SECTION 5

MAJOR CROSS SECTION ELEMENTS

5-01 GENERAL

The major cross section elements considered in the design of streets and highways include the pavement surface type, cross slope, lane widths, shoulders, roadside or border, curbs, sidewalks, driveways and medians.

5-02 PAVEMENT

5-02.1 Surface Type

The type of pavement is determined by the volume and composition of traffic, the soil conditions, the availability of materials, the initial cost, and the extent and cost of maintenance, all of which affect the relationship of cost to traffic service.

Generally, all roadways in the State are surfaced with bituminous materials or portland cement concrete. These pavements provide good riding qualities, help to maintain the cross section, and adequately support the expected volume and weights of vehicles without failure due to fatigue.

Important characteristics in relation to geometric design are the ability of a surface to sustain its shape and dimensions, the ability to drain, and the affect on driver behavior.

5-02.2 Cross Slope

The cross slope of the pavement is the slope of the pavement surface measured transverse to the centerline of the highway. The high point of the normal cross slope of the roadway is sometimes called the crown. Undivided pavements on tangents or on flat curves have a crown or high point in the middle of the traveled way and slope downward toward both edges.

The minimum cross slope for concrete pavement and bituminous pavement should be 1.5 percent. The cross slope shall be uniform across the pavement section, from the high point to the edge of lane. The cross slope in each successive lane should be increased by 0.5 percent. However, it may be increased on each successive pair of lanes by 0.5 to 1 percent in order to cause the least disturbance to the existing border area, to limit the amount of resurfacing weight on a structure, or to minimize the cross slope in the outer lane when more than three lanes are sloped in the same direction. Also, if the left-turn lane's cross slope is in the same direction as the adjacent lane, the same cross slope as the adjacent lane may be used.

On divided highways, each one-way pavement may be crowned separately, as on two-lane highways, or it may have a unidirectional slope across the entire width of pavement, which is almost always downward to the outer edge.

A cross section with each roadway crowned separately, as shown near the top of Figure 5-A, has an advantage in rapidly draining the pavement during rainstorms. In addition, the difference between high and low points in the cross section is kept to a minimum. Disadvantages are that more inlets and subsurface drainage lines are required, and treatment of at-grade intersections is more difficult because of the several high and low points on the cross section. Use of such sections preferably should be limited to regions of high rainfall. Sections having no curbs and a wide depressed median are particularly well suited for high rainfall conditions.

Roadways that slope in only one direction, as shown near the bottom of Figure 5-A, are more comfortable to drivers because vehicles tend to be pulled in the same direction when changing lanes. Roadways having a unidirectional slope may drain away from or toward the median. Drainage away from the median may effect a savings in drainage structures and simplify treatment of intersecting streets. Advantages of drainage toward the median are an economical drainage system, in that all surface runoff is collected into a single conduit, and the outer lanes, which are used by most traffic are freer of surface water. A major disadvantage of this section is that all the pavement drainage must pass over the inner, higher speed lanes. Where curbed medians exist, the drainage is concentrated next to and on higher speed lanes. This concentration results in the annoying and undesirable splashing on the windshields of opposing traffic when the median is narrow.

The rate of cross slope on curves as well as on tangent alignment is an important element in cross section design. Pavement superelevation on curves is determined by the speed-curvature relationships given in Section 4, "Basic Geometric Design Elements".

5-03 LANE WIDTHS

Lane widths have a great influence on driving safety and comfort. On freeways and land service highways, the predominant lane width is 3.6 m.

Although lane widths of 3.6 m are desirable, there are circumstances on land service highways that necessitate the use of lanes less than 3.6 m wide. In urban areas, the use of 3.3 m wide lanes is acceptable. Three meter wide lanes have been provided in the past at certain locations where right-of-way and existing development became stringent controls and where truck volumes were limited. However, new or reconstructed 3 m wide lanes would not be proposed today.

On land service highways, where it is not practical to provide a shoulder adjacent to the outside lane, the outside lane width shall be 4.5 m to accommodate the bicyclists. Where alternate bike access is provided, the outside lane width should be 0.3 m wider than the adjacent through lane width.

Insert Figure: 5-A

When resurfacing existing highways that have lane widths of 3 m or less, the existing lanes should be widened to either 3.3 m minimum or 3.6 m desirable.

Auxiliary lanes at intersections are often provided to facilitate traffic movements. Such lanes, when constructed adjacent to a shoulder, should be equal in width to the through lanes but not less than 3 m wide. When there is no right shoulder adjacent to a new or reconstructed auxiliary lane (acceleration or deceleration lane), the width of the auxiliary lane shall be 4.5 m to accommodate the bicyclist. Where alternate bike access is provided, the outside lane width should be 0.3 m wider than the adjacent through lane width. The criteria in this paragraph shall also apply to auxiliary lanes at interchanges on land service highways.

On Interstate and freeways, the width of the auxiliary lane (accel. or decel. lane) shall be 3.6 m. Lane widths for specific types of highways are enumerated as part of the typical sections illustrated at the end of this section.

For the width of climbing lanes and left-turn lanes, see Section 4, "Basic Geometric Design Elements" and Section 6, "At Grade Intersections", respectively.

The designer should strive to accommodate the bicyclist on all projects even if only marginal improvements can be made such as providing bicycle-safe inlet grates, or providing shoulders or wider lanes to fill in short gaps. The designer should consult the current *Bicycle Compatible Roadways - Planning and Design Guidelines.*

5-04 SHOULDERS

5-04.1 General

A shoulder is the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of subbase, base and surface courses.

Some of the more important advantages of providing shoulders are:

1. Space for the motorist to pull completely off the roadway for emergencies.

2. An escape zone to allow motorists to avoid potential accidents or reduce accident severity.

3. An aid to driver comfort by creating a sense of openness; improves highway capacity.

4. An improvement in sight distance in cut sections.

5. A provision to enhance lateral clearance for the placement of signs, guide rails, or other roadside appurtenances.

6. Space for pedestrians where there is no sidewalk and for bicycle usage.

5-04.2 Width of Shoulders

Desirably, a vehicle stopped on the right shoulder should clear the pavement edge by at least 0.3m, preferably by 0.6 m. On land service highways, a minimum 2.4 m wide shoulder may be provided in difficult terrain, or in areas where right of way is restricted due to roadside development or environmental factors. On 3R projects, the existing shoulder width may be reduced to 2.4 m to provide wider lanes. New or reconstructed shoulders on heavily traveled and high-speed land service highways, especially those carrying large numbers of trucks (250 DHV), where turning volumes are high or dualization is anticipated, should have usable shoulders at least 3 m and preferably 3.6 m wide. Shoulders should be provided adjacent to all new acceleration and deceleration lanes at interchanges, where practical, in major new construction or reconstruction projects along major land service highways having an AADT of 10,500 per lane (DHV of 1,500 per lane) or greater, for the project design year. "Practical" is defined as given consideration to social, economic and environmental impacts in concert with safe and overall efficient traffic operations.

Shoulder widths on freeways and Interstate highways shall be 3 m minimum, however, where truck traffic exceeds 250 DDHV, a 3.6 m shoulder should be provided. A 3 m shoulder shall be provided adjacent to all new or reconstructed auxiliary lanes. Where no right shoulder exists, the existing auxiliary lane width may be maintained on Interstate and freeway resurfacing, restoration and rehabilitation (3R) projects. However, whenever practical, a 3 m desirable or a 1.8 m minimum shoulder should be provided on interstate and freeway 3R projects.

Shoulder widths for specific types of highways are enumerated as part of the typical sections illustrated at the end of this section.

Although it is desirable that a shoulder be wide enough for a vehicle to be driven completely off the traveled way, narrower shoulders are better than none at all. Partial shoulders are sometimes used when full shoulders are unduly costly, as on long span bridges or in mountainous terrain. Regardless of the width, a shoulder should be continuous where feasible.

Left shoulders are preferred on all divided highways. The desirable median shoulder width on 4-lane and 6 to 8-lane highways is 1.5 m and 3 m respectively. The minimum left shoulder width on land service highways is 0.9 m and on freeways is 1.2 m. In order to provide wider lanes on 3R projects the left shoulder width existing divided multilane land service highway may be reduced to 0.3 m (Programmatic Design Exception).

Shoulders on structures should have the same width as the usable shoulders on the approach roadways, both right and left. This design is essential on freeways, and is desirable on all arterials where shoulders are provided. Long span, high-cost structures usually warrant detailed special studies to determine feasible dimensions. Wherever practicable, full shoulders should be included, but as has been indicated, for some cases, it may be judged proper to use only partial-width shoulders.

5-04.3 Cross Slope

Shoulders are important links in the lateral drainage systems. Shoulders should be flush with the roadway surface and abut the edge of the through lane/auxiliary lane. On divided highways with a depressed median, all shoulders should be sloped to drain away from the traveled way. With a raised narrow median, the median shoulders may slope in the same direction as the traveled way. All shoulders should be pitched sufficiently to rapidly drain surface water.

Desirably, shoulder cross slopes should not be less than 4 percent to minimize ponding on the roadway. As a minimum, shoulder cross slopes should not be less than 2 percent. However, when left shoulders are less than 1.5 m in width and the median slopes away from the roadway or where the median and adjacent lane both slope toward the median gutter, the shoulder cross slope may be at the same rate and direction as the adjacent lane for ease of construction.

On 3R projects and reconstruction projects, shoulder cross slope may be increased to 6 percent to minimize impacts on existing curb, drainage, adjacent properties, access, etc. But, shoulder cross slope should not exceed 5 percent where curb ramps are present since the angle of incidence between a wheelchair descending a curb ramp and the counter slope of the gutter must be limited to avoid catching the wheelchair footrest.

Shoulders on the high side of superelevated sections should be designed to drain away from the adjacent traffic lanes. Shoulder cross slopes that drain away from the paved surface on the high side of superelevated sections should be designed to avoid too great a cross slope break. The cross slope of the shoulder shall be as follows:

1. The shoulder cross slope should be 4 percent where the superelevation rate is 3 percent or less.

2. For superelevation rates greater than 3 percent and less than 5 percent, a maximum rollover rate of 7 percent will be used to establish the shoulder cross slope.

3. When superelevation rates range from 5 percent to 6 percent, the shoulder cross slope will be 2 percent.

On existing superelevated curves where there is a history of run-off-the-road accidents, the location should be evaluated for proper clear zone, sight distance, superelevation, and signing. The shoulder cross slope on the outside of the curve may be constructed in the same direction as the adjacent lane. But, consideration should be given to snow storage in border area (snow melting in border area then draining and refreezing on roadway surface) by sloping the border away from roadway or by providing slotted drains along shoulder.

The shoulder on the inside of the curve or the low side of superelevated sections should be sloped at 4 percent or equal to the superelevation of the adjacent lane, whichever is greater.

5-04.4 Intermittent Shoulders or Turnouts

It will not always be economically feasible to provide desirably wide shoulders continuously along the highway through high cut areas or along steep mountainsides. In such cases, consideration should be given to the use of intermittent sections of shoulders or turnouts that can be placed at favorable locations along the highway. Where intermittent shoulders or turnouts are provided, the length of the transition section should be approximately 15 m to encourage usage and to permit safe entry and exit.

5-04.5 Rumble Strips

Rumble strips shall be constructed on inside shoulders that are 1.5 m or greater in width and outside shoulders that are 2.4 m or greater in width, along the mainline on all Interstate highways, freeways and other limited access highways.

Rumble strips should be constructed on inside shoulders that are 1.5 m or greater in width and outside shoulders that are 2.4 m or greater in width, along the mainline of land service highways at locations where:

X Accident data indicates a nighttime run-off-the road accident problem.

X The shoulder approaching a bridge overpass or underpass is reduced or eliminated. The rumble strips should be provided a minimum of 150 m in advance of the bridge.

Rumble strips shall not be constructed 30 m in advance of and beyond all street intersections and driveways. The minimum length of rumble strip measured longitudinally along the shoulder is 30 m.

Rumble strips shall not be constructed across bridge decks.

5-05 ROADSIDE OR BORDER

5-05.1 General

The area between the roadway and the highway right of way is referred to as the roadside or border. The term "roadside" generally applies to freeways and the term "border" applies to land service highways. The distance between the outside edge of roadway and the hinge point may be less than the width of the roadside or border area.

5-05.2 Width

The minimum right-of-way width on rural and urban freeways is 90 m and 45 m respectively. Depending upon the median, traveled way and shoulder widths, the roadside width is in the range of 20 m for rural freeways and 7.5 m for urban freeways.

Desirably, the width of the border should be sufficient to permit the placement of utility poles and all fixed obstructions beyond the clear zone area. Normally, an additional 1.5 m should be added to the clear zone distance to provide the necessary placement of utilities within the highway right-of-way yet beyond the clear zone recovery area.

See Section 8 for the required clear zone distance for various design speeds.

When it is not practical to provide for the clear zone width, a border width on land service highways of 4.5 m is preferred. Where right-of-way acquisition costs or terrain features make the 4.5 m border width impractical, a 3 m minimum border width may be used. However, the designer should first determine if the border width can accommodate the proper placement of roadside appurtenances such as longitudinal barriers, longitudinal barrier end treatments, utility poles, signal pole foundations, signs, underground utilities, etc.

Before reducing the border width on existing highways to a minimum of 2.4 m to accommodate the widening of lanes and/or shoulders, first determine if the reduced border width can accommodate the proper placement of roadside appurtenances such as the items mentioned in the previous paragraph.

5-06 CURBS

5-06.1 General

The type and location of curbs appreciably affect driver behavior and, in turn, the safety and utility of a highway. Curb may be used to separate pedestrian walkways from the roadway, to control drainage and to control ingress and egress from roadside development. Curbing may also be permitted at intersections where required for channelization or for sustaining the integrity of pavement (i.e. curb at

intersection radius returns). To be considered a curb, some raised aspect or vertical element is required. Curb is not a substitute for pavement markings.

Curb normally is used extensively on urban land service highways. However, on rural land service highways, caution should be exercised in the use of curbs. In the interest of safety, new installations of vertical curb shall not be constructed on freeways and Interstate highways; however, sloping curb may be used for drainage control.

5-06.2 Types of Curbs

The two general classes of curbs are vertical curbs and sloping curbs. Each may be designed as a separate unit, or integrally with the pavement. Vertical and sloping curbs may be designed with a gutter to form a combination curb and gutter section.

Sloping curbs are designed so that errant vehicles can cross them readily without further loss of vehicular control. They are low with flat sloping faces. On land service highways, sloping curbs can be used at median edges to discourage vehicles from illegally crossing a grass median or to outline channelizing islands in intersection areas. Sloping curbs may also be provided at the outer edge of the shoulder. Sloping curb is the preferred treatment on left-turn slots. Sloping curb would permit vehicles with large off-tracking to have a less damaging effect to both vehicle and curb. However, vertical curb may be used on left-turn slots where there is existing vertical curb in the median.

Vertical curbs and safety walks may be desirable along the faces of long walls, bridges and tunnels, particularly if full shoulders are not provided.

New installations of vertical curb shall not be constructed on freeways and Interstate highways; and are considered undesirable on other high-speed arterials. When accidentally struck at high speeds, it is difficult for the operator to retain control of the vehicle. In addition, most vertical curbs are not adequate to prevent a vehicle from leaving the roadway. Where positive protection is required, such as on long narrow medians or adjacent to bridge substructures, suitable median barrier or guide rail should be provided.

Generally, vertical curb should not be provided inside the faces of bridge parapets. A preferred, and more widely used method is to design the parapet in the shape of our concrete barrier curb. On urban streets, vertical curb may be used on bridges with the same curb height as the approach roadway curb. Inlets should be provided in the gutter or the curb, or both.

Generally, it is not practical to design gutter sections to contain all of the runoff, even from frequent rains, and some overflow onto the traveled surface can be expected. The spread of water on the traveled way is kept within tolerable limits by the proper spacing of inlets. Grate inlets and depressions or curb-opening inlets

should not be placed in the travel lane because of their adverse effect on drivers and bicycle riders who veer away from them. Warping of the gutter for curb-opening inlets should be limited to the portions within 1.2 m of the curb to minimize adverse driving effects. See Section 10 for the proper spacing of inlets.

5-06.3 Placement of Curbs

Curbs introduced intermittently along streets should be offset 0.9 m from the edge of pavement; where the curb is continuous, the offset should be at least 0.3 m.

5-06.4 Curb Height

For new installations of sloping curb, the overall curb height shall not exceed 100 mm.

For new installations of vertical curb, the curb height (face) shall conform to the following:

1. For posted speeds greater than 60 km/h, the curb height shall not exceed a 100 mm face.

2. For posted speeds less than or equal to 60 km/h, the desirable curb height is 100 mm. Where sidewalks are to be constructed, a 150 mm face may be used.

When curbs are used in conjunction with guide rail, see Section 8, "Guidelines for Guide Rail Design and Median Barriers", for the placement of guide rail.

The vertical curb face on bridges and on curbs in front of retaining walls should match the vertical curb face on the approach roadway.

Where posted speeds are 60 km/h or less and no guide rail exists, a 200 mm face vertical curb may be used to discourage parking of vehicles in the border area of the highway.

When resurfacing adjacent to curb, the curb should not be removed unless it is deteriorated or the curb face will be reduced to less than 75 mm. A curb face less than 75 mm is permissible, provided drainage calculations indicate the depth of flow in the gutter does not exceed the remaining curb reveal.

When replacing short sections of existing curb or installing short sections of new curb, the curb face should match the adjacent existing curb face. A short section of curb is approximately less than 30 m long at each location. When there are closely spaced short sections of curb to be replaced, install the entire run of curb at the standard curb height and type as specified above.

5-07 SIDEWALKS

5-07.1 General

On new roadway construction, roadway rehabilitation, roadway reconstruction, new bridge construction, bridge replacement and bridge widening projects, sidewalks will generally be provided on both sides of land service highways (including structures) in urban areas. A sidewalk may be omitted where there is insufficient border width or there is no anticipated pedestrian traffic due to the land use adjacent to the roadway or there is no worn pedestrian path. When a sidewalk will be provided only along one side of the highway, the designer should include provisions to accommodate pedestrian crossing of the highway to access the sidewalk if there is a substantiated existing or future need. Such provisions should include one or more of the following: signing, painted cross walks, at-grade pedestrian signals, pedestrian overpasses, etc.

Generally, sidewalks will not be provided in rural areas. However, sidewalks may be provided to close short gaps in existing sidewalk and where there are major pedestrian traffic generators such as churches, schools, hospitals, public transportation facilities, etc. adjacent to the highway or where there is a worn pedestrian path. Future development should also be considered for possible major traffic generators.

On bridge projects in urban and rural areas where there is no existing or proposed sidewalk at the approaches to a structure and the structure is to be replaced or widened, sidewalk may be provided on the new structure where additional width would be required to maintain traffic during future bridge deck reconstruction.

Urban and rural areas shall be those identified in the current State Highway Straight Line Diagrams.

5-07.2 Widths and Cross Slopes

The minimum width of a sidewalk should be 1.2 m when separated from the roadway by a buffer strip. The width of the buffer strip should be a minimum of 0.9 m. However, where the border width is 4.5 m, the minimum width of the buffer strip should be 1.8 m.

Where no buffer strip is provided, the width of the sidewalk should be 1.8 m, especially where there is no shoulder (aids in preventing truck overhangs or side view mirrors from hitting pedestrians). Where utility poles, sign supports, fire hydrants, etc. are provided in the sidewalk, the minimum usable width of sidewalk shall be 0.9 m to allow for wheelchair passage.

The maximum sidewalk cross slope is two percent. The maximum grade is 1:12 (8.3 percent). If the 1:12 grade is not feasible due to topography and other

physical constraints, the least practical grade greater than 8.3 percent should be used.

5-07.3 Public Sidewalk Curb Ramps

Public sidewalk curb ramps shall be provided where sidewalks permit pedestrians to cross curbs such as at:

1. intersections,
2. painted crosswalks at mid-block locations,
3. crosswalks at exit or entrance ramps,
4. driveways, and
5. channelized islands or divisional islands.

Projects which include existing, new or reconstructed sidewalks shall provide curb ramps. There are a number of unique projects that will not require curb ramps to be constructed. These projects may involve, but are not limited to:

X Bridge patching
X Demolition
X Fencing
X Fender repair
X Fiber optics
X Guide rail
X Landscape
X Raised pavement markers
X Signing
X Traffic/Electrical
X Truck weigh station
X Utility

In most cases, the unique projects mentioned previously will not modify a pedestrian route. However, the designer should consider every project as an opportunity to further the accessibility of its pedestrian network and should not unnecessarily restrict the scope of work so as to avoid the requirements for new curb ramps.

The *Standard Roadway Construction Details* illustrate the design criteria for public sidewalk curb ramps. The designer should keep in mind that existing conditions at a curb ramp location may present special problems.

The sight distance should be checked to ensure curb ramps are not placed in such a location that a motorist will find it difficult to perceive the low profile of a wheelchair occupant crossing the roadway.

The curb ramp area shall be kept clear of obstructions such as light standards, traffic signals, meter boxes, controller boxes, junction boxes, utility poles, inlets, fire hydrants, guide rail, signs, planters, etc. Existing obstructions should be

relocated as necessary, so as to provide maximum visibility of and for the curb ramp user. Existing manholes and valve boxes shall be reset to slope of curb ramp. Wherever possible, curb ramps should be located to avoid drainage low points in the gutter grade. Gratings or similar access covers shall not be located in the area at the base of the public sidewalk curb ramp.

Curb ramps shall be designed to accommodate all users, thus, transitions from the sidewalk to the curb ramp or to the landing area shall be gradual. Relocation of the sidewalk at an intersection is permissible, and in some cases necessary in order to obtain the required sidewalk and curb ramp slope.

In general, two curb ramps are required at each corner, one on each highway within the crosswalk area. If the curb ramp cannot be constructed within the existing crosswalk, the crosswalk shall be modified to include the ramp. The best location for a curb ramp is usually parallel to the sidewalk and out of the normal pedestrian path (Curb Ramp Type 1: see Detail A in the *Standard Roadway Construction Details*. However, where field conditions prohibit this location, one ramp at the center of the corner radius is acceptable (Curb Ramp Type 2: see Detail B in the *Standard Roadway Construction Details*).

For Curb Ramp Type 1, the designer may want to prohibit pedestrians from crossing the mainline on a high volume and/or high speed section of highway except at signalized intersections. Therefore, at the unsignalized intersections along this section of highway, a curb ramp would be required on the sidestreet corner but not on the mainline corner.

Where a grass buffer strip exists between the curb and the sidewalk at a Curb Ramp Type 1 or 2 location, the flared side should be altered as shown in Detail C in the *Standard Roadway Construction Details*. Also, curb ramp designs which result in undesirable wide crosswalks (greater than 3m) should be avoided.

Where there is limited right of way (ROW) at a Curb Ramp Type 1 or 2 location, the flared side should be altered and the landing made flush with the gutter line as shown in Detail D in the *Standard Roadway Construction Details*. These limited ROW locations are where the distance from the gutter line to the outside edge of sidewalk is 1.8 m or less.

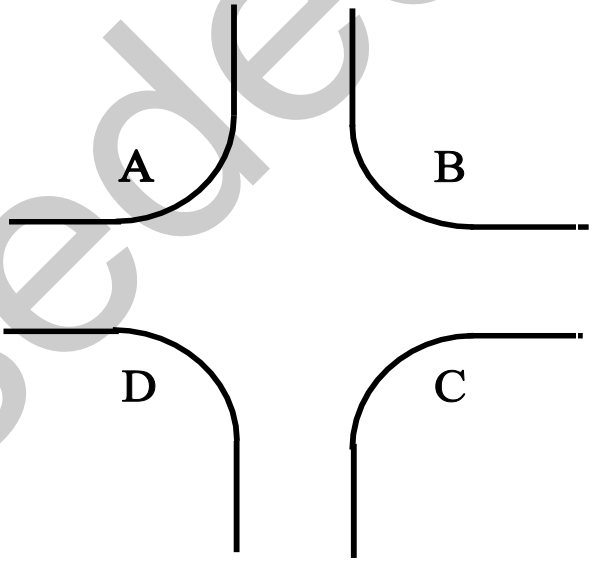
Curb Ramp Type 3 may be used where pedestrians would not normally walk across the curb ramp. One example of this ramp use is where there is sidewalk along a state route but not along the side streets, see the *Standard Roadway Construction Details*. Another example of this ramp use is where there is a wide enough buffer strip to accommodate the 1:12 ramp in its entirety without having to lower the landing area, see the *Standard Roadway Construction Details*. It is desirable to offset Curb Ramp Type 3 out of the normal pedestrian path but not necessary where right of way width cannot accommodate the offset.

The following criteria shall apply to providing curb ramps at a four corner intersection. These principles shall also apply to any intersection:

1. Where all the corners of an intersection have existing or proposed sidewalk, curb ramps shall be provided at each corner.

2. Where all the corners of an intersection do not have existing or proposed sidewalk, the following provisions shall apply:

   a. Where there is existing or proposed sidewalk at only one corner, A only, B only, C only or D only; no curb ramp is required. If the curb at the corner with sidewalk is to be constructed or reconstructed, it is optional to provide depressed curb for future curb ramps for compatibility with other corners.



   b. Where there is existing or proposed sidewalk at two adjacent corners only, such as A and B curb ramps shall be constructed at corners A and B only.

   c. Where there is existing or proposed sidewalk at two diagonally opposite corners only, such as A and C curb ramps shall be constructed at corners A and C together with a curb ramp at one of the other corners (B or D).

   d. Where there is existing or proposed sidewalk at three corners; curb ramps shall be constructed at each corner where existing sidewalk is to remain or where new sidewalk is proposed.

Where a corner at an intersection is without existing or proposed sidewalk, but with curb to be constructed or replaced or with existing curb to remain as is; it is optional to provide depressed curb for future curb ramps.

Where islands exist or are proposed at intersections with curb ramps, the following provisions shall apply:

1. Where a small channelizing island (5 to 7 m^2) is encountered at an intersection, it is not necessary to provide for a curb ramp or walkway opening for the island, but crosswalks shall be adjusted to safely

accommodate a person with disabilities without encroaching into the adjacent traveled way.

2. Where a channelizing island is greater than 7 m^2, provide a 1.2 m wide walkway opening level with the street in the part of the island intersected by the crosswalk. Where the walkway opening would be long or would create drainage problems, an alternate design is to place curb ramps at both sides of the island where it is intersected by the crosswalks and have a level area of at least 1.2 m between the curb ramps.

3. At intersections where a left turn island or divisional island is encountered and the island cannot be moved back so that the nose is out of the crosswalk, provide a 1.2 m wide walkway opening level with the street in the part of the island intersected by the crosswalk, see the *Standard Roadway Construction Details*.

At a location where a curb ramp is not presently required, the curb ramp area should be kept clear of obstructions such as light standards, traffic signals, meter boxes, controller boxes, junction boxes, utility poles, inlets, fire hydrants, guide rail, signs, planters, etc. which would interfere with future curb ramp construction.

The surface of a public sidewalk curb ramp shall be stable, firm and slip-resistant. The surface of a concrete curb ramp (excluding landing and flared sides) shall be the color red where the adjoining public sidewalk surface is also concrete. Where the adjoining public sidewalk surface is not concrete, the surface of a public sidewalk curb ramp shall contrast visually with adjoining public sidewalk surfaces, either light-on-dark or dark-on-light.

5-08 DRIVEWAYS

Driveway terminals are, in effect, low volume intersections. The number of driveways and their location have a definite effect on highway capacity, primarily on arterial highways.

Design requirements for driveways and the process under which the Department of Transportation will handle an access permit request are contained in the Department's publication, *New Jersey State Highway Access Management Code* and the *Memorandum to All Design Units* entitled "Access Control at Jughandles and Interchanges, and Driveway Reviews", October 3, 1994.

To determine the adequacy of the sight distance at driveways, see Section 6 for sight distance at intersections.

5-09 MEDIANS

5-09.1 General

A median is a highly desirable element on all arterials carrying four or more lanes. It separates the traveled ways for traffic in opposing directions. The median width is expressed as the dimension between the through-lane edges and includes the left shoulders, if any. The principal functions of a median are to :

1. Provide the desired freedom from the interference of opposing traffic.
2. Provide a recovery area for out-of-control vehicles.
3. Provide a stopping area in case of emergencies.
4. Provide for speed changes and storage of left-turning & "U" turning vehicles.
5. Minimize headlight glare; and
6. Provide width for future lanes.
7. Add open green space in an urban area.

For maximum efficiency, a median should be highly visible both night and day and in definite contrast to the through traffic lanes. A median may vary in scope from pavement markings to an expansive grass area of varying width between two independently designed roadways. Medians may be depressed, raised, or flush with the pavement surface.

Medians should be as wide as feasible, but of a dimension in balance with other components of the cross section. The general range of median widths is from a minimum of 1.2 m to a desirable dimension of 25 m or more on freeways in rural areas.

Desirable median width without a barrier for urban land service highways should be 9.6 m to accommodate future widening and 4.8 m where no future widening is anticipated. Desirable and minimum median widths without a barrier for rural land service highways should be 13.8 m (to accommodate future 3.6 m lane and 3.0 m wide shoulder) and 10.8 m (to accommodate a future 3.6 m lane and 1.5 m wide shoulder), respectively. For minimum median widths with barrier and for median widths for freeways, see the typical sections illustrated at the end of this section.

Medians 1.5 m or less in width will be paved, except where the special nature of an area might warrant the higher cost and risk involved in maintaining grass. Special areas might be parks or refined areas in towns or cities where a narrow grass strip would be in harmony with the surroundings or where shrubbery is planted to reduce oncoming headlight glare.

Where practical, nose areas shall be paved back to a point where the distance is 1.5 m between curblines.

In general, the median should be as wide as can be used advantageously. As far as the safety and convenience of motor vehicle operation are concerned, the farther the pavements are apart, the better. However, economic factors limit the width of median that can be provided. Construction and maintenance costs increase generally with an increase in the width of roadbed, but the additional cost may not be appreciable compared with the cost of the highway as a whole and may be justified in view of the benefits derived. A distinct advantage of wider medians on roadways, other than freeways, is to provide adequate shelter for vehicles crossing at intersections with public roads and at crossovers serving commercial and private drives. However, wide medians are a disadvantage when the intersection is signalized. The increased time for vehicles to cross the median may lead to inefficient signal operation.

If the right-of-way is restricted, the median should not be widened beyond a desirable minimum at the expense of narrowed roadside areas. A reasonable roadside width is required to adequately serve as a buffer between the private development along the road and the traveled way, particularly where zoning is limited or nonexistent. Space must be provided in the roadside areas for sidewalks, highway signs, utility lines, drainage channels and structures, and for proper slopes and any retained native growth. Narrowing these areas may tend to develop hazards and hindrances similar to those that the median is designed to avoid.

Raised medians have application on arterial streets where it is desirable to regulate left-turn movements. They are also frequently used where the median is to be planted, particularly where the width is relatively narrow. It must be pointed out, however, that planting in narrow medians creates hazardous conditions for maintenance operations.

Flush medians are used to some extent on all types of urban arterials. When used on freeways, a median barrier may be required. The median should be slightly crowned or depressed for drainage.

Additional discussion on median openings and intersections including emergency median openings on land service highways and freeways is discussed in Section 6, “At Grade Intersections”.

5-09.2 Median Fencing on Land Service Highways

This section pertains to the installation of fence on top of median barrier curb or in grass medians along our State land service highways. The purpose of the fence is to prohibit the unlawful and potentially dangerous crossing of the highway by pedestrians where barrier curb or a grass median exists. It is the Department's policy to provide median fencing on a case by case basis only.

Fencing in the median may be considered when there is a known pedestrian/vehicle accident history, or the Department has been requested by the local municipality to eliminate an illegal pedestrian crossing of the median. Upon notification of such a

problem or when requested by the local municipality; the local municipality (township engineer, police, etc.) should be contacted for their input, accident reports should be requested and analyzed and a field review of the site should be conducted in order to determine the exact location and reason for the illegal pedestrian crossings. An example of a reason for an illegal pedestrian crossing may be that pedestrians at a bus stop are crossing the highway to get to and from their vehicles parked on the opposite side of the highway.

If the pedestrian crossing is an isolated incident, fencing or other countermeasures are not warranted. If the pedestrian crossing is an ongoing patterned problem, evaluate the following safety countermeasures for use before installing fence in the median. They can be used by themselves or in combination with each other:

- Eliminate or relocate the attractive nuisance if practical. Example: move a mid-block bus stop close to a signalized intersection.

- Contact the local police department and request that they step up policing of jaywalkers.

- Encourage safe use of crosswalks at signalized intersections by providing clearly defined crosswalks, pedestrian actuated signals and signs. Provide proper traffic signal signs for the instruction of pedestrians and drivers, see "Section 2B-37" of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), 1988. Provide pedestrian crossing signs to selectively aid in limiting pedestrian crossing to safe places. For proper placement of these signs, see "Section 2B-36" of the MUTCD.

- Provide fencing along right-of-way line between widely spaced driveway access locations in order to limit areas of pedestrian access to the highway.

- Provide a pedestrian overpass if intersection/ interchange spacing exceeds one mile and if a user benefit cost analysis warrants an overpass. A pedestrian overpass is very effective when accompanied by median fencing.

- Provide roadway lighting.

Only after the previous countermeasures are evaluated and implemented should the engineer consider providing fencing in medians. That is, fencing should be used as a last resort. Fencing in medians should stop approximately 90 percent of the pedestrian crossings; however, it has its drawbacks:

- Difficulty in maintaining fence on median barrier curb.

- Potential to reduce horizontal sight distance when installed on median barrier curb.

- Litter can be a problem along fence located in grass medians adjacent to high litter generators such as shopping malls.

The fencing should be installed in well-lighted areas so that pedestrians can see the fence prior to attempting to cross the highway at night. Where existing roadway lighting is inadequate, provide additional roadway lighting in accordance with Section 11, "Roadway Lighting Systems".

Adequate sight distance at intersections and emergency "U" turns should be provided when designing limits of fencing. Therefore, fencing on barrier curb shall stop a minimum of 100 m from the median barrier curb terminal, and fencing in grass medians shall terminate a minimum of 60 m from the end of the grassed island. Fencing shall not be installed in medians where there is substandard horizontal stopping sight distance.

When installed on median barrier curb, chain link fabric shall be 1.2 m high, with 25 mm diamond mesh, see *Standard Roadway Construction Detail*, "Median Barrier Fencing".

When installed in grass medians, the chain link fabric shall be 1.8 m high, with 25 mm diamond mesh as per *Standard Roadway Construction Detail*, "Chain Link Fence with Breakaway Coupling". All chain link fence posts within the clear zone shall be made breakaway.

5-10 STANDARD TYPICAL SECTIONS

Typical sections should be developed to provide safe and aesthetically pleasing highway sections within reasonable economic limitations.

The typical sections shown in the plans should represent conditions that are "typical" or representative of the project. It is not necessary to show a separate typical section to delineate relatively minor variations from the basic typical. The most common or predominant typical section on the project should be shown first in the plan sheets followed by sections of lesser significance.

Figures 5-B through 5-J inclusive illustrate the various control dimensions for single lane and multi-lane highways.

5-11 BRIDGES AND STRUCTURES

5-11.1 General

Designers should make every effort during the early design phase to eliminate or minimize certain features on bridge decks such as, horizontal curves, vertical curves, variable horizontal widths and cross slopes. Locating these features off the structure simplifies construction, is more economical and reduces future maintenance requirements.

For further information, the designer should review Subsection 1.5.2, "Geometrics on Bridges" in the *NJDOT Design Manual - Bridges and Structures.*

5-11.2 Lateral Clearances

It is desirable that the clear width on the bridge be as wide as the approach pavement plus shoulders.

On underpasses, the desirable treatment is to maintain the entire roadway section including median, pavements, shoulders and clear roadside areas through the structure without change.

Minimum lateral clearances are illustrated in Figures 5-K through 5-P inclusive.

On divided highways where the median width is less than 9 m consideration should be given to eliminating the parapets and decking the area between the structures.

5-11.3 Vertical Clearance

Vertical clearances for bridges and structures shall be in accordance with Subsection 1.3.1, in the *NJDOT Design Manual - Bridges and Structures*.

Bridges and Structures Design should be notified of all changes in bridge clearances.