f. Perpendicular Curb Ramps: Placement of detectable warning varies based upon location of grade break as shown in Figure 12A-2.09.

Figure 12A-2.09: Detectable Warnings on Perpendicular Curb Ramps



g. **Refuge Islands:** Where refuge islands are 6 feet wide or greater from back of curb to back of curb, detectable warning shall be placed at the edges of the pedestrian island and separated by a minimum 2 foot strip without detectable warnings. Where the refuge island is less than 6 feet wide, a 2 foot strip without detectable warnings cannot be installed. In these situations, detectable warnings shall not be installed at the island and the pedestrian signal must be timed for full crossing. (R208.1 and R208.2)

h. **Rural Cross-section:** Detectable warnings should be placed similar to urban layouts, except at the edge of shoulder instead of the back of curb.

F. Bus Stop

1. **Bus Stop Pads:** New and altered bus stop pads shall meet the following criteria.
   - Provide a firm, stable, and slip resistant surface (R308.1.3.1).
   - Provide a minimum clear length of 8 feet (measured from the curb or roadway edge) and minimum clear width of 5 feet (measured parallel to the roadway) (R308.1.1.1).
   - Connect the pad to streets, sidewalks, or pedestrian circulation paths with at least one accessible route (R308.1.3.2).
   - The slope of the pad parallel to the roadway will be the same as the roadway to the maximum extent practicable (R308.1.1.2).
   - Provide a desirable cross slope of 1.5% up to a maximum cross slope of 2.0% perpendicular to the roadway (R308.1.1.2).

2. **Bus Shelters:** Where new or replaced bus shelters are provided, install or position them to allow a wheelchair user to enter from the public way. An accessible route shall be provided from the shelter to the boarding area. (R308.2)

G. Accessible Pedestrian Signals

An accessible pedestrian signal is an integrated device that communicates information about the WALK and DON'T WALK intervals at signalized intersections in a non-visual format (i.e. audible tones and vibrotactile surfaces) to pedestrians who have visual disabilities. Consistency throughout the pedestrian system is very important. Contact the Jurisdictional Engineer regarding the standards and equipment types that should be incorporated into the design of the accessible pedestrian system. Where new or altered pedestrian signals and pushbuttons are provided they shall comply with MUTCD 4E.08 through 4E.13. Operable parts shall comply with R403. (R209.1)

1. **New Pedestrian Signals:** Each new traffic signal project location should be evaluated to determine the need for accessible pedestrian signals. An engineering study should be completed that determines the needs for pedestrians with visual disabilities to safely cross the street (MUTCD 4E.09). The study should consider the following factors:
   - Potential demand for accessible pedestrian signals
   - Requests for accessible pedestrian signals by individuals with visual disabilities
   - Traffic volumes when pedestrians are present, including low volumes or high right turn on red volumes
   - The complexity of the signal phasing, such as split phasing, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases
   - The complexity of the intersection geometry

   If a pedestrian accessible signal is warranted, audible tones and vibrotactile surfaces should be included. Pedestrian push buttons should have locator tones for the visually impaired individual to be able to access the signal.

2. **Existing Pedestrian Signals:** Excluding routine maintenance or repairs due to accidental damage, when the existing pedestrian signal controller and software are altered, or the pedestrian signal head is replaced, the pedestrian signals shall include accessible pedestrian signals and pushbuttons. (R209.2)

   If pedestrian signals are non-compliant, upgrades are recommended but not required when alterations are being made to the pedestrian circulation path.

H. On-Street Parking

- When on-street parking is marked or metered, provide accessible parking spaces according to Table 12A-2.01 (R214 and R309.1).

Table 12A-2.01 On-Street Accessible Parking Spaces

Total Number of Marked or Metered Parking Spaces on the Block Perimeter	Minimum Required Number of Accessible Parking Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 and over	4% of total

- Identify accessible parking spaces by displaying signs with the International Symbol of Accessibility (R411).
- Comply with R403 Operable Parts for parking meters and pay stations that serve accessible parking spaces.
- Locate accessible parking spaces where the street has the least crown and grade (R309.1).
- Accessible parking spaces located at the end of the block can be served by the curb ramps or blended transitions at the pedestrian street crossing (R309.4).
- Keep sidewalks adjacent to parallel accessible parking spaces free of signs, street furniture, and other obstructions. Locate curb ramps or blended transitions so the van side-lift or ramp can be deployed to the sidewalk (R309.2)
- At parallel accessible parking spaces, locate parking meters at the head or foot of the parking space (R309.5.1). Ensure information is visible from a point located 3.3 feet maximum above the center of the clear space in front of the parking meter or parking pay station (R309.5.2).
- For areas where the sidewalk width or available right of way exceeds 14 feet, provide an access aisle 5 feet wide at street level the full length of the parallel parking space and connect it to a pedestrian access route (R309.2.1). When an access aisle is not provided due to the sidewalk or right-of-way not exceeding 14 feet, locate the accessible parallel parking space at the end of the block face (R309.2.2)
- Provide an 8 feet wide access aisle the full length of the parking space for perpendicular or angled accessible parking spaces. Two accessible parking spaces are allowed to share a common access aisle (R309.3).
- For perpendicular or angled spaces, connect the access aisle to the pedestrian access route with a curb ramp. Do not locate curb ramps within the access aisle (R309.4).

Protruding Objects

A. Introduction

This section provides guidance to comply with section R402 of PROWAG. The pedestrian area is any prepared area available for pedestrians (equivalent to the pedestrian circulation path as defined in PROWAG). A protruding object is any obstacle that reduces the clearance width and/or the clearance height within a pedestrian area. The pedestrian area is not limited to the sidewalk or the pedestrian access route intended by the designer. The pedestrian area includes any areas that may be perceived as a pedestrian walking space, including adjacent parking lots and paved frontage.

Common protruding objects include:

- Signs and Sign poles
- Landscaping and branches
- Utility boxes or poles and their stabilizing wires
- Mailboxes (public and private)
- Trash cans
- Transit shelters
- Bike racks
- Planters
- Fire hydrants
- Parking meters
- Benches
- Public Art

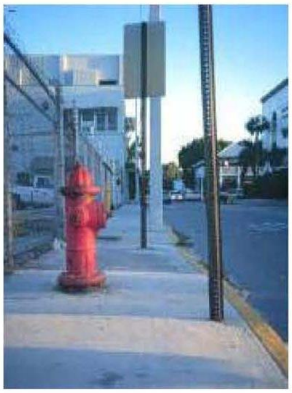
B. Protruding Object Locations

1. **Outside the Pedestrian Area:** A protruding object can result in narrow passing spaces, reduced access, and injury. Therefore, protruding objects should be placed completely outside of the pedestrian area whenever possible.

2. **Within the Pedestrian Area:** Ideally, the full width of the pedestrian area should be free of protruding objects and the pedestrian access route would be clearly separated from other paved surfaces. However, if some obstacles must be located within the pedestrian area, they should all be placed either right or left of center to provide a consistent pedestrian access route. Figure 12A-3.01 shows an acceptable pedestrian area with obstacles aligned, providing a consistent pedestrian access route. Figure 12A-3.02 shows an undesirable pedestrian area with a poorly defined pedestrian access route. The pedestrian access route within the pedestrian area must meet guidelines defined in this chapter. Special sidewalk treatments (such as brick pavers or stamped concrete) are recommended to provide a different surface texture to differentiate between the object corridor and the pedestrian access route.

Figure 12A-3.01: Acceptable Pedestrian Area

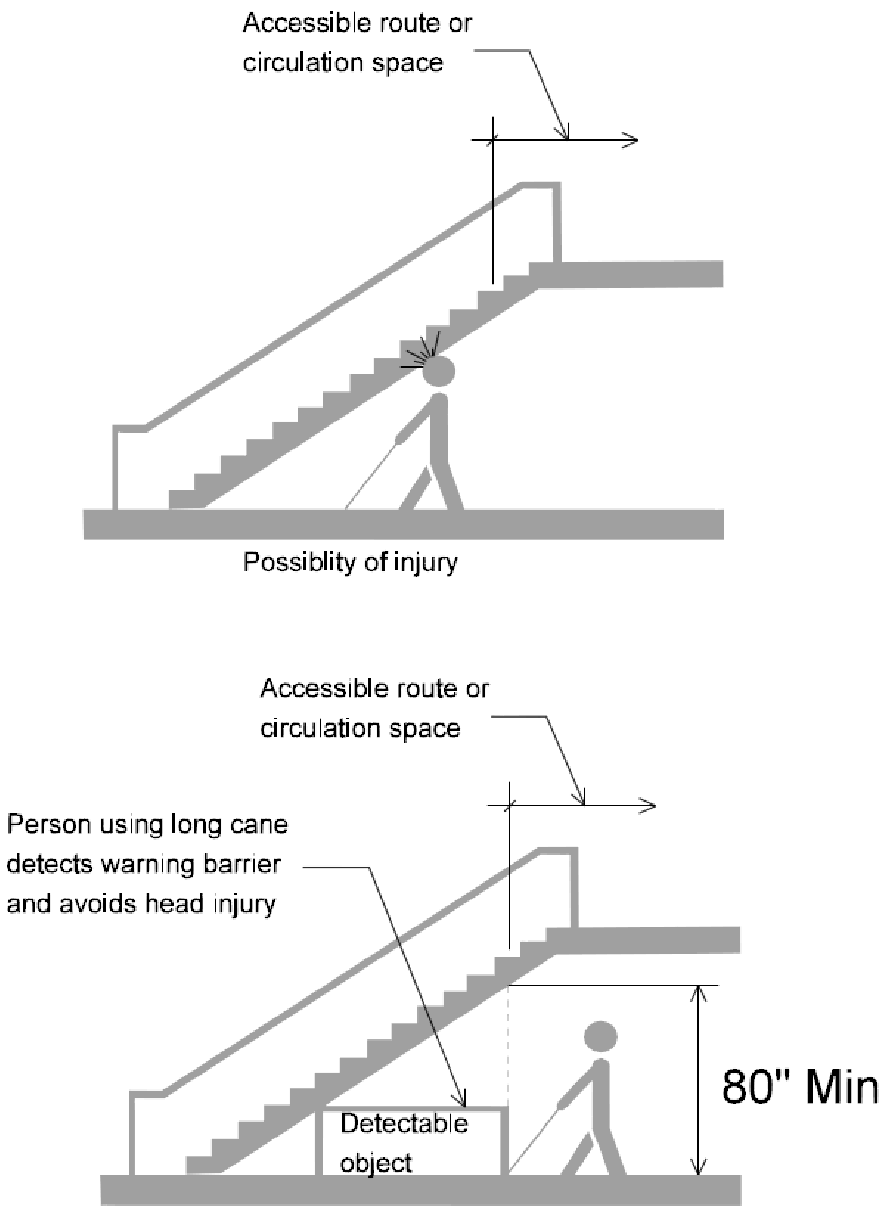
Figure 12A-3.02: Undesirable Pedestrian Area



C. Clearance

1. **Vertical Clearance:** Vertical clearance is minimum unobstructed vertical passage space required along the entire width of the pedestrian corridor. A minimum vertical clearance of 80 inches must be provided or the object must be shielded with a barrier. The leading edge of the barrier shall be a maximum of 27 inches above the finished surface. See Figure 12A-3.03.

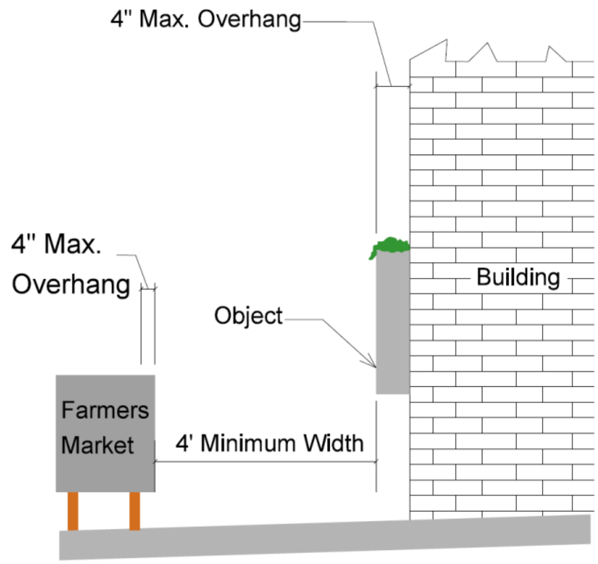
Figure 12A-3.03: Shielding for Vertical Clearance Obstacles



2. **Horizontal Clearance:** Objects mounted at or below 27 inches may extend from a fixed structure into the pedestrian area, provided the remaining sidewalk width complies with Section 12A-2. Objects that extend below 27 inches are easily detectable by most pedestrians.

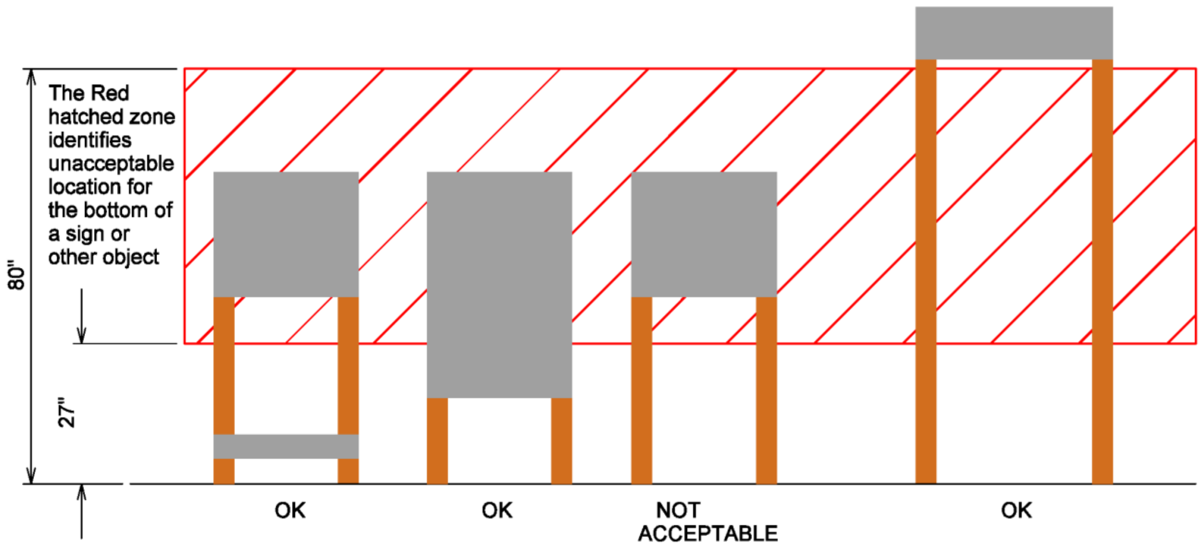
Objects that extend into the pedestrian area at a height above 27 inches are not easily detected with a cane and pedestrians may walk into them. This type of object cannot extend into the pedestrian corridor more than 4 inches from its base. The base shall be at least 2.5 inches in height. See Figure 12A-3.04.

Figure 12A-3.04: Horizontal Clearance



3. **Objects Mounted Between Posts:** Where an object is mounted between posts or pylons and the clear distance between the posts or pylons is greater than 12 inches, the lowest edge of the object shall be between 0 and 27 inches or 80 inches or more above the ground (see Figure 12A-3.05). For objects mounted on posts closer than 12 inches, follow the requirements for horizontal clearance defined above.

Figure 12A-3.05: Height Restriction for Signs Mounted Between Posts



Pedestrian Facilities During Construction

A. Introduction

When projects impact pedestrians, it is important for the engineer to develop a temporary traffic control plan for pedestrians, including those with disabilities. For Iowa DOT projects, see Iowa DOT Design Manual Section 9A-5 for temporary traffic control plans. The applicable guidelines for the temporary traffic control plan are the July 26, 2011 "Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way" (PROWAG) and the Manual on Uniform Traffic Control Devices (MUTCD).

According to PROWAG, when a pedestrian circulation path is temporarily closed for construction or maintenance activities, an alternate pedestrian access route complying with sections 6D.01, 6D.02, and 6G.05 of the MUTCD shall be provided (R205). However, MUTCD (Section 6D.01) also requires knowledgeable persons to conduct appropriate evaluations or use engineering judgment in determining temporary traffic controls for pedestrian circulation paths. This section includes guidance on conducting the evaluation when an alternate pedestrian access route may not be practical.

B. Evaluating Pedestrian Needs

The initial design activity should be to determine the level of the accessibility of the current pedestrian circulation path within the area of the project and the adjacent areas. The impact to the pedestrian circulation path, including transit stops, from the construction or maintenance activity needs to be determined. Develop pedestrian accommodations to provide the best accessibility practical through all stages of work. Consider obtaining local input through a public meeting or contact with residents or public officials to see where additional accessibility needs should be addressed (e.g. senior centers, medical facilities, schools, public facilities, etc.).

Whenever possible, the work should be done in such a manner that does not create a need to detour pedestrians from existing routes. Pedestrians rarely observe detours and the cost of providing accessibility and detectability might outweigh the cost of maintaining a continuous route through the construction zone (MUTCD 6D-01). All methods should be given consideration, including providing alternate means of traversing the construction zone. If pedestrians are to be directed through the construction zone, safety as well as accessibility must be addressed. If a pedestrian detour is developed, it should replicate the accessibility of the existing route.

C. Facility Options

To address the impacts to the pedestrian circulation path, including transit stops, consider the following:

- Develop a temporary traffic control plan to guide the pedestrians through the construction zone.
- Close the pedestrian circulation path through the construction zone.
- Close the pedestrian circulation path through the construction zone; develop a detour route consistent with the accessibility features present in the pedestrian circulation path being closed.
- Provide alternate means for pedestrians to traverse the construction zone, such as free accessible shuttles or other forms of assistance.

D. Barricades, Channelizing Devices, and Signs

Pedestrian barricades and channelizing devices shall comply with sections 6F.63, 6F.68, and 6F.71 of the MUTCD.

1. **Barricades:** Barricades are used for pedestrian circulation path closures. See Iowa DOT Specifications Section 2528.

2. **Channelizing Devices:** The designer should consider the safety of pedestrians and vehicles when choosing channelizing devices.

    a. **Type A:** Type A devices are redirective barriers designed for highway applications. These devices are suitable when pedestrians are routed into the travel way and allow for the most protection for pedestrians from vehicular intrusion.

    b. **Type B:** Type B devices are crashworthy but do not redirect vehicles. These devices are designed to minimize risks associated with flying debris.

    c. **Type C:** Type C devices include any device that meets ADA requirements for channelizing pedestrians and may not be crashworthy. These devices are for locations where vehicular intrusions are unlikely (e.g. closed roads, when there is a separation between pedestrians and vehicular traffic, or where vehicular traffic is at low speeds).

3. **Signs:** See Iowa DOT Standard Road Plan TC-601 and TC-602.

E. Temporary Pedestrian Facilities

Temporary pedestrian facilities should comply with the other sections within this chapter to the extent practical. It is strongly recommended that detour routes be on paved surfaces.

Temporary pedestrian facility surfaces must be firm, stable, and slip resistant. Granular surfacing for short term, temporary pedestrian facilities is acceptable. The granular surfacing material should be well graded, such as Class A road stone (Iowa DOT Specifications Section 4109, Gradation No. 8) or special backfill (Iowa DOT Specifications Section 4109, Gradation No. 30). Maintenance of the temporary pedestrian facility surface to meet the firm, stable, slip resistant, and minimum width is required at all times. The temporary pedestrian facility surface must be removed and a permanent pedestrian facility must be replaced prior to the end of the construction season.

F. Utility Construction

If the pedestrian circulation path is disturbed during utility construction, the requirements of this section and Section 12A-2 shall apply.

Bicycle and Pedestrian Facilities

A. Introduction

There are four major categories for bicycle and pedestrian facilities: sidewalks, shared use paths, on-street, and trails. Sidewalks are an integral component of the transportation system, usually used only by pedestrians. For information on designing sidewalks, see Section 12A-1 and Section 12A-2. Shared use paths are also an integral component of the transportation system and use the sidewalk standards, but must also be designed for bicycle usage. Shared use paths are generally separate from the street, but in limited instances it may be necessary to utilize an on-street facility.

The word “trail” has conflicting definitions in ADA, AASHTO, program funding, and common usage. Projects developed around the state and those let through the Iowa DOT are generally shared use paths as defined by the Access Board, not trails. Facilities with a transportation purpose cannot use the trail guidelines published by the Access Board, even though they are commonly referred to as trails. The trail information from the Access Board only applies in parks and other limited locations; therefore, they are not covered in this manual.

B. Definitions

The following definitions are from the “AASHTO Guide for the Development of Bicycle Facilities” (or *AASHTO Bike Guide*).

Bicycle Boulevard: A street segment, or series of contiguous street segments, that has been modified to accommodate through bicycle traffic and minimize through motor traffic.

Bicycle Facilities: A general term denoting improvements and provisions to accommodate or encourage bicycling, including parking and storage facilities, and shared roadways not specifically defined for bicycle use.

Bicycle Lane or Bike Lane: A portion of roadway that has been designated for preferential or exclusive use by bicyclists by pavement markings and, if used, signs. It is intended for one-way travel, usually in the same direction as the adjacent traffic lane, unless designed as a contra-flow lane.

Bicycle Route: A roadway or bikeway designated by the jurisdiction having authority, either with a unique route designation or with BIKE ROUTE signs, along which bicycle guide signs may provide directional and distance information. Signs that provide directional, distance, and destination information for bicyclists do not necessarily establish a bicycle route.

Bikeway: A generic term for any road, street, path, or way that in some matter is specifically designated for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

Independent Right-of-Way: A general term denoting right-of-way outside the boundary of a conventional highway.

Roundabout: A type of circular intersection that provides yield control to all entering vehicles and features channelized approaches and geometry to encourage reduced travel speeds through the circular roadway.

Rumble Strips: A textured or grooved pavement treatment designed to create noise and vibration to alert motorists of a need to change their path or speed. Longitudinal rumble strips are sometimes used on or along shoulders or center lines of highways to alert motorists who stray from the appropriate traveled way. Transverse rumble strips are placed on the roadway surface in the travel lane, perpendicular to the direction of travel.

Shared Lane: A lane of a traveled way that is open to both bicycle and motor vehicle travel.

Shared Lane Marking: A pavement marking or symbol that indicates an appropriate bicycle positioning in a shared lane.

Shared Use Path: (From U.S. Department of Transportation, Federal Highway Administration) The term “shared use path” means a multi-use trail or other path, physically separated from motorized vehicular traffic by an open space or barrier, either within a highway right-of-way or within an independent right-of-way, and usable for transportation purposes. Shared use paths may be used by pedestrians, bicyclists, skaters, equestrians, and other nonmotorized users.

Traveled Way: The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and any bike lane immediately inside of the shoulder.

C. Design Process

Comprehensive systematic design is necessary to ensure a useful shared use path or on-street bicycle facility is provided for the public. To do this, the following items need to be addressed.

1. Identification of need of shared use path(s) and/or on-street bicycle system.

2. Determine objective of shared use path(s) and/or on-street bicycle facility.

3. Develop shared use path(s) and/or on-street bicycle facility potential use.

4. Route(s) evaluation, location, and selection:
   - Adequate access
   - Directness and convenience
   - Continuity with shared use path network
   - Attractiveness of route
   - Safety and security
   - Delays along route
   - Cost of improvements
   - Shared use of facility
   - Maintenance
   - Conflicts with other vehicles
   - Adequacy of street use
     - Grades and geometrics
     - Surface obstructions and conditions
     - Traffic volumes and speeds
     - Truck and bus traffic
     - Parking
     - Intersection conditions

    - Signing and pavement markings
    - Sight distances
    - Clearance (vertical and horizontal)
    - Bridge and railroad crossings

5. Choosing an appropriate facility type. (Refer to *AASHTO Bike Guide* Exhibit 2.3 for more information in selecting a facility type).
    - Shared lanes
    - Paved shoulders
    - Bike lanes
    - Bike boulevards
    - Shared use paths

Shared Use Path Design

A. Accessible Shared Use Path Design

1. **General:** Applicable portions from the following draft documents were used to develop this section.

   a. **AASHTO Bike Guide:** The fourth edition (2012) of the AASHTO "Guide for the Development of Bicycle Facilities" (or *AASHTO Bike Guide*). References made to the *AASHTO Bike Guide* within this section are shown in parentheses, e.g. (AASHTO 5.2.1).

   b. **AGODA:** The June 20, 2007 Proposed Architectural Barriers Act "Accessibility Guidelines for Outdoor Developed Areas" (AGODA). This document is primarily used for shared use paths designed as bicycle facilities.

   c. **PROWAG:** The July 26, 2011 "Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way," also known as the Public Right-of-Way Accessibility Guidelines or PROWAG. This document is primarily used for shared use paths designed as sidewalks.

2. **Documenting Exceptions:** If the project cannot fully meet the minimum requirements included within this section, a document should be developed to describe why the minimum requirements cannot be met. It is recommended that this document be retained in the project file. For local agency projects administered through Iowa DOT, a certification with supporting documentation shall be submitted to the Iowa DOT administering office. The certification shall be as prescribed by the Iowa DOT and signed by a registered professional engineer or landscape architect licensed in the State of Iowa. For Iowa DOT projects, contact the Design Bureau, Methods Section.

B. Shared Use Path Categories

1. **Type 1:** A shared use path adjacent or in close proximity to the roadway and functions similar to a sidewalk. In rural cross-sections, these paths would be at the top of the foreslope. These paths are generally used for transportation purposes.

2. **Type 2:** A shared use path similar to Type 3, except they serve as a transportation route to facilities that fulfill a basic life need, provide access to a program or service, or provide a safe route for non-drivers.

3. **Type 3:** A shared use path in independent right-of-way or not in close proximity to the roadway. Although Type 3 paths may fulfill a transportation function, these paths primarily serve a recreation and fitness benefit.

One shared use path project may have different combinations of Type 1, Type 2, and/or Type 3 segments, based on location and function. If Federal or State funding is being used on a project, the funding application should identify where Type 1, Type 2, or Type 3 segments will be used.

C. Shared Use Path Design Elements

The following considerations should be used as a guide when designing shared use paths.

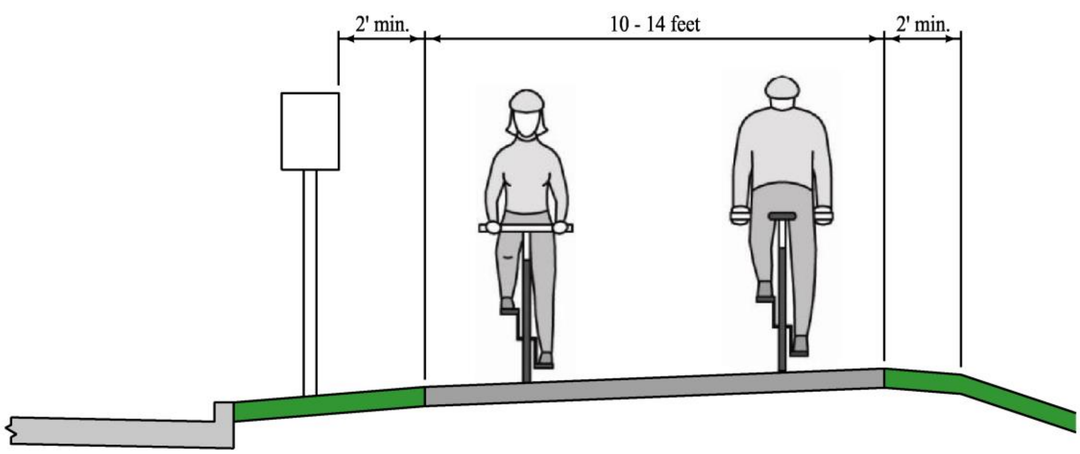
1. **Width:** A bicyclist requires a minimum of 4 feet and a preferred 5 feet of essential operating space based upon their profile. The typical path width is 10 feet to accommodate two-way traffic. Consider wider paths (11 to 14 feet) when at minimum one of the following is anticipated:
    - User volume exceeding 300 users within the peak hour.
    - Curves where more operating space should be provided.
    - Large maintenance vehicles.
    - There is a need for a bicyclist to pass another path user while maintaining sufficient space for another user approaching from the opposing direction. 11 feet is the minimum width for three lanes of traffic.

    Path width can be reduced to 8 feet where the following conditions prevail:
    - Bicycle traffic is expected to be low.
    - Pedestrian use is generally not expected.
    - Horizontal and vertical alignments provide well-designed passing and resting opportunities.
    - The path will not be regularly subjected to maintenance vehicle loading conditions.
    - A physical constraint exists for a short duration such as a utility structure, fence, etc.

    Path widths between 8 and 5 feet should be avoided; paths less than 5 feet do not meet ADA requirements.

    If segregation of pedestrians and bicycle traffic is desirable, a minimum 15 foot width should be provided. This includes 10 feet for two-way bicycle traffic and 5 feet for two-way pedestrian traffic. (AASHTO 5.2.1).

Figure 12B-2.01: Typical Cross-Section of Two-Way Shared Use Path on Independent Right-of-Way



Source: Adapted from *AASHTO Bike Guide* Exhibit 5.1

2. **Minimum Surface Thickness:** For Iowa DOT projects, contact the Pavement Design Section in the Design Bureau for a pavement determination. For local agency projects administered through Iowa DOT, Iowa DOT will accept the thickness design as determined by the engineer.

For local projects, the pavement depth for both PCC and HMA pavements should have a minimum of 4 inches and a recommended thickness of 5 inches; if pavement thickness is proposed to be less than 4 inches, a pavement determination should be completed and documented.

3. **Cross Slope:** Shared use paths must have the capabilities to serve people with disabilities.
   a. **Type 1 and Type 2:** Cross slopes shall not exceed the requirements in Section 12A-2.
   b. **Type 3:** A 1.5% cross slope is recommended, but cross slopes should be a minimum of 1% and shall not exceed 5%. Cross slopes greater than 2% should be sloped to the inside of the horizontal curve regardless of drainage conditions. On unpaved paths, cross slopes may increase up to 5% due to the need of draining water off the path. On rare bicycle only facilities, the path does not need to meet accessibility guidelines and the cross slope can be between 5% and 8%. Cross slope transition should be comfortable for the user; therefore, a minimum transition length of 5 feet for each 1% change in cross slope should be used.

4. **Separation of Roadway and Path:** A separation should be provided between a two-way shared use path and the adjacent roadway to demonstrate to both the bicyclist and the vehicle driver that each facility is independent of the other. This is particularly important at night. If the separation from the face of the curb or the edge of the traveled way to the near edge of the path is less than 5 feet, a barrier or railing is recommended. The barriers or railings need not be of the size and strength to redirect errant motorists unless a crashworthy barrier is needed due to high speeds and clear zone requirements. Barriers at other locations serving only as a separation should be the height of standard guardrail.

   If needed, barriers and railings should be used, but since they can create considerable concerns in urban areas due to aesthetics, visibility, and maintenance problems, it may be necessary to initiate the documenting exceptions process (Section 12B-2, A, 2). The separation between the face of the curb and the path should be maximized, but with the presence of the curb, some landscaping area, and street lighting, the overall objectives of the separation can be satisfied.

5. **Lateral and Vertical Clearance:** Perhaps the most critical factor in developing safe and comfortable shared use path facilities is the provision of adequate clearance to a wide variety of potential obstructions that may be found along a prospective route. Guidelines for lateral and vertical clearance are particularly important in view of the wide range of riding proficiency that is found among riders. Clearance consideration must include:

   a. **Lateral Clearances to Fixed and Movable Obstructions:** A 2 foot minimum graded area with a 6:1 maximum cross slope (i.e., shoulder area) should be provided for clearance from lateral obstructions such as trees, poles, and bridge abutments measured from the edge of the pathway. The MUTCD requires a 2 foot minimum clearance to the sign face of post-mounted signs.

      If a barrier or rail is necessary, a minimum of 1 foot lateral offset from the edge of the path is desirable. Barriers terminating within 2 feet of the edge of the path should be marked with object markers. It is undesirable to place the pathway in a narrow corridor between 2 fences for long distances.

      A designer may want to consider that a typical ambulance width (including mirrors) is 11 feet.

      When minimum clearance cannot be achieved, refer to Section 12A-3 for protruding object requirements; refer to the *AASHTO Bike Guide* for mitigation measures, such as pavement markings, delineation, and signing.

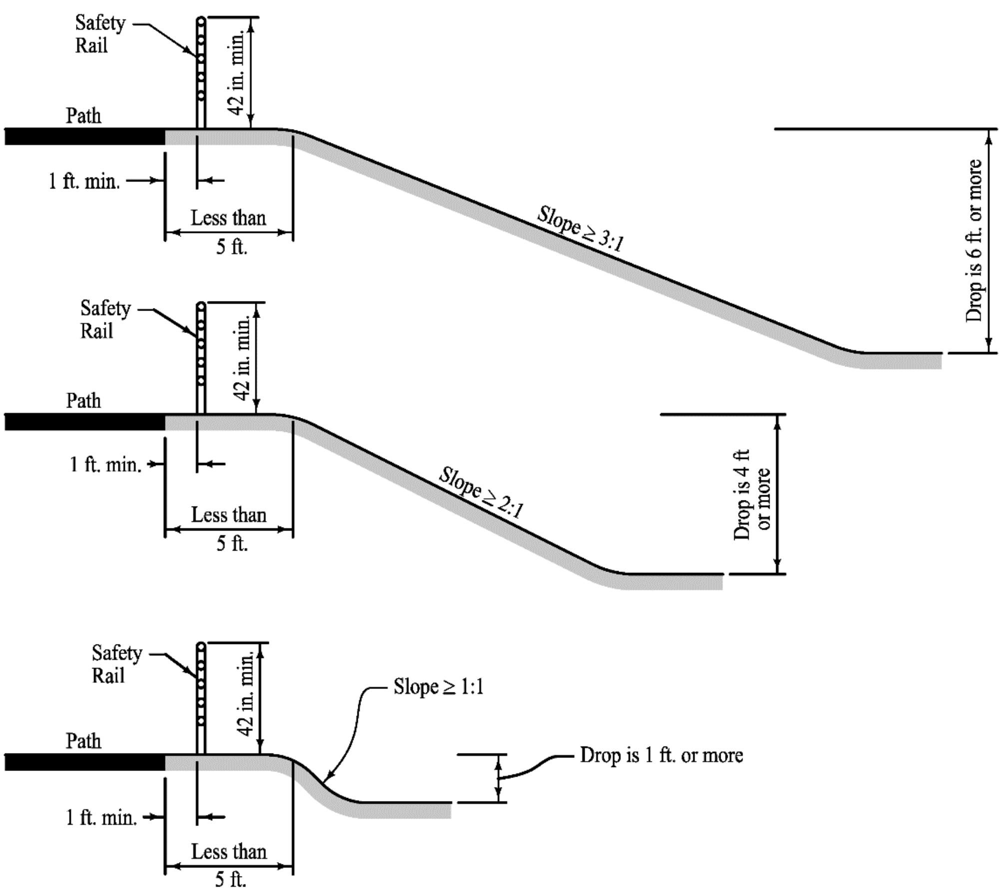
b. **Vertical Clearances to Overhead Obstructions:** The minimum vertical clearance is 10 feet. In some situations, such as tunnels and bridge underpasses, the vertical clearance should be greater than 10 feet in order to accommodate maintenance and emergency vehicles. In constrained areas, AASHTO allows the vertical clearance to obstructions to be a minimum of 8 feet. (AASHTO 5.2.1).

   Refer to Section 12A-3 for legal requirements in low clearance situations.

6. **Shoulder Width and Slope:** The minimum graded shoulder width is 2 feet. The maximum shoulder area cross slope is 6:1.

7. **Safety Rail:** Safety rail should be a minimum of 42 inches in height. Provide safety rails at the outside of a structure. On steep fill embankment as described below, provide a safety rail or widen the shoulder area to 5 feet. (AASHTO 5.2.1)
   - Slopes 3:1 or steeper with a drop of 6 feet or greater.
   - Slopes 3:1 or steeper adjacent to a parallel body of water or other substantial obstacle.
   - Slopes 2:1 or steeper with a drop of 4 feet or greater.
   - Slopes 1:1 or steeper with a drop of 1 foot or greater.

Figure 12B-2.02: Safety Rail between Path and Adjacent Slope



See Iowa DOT Design Manual Section 12B-10 for guidance on safety rails.

Source: Adapted from *AASHTO Bike Guide* Exhibit 5.3

8. Design Speed and Alignments:

a. Type 1: Grades shall meet the requirements of Section 12A-2.

b. Type 2: Grades shall be less than or equal to 5% and all other Type 3 requirements should be met.

c. Type 3: There is no single design speed that is recommended for all paths. In general, a minimum design speed of 18 mph should be used, unless posted for slower speeds or in areas of steeper decline, in which case the design speed should be adjusted according to Table 12B-2.01. (AASHTO 5.2.4)

Table 12B-2.01: Minimum Design Speed and Horizontal Alignment

Terrain	Design Speed (mph)	Minimum Radius[1] (Horizontal Curve) (feet)
Grades less than 2%	18	60
Grades less than or equal to 5%	25	115
Grades 6% and more	30	166

[1] Based on 20 degree maximum lean angle

Source: *AASHTO Bike Guide* 5.2.4

The minimum radius of curvature negotiable by a bicycle can be calculated using the lean angle of the bicyclist or the superelevation and coefficient of friction of the shared use path. The minimum radii of curvature for a paved path are shown in Table 12B-2.02 based on lean angle of the cyclists.

Table 12B-2.02: Minimum Radii for Lean Angle of Cyclists

Design Speed (mph)	Minimum Radius (feet)
12	27
14	36
16	47
18	60
20	74
25	115
30	166

Source: *AASHTO Bike Guide* Exhibit 5.6

The minimum radii of curvature for a paved path based on superelevation should be calculated per the equations shown in the *AASHTO Bike Guide*. (AASHTO 5.2.2, 5.2.5, 5.2.6, and 5.2.8).

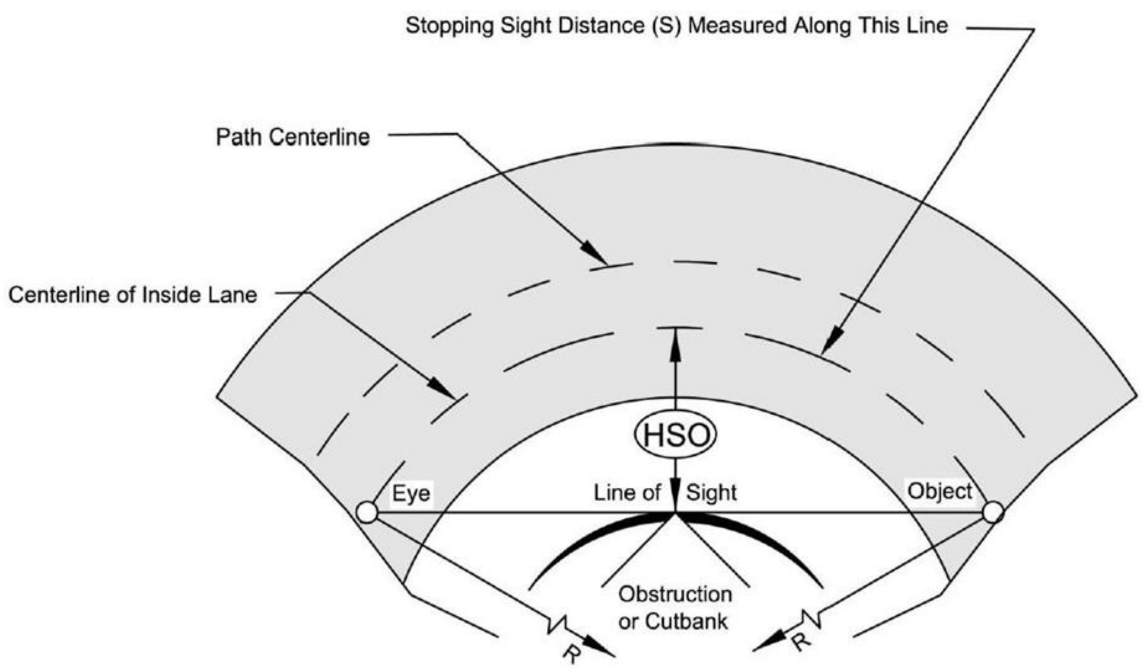
Table 12B-2.03 and Figure 12B-2.03 should be used to determine the minimum clearance necessary to avoid line-of-sight obstructions for horizontal curves. The lateral clearance (horizontal sight line offset or HSO) can be obtained from Table 12B-2.03, given the stopping sight distance from Equation 12B-2.01 and the proposed horizontal radius of curvature. Lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for both users traveling in opposite directions around the curve because bicyclists have a tendency to ride near the middle of narrow paths.

Table 12B-2.03: Minimum Lateral Clearance (Horizontal Sightline Offset or HSO) for Horizontal Curve

R	S= Stopping Sight Distance (ft)														
(ft)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
25	2.0	7.6	15.9												
50	1.0	3.9	8.7	15.2	23.0	31.9	41.5								
75	0.7	2.7	5.9	10.4	16.1	22.8	30.4	38.8	47.8	57.4	67.2				
95	0.5	2.1	4.7	8.3	12.9	18.3	24.7	31.8	39.5	48.0	56.9	66.3	75.9	85.8	
125	0.4	1.6	3.6	6.3	9.9	14.1	19.1	24.7	31.0	37.9	45.4	53.3	61.7	70.6	79.7
155	0.3	1.3	2.9	5.1	8.0	11.5	15.5	20.2	25.4	31.2	37.4	44.2	51.4	59.1	67.1
175	0.3	1.1	2.6	4.6	7.1	10.2	13.8	18.0	22.6	27.8	33.5	39.6	46.1	53.1	60.5
200	0.3	1.0	2.2	4.0	6.2	8.9	12.1	15.8	19.9	24.5	29.5	34.9	40.8	47.0	53.7
225	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.1	17.8	21.9	26.4	31.3	36.5	42.2	48.2
250	0.2	0.8	1.8	3.2	5.0	7.2	9.7	12.7	16.0	19.7	23.8	28.3	33.1	38.2	43.7
275	0.2	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.6	18.0	21.7	25.8	30.2	34.9	39.9
300	0.2	0.7	1.5	2.7	4.2	6.0	8.1	10.6	13.4	16.5	19.9	23.7	27.7	32.1	36.7
350	0.1	0.6	1.3	2.3	3.6	5.1	7.0	9.1	11.5	14.2	17.1	20.4	23.9	27.6	31.7
390	0.1	0.5	1.2	2.1	3.2	4.6	6.3	8.2	10.3	12.8	15.4	18.3	21.5	24.9	28.5
500	0.1	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0	12.1	14.3	16.8	19.5	22.3
565		0.4	0.8	1.4	2.2	3.2	4.3	5.7	7.2	8.8	10.7	12.7	14.9	17.3	19.8
600		0.3	0.8	1.3	2.1	3.0	4.1	5.3	6.7	8.3	10.1	12.0	14.0	16.3	18.7
700		0.3	0.6	1.1	1.8	2.6	3.5	4.6	5.8	7.1	8.6	10.3	12.0	14.0	16.0
800		0.3	0.6	1.0	1.6	2.2	3.1	4.0	5.1	6.2	7.6	9.0	10.5	12.2	14.0
900		0.2	0.5	0.9	1.4	2.0	2.7	3.6	4.5	5.6	6.7	8.0	9.4	10.9	12.5
1000		0.2	0.5	0.8	1.3	1.8	2.4	3.2	4.0	5.0	6.0	7.2	8.4	9.8	11.2

Source: *AASHTO Bike Guide* Exhibit 5.10

Figure 12B-2.03: Components for Determining Horizontal Sight Distance



Source: *AASHTO Bike Guide* Exhibit 5.9

For vertical alignment, use the preferred maximum segment length shown in Table 12B-2.04 whenever possible. Using the acceptable and allowed criteria should only be done when the engineer considers the ability of the users. For example, long rural segments would generally serve more physically capable users who have selected the path and could navigate the steeper grades over longer lengths.

Table 12B-2.04: Vertical Alignment

Grade Range	**Maximum Segment Length (feet)**		
	Preferred	***Acceptable***[1]	***Allowed***[2]
< 5%	Any length	Any Length	Any Length
≥ 5% and < 8.33%	--	50	200
≥ 8.33% and < 10%	--	30	30
≥ 10% and < 12.50%	--	--	10

[1] Derived from AGODA Section 1016 (Outdoor Recreation Access Routes)

[2] Derived from AGODA Section 1017 (Trails)

The minimum length of vertical curve needed to provide minimum stopping sight distance at various speeds on crest vertical curves is presented in Table 12B-2.05. The eye height of the typical adult bicyclist is assumed to be 4.5 feet. For stopping sight distance calculations the object height is assumed to be 0 inches. (AASHTO 5.2.7). Equation 12B-2.01 can also be used to determine the minimum length of crest vertical curve necessary to provide adequate sight distance.

Equation 12B-2.01

$$S > L \qquad L = 2S - \frac{200(\sqrt{h_1}+\sqrt{h_2})^2}{A}$$

$$S > L \qquad L = 2S - \frac{200(\sqrt{h_1}+\sqrt{h_2})^2}{A}$$

$$L > S \qquad L = \frac{AS^2}{100(\sqrt{2h_1}+\sqrt{2h_2})^2}$$

where:

L= Minimum length of vertical curve (ft)
A = Algebraic grade difference (percent)
S = Stopping sight distance (ft)
h_1 = Eye height (4.5 feet for a typical bicyclist)
h_2 = Object height (0 ft)

Table 12B-2.05: Minimum Length of Crest Vertical Curve Based on Stopping Sight Distance

A	S=Stopping Sight Distance (ft)														
(%)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2												30	70	110	150
3								20	60	100	140	180	220	260	300
4						15	55	95	135	175	215	256	300	348	400
5					20	60	100	140	180	222	269	320	376	436	500
6				10	50	90	130	170	210	267	323	384	451	523	600
7				31	71	111	151	191	231	311	376	448	526	610	700
8			8	48	88	128	168	208	248	356	430	512	601	697	800
9			20	60	100	140	180	220	260	400	484	576	676	784	900
10			30	70	110	150	190	230	270	444	538	640	751	871	1000
11			38	78	118	158	198	238	278	489	592	704	826	958	1100
12		5	45	85	125	165	205	245	285	533	645	768	901	1045	1200
13		11	51	91	131	171	211	251	291	578	699	832	976	1132	1300
14		16	56	96	136	176	216	256	296	622	753	896	1052	1220	1400
15		20	60	100	140	180	220	260	300	667	807	960	1127	1307	1500
16		24	64	104	144	184	224	264	304	711	860	1024	1202	1394	1600
17		27	67	107	147	187	227	267	307	756	914	1088	1277	1481	1700
18		30	70	110	150	190	230	270	310	800	968	1152	1352	1568	1800
19		33	73	113	153	193	233	273	313	844	1022	1216	1427	1655	1900
20		35	75	115	155	195	235	275	315	889	1076	1280	1502	1742	2000
21		37	77	117	157	197	237	277	317	933	1129	1344	1577	1829	2100
22		39	79	119	159	199	239	279	319	978	1183	1408	1652	1916	2200
23		41	81	121	161	201	241	281	321	1022	1237	1472	1728	2004	2300
24	3	43	83	123	163	203	243	283	323	1067	1291	1536	1803	2091	2400
25	4	44	84	124	164	204	244	284	324	1111	1344	1600	1878	2178	2500

The line between the shaded and un-shaded portions of the table shows when the stopping sight distance is equal to the length of the crest vertical curve.

Source: *AASHTO Bike Guide* Exhibit 5.8

9. Stopping Sight Distance: Shared use paths must be designed with adequate stopping sight distance along the entire path to provide users with the opportunity to see and react to unexpected conditions. The distance needed to bring a path user to a fully controlled stop is a function of the user's perception and braking reaction time, the initial speed, the coefficient of friction between the wheels and the pavement, the braking ability of the user's equipment, and the grade. Minimum stopping sight distances can be determined using Equation 12B-2.02. Stopping sight distance must be provided along the entire length of the pathway and should be checked at all horizontal and vertical curves. (AASHTO 5.2.8).

$$S = \frac{V^2}{30(f \pm G)} + 3.67V$$

Equation 12B-2.02

where:

S = Stopping sight distance (ft)
V = Velocity (mph)
f = Coefficient of friction (use 0.16 for a typical bicycle)
G = Grade (ft/ft) (rise/run)

10. **Accessibility Requirements:** For construction of curb ramps and placement of detectable warnings, see Section 12A-2 to ensure ADA compliance.

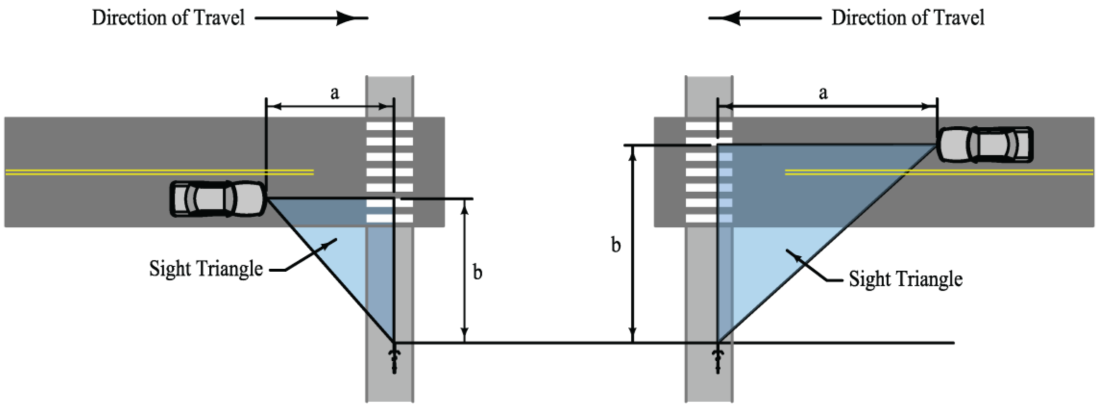
D. Intersection Sight Distance

1. **General:** Intersection sight distance is a fundamental component in the selection of appropriate control at a midblock path-roadway intersection. The least restrictive control that is effective should be used. The line of sight is considered to be 2.3 feet above the path surface.

   Roadway approach sight distance and departure sight triangles should be calculated using motor vehicles, which will control the design criteria. (AASHTO 5.3).

2. **Approach Sight Distance:** Pathway approach sight distance should be determined by the fastest path user, typically the adult bicyclist. If yield control is to be used for either the roadway approach or the path approach, available sight distance adequate for a traveler on the yield controlled approach to slow, stop, and avoid a traveler on the other approach is required. The roadway leg (a) of the sight triangle is based on the ability of a bicyclist to reach and cross the roadway if they do not see a conflict (see Figure 12B-2.04). Similarly, the path leg (b) of the sight triangle is based on the ability of a motorist to reach and cross the junction if they do not see a conflict (see Figure 12B-2.04). If sufficient sight distance is unable to be provided by the yield sight triangle described above, more restrictive control should be implemented.

Figure 12B-2.04: Yield Sight Triangles



Source: Adapted from *AASHTO Bike Guide* Exhibit 5.15

$$a = 1.47V_{Road}\left(\frac{S}{1.47V_{Path}} + \frac{w + L_a}{1.47V_{Path}}\right)$$

Equation 12B-2.03
Length of Roadway Leg of Sight Triangle

$$b = V_{Path}\left(\frac{1.47V_e - 1.47V_b}{a_i} + \frac{w + L_a}{0.88V_{Road}}\right)$$

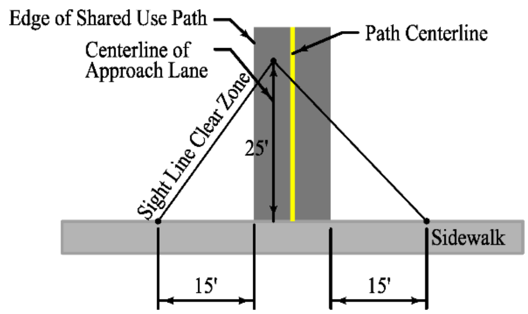
Equation 12B-2.04
Length of Path Leg of Sight Triangle

where:

a = Length of leg of sight triangle along the roadway approach (ft)
b = Length of leg of sight triangle along the path approach (ft)
w = Width of the intersection to be crossed (ft)
L_a = Design vehicle length
For Equation 12B-2.03: Typical bicycle length = 6 ft
For Equation 12B-2.04: Design vehicle length (ft)
V_{Path} = Design speed of the path (mph)
V_{Road} = Design speed of the road (mph)
S = Stopping sight distance for the path user traveling at design speed
V_e = Speed at which the motorist would enter the intersection after decelerating (mph) (assumed 0.60 x road design speed)
V_b = Speed at which braking by the motorist begins (mph) (same as road design speed)
a_i = motorist deceleration rate (ft/s^2) on intersection approach when braking to a stop is not initiated (assume -5.0 ft/s^2)

3. **Path-Sidewalk Intersection:** At an intersection of a shared use path and a sidewalk, a clear sight triangle extending at minimum 15 feet along the sidewalk must be provided. Refer to Figure 12B-2.05. If two shared use paths intersect, the same process for the roadway-path intersection should be used.

Figure 12B-2.05: Minimum Path-Sidewalk Sight Triangle



Source: Adapted from *AASHTO Bike Guide* Exhibit 5.16

E. Surface

It is important to construct and maintain a smooth riding surface on shared use paths. Shared use path pavements should be machine placed. Surface texture is needed but care must be exercised not to cause operational problems with too little or too much texture. Broom finish or burlap drag concrete surfaces are preferred over trowel finishes. Joints shall be sawed, not hand tooled.

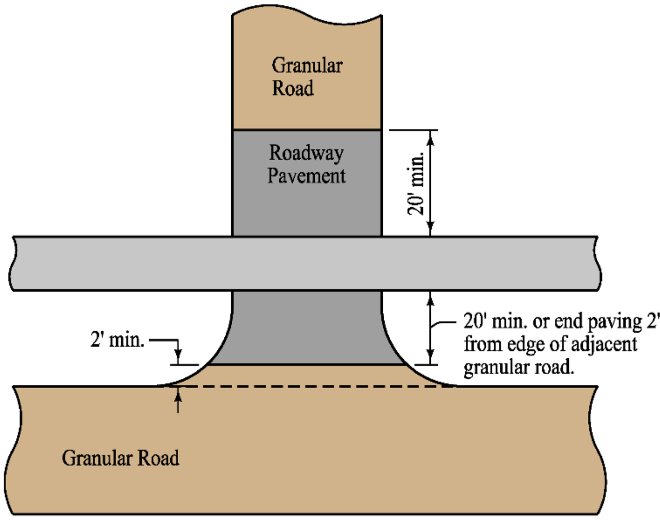
1. **Type 1 and Type 2:** Type 1 and Type 2 shared use paths shall be paved.

2. **Type 3:** Hard, all-weather pavement surfaces are preferred to unpaved surfaces due to the higher service quality and lower maintenance. Type 3 shared use paths should be paved; however, a granular surface may be allowed. If a granular surface is used, it must be maintained to be firm, stable, and slip resistant.

F. Crossings at Unpaved Surfaces

When crossing an unpaved roadway, alley, or driveway, a minimum of 20 feet in addition to the path width should be paved on each side of the path to reduce the amount of gravel tracked onto the path. If edge of parallel unpaved roadway is less than 20 feet from the closest edge of the path, only pave to within 2 foot of edge of the parallel unpaved roadway. The thickness of the path and adjacent roadway paving should be designed to accommodate vehicular traffic and meet the requirements of the agency responsible for the roadway.

Figure 12B-2.06: Crossing at Unpaved Surface



G. At-grade Railroad Crossing

Whenever it is necessary to cross railroad tracks with a bicycle, special care must be taken. The crossing should be at least as wide as the approaches of the shared use path. Whenever possible, the crossing should be straight and between 90 and 60 degrees to the rails. The greater the crossing angle deviates from being perpendicular, the greater the chance that a bicyclist's front wheel may be trapped in the flangeway causing a loss of control. (AASHTO 4.12).

H. Drainage

Drainage structures underneath paths should typically be designed to the same design year storm as the roadway drainage structures. When a Type 3 shared use path is built on a berm, consider the drainage needs of that path. For shared use paths constructed on slopes, drainage design should take into account control of the runoff from the slope. For higher flows it may be necessary to develop parallel ditches and culverts under the path. Drainage designs should also provide for low flows and seepage from the slope. Due to the potential for accidents from buildup of algae from low flows and side hill seepage, the need for subdrains or other treatments on the high side of the path should be evaluated.

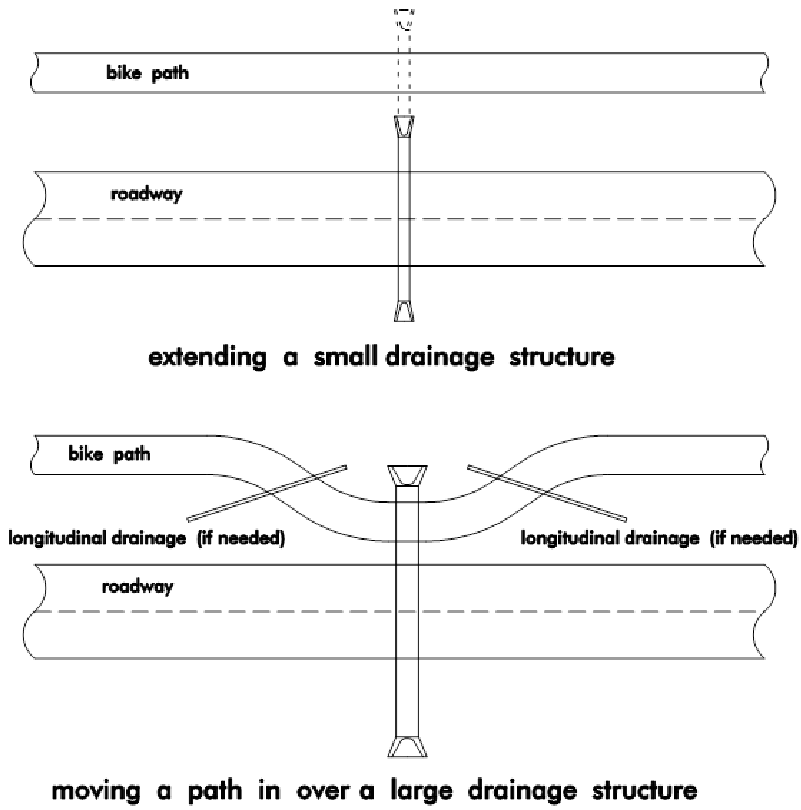
1. **Urban Areas:** The minimum recommended pavement cross slope of 1% usually provides enough slope for proper drainage. Sloping in one direction, usually toward the street, instead of crowning is preferred and usually simplifies the drainage and surface construction. However, care must be exercised not to trap water on the high side of the shared use path, particularly in curved areas. (AASHTO 5.2.11).

2. **Rural Areas:** The best way to accomplish drainage underneath a shared use path is by extending smaller structures under the path or moving the path closer to the roadway to cross larger structures, see Figure 12B-2.07.

   For paths placed on the backslope, smaller drainage structures (normally pipes less than 60 inches and box culverts less than 5 feet by 4 feet) should be extended through the path. For larger culverts, the path should be moved in to cross the structure and then moved back out to the backslope. If this is done, longitudinal drainage will have to be provided where the path crosses the ditch. Depending upon how close the path comes to culvert openings, safety railing may be needed on the culverts.

For paths on the foreslope, culverts should be extended as necessary.

Figure 12B-2.07: Accommodating Drainage Structures



I. Structure Design

The minimum width for a shared use path on a new roadway bridge, widened roadway bridge, or separate pedestrian structure is 10 feet. Through conversations with the Iowa Bicycle Coalition, this was determined to be adequate width in most situations. If heavy use is anticipated, such as near a school, a 12 or 14 foot wide path should be used. If a separate shared use path structure is to be constructed, it should have a 5% maximum running grade.

If widening a bridge or building a new structure is beyond the scope of a project, it may be possible to use an existing sidewalk as a path. The path should be separated from vehicular traffic with a barrier. Signage may be necessary instructing cyclists to dismount before crossing the bridge. For Iowa DOT administered projects, the designer should contact the Design Bureau and the Traffic and Safety Bureau for further assistance if considering a narrowed path across a bridge.

J. Pavement Markings

Ladder or zebra pavement markings per MUTCD are recommended at crosswalks. Other pavement markings are not required, except as mitigation strategies. (AASHTO 5.4).

K. Signing

All signs should be retroreflective and conform to the color, legend, and shape requirements described in the MUTCD. In addition, guide signing, such as to indicate directions, destinations, distances, route numbers, and names of crossing streets should be used. In general, uniform application of traffic control devices, as described in the MUTCD, should be used and will tend to encourage proper bicyclist behavior. (AASHTO 5.4).

L. Lighting

Fixed-source lighting reduces conflicts along shared use paths and at intersections. In addition, lighting allows the bicyclist to see the shared use path direction, surface conditions, and obstacles. Lighting for paths is important and may be considered where heavy nighttime riding is expected (e.g., paths serving college students or commuters) and at roadway intersections. Lighting should be considered through underpasses or tunnels and when nighttime security could be a problem. Where special security problems exist, higher illumination levels may be considered. Light standards (poles) should meet the recommended horizontal and vertical clearances. (AASHTO 5.2.12).

On-Street Bicycle Facilities

A. General

Cyclists have similar access and mobility needs as other transportation users. However, cyclists must use their own strength and energy to propel the bicycle, thus a bicyclist is generally slower than other vehicles that are operating on the roadway. Additionally, cyclists are more vulnerable to injury during a crash and are of any age group. With these factors in mind, it is imperative that designing bicycle facilities is done with great care.

The fourth edition (2012) of the AASHTO "Guide for the Development of Bicycle Facilities" (or *AASHTO Bike Guide*) was used as a reference for developing this section. References made to the *AASHTO Bike Guide* within this section are shown in parentheses, e.g. (AASHTO 4.2).

B. Elements of Design

Since cyclists usually have a higher eye height and are slower than the adjacent traffic, the roadway design elements for motor vehicles usually meet or exceed the minimum design elements required for cyclists.

Surface conditions affect cyclists more significantly than motor vehicles. Therefore, when establishing bicycle lanes and routes, it is important that the roadway surface is in good condition and is free of potholes, bumps, cracks, loose gravel, etc. If the roadway is not in good bicycle riding condition, it should be repaired either with resurfacing or reconstruction. Chip-sealed surfaces prove to create difficult riding conditions. (AASHTO 4.2).

C. Facilities

Except where prohibited, bicycles may be operated on all roadways. The following are the different types of bicycle facilities that are located on the roadway along with their design criteria.

1. **Shared Lanes:** Shared lanes already exist on local neighborhoods and city streets. However, these lanes can include design features that will make the lanes more bicycle friendly. This includes good pavement quality, adequate sight distance, lower speeds, bicycle-compatible drainage grates, bridge expansion joints, railroad crossings, etc. (AASHTO 4.3).

    a. **Major Roads (Wide Curb/Outside Lanes):** Lane widths should be 13 to 15 feet wide with 14 foot lanes as preferred. Lane widths of 14 feet and greater allow motorists to pass cyclists without encroaching into adjacent lanes; however, it is important to note that 15 foot lanes should be used only on appropriate sections with steep grades or sections where drainage grates, raised delineators, or on-street parking effectively reduces the usable width. The gutter should not be included in the measurement as usable width. Lanes 15 feet or wider could encourage faster vehicular movements or even two vehicles operating side by side in one lane. (AASHTO 4.3.1).

b. **Marked Shared Lanes:** In areas that need to provide enhanced guidance for cyclists, shared lanes may be marked with pavement marking symbols. This marking should be provided in locations where there are insufficient widths to provide bicycle lanes or shared use paths. This pavement marking not only lets the cyclists know where to be located within the lane but also the direction of travel.

Shared lane markings are not appropriate for paved shoulders or bicycle lanes, and should not be used on roadways that have a speed limit above 35 mph. Markings should be placed immediately after an intersection and spaced not greater than 250 foot intervals. Refer to both the MUTCD and AASHTO 4.4.

c. **Signs for Shared Roadways:** Along with pavement markings, signage is a very useful tool to communicate and inform both motorists and cyclists about shared roadways. It is important to note, that signs shall be used only when needed in order to prevent confusion, reduce clutter, and improve visibility. Refer to both the MUTCD and AASHTO 4.3.2.

Figure 12B-3.01: Share the Road Sign Assembly

Source: *AASHTO Bike Guide* Exhibit 4.1

2. **Paved Shoulders:** For higher speed and higher traffic roadways, adding or improving a paved shoulder can greatly improve cyclist accommodations on roadways. This will not only benefit the cyclists and motorists by giving the cyclists a place to ride that is located outside of the travel lane, but it also can extend the service life of roads by reducing edge deterioration.

   It is important to note that paved shoulders should not be confused with bicycle lanes, as bicycle lanes are travel lanes and paved shoulders are not. Paved shoulders should have a minimum width of 4 feet wide with a preferred width of 5 feet. Also, they should be at least 5 feet in locations of guardrails, curbs, or other roadside barriers. Additionally, the width may be increased in areas where the speeds exceed 50 mph, areas of heavy truck traffic, or locations with static obstruction exist at the right side of the roadway.

   It is preferred to have paved shoulders on both sides of a two-way roadway; however, in constrained locations and where pavement widths are limited, it may be preferable to provide a wider shoulder on one side of the roadway and a narrower shoulder on the other. This may be beneficial in uphill roadway sections to provide slow-moving cyclists additional maneuvering space and sections with vertical or horizontal curves that limit sight distance over crests and on the inside of horizontal curves.

In locations where unpaved driveways or roadways meet a paved shoulder, it is recommended to pave at least 10 feet of the driveway and 20 feet or to the right-of-way line, whichever is less, of the unpaved public road. This will help minimize loose gravel from spilling onto the travel way and affecting the cyclists. Additionally, raised pavement markers should not be used, unless they are beveled or have tapered edges.

Rumble strips may be used on paved shoulders that include the bicycle traffic; however, the minimum clear path should be 4 feet from the rumble strip to the outside edge of paved shoulder or 5 feet to the adjacent curb or other obstacle. Gaps at a minimum of 12 feet and a recommended distance of 40 to 60 feet for the rumble strips should also be provided in order to allow room for cyclists to leave or enter the shoulder without crossing the rumble strip. (AASHTO 4.5). Rumble strips should have the following design:

- Width: 5 inches
- Depth: 0.375 inches
- Spacing: 11 to 12 inches (may be reduced to 6 inches)

3. **Bicycle Lanes:** Bicycle lanes are a portion of the roadway that is designated for bicycle traffic. They are one-way facilities that typically carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. They are appropriate and preferred on corridors located in both urban and suburban areas; however, they may be used on rural roadways. They are typically used when vehicle traffic exceeds 3,000 vehicles per day and vehicle speeds are greater than 30 mph. Frequent use of visible pavement markings is essential to identify the lane for use by bicycles only. Color may be added for increased visibility. The use of colored markings should be consistent throughout the corridor and community. Public information and education programs may be necessary when a specific type of bicycle lane is introduced into a community. Programs should include a focus for drivers, as well as for bicyclists. Paved shoulders can be designated as bicycle lanes by installing bicycle lane symbol markings, yet marked shoulders will still need to meet the criteria listed herein.

Bicycle lanes should have a smooth surface with utility and grate covers flush with the surface of the lane. Additionally, bicycle lanes should be free of ponding water, washouts, debris accumulation, and other potential hazards. (AASHTO 4.6). Designers need to be aware that pavement joints, especially near curb and gutter sections, could impact the usability of the bicycle lane.

There are three types of bicycle lanes:

- Conventional
- Buffered
- Separated

a. **Conventional:** Located between the travel lanes and the curb, road edge, or parking lane and generally flow in the same direction as motor vehicles. They are the most common bicycle facility in the United States.

   1) **Two-way Streets:** It is recommended that bicycle lanes are provided on both sides of two-way streets as bicycle lanes on only one side may encourage wrong-way use. The exceptions are in cases of long downhill grades where bicyclists' speeds are similar to typical motor vehicle speeds. In this case, shared lane markings may be used in the downhill direction and a bicycle lane in the uphill direction.

2) **One-way Streets:** On one-way streets, the bicycle lane should be on the right-hand side of the roadway. A bicycle lane may be placed on the left side of the roadway if there are a significant number of left turn lanes, or if left-sided bicycle lanes will reduce conflicts with bus traffic, on-street parking, and/or heavy right-turn movements, etc.

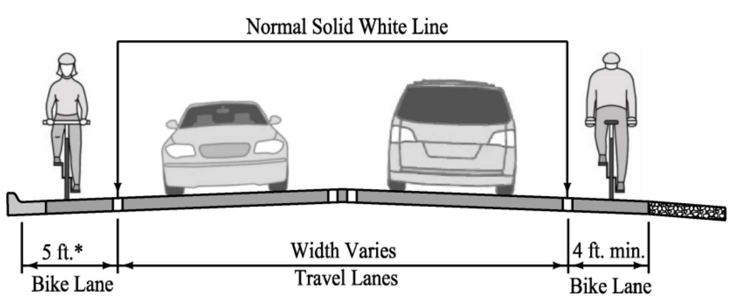
   Bicycle lanes should also be provided on both streets of a one-way couplet as to provide a more complete network and discourage wrong-way riding. If width constraints are in effect, shared lane markings should be considered.

   In some designated one-way streets, it may be preferred to provide bicyclists a contra-flow bicycle lane using markings and separated by a double yellow centerline. This design should be used where there are few intersecting driveways, alleys, and streets on the side of the street with the contra-flow lane. (AASHTO 4.6.3).

3) **Lane Widths:** The preferred operating width for bicycle lanes is 5 feet; however, 4 feet is the minimum in locations where there is an absence of on-street parking and a curb and gutter. In some instances, wider lanes may be more desirable. These instances are:
   - In locations with narrow parking lanes and high turnover. A wider bicycle lane of 6 to 7 feet will allow cyclists to ride out of the area of opening vehicle doors.
   - In areas with high bicycle use. A bicycle lane width of 6 to 8 feet will allow cyclist to pass each other or ride side-by-side.
   - In high-speed and high-volume roadways and/or high heavy vehicle traffic. A wider lane will provide an additional separation between cyclists and motorist, thus increasing safety and comfort of the cyclists.

   With wider bicycle lanes, appropriate signage and markings shall be used to delineate the bicycle lanes from the vehicle lanes.

Figure 12B-3.02: Conventional Bicycle Lane Cross-sections - Parking Prohibited

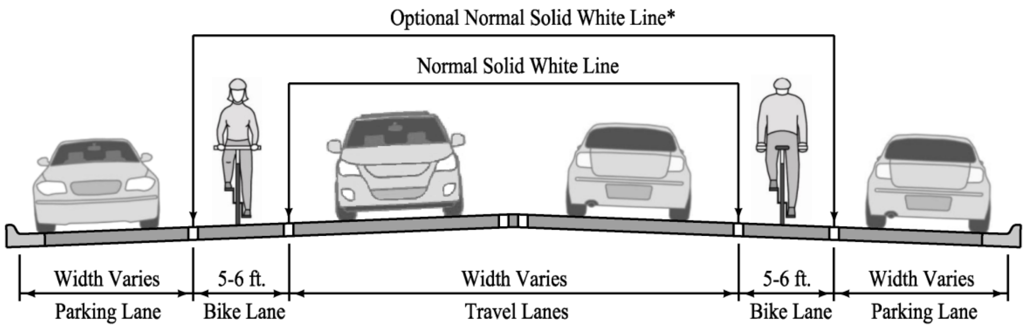


* On extremely constrained, low-speed roadways with curbs but no gutter, where the preferred bicycle lane width cannot be achieved despite narrowing all other travel lanes to their minimum widths, a 4 foot wide bicycle lane can be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

4) **Bicycle Lanes and On-street Parking:** With on-street parking facilities, bicycle lanes shall be located between the vehicle travel lane and the parking spot. For parallel on-street parking, the recommended width of a marked parking lane is 8 feet with a minimum of 7 feet. When the parking lane is not marked, the recommended width of the shared bicycle and parking lane is 13 feet with a 12 foot minimum. Any on-street diagonal parking that is adjacent to bicycle lanes shall be back-in parking as to prevent accidents due to poor visibility of bicyclists. (AASHTO 4.6.5).

Figure 12B-3.03: Conventional Bicycle Lane Cross-sections - On-street Parking

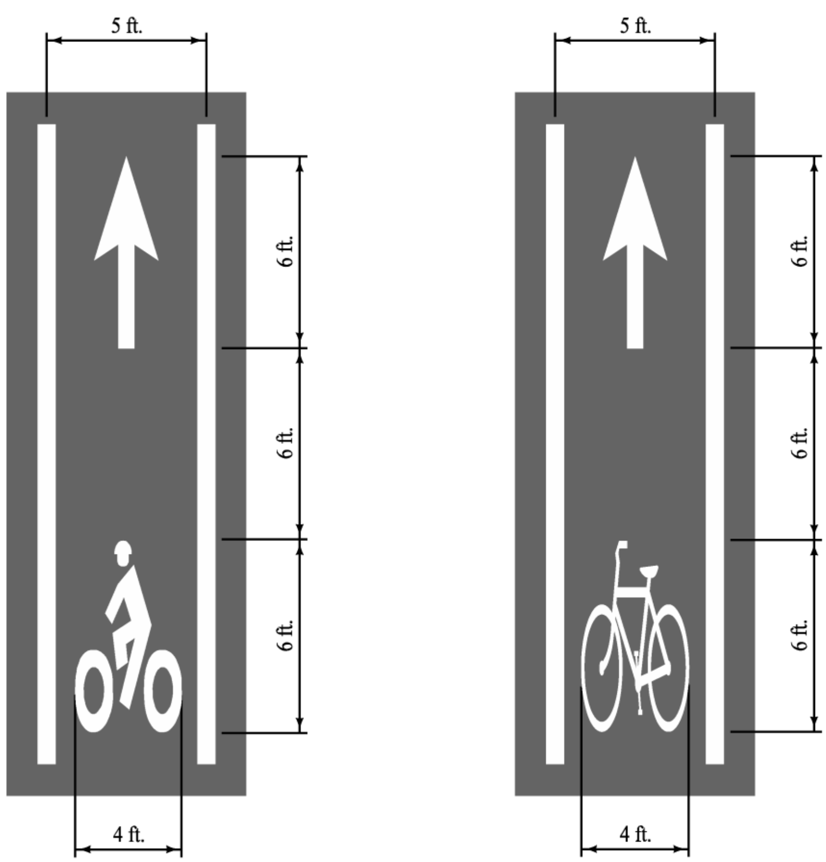


* The optional normal (4 to 6 inch) solid white line may be helpful even when no stalls are marked (because parking is light), to make the presence of a bicycle lane more evident. Parking stall markings may also be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

5) **Signs and Markings:** Bicycle lanes are designated for preferential use by bicyclists with a normal white line (4 to 6 inches wide) and one of the two standard bicycle lane symbols, which may be supplemented with a directional arrow marking. Pavement signs and non-raised pavement markings should be used instead of curbs, posts, raised pavement markings, or barriers. Raised devices are hazardous to cyclists and make it more difficult for cyclists to maintain riding in the bicycle lane. Refer to both the MUTCD and AASHTO 4.7.

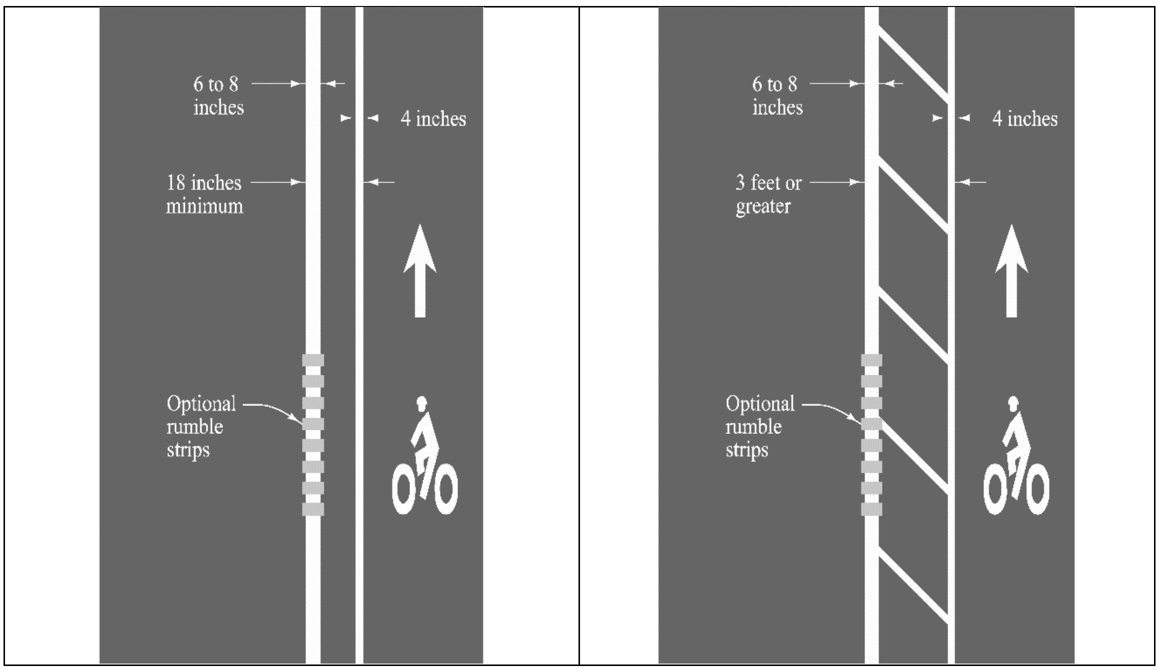
Figure 12B-3.04: Conventional Bicycle Lane Symbol Markings



Source: Adapted from *AASHTO Bike Guide* Exhibit 4.17

b. Buffered: Conventional bicycle lanes coupled with a designated buffer space separating the bicycle lane from adjacent motor vehicle lanes and/or a parking lane. They are generally used when traffic volumes include high percentages of trucks or buses and higher travel speeds. The lane widths are the same as for conventional bicycle lanes. The buffered bicycle lane provides a greater space for cycling without making the bicycle lane appear so wide that it might be mistaken for a travel or parking lane. The buffer should be a minimum of 18 inches wide and marked with two solid white lines with diagonal hatching or chevron markings if the width is 3 feet or greater. Colored markings may be used at the beginning of each block to discourage motorists from entering the buffered lane. The combined width of the buffer(s) and bicycle lane should be considered the "bicycle lane width." For buffered lanes between travel lanes and on-street parking, the bicycle lane should be a minimum of 7 feet wide (inclusive of buffer width) to encourage bicyclists to ride outside the door zone. Rumble strips may be added to the painted buffer area as an additional indicator for vehicles to remain clear of the bicycle lane. Placement of rumble strips should comply with Iowa DOT requirements.

Figure 12B-3.05: Buffered Bicycle Lane Markings



Source: Adapted from *Urban Bikeway Design Guide, NACTO*

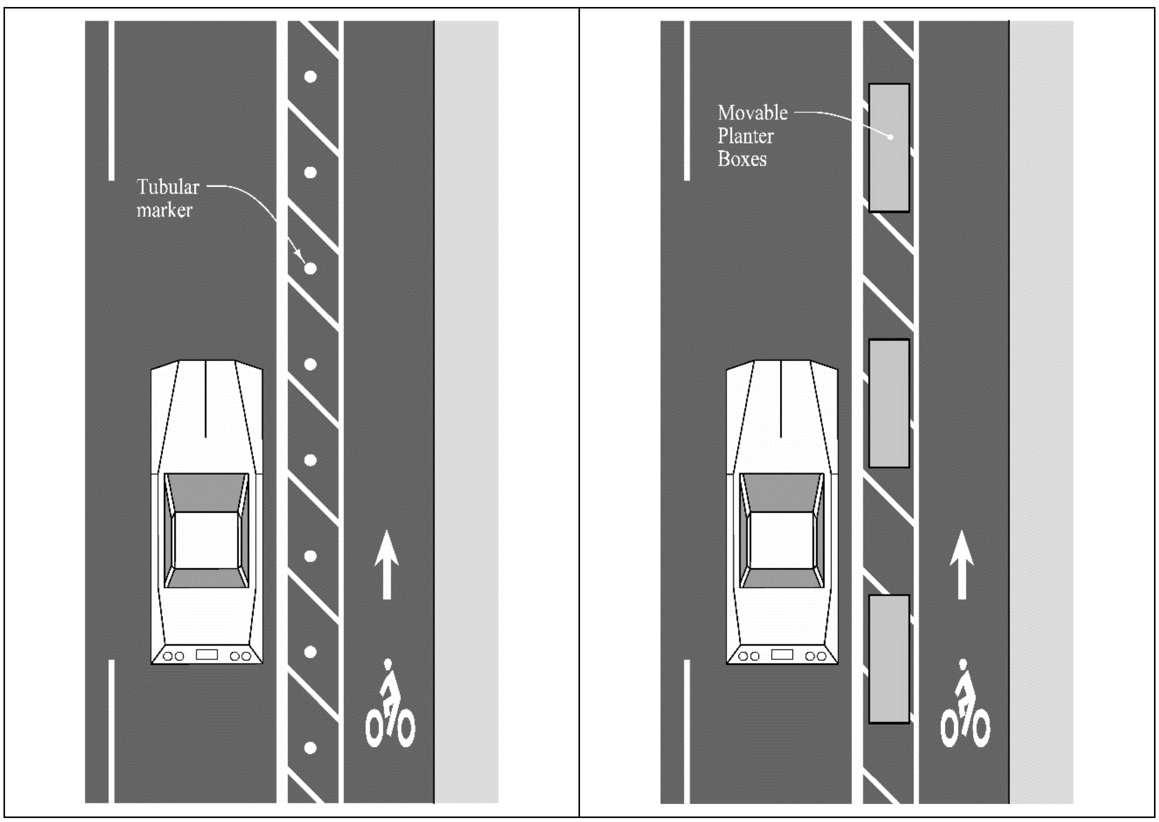
c. Separated: An exclusive facility for bicyclists that is physically separated from motor vehicle or parking lanes by a vertical element. Separated bicycle lanes are also sometimes called cycle tracks or protected bicycle lanes. Examples of vertical separation include delineators, bollards, curbs, medians, planters, concrete barriers, and on-street parking. Separated bicycle lanes can provide a safer, more comfortable experience for less-skilled bicycle riders and encourage more use of bicycles for travel if interconnected with other community bicycle facilities. Separated bicycle lanes typically include a painted buffer space that is used to locate the vertical element. Separated bicycle lanes are often implemented through the removal of a parking lane or by moving the parking lane between the separated bicycle lane and the travel lanes.

If the separated bicycle lane is parking protected, parking should be prohibited a minimum of 30 to 50 feet from the crosswalk of an intersection. Make sure to provide ADA access across the separated bicycle lane from parking spaces.

Separated bicycle lanes can operate as one-way or two-way facilities. Minimum width is 5 feet (exclusive of width for physical separation) for a one-way facility. Widths of 7 feet or greater are required for passing or side-by-side riding. Consideration should be given to the equipment that will be needed to perform sweeping and snow removal maintenance. Unobstructed widths of less than 8 feet will likely require specialized maintenance equipment. If a solid median is used as the means of vertical separation, drainage may also be impacted. Separation devices such as delineators or planters may be removed during the winter months to facilitate snow plowing and removal activities.

Interaction between transit stops and separated bicycle lanes can be difficult. When possible, the bicycle lane should be routed behind the bus platform. If bus traffic is infrequent (less than four buses per hour), bus stops can utilize the bicycle lane space. When buses are present, cyclists should merge left and pass the stopped bus.

Figure 12B-3.06: Separated Bicycle Lane

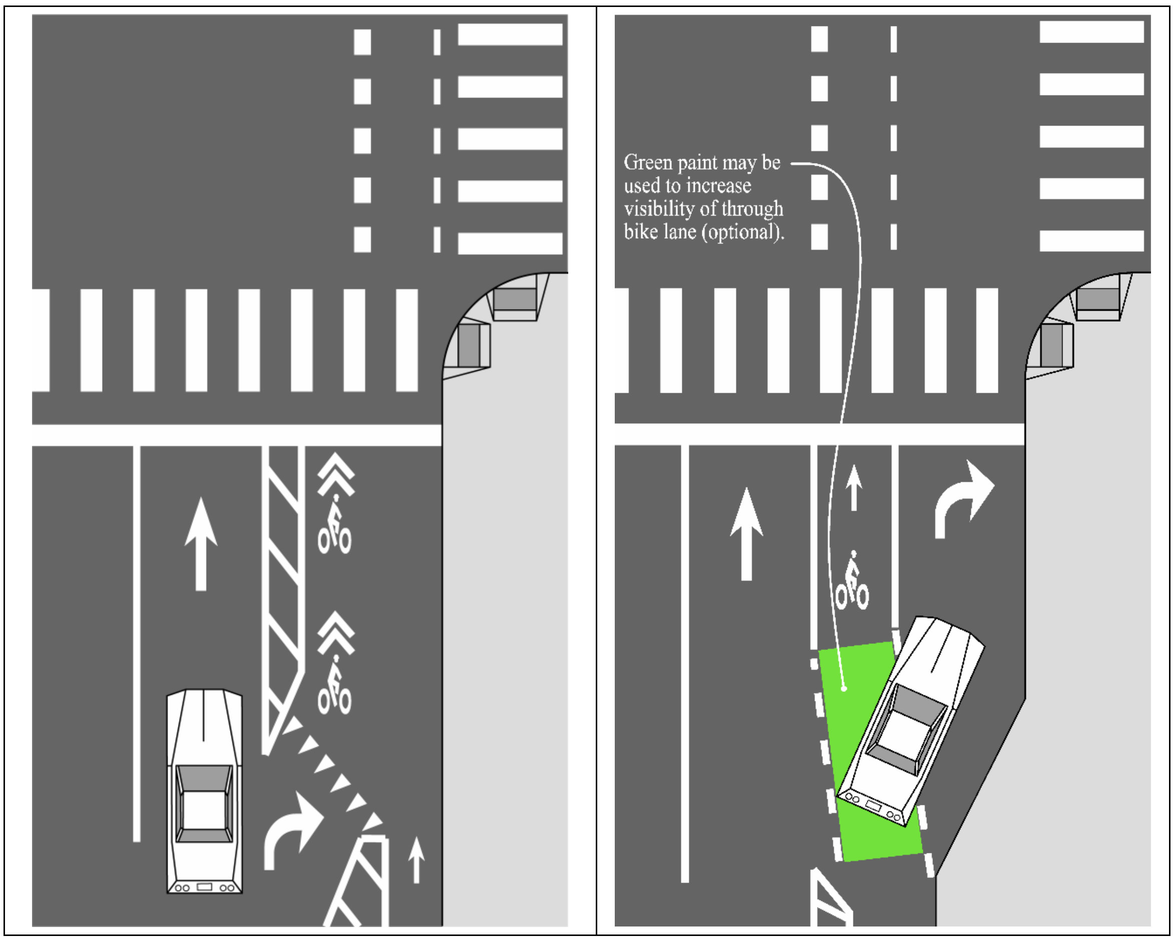


Source: Adapted from *Urban Bikeway Design Guide, NACTO*

d. Intersection Design: Most conflicts between motor vehicles and bicyclist occur at intersections and driveways. Due to the vulnerability of cyclists as well as the low visibility the cyclists have in relationship to the motorists, good intersection bicycle lane design and intersection pavement marking design is crucial to the success of an intersection that incorporates bicycle lanes. Refer to both the MUTCD and AASHTO 4.8 for additional information pertaining to intersection pavement marking and bicycle lane design.

Intersection design is critical since it is not possible to maintain physical separation between bicycles and vehicles where cross-street traffic and turning movements must cross the bicycle lane. One technique for intersections that do not have sufficient volumes for traffic signals is to use a mixing zone. The vertical element is discontinued about 100 feet from the intersection and the bicycle lane becomes a shared lane with the turning vehicles. Sharrow markings are used to guide the bicyclists to the left side of the right turning vehicles. The combined lane should be a minimum of 9 feet and a maximum of 13 feet wide. Another technique involves a lateral shift of the bicycle lane to a position to the left of the right turn lane (through bicycle lane). The transition involves a 30 feet long merge area without the vertical elements for vehicles to cross the bicycle lane and eliminate the conflict with right turning vehicles. The lateral shift also positions bicyclists to take advantage of a bicycle box that provides a space for bicycles to queue in front of vehicles during red signal indications.

Figure 12B-3.07: Mixing Zones and Through Bicycle Lane

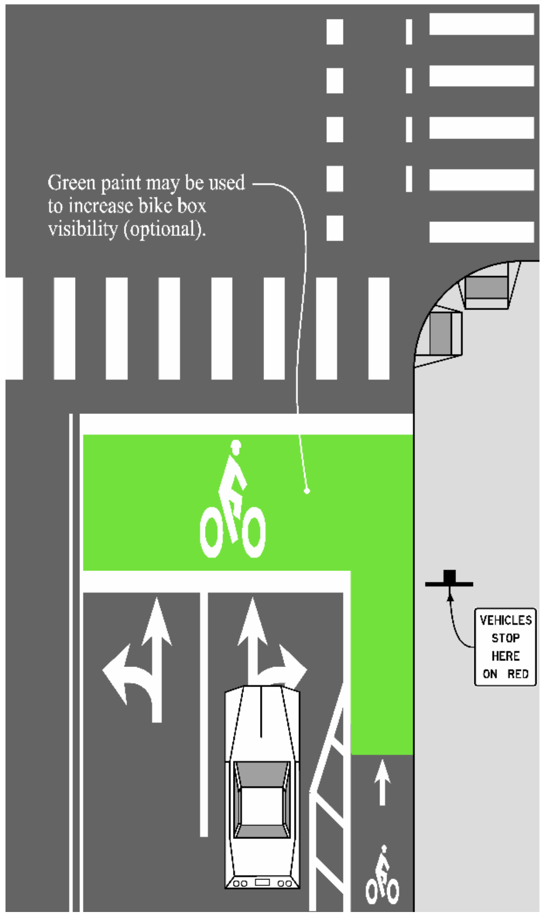


Source: Adapted from *Urban Bikeway Design Guide, NACTO*

The mixing zones and bicycle boxes may include an optional green pavement paint. If used, the green pavement paint must meet the MUTCD “Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14).”

Bicycle boxes, which have experimental status by the MUTCD, are placed between the vehicle stop line and the pedestrian crosswalk. Bicycle boxes increase the visibility of bicyclists and provide them with the ability to start up and enter the intersection in front of motor vehicles when the signal turns green. Bicycle boxes are used at signalized intersections with high volumes of bicycle left turns. The bicycle box should be a minimum of 10 feet deep and the combined width of the bicycle lane, the buffer space, and all of the adjacent same direction traffic lanes at the intersection. Bicycle boxes provide the opportunity for bicyclists to position for a left turn.

Figure 12B-3.08: Bicycle Box



Source: Adapted from *Urban Bikeway Design Guide, NACTO*

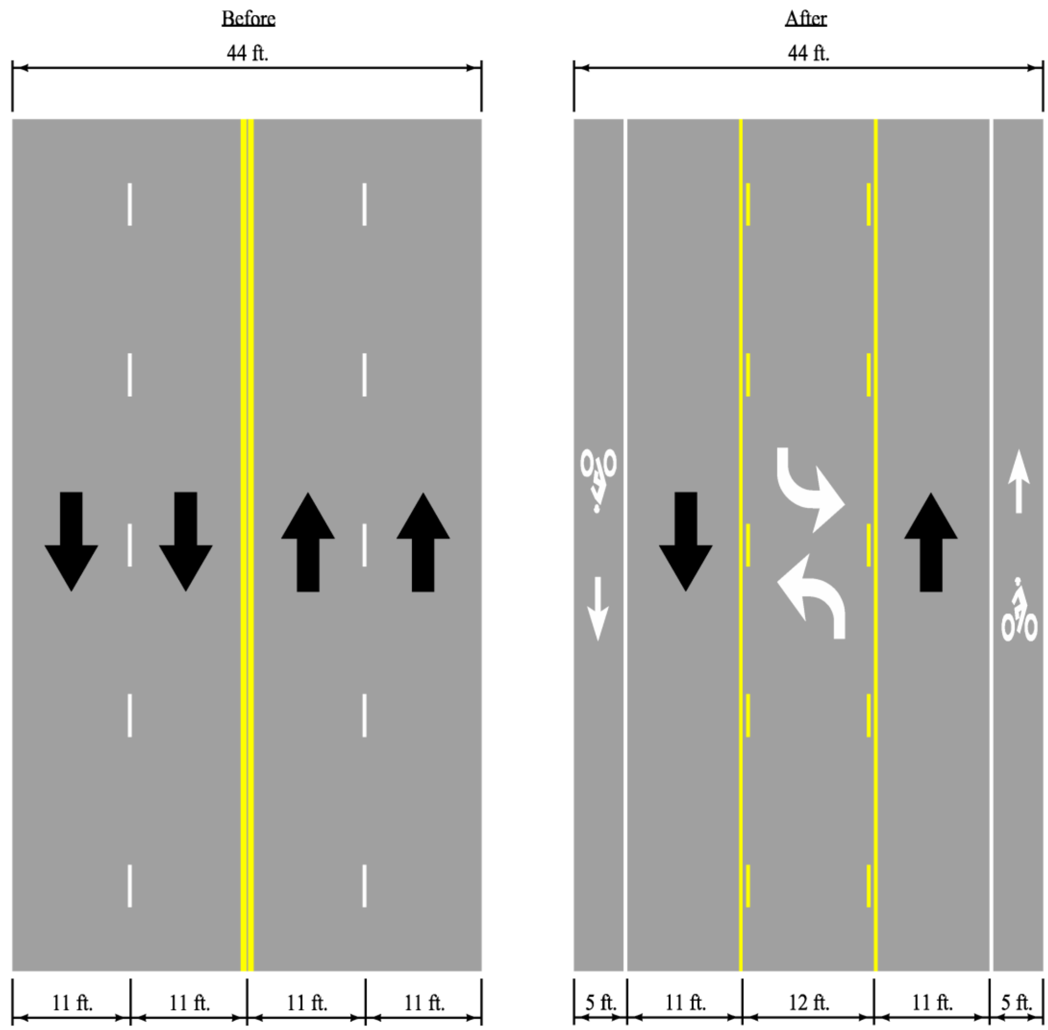
Bicycle signals may be used to separate bicycle through movements from vehicle movements for increased safety. They should only be used in combination with a conventional traffic signal. Bicycle signal heads use the traditional green, yellow, and red indications but have bicycle stenciled lenses. A supplemental "Bicycle Signal" plaque should be added below the bicycle signal head. A leading bicycle signal phase, which uses a bicycle signal lens to provide three to five seconds of green time before the corresponding vehicle green indication, can be used to increase the visibility and safety for bicyclists. Bicycle signal detection is critical to appropriate operation of a bicycle signal. There are four major types of bicycle detection including induction loop, video, push-button, and microwave.

Because drivers and bicyclists in Iowa are not familiar with the use of bicycle boxes and bicycle signals, it is critical to provide extensive educational information prior to implementing either of these strategies at urban intersections.

4. **Retrofitting Bicycle Facilities on Existing Roadways:** Existing streets and highways may be retrofitted to improve bicycle accommodations by either reconfiguring the travel lanes to accommodate bicycle lanes or by widening the roadway to accommodate bicycle lanes or paved

shoulders. These retrofits are best accomplished as either a reconstruction project or a repaving project as these projects will eliminate traces of old pavement markings. (AASHTO 4.9).

Figure 12B-3.09: Example of Road Diet



* Dimensions are illustrative

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.23

5. **Bicycle Boulevards:** A bicycle boulevard is described as a local street or a series of contiguous street segments that have been modified to function as a through street for cyclists while discouraging through vehicle traffic. To be effective, bicycle boulevards should be long enough to provide continuity over a distance of between 2 and 5 miles.

   Due to the low traffic volumes and speeds, local streets naturally create a bicycle-friendly environment in which the cyclists share the roadway with the vehicles. However, many local streets are not continuous enough for long bicycle routes. Therefore, in order to create a bicycle boulevard, some short sections of paths or segments may need to be constructed between local streets in order to create the continuous route.

Some design elements that are involved in the design of bicycle boulevards are:

- Traffic diverters at key intersections that allow bicycle through traffic but reduce or deny vehicle traffic
- Two-way stop-controlled intersection that give the bicycle boulevard priority
- Neighborhood traffic circles or mini-roundabouts
- Traffic-calming features
- Wayfinding signs to guide bicyclists
- Shared lane markings where appropriate
- Bicycle-sensitive traffic signals at busy intersections
- Median refuges large enough for bicycles
- Curb extensions on crossed thoroughfare with on-street parking

It is important to note that before the design of a bicycle boulevards, an investigation of the proposed boulevards should be performed since many of the design elements listed may already be in use. (AASHTO 4.10).

D. Bicycle Guide Signs

Guide signs are an important element to all bicycle facilities as they help cyclists navigate to their destination. There are many guidelines and standards that go along with the type and placement of guide signs. See both the MUTCD and AASHTO 4.11.

E. Railroad Crossings for Bicycles

Where roadways or shared use paths cross railroad tracks on a diagonal, the designer should take care in the design of the crossing as to prevent steering difficulties for the cyclists. This includes:

- Increasing the skew angle between the tracks and the bicycle path to 60 degrees or greater so bicyclists can avoid catching their wheels in the flange of the tracks. This can be accomplished with reverse curves or with a widened shoulder.
- Creating a smooth crossing surface that will last over time and not be slippery when wet.
- Minimizing flange openings as much as possible. Under special rail conditions, rubber fillers products may be used. Contact the railroad company for approval prior to the design and installation of the fillers.

See both the MUTCD and AASHTO 4.12.1.

F. Obstruction Markings for Bicycle Lanes

The design of bicycle facilities should avoid obstruction and barriers as much as possible. However, in rare circumstance in which an obstruction or barrier cannot be avoided, signs, reflectors, and markings should be utilized to alert they cyclists. (AASHTO 4.12.2).

G. Traffic Signals for Bicycles

Traffic signals have traditionally been designed based off the operating characteristics of motor vehicles. However, at intersections with medium to high bicycle usage that incorporates shared lanes or bicycle lanes, traffic signal designers should include the characteristics of bicyclists to their traffic signals. The signal parameters that could be modified to accommodate bicyclists when appropriate are minimum green interval, all-red interval, and extension time. This information can be found in AASHTO 4.12.3 and 4.12.4 as well as the latest edition of the "Highway Capacity Manual."

H. Bridges and Viaducts for Bicycles

Two considerations should be taken into account before the design of bicycle accommodations with bridges - the length of the bridge and the design of the approach roadway. If the bridge approach does not include bicycle accommodations, the bridge can still facilitate use by bicyclists by including a wide shoulder or bicycle lanes and include paved shoulder, shared lanes, or shared use path as part of the bridge project. Additionally, if the bridge is continuous and spans over a 1/2 mile in length with speed of excess of 45 mph, a concrete barrier separated shared use path on both sides of the bridge should be considered. By allowing paths on both sides of the bridge, wrong-way travel of the cyclists will be deterred. (AASHTO 4.12.5).

I. Traffic Calming and Management of Bicycles

There are many things that a designer can do to reduce the traffic speed of cyclists and to manage bicycles effectively. These things include narrowing streets to create a sense of enclosure; adding vertical deflections such as speed humps, speed tables, speed cushions, and raised sidewalks; adding curb extension or chokers; adding chicanes; installing traffic circles; and incorporating multi-way stops. (AASHTO 4.12.6 and 4.12.7).

J. Intake Grates and Manhole Castings for Bicycle Travel

It is important to have intake grate openings run perpendicular to the direction of travel as this will prevent bicycle wheels from dropping into the gaps and causing crashes. SUDAS Specifications Figure 6010.603, Type R and Type S, are intake grates that are appropriate for use on bicycle routes. Where it is not immediately feasible to replace existing grates, metal straps can be welded across slots perpendicular to the direction of travel at a maximum longitudinal spacing of 4 inches. Additionally, open-throat intakes can be used instead of grate intakes in order to eliminate the grate all together. The presence of the depressed throat of the intake should be taken into account.

Surface grates and manhole castings should be flush with the roadway surface. In the case of overlays, the grates and castings should be raised to within 1/4 inch of the new surface. If this is not possible or practical, the pavement must taper into drainage inlets so it does not have an abrupt edge at the inlet. Take care in the design of the taper of the pavement around inlets and castings so to avoid “birdbaths” or low spots that are not drainable in the pavement. (AASHTO 4.12.8).

K. Bicycles at Interchanges

When designing bicycle facilities at interchanges, it is important to consider both safety and convenience for the cyclists. This is best achieved by designing right-angle intersection or single lane roundabouts at the intersection between the local route and the ramps. These designs promote low speeds, minimize conflict areas, and increase visibility. Additionally, stop signs or signals are encouraged for motorists turning from the off ramp to the local route rather than allowing a free-flowing movement as this will increase the safety of the cyclists.

At complex interchanges that include high-speeds and free-flowing motor vehicle movements, a well signed and clearly directed grade-separated crossings may be necessary. These grade-separated facilities should still include good visibility, be convenient, and consist of adequate lighting. (AASHTO 4.12.9).

L. Bicycles at Roundabouts

In designing roundabouts for bicycle usage, single lane roundabouts are safer and easier to navigate for cyclists. Multi-lane roundabouts include too many conflict points due to bicycle weaving/changing lanes and motorist cutting off cyclists when exiting the roundabout.

In instances of bicycle lanes approaching a roundabout, the bicycle lane should be terminated at least 100 feet from the edge of the entry curve of the roundabout and prior to the crosswalk. Also, prior to the roundabout and after the termination of the bicycle lane, a tapering of the bicycle lane to the travel lane should be provided. This is done to achieve the appropriate entry width for the roundabout and the taper should be 7:1 for a 20 mph design speed or 40 feet for a 5 to 6 foot bicycle lane. Additionally, the bicycle lane line should be dotted 50 to 200 feet in advance of the taper to encourage cyclists to merge into traffic.

In rare circumstances, bicyclists should be given the option to merge with traffic prior to the roundabout or exit onto the adjacent sidewalk via a ramp. These instances include multi-lane roundabouts, high design speed roundabouts, and/or complex roundabouts. However, in some jurisdictions, cyclists riding on sidewalks may be prohibited. In designing bicycle ramps prior to a roundabout, the following criteria should be followed:

- Place bicycle ramps at the end of the full width bicycle lane and just before the taper of the bicycle lane.
- Where no bicycle lane is present on the approach to the roundabout, a bicycle ramp should be placed at least 50 feet prior to the crosswalk at the roundabout.
- Bicycle ramps should be placed at a 35 to 45 degree angle to the roadway.
- If the ramp is placed outside of the sidewalk, it can have up to a 20% slope; if the ramp is placed within the sidewalk, it should be designed in a manner to prevent a tripping hazard.
- If the ramp is placed outside the sidewalk, a detectable warning device should be placed at the top of the ramp; if the ramp is placed within the sidewalk, the detectable warning device should be placed at the bottom of the ramp.
- Bicycle ramps should be placed relatively far from the marked crosswalk as to prevent pedestrians from mistaking the ramp as a crosswalk.

Bicycle ramps at the exits of roundabouts should be built with the similar geometry and placement as the ramps that are designed at roundabout entries. Bicycle ramps at the exits of roundabouts should be placed at least 50 feet beyond the crosswalk of the roundabout. Refer to AASHTO 4.12.10 and the FHWA Roundabout Guide.

M. References

American Association of State Highway and Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets* (“Green Book”). Washington, DC. 2004.

American Association of State Highway and Transportation Officials (AASHTO). *Guide for the Development of Bicycle Facilities*. Fourth Edition. Washington, DC. 2012.