CHAPTER 4

BIKEWAY AND WALKWAY PLANNING AND DESIGN GUIDELINES

This chapter provides a general understanding of what is required to plan and design a bikeway or walkway. It is a summary of ConnDOT's Draft Bicycle Planning and Design Guidelines Manual, currently being developed by ConnDOT, and the Federal Highway Administration (FHWA) publication, "Planning, Design, and Maintenance of Pedestrian Facilities.

BIKEWAYS

Planning

Bicycle Planning incorporates the facility and location selection criteria for bicycle routes. A bicycle route is a system of on street facilities such as **shared roadways, wide curb lanes, bicycle lanes** and or separate **multi-use paths** that allow a rider to go from point A to point B. The location and type of bicycle route is dependant on factors such as accessibility, safety and the riding environment.

Bicycle routes should be located where their use can be maximized. Factors that should be considered are the routes ability to serve employment centers, commercial areas, shopping centers, education facilities, and parks and recreation areas. The location of bicycle routes should provide for adequate access points, and provide a route that connects origin and destination points in a direct manner.

Bicycle facility types should be selected in a manner whereby conflicts with motorists and pedestrians are minimized. They should also provide a riding environment that is aesthetically pleasing and conducive to the physical ability of the average cyclist. One important consideration in selecting the type of facility is continuity. A bicycle route of alternating segments of separate bicycle paths and on street bike lanes should be avoided, if possible. They tend to encourage wrong way bicycle travel beyond the end of a bike path where bicyclists are required to cross to the other side of the street to travel with traffic. If a route type change is necessary, the transitions from one type of facility to another must be well signed.

Selection of the appropriate facility type to meet the bicyclists needs is dependent on many factors. The following paragraphs describe the most common uses for each facility type.

Shared Roadway - Shared roadways are streets on which both bicycle and motor vehicle travel is permitted. By State Law, all streets and highways, other than limited controlled highways such as expressways, fall into this category. A shared roadway that is designated as part of a Bicycle Route should: (1) provide continuity to other bicycle facilities or (2) designate preferred routes through high-demand corridors. The designation of a shared roadway as part of a Bicycle Route should indicate to bicyclists that there are particular advantages to using these routes as compared with alternative routes. This also means that responsible agencies have taken actions to ensure that these routes are suitable as shared routes and will be maintained in a manner consistent with the needs of bicyclists.

Wide Curb-lanes - Wide curb-lanes are essentially shoulders placed along streets in corridors where there is significant bicycle demand. However, wide curb-lanes are for shared use by bicycle and motorized traffic. The added lane width provides greater room for maneuvering and increases the lateral distance between bicyclists and vehicles. Wide curb-lanes are appropriate bicycle facilities where traffic speeds and volumes are tolerable for shared roadway facilities.

Wide curb-lane facilities are selected when there is insufficient room for a separate bike lane, yet significant demand exists for providing a facility of some kind. To many experienced riders, wide curb-lanes are a preferred facility type because it integrates bicycle and vehicular traffic, and forces recognition and awareness on the part of the motorist.

Wide curb-lane facilities can be created by widening roadways, by narrowing traffic lanes, or both. It should be noted that both the American Association of State Highway Transportation Officials (AASHTO) and the National Advisory Committee on the Manual of Uniform Traffic Control Devices (MUTCD) have commented in favor of reducing vehicle lanes from 12 ft. (3.6m) to 11 ft. (3.3m) for the purpose of widening the rightmost curb-lane for bicycle use.

Bicycle Lanes - Bicycle lanes are painted and signed lanes, generally in the shoulder of the roadway, established along streets in corridors where there is significant bicycle demand, and where there are distinct needs that can be served by them. The purpose should be to improve conditions for bicyclists in the corridors and to better accommodate bicyclists where there is insufficient room for safe bicycling on existing streets. Bike lanes are desirable when traffic volumes or speeds are such that wide curb-lanes are not practical.

Additional measures, that might not be possible on all streets, should be implemented on bike lane streets to improve the situation for bicyclists. These include pavement surface improvements, stronger sweeping programs, special signal facilities, etc. Special efforts should also be made to ensure that high levels of service are provided with these lanes (i.e., bicycle-sensitive signal actuators, pavement markings, etc.), if bicycle travel is to be regulated by delineation. Additional night lighting of extensively traveled bicycle corridors also increases safety and comfort. Bicycle lanes can be provided by widening existing roadways or paving shoulder areas.

Multi-use Paths - Multi-use paths are trails generally located on exclusive rights-of-way and with minimal cross flow by motor vehicles. They should be used to serve corridors not served by streets and highways or where wide rights-of-way exist permitting such facilities to be constructed away from the influence of parallel streets. Multi-use paths should offer opportunities not provided by the road system. They can either provide a recreational opportunity or, in some instances, can serve as direct high-speed commuter routes if cross flow by motor vehicles can be minimized. The most common uses are along highway rights-of way, rivers, oceanfronts, canals, utility rights-of-way, abandoned railroad rights-of-way, within college campuses, or within and between parks. There may also be situations where such facilities can be provided as part of planned developments. Another common application is to eliminate impediments to bicycle travel caused by construction of freeways, or because of the existence of natural barriers. Right-of-way widths have to be such that adequate room exists for the separated facilities and physical separation of the modes.

Location

The factors to be considered in choosing the proper location for a bicycle route vary depending on the situation. The most important variables usually include accessibility, safety and riding environment. These variables are discussed as follows:

Accessibility

Potential Use - The route should be located where its use can be maximized. The major factors that should be examined to identify origins and destinations of trips is the location of household distribution (single-family and multi-family), employment centers, major commercial areas, shopping centers, educational institutions, multi-modal interface points (e.g., end points of the transit system; major transfer points), restaurants and convenience stores, parks and recreational areas.

Access Points - In locating a bicycle route, consideration should be given to provision of adequate access points. The more frequent and convenient the access points, the more the facility will be used. This is important for bicycle routes, serving utility trips as well as recreational trips. Adequate access for emergency and service vehicles should also be provided.

Directness - The bicycle route should serve activity centers along a direct course except along recreational routes where this factor is not as important. The bicycle is considered to be a legitimate mode of transportation; accordingly, access is required from all major origins to all destinations. Ideally, all origin and destination pairs should be made accessible.

Existing Barriers - In some areas, there are major physical barriers to bicycle travel, caused by topographical features, freeways, canals, railroad tracks, or other impediments. The development of a bicycle route that crosses a barrier can provide new opportunities for bicyclists.

Delays - Bicycle travel is inherently a slower mode of travel and if there are frequent stops, bicyclists will generally avoid the route. When a bicycle route is established on a minor street, consideration should be given to orienting stop signs to stop traffic at crossing road, rather than on the bike route. This does not apply to major crossings, such as arterials and collectors, where stopping the traffic in favor of the bike route would disrupt the hierarchy of the street systems.

Safety

Use Conflicts - Different types of facilities introduce different types of conflicts. On street facilities can involve conflicts between bicyclists and motor vehicles. Multi-use paths usually involve conflicts with other bicyclists and pedestrians on the path, and with moving and parked motor vehicles at street intersections, curb cuts, and driveways. Sidewalk facilities can increase conflicts with pedestrians, motor vehicles at highway and driveway intersections, and fixed objects such as utility poles and guy wires.

Accidents - Reducing the number of bicycle accidents along routes is important. The potential for alleviating accident problems through the improvement of a facility should be assessed, as should the potential for introducing new accident problems. When locating bicycle routes, the following guidelines should be followed in order to reduce the potential accidents:

1. The location of bicycle routes should be governed by the principle that the facility should not encourage or require bicyclists or motorists to operate in a manner inconsistent with the normal rules of the road.

2. Bicycle lanes should always be one-way facilities and carry traffic in same direction as adjacent motor vehicle traffic.
3. Sidewalks are not a recommended alternative for bicycle facilities.

Traffic Volumes and Speeds - For facilities on a street, traffic volumes and speeds must be considered along with the roadway width, frequency of intersections, number of driveways and signs. Commuting bicyclists frequently use arterial streets because they minimize delay and offer continuity for trips of several miles. If adequate width for all vehicles is available on more heavily traveled streets, improving the streets can be more desirable than improving adjacent streets. When this is not possible, a nearby parallel street may be improved for bicyclists, provided that stops are minimal and the route conditions are adequate.

Truck and Bus Traffic - Because of their aerodynamic effect and width, high-speed trucks, buses, motor homes, and trailers can cause special safety problems for bicyclists. Thus, if there is a choice between comparable routes, the one with the lower traffic volume would be preferable. As a general guide, shared roadway bike routes may be placed on roadways that carry truck/bus volumes of less than five percent of average daily traffic (ADT), and bike lanes may be accommodated on roadways with a combined truck/bus volume greater than five percent.

Pavement Surface Quality - On street facilities must have smooth pavement. The need for a bike route surface as smooth, if not smoother, than the normal road surface is predicated on the fact that most bicycles have high-pressure tires that transmit every bump and do not have a suspension system to absorb these bumps. Utility covers and drainage grates should be flush with the pavement surface, and drainage grates should be designed to allow the crossing of bicycles without causing a fall. Grates must have a checkerboard pattern, or have slats oriented perpendicular to the flow of traffic. Approaches to railroad crossings should be improved as necessary to provide for safe bicycle crossings.

Maintenance - Ease of maintenance is important when locating facilities. Inadequately maintained facilities may prove to be poor investments. Proper maintenance can correct some unsafe conditions for bicycling; however, the cost of additional maintenance should also be considered.

On-Street Parking - The turnover and density of on-street parking can affect the safety of bicyclists (e.g., opening car doors and cars entering or leaving angle parking spaces).

Riding Environment

Aesthetics - The scenic value is particularly important along a bikeway that can serve a recreational purpose as well as a transportation purpose.

Grades - Steep grades on bicycle routes should be avoided if possible. Most bicyclists cannot negotiate steep hill grades greater than 5 percent; these can be a severe deterrent to use of the facility. Also, riding downhill can be risky, particularly for unskilled bicyclists or for bicyclists with faulty equipment.

Regulatory Considerations

Regulatory considerations generally are applicable only to multi-use paths. If the Federal Highway Administration (FHWA) funds are utilized, all applicable federal rules and regulations need to be followed. This includes the required reviews and clearances from the appropriate state and federal resource agencies. Sometimes, an environmental study must be prepared to assess any adverse social, economic and environmental factors. Work involving sensitive historic structures or archaeological sites must conform to the Department of the Interior's standards and guidelines for archaeology and historic preservation. Any property acquisition must conform to the Uniform Relocation Assistance and Real Property Acquisition Act. Also, engineering and architectural designs for all facilities must conform to the Americans with Disabilities Act.

Before becoming too heavily involved in a design, it is recommended that a check of all local, state and federal agencies be made to determine potential areas of concern and/or regulatory permit requirements.

DESIGN GUIDELINES FOR BICYCLE AND PEDESTRIAN FACILITIES

Bikeways are considered transportation facilities, therefore their design should adhere to AASHTO guidelines. When designing a facility many factors are taken into consideration, including cost, functionality, safety, and the impacts associated with construction such as wetlands and rights-of way. Signing for Bicycle Routes is a major element in all Bike Routes and should provide the user with the basic information needed to make it a safe and effective transportation facility. Signs indicating a route name or number should be installed in such a way that the user is aware of what direction to turn at intersections and to assure the user that he or she is on the desired route and going in the right direction after a decision point. The following sections describe design details for significant components for the various types of bicycle facilities. These details should be considered in the facilities design.

Shared Roadway Bicycle Route

Bicycles may be ridden on all highways where they are permitted. As a result, all new highways, except those where bicyclists legally are prohibited, should be designed and constructed under the assumption that they will be used by bicyclists. Bicycle-safe design practices, as described in this guide, should be followed to avoid costly retrofit improvements. Conditions on roadways that will be designated as part of a Bicycle Route should be examined and, where necessary, improvements as described below should be provided. It should be noted that these items should be applied to all bicycle routes.

Drainage Grates

Drainage grate inlets and utility covers can be serious hazards to bicyclists. Unsafe grates can divert a cyclist's front wheel, causing a crash. Parallel bar drainage grate inlets are the most hazardous because they can trap the front wheel of a bicycle causing loss of steering control and the bar spacing is such that they can allow narrow bicycle wheels to drop into the grates. Unsafe grate covers should be replaced with Type A catch basin grates as shown in Figure 3

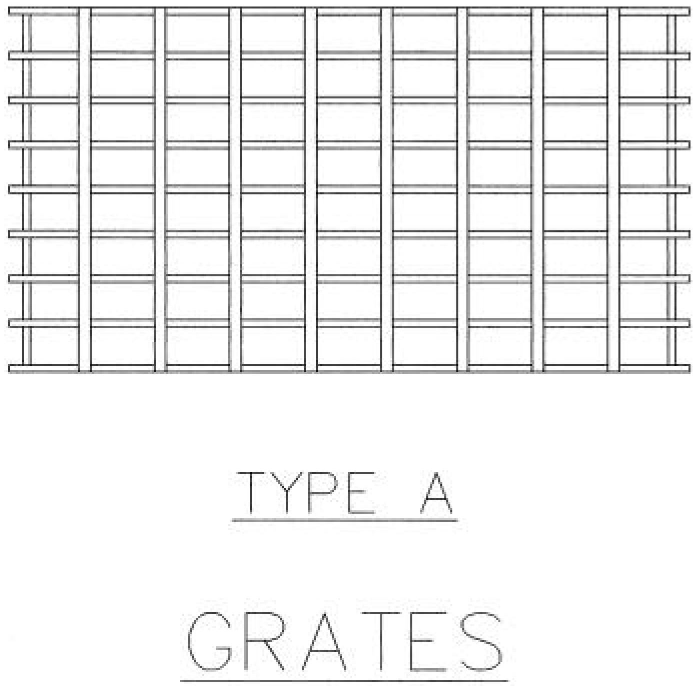


Figure 3

Bicycle Safe Catch Basin Grates.
Source: ConnDOT Standard Details

Railroad Crossings

For bicycle traffic, there are two main problems with at-grade railroad crossings. First, if the tracks cross the roadway at less than 60 degrees, a bicyclist's front wheel may be diverted by the rail or trapped in the flange way, causing loss of steering control. In design, an attempt should be made to have the bicyclist cross the track at as close to 90 degrees as possible. Second, a rough crossing - regardless of angle - may cause wheel damage or may cause a bicyclist to crash. As shown in Figure 4, widening the approaching roadway, bike lane or shoulder will allow the bicyclist to cross at approximately 90 degrees without veering into the path of overtaking traffic. The minimum amount of widening should be 6-ft (1.8m); however, 8-ft. (2.4m) is desirable, depending on the amount of available right-of-way. Adequate tapers should be provided.

On low-speed, lightly traveled railroad tracks, commercially available flange way fillers can eliminate the gap next to the rail. The filler normally fills the gap between the inside railbed and the rail. When a train wheel rolls over it, the flange way filler compresses. This solution, however, is not acceptable for high-speed rail lines, as the filler will not compress fast enough and the train may derail.

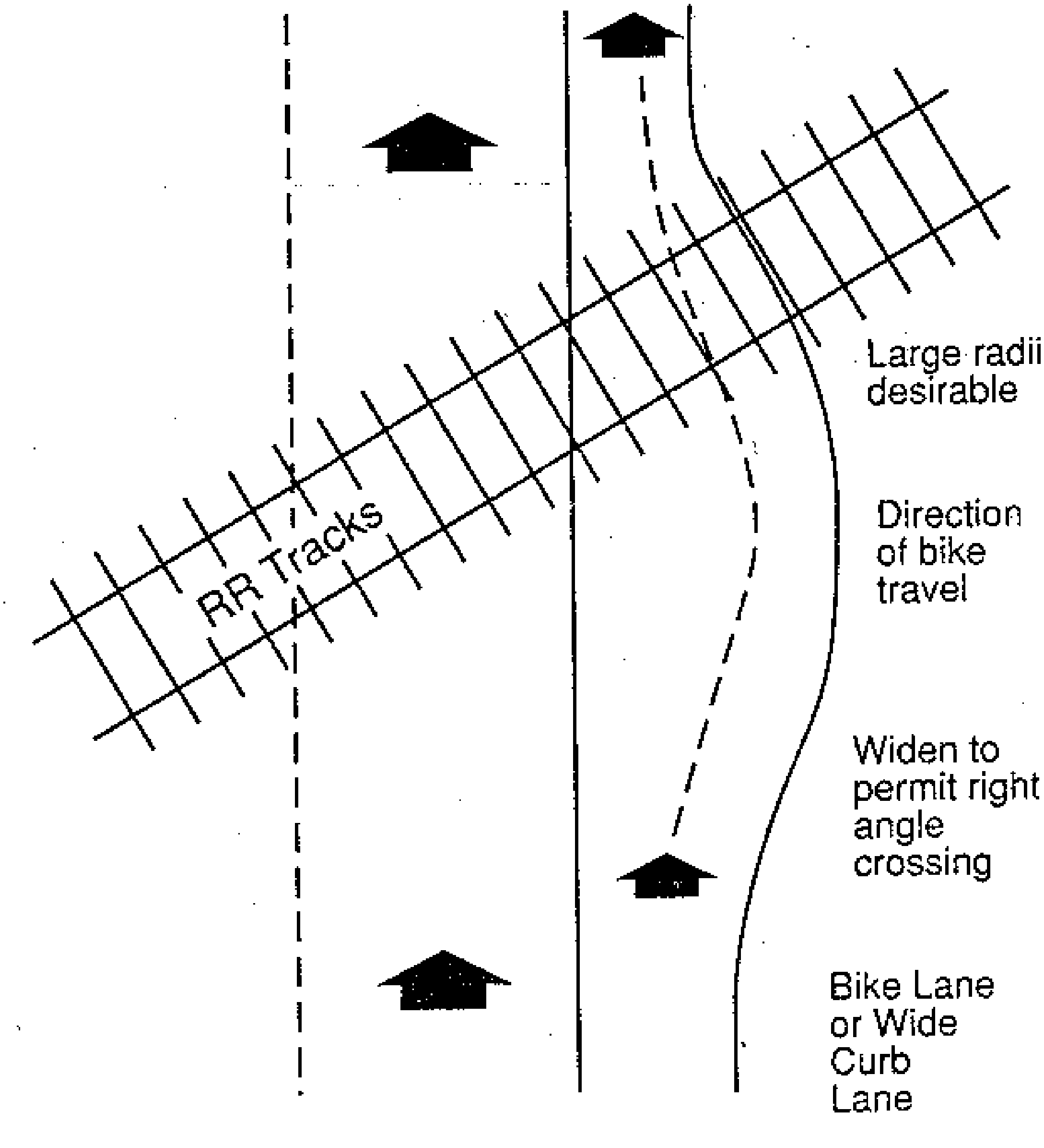


Figure 4

Flared roadway permits bicyclists to cross-angled railroad crossing at or near 90 degrees.

Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988.

Wide Curb-lane Bicycle Route

A wide curb-lane is best described as a lane of a roadway, which is of adequate width to accommodate both bicycle and motorized traffic in the same lane. This lane should always be the through lane closest to the curb, or shoulder edge of the road where a curb is not provided. The design considerations described here are specific to wide curb-lanes and are in addition to the items described for Shared Roadways.

Lane Width

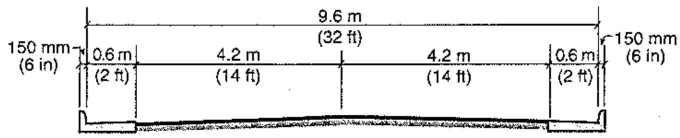
The desirable motor vehicle lane width is 12-ft (3.6m). On roadways without separate bicycle lanes, a right-hand (outside) through lane wider than the standard width better accommodates both bicycles and motor vehicles. The additional width on the outside lane also improves sight distances and provides more maneuvering room for vehicles turning into the roadway. In many cases where there is a wide outside through lane, motorists will not need to change lanes to pass a bicyclist. Thus, on roadways with bicycle traffic, widening the outside lane can have a beneficial effect on capacity and safety.

There are two separate ways to provide a wide curb-lane. The most desirable is to widen the road. However, where conditions exist such that widening the road is not possible, a wide curb-lane can be achieved by modifying the existing pavement markings and using 11-foot lanes.

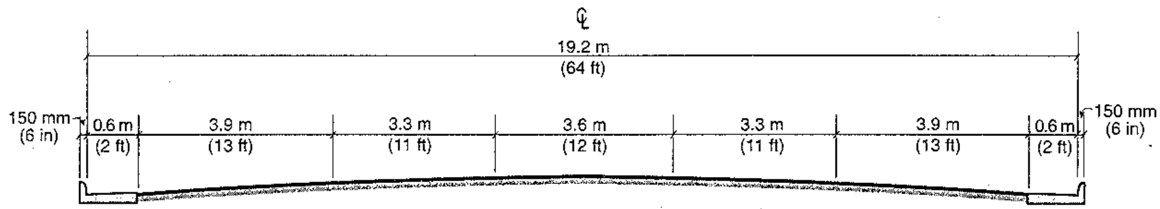
Road Widening - On roadways that accommodate both bicycles and motor vehicles within the travel lanes, 14 ft, (4.2m) of useable width should be provided on the outside through lanes. The 14-ft (4.2 m) width should be considered a minimum width and 16 ft (5.0m) should be considered a desirable width. In determining the useable width of an outside lane, adjustments need to be made for obstructions. Bicyclists shy away from obstructions such as drainage grates, parked vehicles and longitudinal ridges between the pavement and gutter sections. An extra 1-ft (0.3m) of "shy distance" should be added for flush or depressed obstructions, such as a joint or soft shoulder. If a raised obstruction, such as a curb and gutter is present, an extra 2 ft (0.6m) "shy distance" should be added before the raised face of the curb. If drainage grates are located in the gutter or near the right edge of the roadway, they should not be included in the calculations of useable width.

Pavement Marking Modification - If the outside lane width cannot be increased by widening the pavement, the lane striping may be shifted to narrow the inside lane(s) while widening the outside lane. Since narrowing the vehicle travel lane reduces its capacity, this approach should only be taken when the roadway is operating at Level of Service C or better and truck traffic accounts for 5% or less of the total traffic flow. In any case, a vehicle travel lane should not be reduced to less than 11-ft (3.3m) in width.

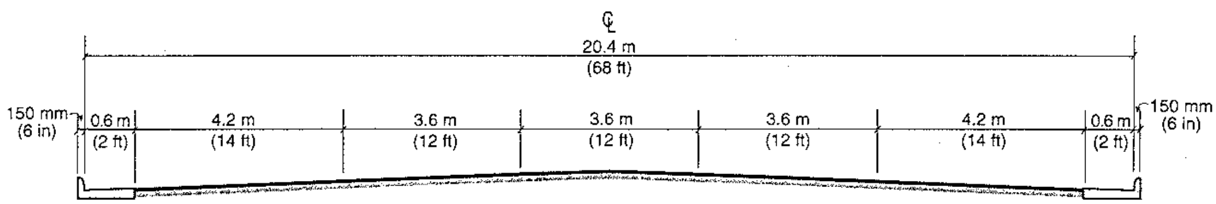
Some have recommended 15-ft (4.5m) of useable width for an actual "wide outside thru lane." However, widths greater than 14 ft (4.2m) can encourage the operation of two motor vehicles in one lane. This is likely to occur near intersections with heavy turn volumes during periods of peak congestion. Such conditions may reflect a need to consider improvements at the intersection. If this condition exists, it may be necessary to consider designated bicycle lanes at intersections to ensure safety. Figures 5 thru 7 show examples of typical wide curb-lane arrangements in both existing and new facilities.



(1) Two-lane roadway with wide lanes



(2) Typical 5-lane roadway with curb & gutter and differential striping



(3) Five-lane roadway with curb & gutter, standard 3.6 m (12 ft) inside lanes, and widened curb lanes

Figure 5 thru 7

Options for creating wide lanes for bicycle traffic in different situations.

Source: North Carolina Bicycle Facilities Planning and Design Guidelines, 1994.

Bicycle Lane Bicycle Route

Bicycle lanes may be considered when it is desirable to delineate available road space for preferential use by bicyclists. Bicycle lanes should always be **one-way** facilities and carry traffic in the same direction as adjacent motor vehicle traffic. Two-way bicycle lanes on one side of the roadway are unacceptable because they promote riding against the flow of motor vehicle traffic. Wrong-way riding is a major cause of bicycle accidents and violates the rules of the road. Bicycle lanes on one-way streets should be on the right side of the street, except in areas where a bicycle lane on the left will decrease the number of conflicts (e.g., those caused by heavy bus traffic).

Delineation

Bicycle lane lines should be solid, 6 in. (150mm) wide, and marked with white traffic paint. The width of the lines should match the width of other lines on the particular roadway in question. Thermoplastic and preformed tape can be slippery when wet, causing loss of control for bicyclists, and should, therefore, not be used.

Raised barriers (e.g., raised traffic bars and asphalt concrete dikes) or raised pavement markers should not be used to delineate bicycle lanes. Raised barriers prevent motorists from merging into bike lanes before making right turns, restrict the movement of bicyclists desiring to enter or exit bike lanes and impede routine maintenance.

Bike lane markings should be placed at a constant distance from the outside motor vehicle lane. Bike lanes with parking permitted should not be directed toward the curb at intersections or localized areas where parking is prohibited. Such a practice prevents bicyclists from following a straight course. Where transitions from one type of bike lane to another are necessary, smooth tapers should be provided.

Lane Widths

Under ideal conditions, the minimum bicycle lane width is **4**-ft (1.2m). However, certain edge conditions dictate additional desirable bicycle lane width. Additional width also is desirable when the width of the adjacent traffic lane is less than 12-ft (3.6m). This is an important addition because the effective clearance between a bicyclist and adjacent traffic is a function of the combined width of both the bike lane and the adjacent traffic lane.

To examine the width requirements for bicycle lanes, Figures 8 thru 11 show four typical locations for such facilities in relation to the roadway. Figure 8 depicts bicycle lanes on an urban curbed street where a parking lane is provided. The minimum bicycle lane width for this location is 5-ft (1.5m). Bicycle lanes should always be placed between the parking lane and the motor vehicle lanes. Bicycle lanes between the curb and the parking lane create hazards for bicyclists from opening car doors and poor visibility at intersections and driveways. They also prohibit bicyclists from making left turns; therefore, this placement should never be considered.

Where parking is permitted but a parking lane is not provided, the combination lane, intended for both motor vehicle parking and bicycle use, should be a minimum of 12-ft (3.6m) wide. Figure 9 illustrates this condition. However, if it is likely the combination will be used as an additional motor vehicle lane, it is preferable to designate separate parking and bicycle lanes, as shown in Figure 8. In both instances, if parking volume is substantial or turnover is high, an additional 1 ft. or 2 ft (0.3m to 0.6m) width is desirable for safe bicycle operation.

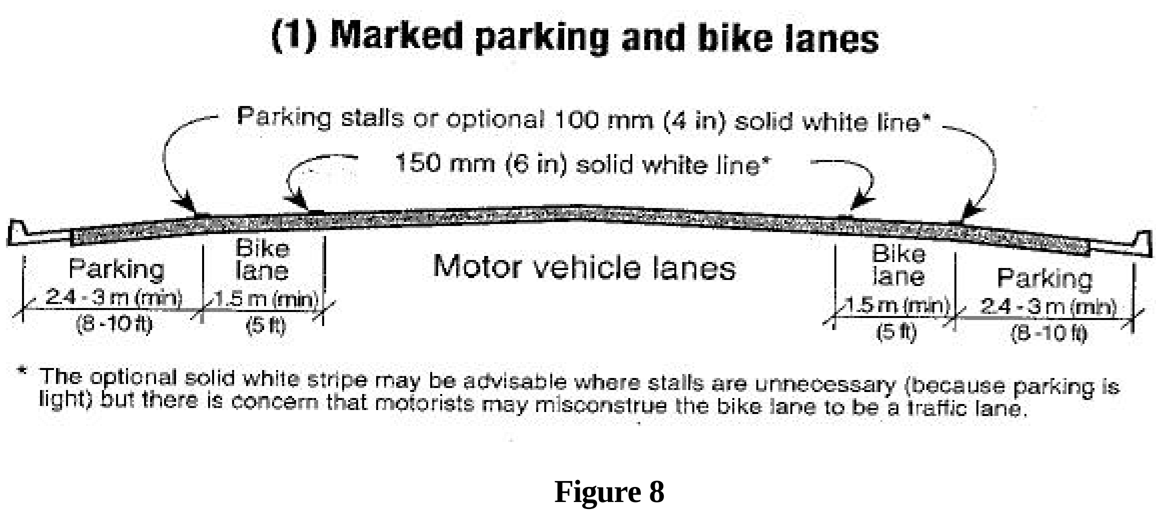


Figure 8

Typical bike lane cross section on two-lane or multi-lane highways.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

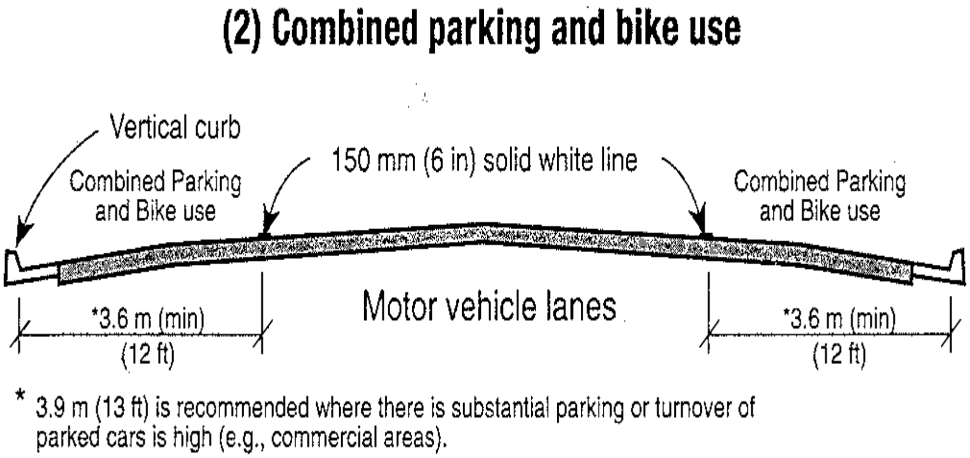


Figure 9

Typical bike lane cross section on two-lane or multi-lane highways.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

Figure 10 depicts bicycle lanes along the outer portions of an urban-type-curbed street where parking is prohibited. Bicyclists do not generally ride near a curb because of the possibilities of riding through debris, over an uneven longitudinal joint, or along a steep cross-slope, or of hitting a pedal on the curb. Bicycle lanes in this location should have a minimum width of 6-ft (1.8m) from the curb face.

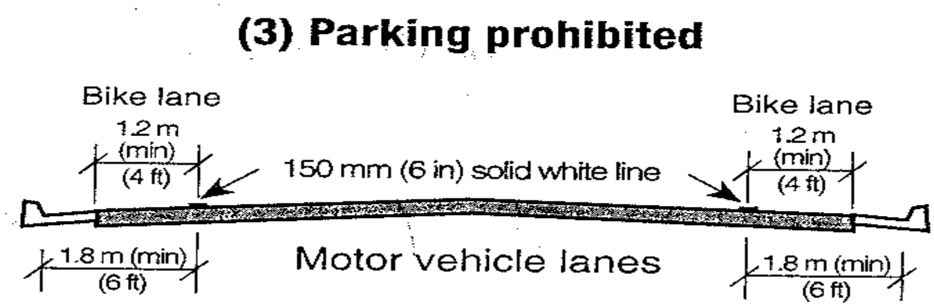


Figure 10

Typical bike lane cross section on two-lane or multi-lane highways.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

Figure 11 depicts bicycle lanes on a highway without curb or gutter. Bicycle lanes should be located between the motor vehicle lanes and unpaved shoulders. Bicycle lanes may have a minimum width of 4 ft (1.2m) , although a width of 5 ft (1.5m) or greater is preferable. Additional width is desirable where substantial truck traffic is present, where prevailing winds are a factor, on grades, or where motor vehicle speeds exceed 35 mph (56 km/h).

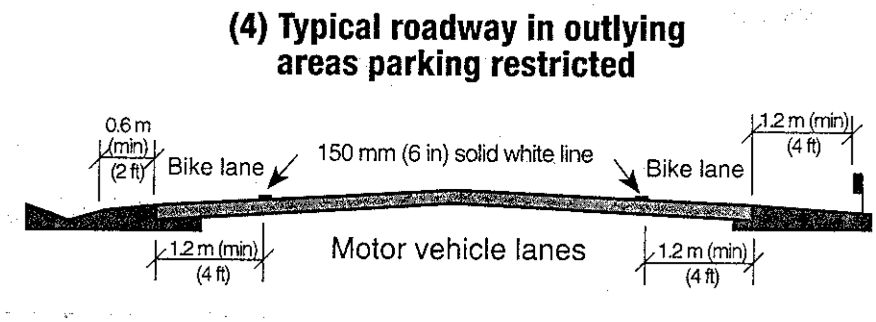


Figure 11

Typical bike lane cross section on two-lane or multi-lane highways.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

Intersection Design

Bicycle lanes tend to complicate both bicycle and motor vehicle turning movements at intersections. Because they encourage bicyclists to keep to the right and motorists to keep to the left, both operators are somewhat discouraged from merging in advance of turns. Thus, some bicyclists will begin left turns from the right side bicycle lane and some motorists will begin right turns from the lane to the left of the bicycle lane. Both maneuvers are contrary to established rules of the road and result in conflicts. Common movements of motorists and bicyclists are shown in Figure 12.

At intersections, bicyclists proceeding straight through and motorists turning right must cross paths. Marking and signing configurations, which encourage these crossings through merging in advance of the intersection, are generally preferable to those that force the crossing in the immediate vicinity of the intersection. To a lesser extent, the same is true for left-turning bicyclists. However, in this maneuver, the rules of the road allow bicyclists to make either a "vehicular style" left turn (where the bicyclists merges left to the same lane used for motor vehicle left turns) or a "pedestrian style" left turn (where the bicyclist proceeds straight through the intersection, dismounts and then walks across the intersection on the cross street)

Figure 13 illustrates recommended striping patterns for bike lanes crossing a motorist right-turn-only lane. When confronted with such intersections, bicyclists will have to merge with right turning motorists. Since bicyclists are typically traveling at speeds less than motorists, they should signal and merge where there is a sufficient gap in right-turning traffic, rather than at a predetermined location. For this reason, it is recommended that either all delineation be dropped at the approach of the right-turn lane (or off- ramp) or that a single, dashed bike lane line be used, extended at a flat angle across the right-turn lane. A pair of parallel lines (delineating a bike lane crossing) to channel the bike merge is not recommended, as bicyclists will be encouraged to cross at a predetermined location, rather than where there is a safe gap in right-turning traffic. Also, some bicyclists are apt to assume they have the right-of-way and may not check for right-turning motor vehicle traffic.

A dashed line across the right-turn-only lane (or off-ramp) is not recommended on extremely long lanes, or where there are double right-turn-only lanes. For these types of intersections, all markings should be dropped to allow the bicyclist's judgement to prevail. Bike lanes crossing on-

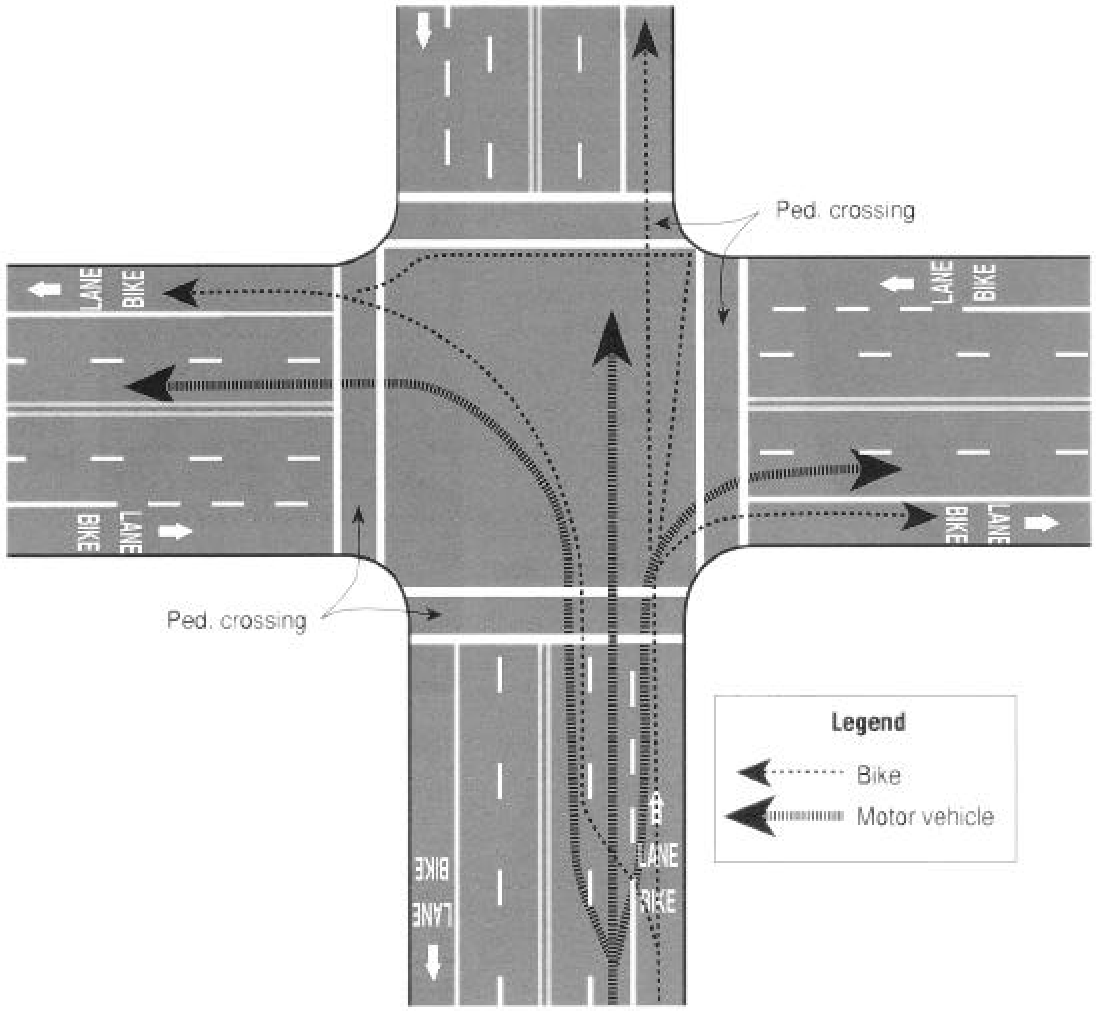


Figure 12

Typical bicyclist and motor vehicle movements in an intersection of two multi-lane streets with bicycle lanes.

Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988.

ramps do not present the same problems, as bicyclists normally have a good view of traffic entering the roadway and will adjust their path as necessary to cross ramp traffic. A "Bike Xing" sign may be used to warn motorists of the potential for bicyclists crossing their path.

Where there are numerous left-turning bicyclists, a separate turning lane should be considered. The design of bicycle lanes also should include appropriate signing at intersections to reduce the number of conflicts. General guidance for pavement marking of bicycle lanes also is contained in the Manual of Uniform Traffic Control Devices (MUTCD).

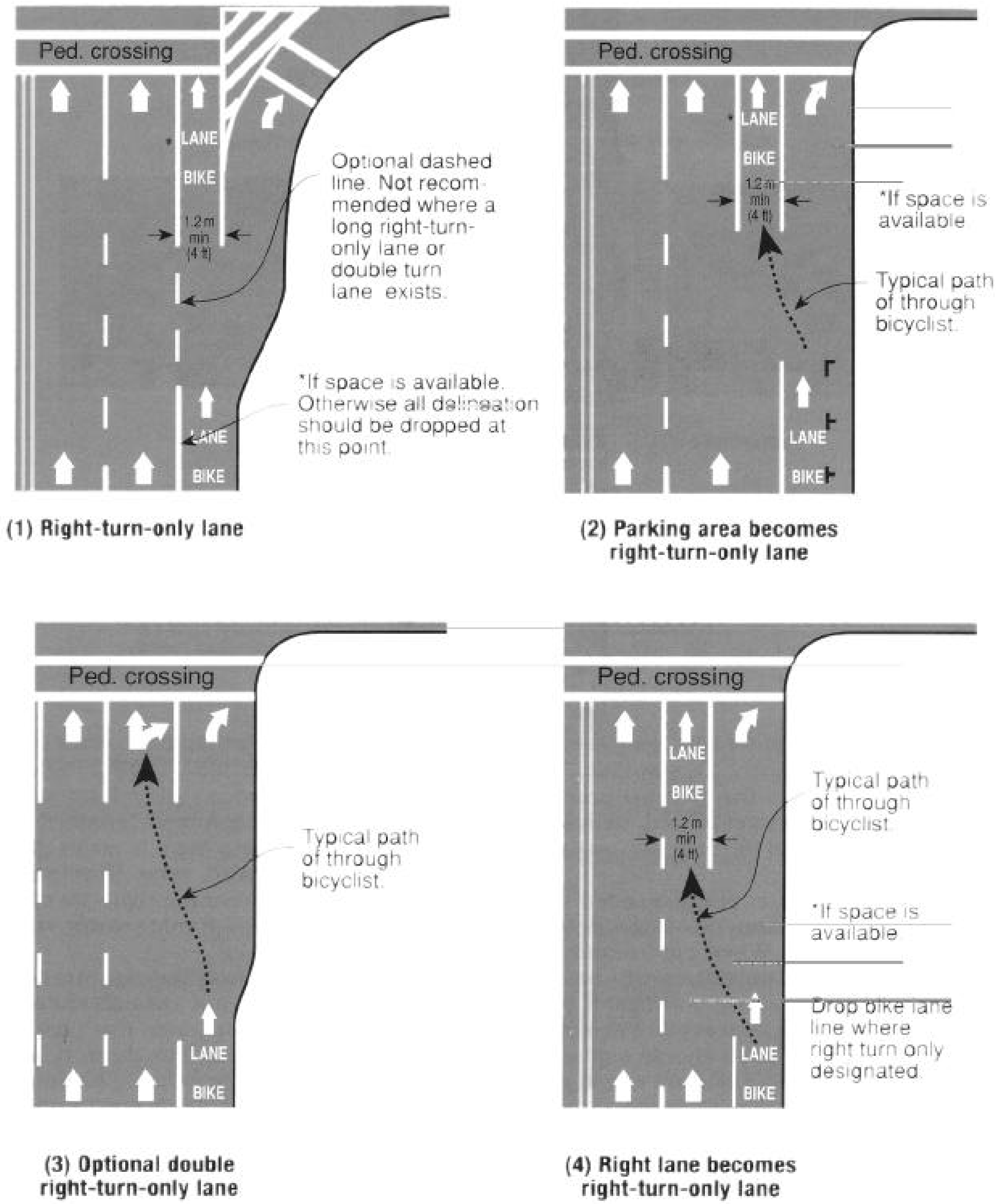


Figure 13

Bicycle lane marking options at intersections with right-turn-only lanes..

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

Multi-use Path Bicycle Route

Multi-use paths are trails generally located on exclusive rights-of-way and with minimal cross flow by motor vehicles. Multi-use paths can serve a variety of purposes. For example, a connecting trail between two cul-de-sac streets can provide commuter bicyclists with a shortcut through a residential neighborhood or around a barrier.

Located in a park, a multi-use path can provide a wide variety of users with an enjoyable recreational experience. Multi-use paths can be located along abandoned railroad rights-of-way, the banks of rivers and other similar linear corridors. Multi-use paths also can provide access to areas that are otherwise served only by limited access highways closed to bicycles. Appropriate locations should be identified during the planning process.

Separating Paths and Highways

When two-way multi-use paths are located immediately adjacent to a roadway, operational problems may occur. The following are some problems with bike paths located immediately adjacent to roadways:

1. They require one direction of bicycle traffic to ride against traffic, contrary to normal rules of the road.
2. When the path ends, bicyclists going against traffic tend to continue to travel on the wrong side of the street. Likewise, bicyclists approaching multi-use paths often travel on the wrong side of the street to get to the path. Wrong way riding is a major cause of bicycle/automobile crashes and should be discouraged at every opportunity.
3. At intersections, motorists entering or crossing the highway often will not notice bicyclists coming from their right, as they are not expecting contra-flow vehicles. Even bicyclists coming from the left often go unnoticed, especially when sight distances are poor.
4. When constructed in narrow roadway right-of-way, the shoulder is often sacrificed, thereby decreasing safety for motorists and bicyclists using the roadway.
5. Many bicyclists will use the highway instead of the multi-use path because they have found the highway to be safer, more convenient or better maintained. Bicyclists using the highway are often subjected to harassment by motorists who feel that in all cases bicyclists should be on the path instead.
6. Bicyclists using the bicycle path generally are required to stop or yield at all cross streets and driveways, while bicyclists using the highway usually have priority over cross traffic because they have the same right-of-way as motorists.
7. Stopped cross street motor vehicle traffic or vehicles exiting side streets or driveways may block the path crossing.
8. Because of the closeness of motor vehicle traffic to opposing bicycle traffic, barriers are often necessary to keep motor vehicles out of multi-use paths and bicycles out of traffic lanes. These barriers can be a hazard to bicyclists and motorists, can complicate maintenance of the facility and can cause other problems as well.

For these reasons, on street facilities, such as wide curb-lanes or bicycle lanes, may be the best way to accommodate bicycle traffic along highway corridors depending upon traffic conditions.

Controlling Design Factors

Multi-use paths should be thought of as non-motorized extensions of the highway system, intended for the exclusive or preferential use of pedestrians, bicycles and other human powered vehicles. While there are many similarities between design criteria for multi-use paths and those for highways (e.g., determining horizontal alignment, sight distance requirements and signing), some criteria (e.g., horizontal clearance requirements, grades and pavement structures) are dictated by operating characteristics of human powered vehicles that are substantially different from those of motor vehicles.

An in-line skater requires a wide area when generating speed or climbing a grade, a person in a wheelchair has difficulty with even small grades over an extended distance, and a person pushing a baby carriage requires a smooth surface for a comfortable ride. However, it is the bicycle, when considered with its wide range of operators, from young children to experienced commuters, that appears to encompass the needs of most human powered vehicles. The young, inexperienced or recreational riders require wider paths, gentler grades and smoother surfaces, while the experienced riders require the geometric designs that will accommodate their higher speeds. It is for this reason that multi-use path design guidelines are based on the operating characteristics of the bicycle. However, the designer should consider all potential users when designing a multi-use path.

Paved Width - The paved width and the operating width required for a bicycle path is a primary design considerations. Under most conditions, the minimum paved width for a two-directional bicycle path is **10** feet (3m). Narrower paths are not recommended as they do not permit safe and frequent passing opportunities where there is high bicycle use, especially where pedestrian use is frequent. Also, a narrow path is subject to pavement edge damage from maintenance vehicle loading conditions. A segment of path less than 10-ft. (3m.) wide may be acceptable or necessary for short distances, such as when passing between buildings or utility poles that cannot be modified. These should be treated on a case-by-case basis and signed in accordance with the MUTCD.

In many cases, it may be desirable to increase the width of a bicycle path to 12-ft (3.6m). For example, wider paths may be needed in cases involving substantial bicycle volume, probable shared use with joggers and other pedestrians, use by large maintenance vehicles, steep grades and locations where bicyclists are likely to ride two abreast.

Horizontal Clearances - A minimum 2-ft. (0.6m) wide graded area should be maintained adjacent to both sides of the pavement (see Figure 14). However, 3 ft. (0.9m) or more is desirable to provide clearance from trees, abutments, piers, poles, walls, fences, box culverts, guardrails or other lateral obstructions. A wider graded area on either side of the bicycle path can serve as a separate jogging path. If adequate clearance cannot be maintained between the path and vertical barriers or other features causing bikeway constriction, a warning sign, as described in Figure 15, should be used in advance of the hazard with an object marker at the location of the hazard (see Part 9C-3 of the MUTCD for diagrams). This treatment should be used only where unavoidable and is by no means a substitute for desirable design.

Vertical Clearances - The vertical clearance to obstructions should be a minimum of 8-ft (2.4m) (see Figure 15). However, vertical clearance may need to be greater to permit passage of maintenance vehicles and, in under crossings and tunnels, a clearance of 10-ft. (3m) is desirable for adequate vertical shy distance.

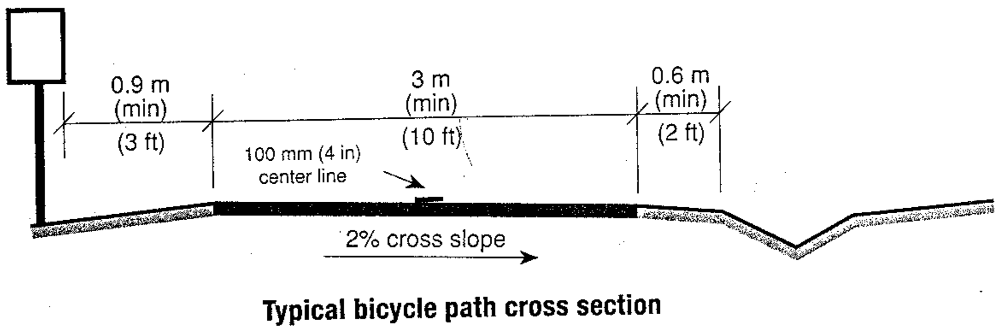


Figure 14

Bicycle path cross sections showing widths, clearances, cross slopes and center line markings.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991 and MUTCD Part IX.

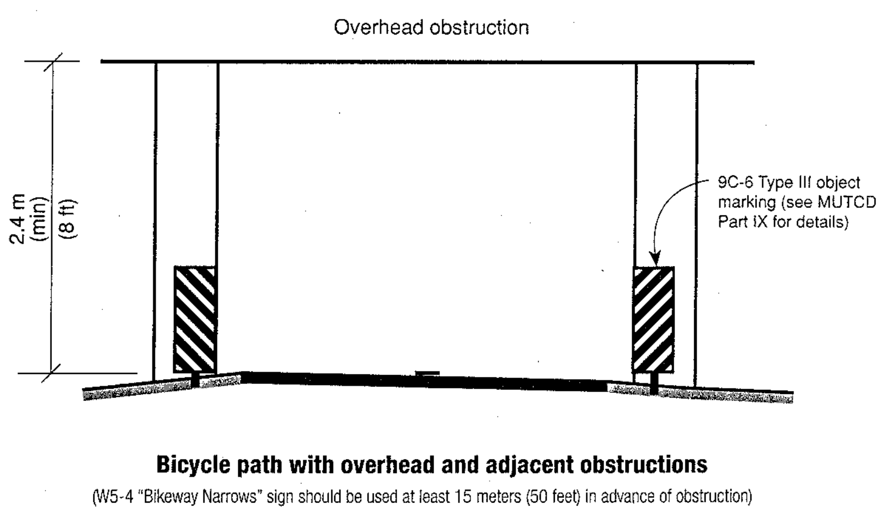


Figure 15

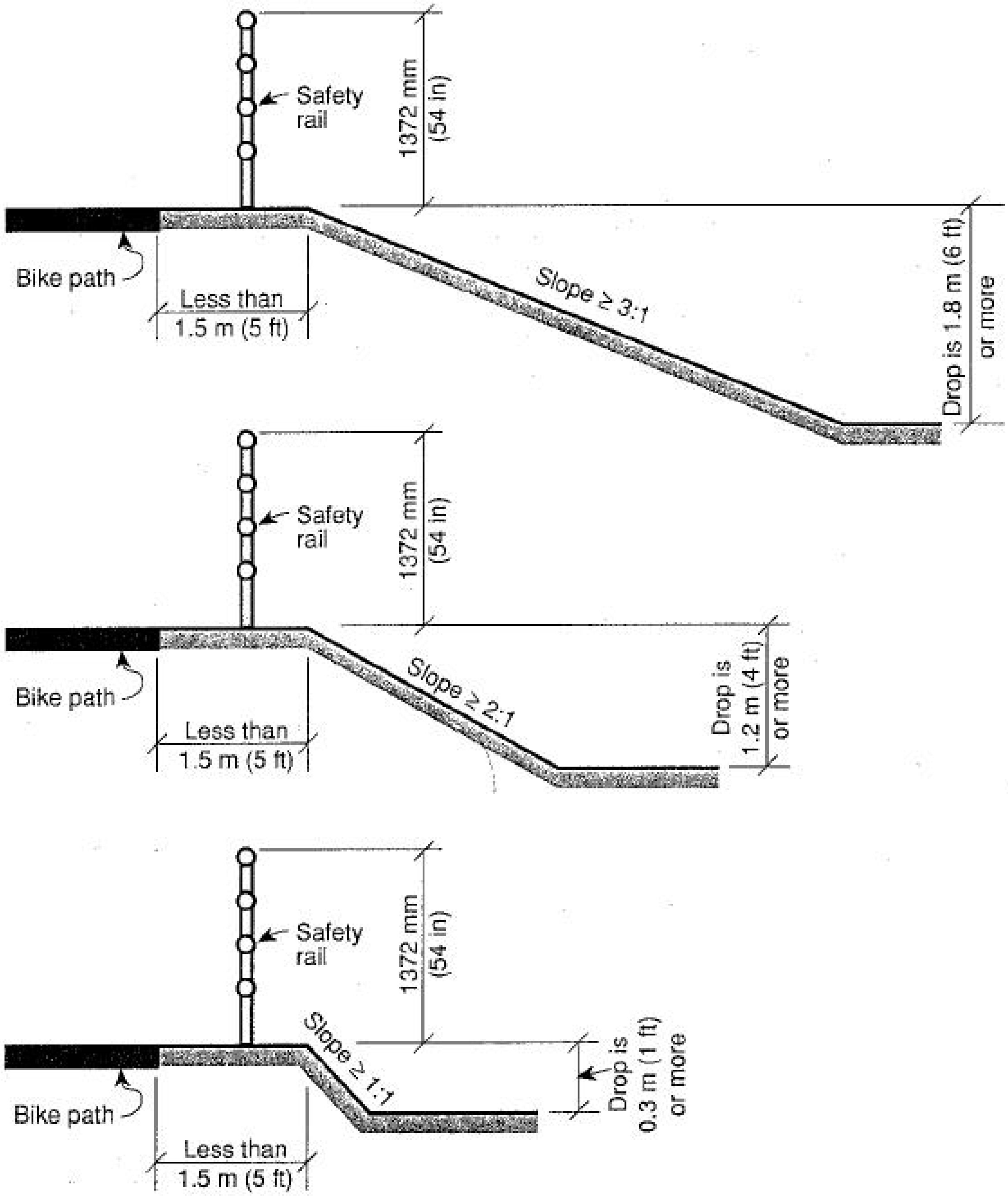
Bicycle path cross sections showing vertical clearance.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991 and MUTCD Part IX.

A wide separation between a multi-use path and canals, ditches or other significant depressions is essential for safety. If a minimum 5-ft. (1.5m) separation from the edge of the bike path pavement is not possible, a physical barrier such as dense shrubbery or a chain link fence should be provided (see Figure 16).

A wide separation between a multi-use path and any nearby highway is also desirable to confirm to both the bicyclist and the motorist that the multi-use path functions as an independent facility. When this is not possible and the distance between the edge of the roadway and the bicycle path is less than 5-ft. (1.5m) then a suitable positive barrier should be provided.

Figure 16



Safety rail between bicycle path and adjacent slope.
Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988.

Railings - Railings are recommended in situations where bicyclists or pedestrians may fall down an embankment or other vertical displacement. Railings, fences or barriers on either side of a multi-use path structure should extend 4.5 ft (1.4m) higher than the bike path and have smooth rub rails attached at handlebar height 3.5 ft. (1.1m). It is required that railing ends be flared away from the path at either end of the railing to prevent bicyclists and pedestrians from catching on the rail.

Such dividers serve to prevent bicyclists from making unwanted movements between the path and the highway shoulder and to reinforce the concept that the multi-use path is an independent facility. Where used, the divider should be a minimum of 54 in. (1.35m) high, to prevent bicyclists from toppling over it. Such a situation should be treated as a special case and appropriate roadside design and warning measures taken. Where the path approaches crossing roadways or driveways, the barrier should be modified as necessary to enhance visibility between bicyclists and motorists.

Fencing - Multi-use path fencing serves several different functions, including separation of properties, access control, noise and wind abatement, and decoration. Fencing comes in many different forms, styles, heights, and colors and is modular so that it can be designed to fit almost any landscape. Some types of fencing are solid walls, solid board, semitransparent panels, transparent panels, post and rail, picket, and vegetative hedges (see Figure 17).

The most common reason for fencing is to separate public and private property. Fencing gives adjacent property owners the privacy, security, and environmental conditions they desire. Windscreens, evergreen hedges, and snow fences are three methods used to control environmental conditions. The style of the fence should be consistent with the natural surroundings.

Plant material is a popular and effective fencing option. Depending on their different growth habits and forms, plants can be used to separate public and private property. They make an excellent buffer along adjacent land where noise is a problem and also can be used to restrict or funnel access and direct circulation patterns. For example, thorny plants can be installed in a hedgerow to prevent unauthorized access between two adjacent tracts of land. This type of planting is often significantly less expensive and more effective than fences or walls.

Design Speed

The speed that a bicyclist travels is dependent on several factors, including the type and condition of the bicycle, the purpose of the trip, the condition and location of the multi-use path, the presence of other traffic, the speed and direction of the wind and the physical condition of the bicyclist. Multi-use paths should be designed for a selected speed that is at least as high as the preferred speed of the faster bicyclists. In general, a minimum design speed of 20 mph (35 km/h) should be used; however, when the grade exceeds four percent, or where strong prevailing tailwinds exist, a design speed of 30 mph (50 km/h) is advisable.

Speed bumps or similar surface obstructions, intended to slow bicyclists in advance of intersections, should **not** be used. They may divert a rider's attention from traffic or catch a pedal causing the cyclist to fall.

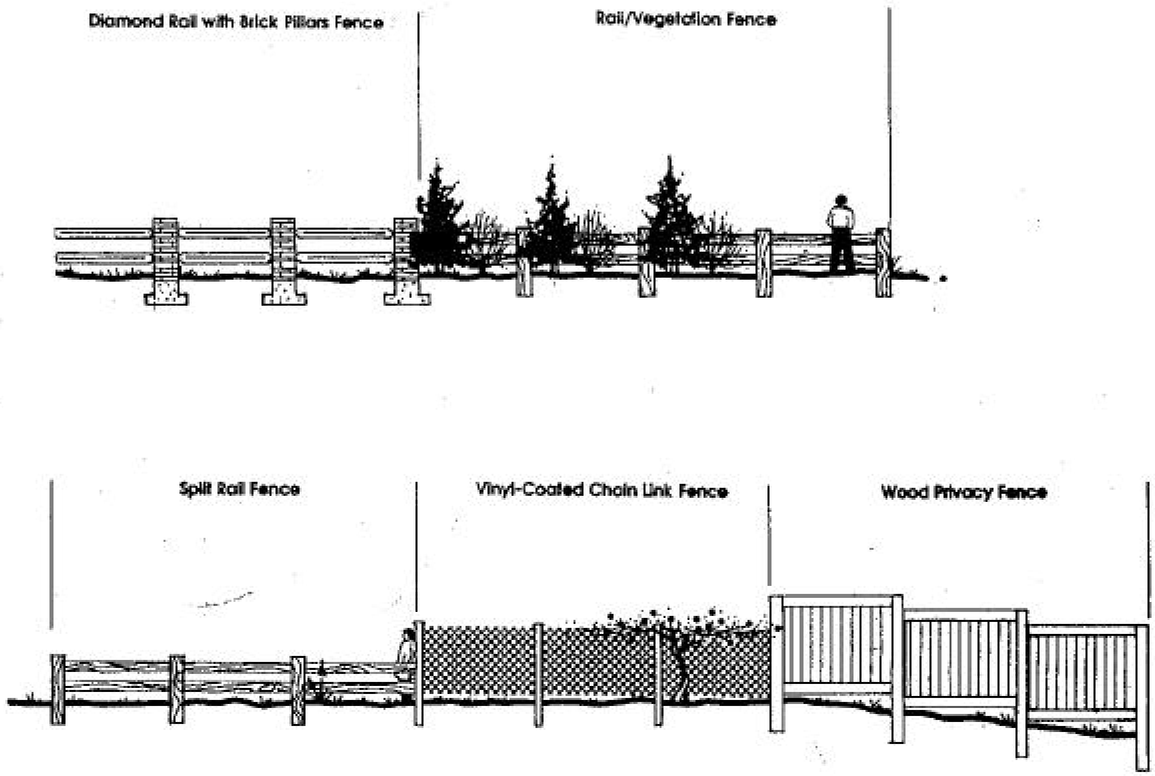


Figure 17

Types of fencing.

Source: Greenways - A Guide to Planning, Design and Development, 1988.

Horizontal Alignment

The minimum radius of curvature negotiable by a bicycle is a function of the superelevation rate of the bicycle path surface, the coefficient of friction between the bicycle tires and the bicycle path surface, the speed of the bicycle and the amount of lean the bicyclist can handle. Leaning is an important aspect of bicycle turns; the farther over a bicyclist can lean in a turn, the sharper a curve that can be negotiate, given the limitations of friction. However, novice bicyclists are less able to lean over safely and, therefore, are unable to negotiate a curve at the same speed as a more skilled rider. For this reason, a conservative approach to setting curve radius is important.

For most bicycle path applications, the superelevation rate will vary from a minimum of +2% (the minimum necessary to encourage adequate drainage) to a maximum of approximately +5% (beyond which maneuvering difficulties by slow bicyclists and adult tricyclists might be expected). The minimum superelevation rate of **+2%** will be adequate for most considerations and will simplify construction. Negative superelevation or reversed curves are to be avoided, since they have the same effect on bicyclists' stability as leaning farther than intended in a turn.

The coefficient of friction depends upon bicycle speed; surface type, roughness and condition; tire type and condition; and whether the surface is wet or dry. Extrapolating from values used in highway design, design friction factors for paved bicycle paths can be assumed to vary from 0.30 at 15 mph(23 km/h) to 0.22 at 30 mph(50 km/h). Although there is no data available for unpaved surfaces, it is suggested that friction factors be reduced by 50 percent to allow a sufficient margin of safety.

Based upon a superelevation rate (e) of +2%, minimum radii of curvature can be selected from Table 4-1.

Table 4-1
Design Radii for Paved Bicycle Paths
(e=2%)

Design Speed mph (km/h	Design Radius ft (m)	Friction Factor f
20 (30)	95 (30)	0.27
25 (40)	155 (50)	0.25
30 (50)	250 (80)	0.22
35 (60)	390 (120)	0.19
40 (65)	565 (175)	0.17

Source: North Carolina Bicycle Facilities Planning and Design Guidelines, 1994

Occasionally, designers are tempted to add curves for the purpose of controlling bicyclist speed or to provide some variation in the path alignment. While sometimes successful, this approach may lead bicyclists to cut corners when the resulting alignment appears either arbitrary or unsafe at typical approach speeds. Further, if the curve has a significantly lower design speed than the connecting trail, cyclists may misjudge the appropriate approach speed and leave the trail.

When substandard radius curves must be used on bicycle paths because of right-of-way, topographical or other considerations, standard curve warning signs and supplemental pavement markings - such as a solid yellow centerline - should be installed in accordance with the MUTCD.

The negative effects of substandard curves can also be partially offset by widening the pavement through the curves , up to 4 feet. The additional pavement may be added on either the inside or outside of the curve.

Vertical Alignment and Grades

Paved multi-use paths generally attract less-skilled and less-knowledgeable bicyclists, so it is important to avoid steep grades in their design. Bicyclists not physically conditioned will be unable to negotiate long, steep uphill grades and, as a result, may well dismount to walk up hill. For a multi-use path to be considered an acceptable alternative, it should have approximately the same amount of climbing as the roadways serving the same destinations. If it includes significantly more difficult climbs, few bicyclists will use it. Since novice bicyclists often ride poorly maintained bicycles and have difficulty in using their brakes for effective speed control, long down grades can cause problems. For this reason, it is especially important to carefully consider design speed, curve radius, sight distance allowances and intersection location on lower sections of hills.

The maximum desirable grade rate recommended for bike paths is **five** percent. It is desirable that sustained grades be limited to **two** percent because of the wide range of riders to be accommodated. Grades greater than five percent are undesirable. However, where terrain dictates, grades over five percent and less than 500 feet (150 m) long are acceptable when a higher design speed is used and additional width is provided. Grades steeper than three percent may not be practical for multi-use paths with crushed stone surfaces because of possible erosion of the facility.

Sight Distance

A bicycle path should be designed with adequate stopping sight distances to provide bicyclists with an opportunity to see and react to the unexpected,. The distance required to bring a bicycle to a full controlled stop is a function of the bicyclist's perception and brake reaction time, the initial speed of the bicycle, the coefficient of friction between the tires and the pavement, and the braking ability of the bicycle.

Figure 18 indicates the minimum stopping sight distance for various design speeds and grades based on a total perception and brake reaction time of 2.5 seconds and a coefficient of friction of 0.25 to account for the poor wet-weather braking characteristics of many bicycles. For two-way bicycle paths, the sight distance in the descending direction, that is, where "G" is negative, will control the design

Figure 19 is used to select the minimum length of vertical curve necessary to provide minimum stopping sight distance at various speeds on crests. The eye height of the bicyclist is assumed to be 1.35 m (4.5 ft.) and the object height is assumed to be zero to recognize that hazards to bicycle travel exist at pavement level.

Bicyclists frequently ride abreast of each other and near the middle of multi-use paths. Therefore, because of the serious consequences of a head-on bicycle accident, lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for bicyclists traveling in opposite directions around the curve. Where this is not possible or feasible, consideration should be given to widening the path through the curve, installing a yellow center stripe, installing a curve ahead warning sign, in accordance with the MUTCD, or some combination of these alternatives.

Sign type, size and location should be in accordance with the MUTCD. Care should be taken to ensure that multi-use path signs are located so that motorists are not confused by them and that highway signs are placed so that bicyclists are not confused by them.

If a multi-use path crosses a highway, such a crossing should occur well away from the influence of major intersections with other highways. Controlling vehicle movements at independent intersections is more easily and safely accomplished through the application of standard traffic control devices and normal rules of the road. Where signals are not warranted, consideration should be given to providing a median refuge area for crossing bicyclists. In this way, they can cross one direction of travel at a time.

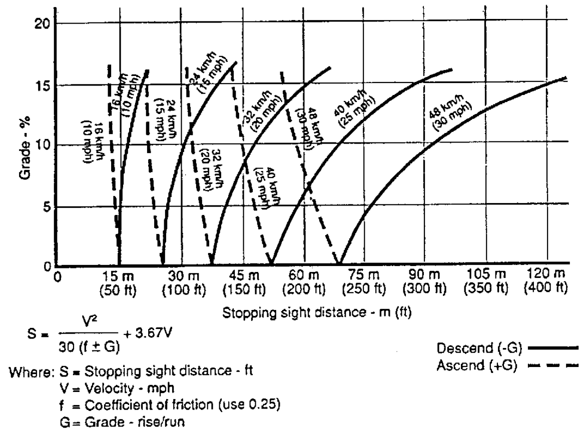


Figure 18

Stopping sight distances on bicycle paths.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

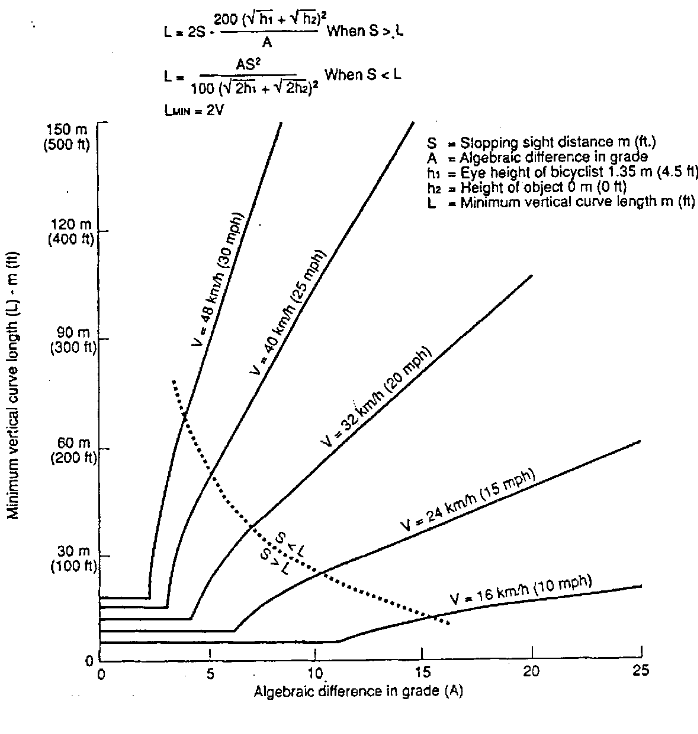


Figure 19

Sight distances for crest vertical curves on bicycle paths.

Source: AASHTO Guide for Development of Bicycle Facilities, 1991.

Where physical constraints or high motor vehicle traffic volumes make crossing at such independent intersections difficult, the path may be brought to a nearby signalized intersection and the crossing made at or adjacent to the pedestrian crossing. Rights-of-way should be assigned and adequate sight distance should be provided so as to minimize the potential for conflict resulting from unconventional turning movements. It may be necessary to prohibit right-turn-on-red for the adjacent roadway and to provide a separate demand-actuated phase for the multi-use path. As a multi-use path intersects with a street, efforts should be made to encourage users of the facility to slow down and notice the intersection ahead. Traffic calming for multi-use path users can be accomplished by various methods. Figure 20 shows a typical method - offsetting the path at roadway intersections to warn users of the approaching intersection. Some other methods include: extra warning signs, extra pavement markings, removable bollards intended to cause bicyclists to slow or even dismount their bicycles.

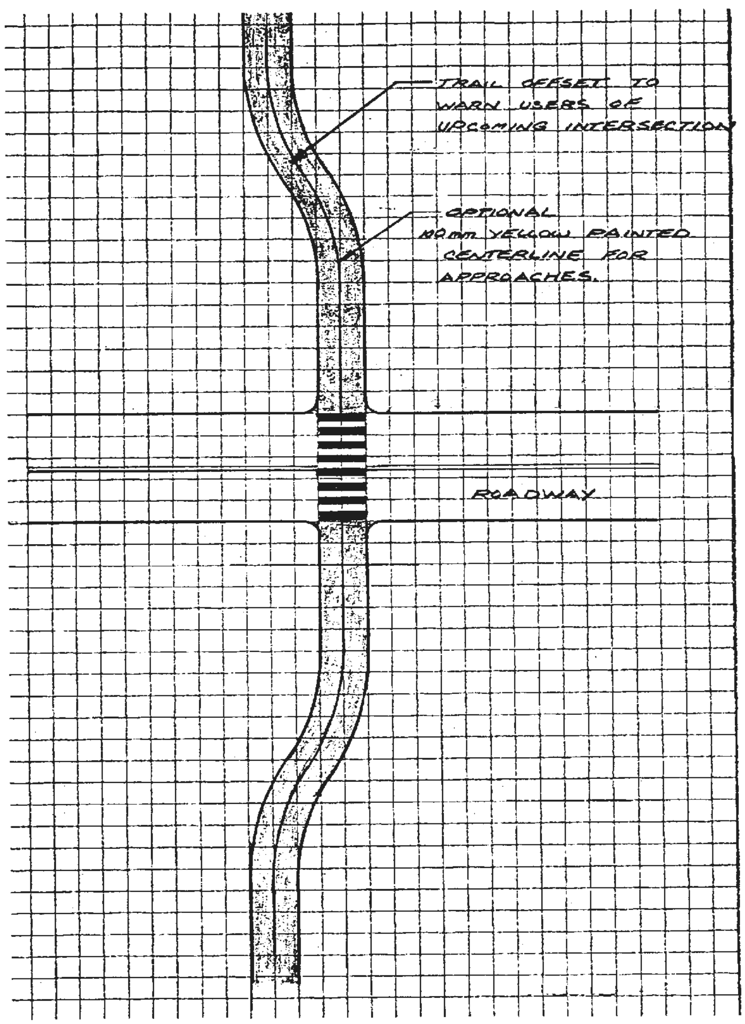


Figure 20

Offsetting the path at roadway intersections.

Source: Thomas J. Galeota; Fuss & O=Neill,Inc.

Multi-use path intersections and approaches should be on relatively flat grades. Stopping sight distances at intersections should be checked and adequate warning should be given to permit bicyclists to stop before reaching the intersection, especially on downgrades.

Curb cuts at intersections should be the same width as the bicycle paths. Curb cuts and ramps should provide a smooth transition between the bicycle path and the roadway. See Figure 21 for acceptable curb cut and ramp details.

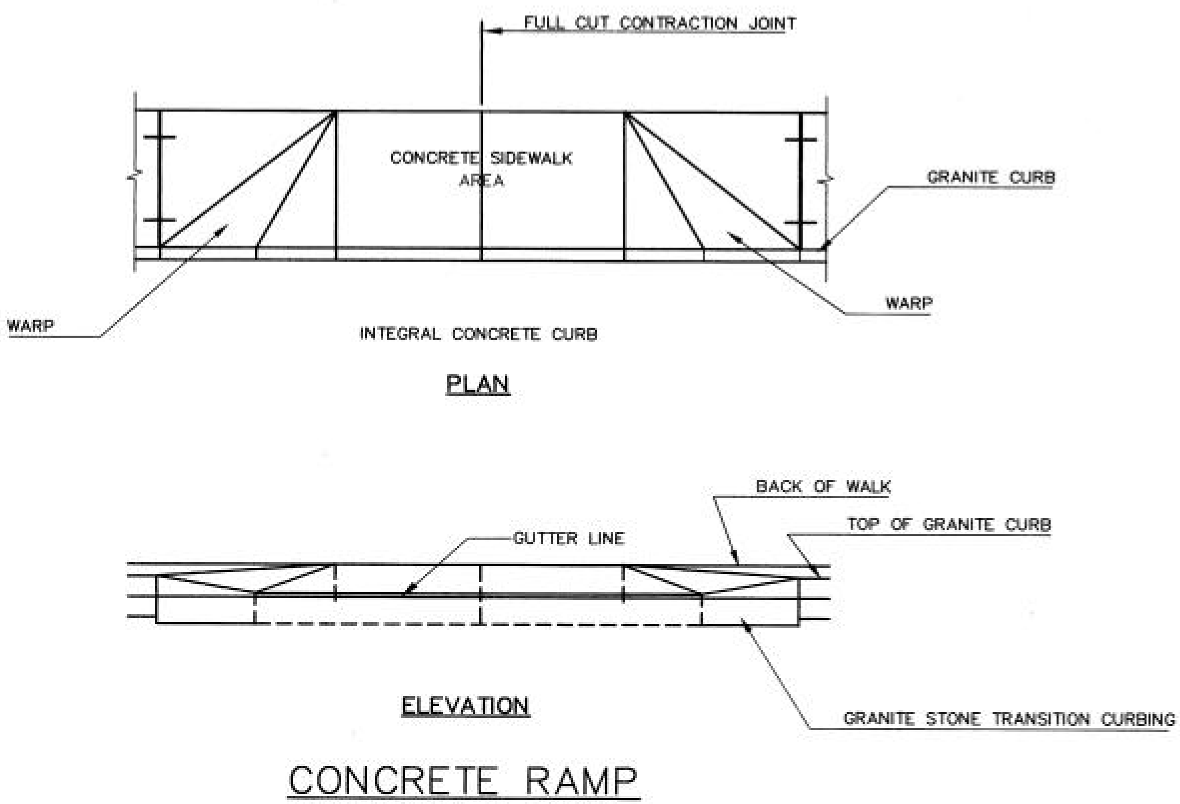


Figure 21

Curb cut and ramp detail.

Source: Fuss & O =Neill,Inc.

Restriction of Motor Vehicle Traffic

Multi-use paths often need some form of physical barrier at highway intersections to prevent unauthorized motor vehicles from using the facilities. At the same time, the barrier should be designed to minimize the danger it poses for bicyclists and to allow the passage of emergency or maintenance vehicles. For this reason, proper materials, adequate design, good visibility and appropriate location are critical. While it is possible to restrict automobile and truck access, eliminating motorcycle access is very difficult. Barriers that can keep motorcycles out may make bicycle access difficult and potentially dangerous as well. At entrances to private driveways, motor vehicle barriers are less important than they are at highways.

However, if a particular driveway is found to be a significant entry point for motorists, barriers should be considered there as well.

Lockable, removable posts at path entrances will allow entry of authorized vehicles. Posts should be at least 3-ft. (0.9m) high, permanently reflectorized for nighttime visibility and painted a bright color for improved daytime visibility. Their surface should be smooth and free of protrusions to prevent snagging a bicyclist's clothing or equipment.

To allow appropriate clearances, a (5 ft. (1.5m) spacing between posts should be used (see Figure 22). Wider spacing can allow entry to motor vehicles, while narrower spacing might prevent entry by adult tricycles and bicycles with trailers, or present a hazard for less proficient bicyclists. On a 10-ft. (3m) path, the paving should be flared slightly and one post located near either edge and one post in the middle. A wider path will require more posts, again spaced at 5 ft. (1.5m).

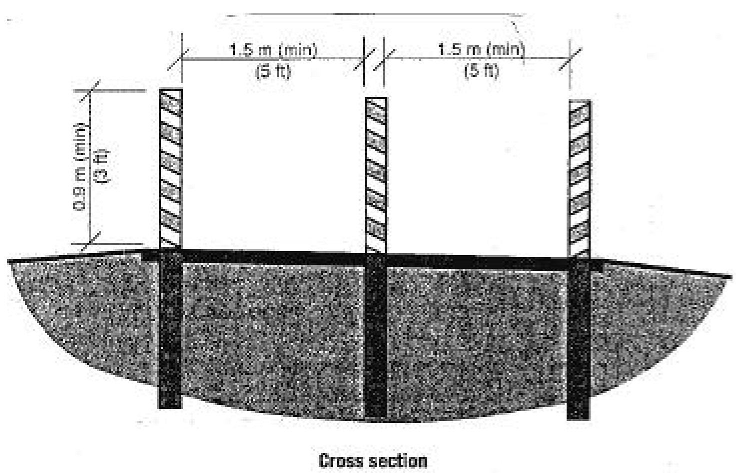


Figure 22
Reflectorized post barrier used to keep motor vehicles off bicycle paths.
Source: California Highway Design Manual; Caltrans, 1987.

The barrier should be installed in a highly visible location with adequate sight distance from either direction. Lighting may be considered if the location has inadequate street lighting to illuminate the barrier. Marking an envelope around the barrier is recommended (see Figure 23). If sight distance is limited, special advance warning signs or painted pavement markings should be

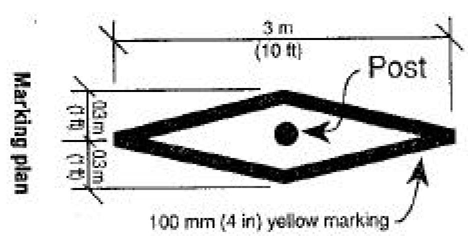


Figure 23
Reflectorized post barrier used to keep motor

vehicles off bicycle paths and marking plan.

Source: California Highway Design Manual; Caltrans, 1987.

provided. It is best to locate the barrier 30-ft. (9m) from the intersection to allow bicyclists to pay full attention to traffic once they reach the crossing and to remove the barrier from the motorists clear recovery zone.

An alternative method of restricting entry of motor vehicles is to split the entry way for the last 10 to 30 ft (3 to 9m) before the intersection into two 5 ft. (1.5m) sections that enter the intersection approximately 5 ft. (1.5m) apart (see Figure 24). The sections may be separated and surrounded by low landscaping. Emergency vehicles can still enter if necessary by straddling the landscaping. The higher maintenance costs associated with landscaping should be acknowledged, however, before this alternative method is selected. Whether the post or split entry method is used, pavement markings and signing may be used to warn bicyclists and direct them in the appropriate direction.

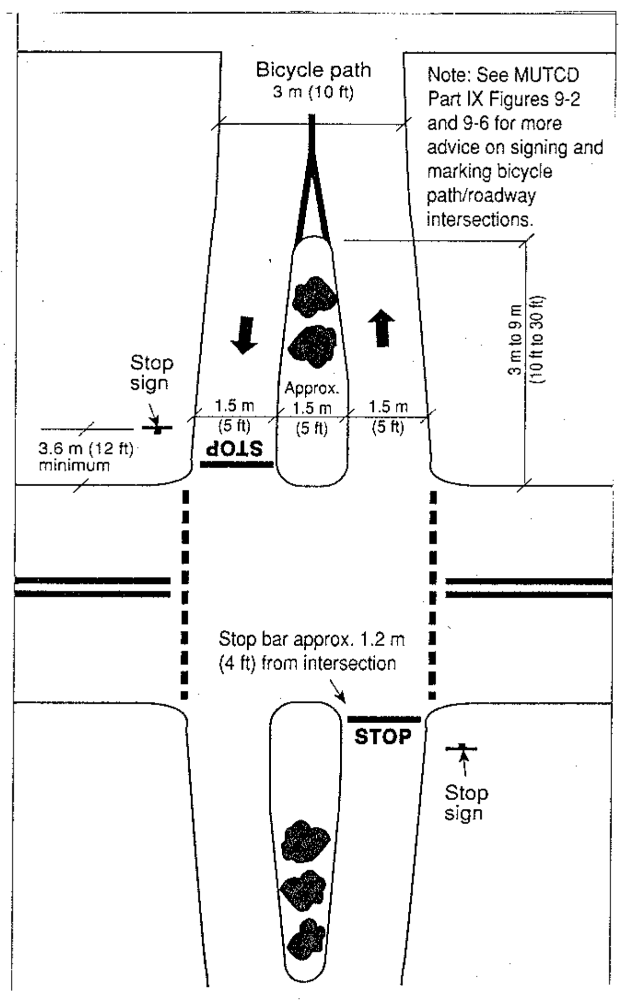


Figure 24

Alternative approach to bike path/roadway intersection.

Source: Bicycle Facility Design; OHDOT, 1988.

Signing and Marking

Adequate signing and marking is essential on multi-use paths, especially to alert bicyclists to potential hazards and to convey regulatory messages to both bicyclists and motorists at highway intersections. In addition, guide signing to indicate directions, destinations, distances, route numbers and names of crossing streets, should be used in the same manner as they are used on highways. In general, uniform application of traffic control devices will tend to encourage proper bicyclist behavior. When deciding whether to install a sign, the designer should ask whether he or she would install one on a roadway with a similar situation. Further, using standard rather than unique signs should reduce sign theft.

General guidance on signing and marking is provided in the MUTCD. Part IX of the MUTCD, refers specifically to traffic controls for bicycle facilities.

In order to keep signs from becoming hazards themselves, they should be offset horizontally 3 ft. (0.9m) from the edge of the multi-use path as previously shown in Figure 14.

A dashed 4 to 6 in. (100 to 150mm) wide yellow centerline should be used to separate opposite directions of travel. A solid double yellow centerline should be used on curves, especially those with restricted sight distance. White edge lines, 4 to 6 in. (100 to 150mm) wide also can be beneficial where significant night-time bicycle traffic is expected (e.g., near a university campus).

In areas where pavement markings are found to be cost effective, consideration should be given to using them in conjunction with warning or regulatory signs, especially at critical locations. Otherwise, theft of warning or regulatory signs may result in bicyclists not being aware of serious hazards or their legal duties in a particular situation. Care should be exercised in the choice of pavement marking materials. Thermoplastic and preformed tape, for example, are slippery when wet and should be avoided in favor of more skid-resistant materials like traffic paint. Whenever construction work is conducted on bicycle paths, it is important to sign, mark and, if necessary, barricade the construction zone with care as shown in the MUTCD, Part VI. If a detour is provided, it should be signed appropriately.

Pavement Structure

Designing and selecting pavement sections for multi-use paths is, in many ways, similar to designing and selecting highway pavement sections. A soils investigation should be conducted to determine the load carrying capabilities of the native soil and the need for any special provisions. The investigation need not be elaborate, but should be done by, or under the supervision of, a qualified engineer.

In addition, several basic principles should be followed to recognize some basic differences between the operating characteristics of bicycles and those of motor vehicles. While loads on multi-use paths will be substantially less than highway loads, paths should be designed to sustain, without damage, wheel loads of occasional emergency, patrol, maintenance and other motor vehicles that are expected to use or cross the path.

Special consideration should be given to the location of motor vehicle wheel loads on the path. When motor vehicles are driven on multi-use paths, their wheels will usually be at or very near the edges of the path. Since this can cause edge damage that, in turn, will result in the lowering of the effective operating width of the path, adequate edge support should be provided. Edge support can be either in the form of stabilized shoulders or in constructing additional pavement width. Constructing a typical pavement width of twelve feet, where right-of-way and other conditions permit, eliminates the edge-raveling problem and offers two additional advantages over shoulder construction. First, it allows additional maneuvering space for bicyclists, and second, the additional construction cost can be less than for constructing shoulders because the separate construction operation is eliminated.

It is important to construct and maintain a smooth riding surface on multi-use paths. Multi-use path pavements should be machine laid. Soil sterilants should be used where necessary to prevent vegetation from growing through the pavement. And, on portland cement concrete pavements, transverse joints, necessary to control cracking, should be saw cut to provide a smooth ride. Skid resistant qualities, however, should not be sacrificed for the sake of smoothness. Broom finish or burlap drag concrete surfaces are preferred over trowel finishes. In areas where climates are extreme, the effects of freeze-thaw cycles should be anticipated. Geotextiles and other similar materials should be considered where subsurface conditions warrant.

At unpaved highway or driveway crossings of multi-use paths, the highway or driveway should be paved as far as practicable on either side of the crossing to reduce the amount of gravel scattered along the path by motor vehicles.

The pavement structure at the crossing should be adequate to sustain the expected loading at that location. Good quality pavement structures can be constructed of asphalt or portland cement concrete. Because of wide variations in soils, loads, materials and construction practices, it is not practical to present specific or recommended typical structural sections. Local standards for construction, preparation of sub-base and soil sterilization for a low-volume road should, in most cases, produce an adequate cross section for a multi-use path. However, Figure 25 shows some typical pavement structural sections.

Attention to the local governing conditions and to the principles outlined above is needed. Experience in highway pavement design, together with sound engineering judgement, can assist in the selection and design of a proper multi-use path pavement structure.

Hard, all-weather pavement surfaces are usually preferred over those of crushed aggregate, sand, clay or stabilized earth since these materials provide a much lower level of service. However, with the growth in popularity of mountain bikes, non-paved surfaces are being considered more frequently. With their wider lower-pressure tires, mountain bikes can easily handle surfaces that would prove unstable for thin-tired bikes. Further, an unpaved path will have a lower design speed, reducing the potential for conflicts between high-speed bicycles and low-speed pedestrians. The best surfaces for unpaved paths are crushed stone, stabilized earth or limestone screenings, depending upon local availability.

Railroad crossings should be smooth and should occur as close to 90 degrees to the direction of travel as possible in order to minimize the danger of falls (Figure 26).

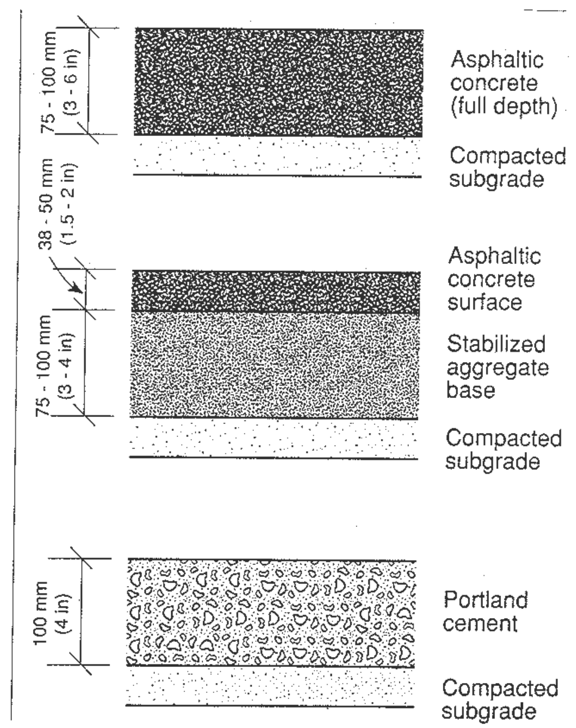


Figure 25

Typical pavement structural sections for bicycle paths.

Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988.

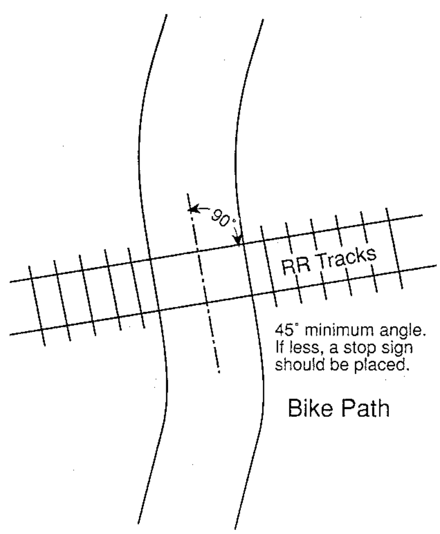


Figure 26

Bicycle path railroad crossing.

Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988.

WALKWAY TYPES

Sidewalks: In urban and suburban environments, the preferred facilities for pedestrians are sidewalks. Sidewalks provide positive separation from motor vehicle traffic, a hard smooth surface on which to walk, and the opportunity to clearly indicate crossing movements at intersections. Sidewalks in residential areas are sometimes used by bicyclists, but cities and towns have the authority to ban bicyclists from riding on sidewalks.

Paths: In fringe areas, outside or near the limits of an urban boundary a path may be appropriate along rural roads. A common example is a path leading to a school in a rural setting, where sidewalks, curbs and drainage are not warranted. The same attention must be paid to safety at intersections as with multi-use paths.

Shoulders: On rural highway sections, where few residences or businesses abut the roadway, the shoulder widths recommended by DOT are usually adequate to accommodate pedestrians. In rural areas that are more residential in character, but do not have high enough densities to warrant sidewalks, shoulders should be a minimum of 4 feet (1.2 m) wide to accommodate pedestrian and bicycle traffic.

Sidewalk Guidelines

Width: The minimum clear width for sidewalks is 3-ft (0.9m), however a width of 5-ft (1.5m) is recommended (See Figure 27). If the sidewalk has less than 5-ft (1.5m) of clear width, then passing spaces at least 5-ft (1.5m) by 5-ft (1.5m) shall be located at reasonable intervals ot to exceed 200 feet (61m). Greater sidewalk widths should be used in high pedestrian use areas, such as Central Business Districts.

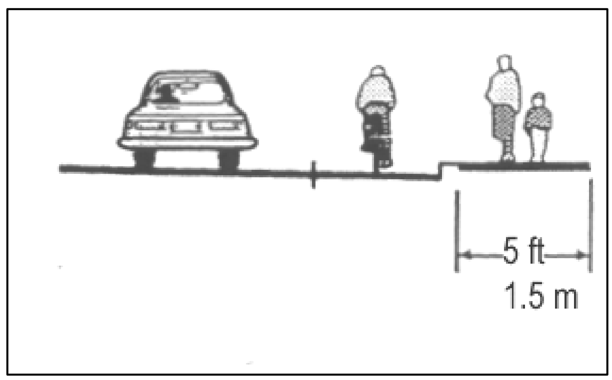


Figure 27

Obstructions: The sidewalk standard is a width clear of all obstructions such as street furniture, sign posts, utility and signal poles, mailboxes, parking meters, fire hydrants, trees, etc. As shown in Figure 28 obstructions should be placed between the sidewalk and the roadway, to create a buffer for increased pedestrian ease. Clearance to vertical obstructions (signs, trees, etc.) must be at least 5 feet (1.5m).

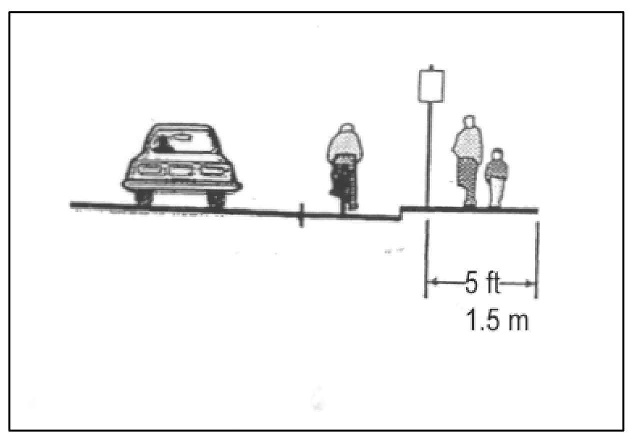


Figure 28

Shy Distance: An additional 2 feet (0.6m) of shy distances shown in Figure 29, is needed from vertical barriers such as buildings, sound walls, retaining walls and fences.

Note: Americans With Disabilities Act (ADA) requires that objects protruding from walls (e.g. signs, fixtures, telephones, canopies) with their leading edge between 27" and 80" (685 and 2030mm) above the finished sidewalk shall protrude no more than 4" (100mm) into any portion of the public sidewalk. (Per ADA Accessibility Guidelines)

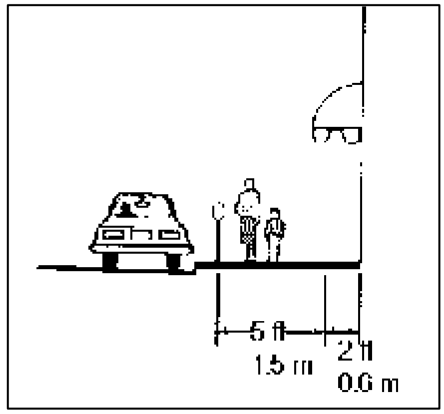


Figure 29

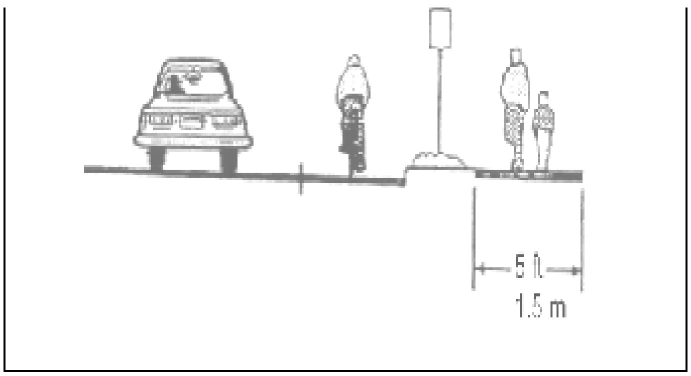


Figure 30

Planting Strips: Well-designed arterial and collector streets should include a planting strip as a standard. A planting strip should be 5 feet (1.5m) wide or greater, minimum 3 feet (0.9m), and landscaped with low maintenance plantings. If parking is allowed, an additional 2 foot (0.6m) wide concrete pad can be placed between the planting strip and the curb, to allow drivers and passengers to step out onto a hard dry surface.

High Speed Roadways: Sidewalks should not be placed directly adjacent to a high-speed travel lane (design speed of 45 MPH [70 km/h] and above). As shown in Figure 30, buffers between the sidewalk and the lane may include a planting strip, a shoulder barrier, a parking lane or a bike lane.

Bridges: The minimum sidewalk width, in Connecticut, for new construction or reconstruction of bridges is 5' (1.5m) (See Figure 31). Sidewalk widths may be increased in areas of heavy pedestrians traffic, on designated bike routes, or at locations requiring additional sight distance. For pedestrian bridges, the curb to curb width of shall generally match the approach pathway width.

Sidewalks should be carried across a bridge if the approach roadway has sidewalks or sidewalk areas. Elsewhere, one or two sidewalks may be provided as warranted by current developments, anticipated area growth, traffic or pedestrian studies, etc.

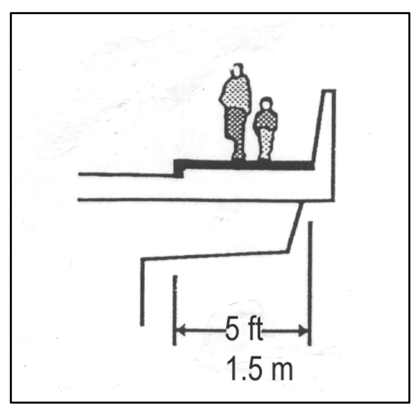


Figure 31

Sidewalk curb heights on structures shall match the exposed height of the approach curbing. Where curbs are not provided on the approaches, the exposed height on the structure shall be 6" (150mm).

The bridge sidewalk width should not be less than the approach sidewalk width; in instances where the approach sidewalks are of differing widths, the lesser of the two widths may be used on the bridge.

Sidewalk Surface and Structure:

All sidewalk surfaces shall be slip resistant. The preferred surfacing material for sidewalks is Portland Cement Concrete. It provides a smooth, durable finish that is easy to maintain. Typical structural sections for sidewalks are shown in Figure 32.

Figure 32