Guidelines for the Design and Placement of Curb Ramps

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The need for guidelines for the design and placement of curb ramps is evident from the confusing and contradictory standards for these features and the problems with curb ramps that have been constructed. The objective of this research was to develop such guidelines. Information was obtained from surveys of 10 state departments of transportation, 4 large U.S. cities, and 18 departments of public works in Virginia. A sample inventory of curb ramps was made in 15 municipalities in Virginia. Observations were made of curb ramps for wheelchair users and the blind. From the information obtained, guidelines for the design and placement of curb ramps were developed, which specify curb ramp dimensions based on sidewalk width and placement relative to obstructions, crosswalks, and types of intersections.

During an examination of the sections of the Code of Virginia that relate to curb ramps and also the several design standards for these facilities, a subcommittee of the traffic research advisory committee for the Virginia Highway and Transportation Research Council found several variations in the standards and also a number of problems.

Various federal, state, and local agencies responsible for complying with legislation related to curb ramps have established standards for their design, as indicated in Table 1. The largest range of specified values among the standards is the 5.0 to 17.0 percent slope for the ramp. The ramp width varies from 3.0 to 4.0 ft for one-way movements. Three of eight sets of standards require a lip. These and other conflicting design criteria evident in Table 1 promote confusion. (Note in the lower half of the table that the factors consider the placement of the curb ramp in relation to its environment.) Most of the standards, like those of VDH&T, address placement partially or not at all. Although the standards must be applicable for a wide range of situations, they should encourage consistency and uniformity in curb ramps.

Problems encountered in the application of standards include (a) obstructions such as utility poles, mailboxes, and hydrants in the path of the handicapped; (b) indirect paths across streets; (c) curb ramps without sidewalks, which encourage pedestrian activity in hazardous areas; (d) undesirable interference of curb ramps with drainage structures; and (e) lack of maintenance. Special considerations are necessary for the visually handicapped who use curbs as a guide. Because of these problems research was undertaken to develop guidelines for the design and placement of curb ramps.

DATA COLLECTION

Following a review of the pertinent literature, surveys were conducted with agencies involved in the design and construction of curb ramps, and an inventory was made of curb ramps in selected localities.

Surveys

Telephone surveys conducted of 10 state departments

Table 1. Standards for the design of curb ramps.

Characteristic	Standards							
	Code of Virginia (1)	Virginia Department of Highways and Transportation (VDH&T) (2)	AASHO (3)	U.S. Department of Housing and Urban Development (HUD) (4)	General Services Administration (GSA) (5)	American National Standards Institute (ANSI) (6)	FHWA (7)	American Public Works Association (APWA) (8)
Type of ramp	Diagonal			Flared; parallel extended continuous curb	Parallel to pedestrian traffic where possible	Diagonal; parallel offset		Diagonal; parallel offset
Ramp slope (%)	5.0	8.33	8.33	17.0	8.33 preferred; 16.67 maximum	8.33 maximum	8.33 maximum	8.33 preferred; 5.0; 16.67 maximum
Ramp width (ft)	4.0	4.0	4.0	4.0	3.0 minimum; 3.5 preferred	4.0	One-way = 3.0 minimum; two-way = 3.5 minimum	3.0 minimum; 4.0 preferred
Lip (in.)		0.5		≤0.5		None	None	0.5
Surface texture (for the blind)	Nonslip	Nonslip	Nonslip	Nonslip	Color contrast and texture	Nonslip	Brush broom finish and grooves	Wood float or other rough finish
Ramp located within crosswalk		Offset from crosswalk and in front of stop line	Yes		Yes			Yes
Adapt ramp to site			Yes					Yes
Deals with obstructions		Yes	Yes; may require offset from crosswalk					Yes; alternatives
Drainage concerns			Yes					Yes
Pedestrian conflicts			Yes		Yes			
Other			Refers to ANSI	Corner ramps; midblock ramps; ramp alignment; access to ramps (parking)				

Table 2. Summary from survey of state DOTs and traffic engineering units in urban areas.

Characteristic	California DOT (Caltrans)	Florida DOT	Georgia DOT	Kentucky DOT	Michigan DOT	New York State DOT	North Carolina DOT
Type of ramp	Parallel; diagonal; built-up ramp	Diagonal; parallel	Parallel; diagonal on (a) paved walk, (b) unpaved area on walk, (c) end of walk	Parallel; offset parallel; diagonal	Parallel; offset parallel; diagonal	Parallel; offset parallel; diagonal	Parallel; diagonal
Ramp slope	1:12	1:12	1:12	1:12	1:12, 1:18 maximum	1:12, 1:18 maximum	1:12
Ramp width (ft)	4	3	3.5 minimum	4 minimum	4 minimum	4 minimum	3.3
Flare width (ft)	Variable	2	4; 2 minimum	Variable	Variable	Variable	4
Lip (in.)	None	None	None	None	None	0.625	None
Surface texture	Groves 0.25 x 0.25 in. on 0.75-in. centers at top of curb ramps 12 in. wide extending the width of ramps and flares	Tined finish	Tamps, wood floats, and broom finish	Broom finish	Coarse broom finish	Deep grooved, 0.5 in. wide by 0.25 in. deep on 1-in. centers transverse to ramp	Nonskid-type finish
Located within crosswalk	Yes		Yes	Yes	Yes		Crosswalk = 10 ft; no parking within 20 ft of ramp
Adapt ramp to site	Five variations for walk depression or widening	Three alternatives with varying flares, depending on walk design	Three types subject to engineering judgment	Five variations based on types of streets and traffic control	Five variations based on types of streets and traffic control	Subject to engineering judgment	Based on 3- and 4-legged intersections; subject to engineering judgment
Deal with obstructions			Subject to engineering judgment			Subject to engineering judgment	Subject to engineering judgment
Drainage concerns			Catch basins should be at least 10 ft from ramps; drop inlets out of line	Alternate locations identified	Structures out of line with ramp	Drainage pickups upstream from ramps; grates are used in area of ramps	Subject to engineering judgment
Date of standard	1/81	2/79	1/79	7/75	4/74	6/76	1/76
Other		Also a bicycle ramp		Revised version of Michigan DOT standard	Orientation notches on side of ramp for the blind are being eliminated	Walks 11 ft wide are sloped 1:24 to accommodate ramp	

of transportation (DOTs), the traffic engineering units in 4 urban areas, and 18 departments of public works in Virginia yielded the information presented below.

Survey of State DOTs and Traffic Engineering Units

A summary of the information obtained in the survey of state DOTs and traffic engineering units in urban areas is given in Table 2. Six respondents (42.9 percent) used three or more types of curb ramps (including diagonal, parallel, and offset parallel). Five respondents (35.7 percent) used two types of curb ramps, and three respondents (21.4 percent) used one type. The selection of the type of curb ramp to use depended on sidewalk design and type of intersecting streets.

Eleven respondents (78.6 percent) have omitted or will soon omit a lip at the bottom of the curb ramp. The length of the flares ranged from 1 to 6 ft. Fifty percent of the respondents used a broom finish on the curb ramp and 14.0 percent used a grooved surface texture. All except two respondents (14.3 percent) considered placement conditions to some degree. In general, site-specific considerations were subject to engineering judgment. Three standards (21.4 percent) were identified as a bicycle and wheelchair ramp, which promotes dual use of the ramp.

The problems cited were (a) incompatibility between the needs of the blind and those of handicapped persons in wheelchairs, (b) conflicting standards for utility poles and other obstructions, and (c) minor drainage concerns.

Survey of Municipal Departments of Public Works in Virginia

Seventeen municipalities in Virginia that had populations greater than 20,000 and 1 county were surveyed. Ten municipalities (55.6 percent) use the VDH&T standard and 7 municipalities and the 1 county use standards similar to the Department's. The diagonal ramp is the primary type used. Two municipalities base their ramp slope on the Code of Virginia [i.e., 5.0 percent slope (1:20)], whereas all others use an 8.33 percent slope (1:12). Flare lengths range from 2 to 6 ft. Only two standards did not have a lip. Minor departures from the Department's standards include the addition of a midblock design and design variations based on the curb radius or presence of an obstruction.

Only a few problems were cited, the most common of which were (a) conflicting standards for utility poles, mailboxes, hydrants, and so on; (b) enforcement of quality control during construction; and (c) curb ramp use by bicycles and motor vehicles. Note that one point of controversy is whether or not bicyclists should be encouraged to use curb ramps.

Inventory of Curb Ramps

Fifteen areas were selected for the inventory of curb ramps in order to identify effective and ineffective design and placement conditions. In addition, the scope of the problem of curb ramp design and placement was defined. The inventory focused on locations where curb ramps were expected, such as central business districts (CBDs), public buildings,

Figure 1. Curb ramp problem: high lips.

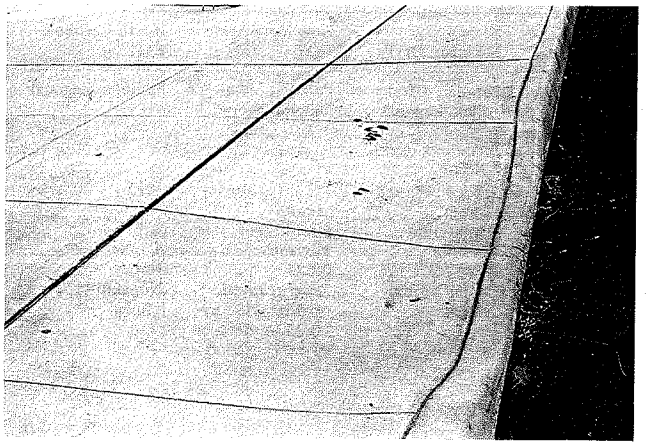


Figure 2. Curb ramp problem: no median break.

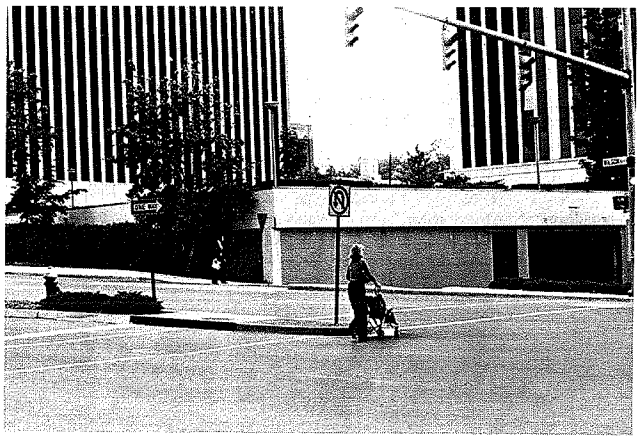


Figure 3. Curb ramp problem: drainage structure affecting placement.

Figure 4. Curb ramp problem: ramp located out of crosswalk.

and residential areas where curb and gutter or sidewalk projects were recently completed. More than 200 sites were reviewed, and 124 were documented in the inventory.

The common problems noted from the inventory are listed below in order of decreasing frequency of occurrence:

1. The absence of matching curb ramps at all corners of an intersection,
2. The presence of high lips (greater than 0.5 in.) and a wide range in lip heights (see Figure 1),
3. Slight problems with obstruction by utility poles and manhole or conduit covers,
4. Ramps offset from the diagonal (or middle of the curb return) for no apparent reason,
5. No median breaks for ramp users on divided highways (see Figure 2),
6. Steep flare and ramp slopes,
7. Presence of drop inlets that affect curb ramp placement (see Figure 3),
8. Curb ramps located outside of marked crosswalks (see Figure 4),
9. Absence of a level area above ramps for turning by wheelchair users, and
10. Parked vehicles blocking the curb ramp.

There appeared to be no distinctions between the curb ramp treatments in rural municipalities and those in urban municipalities, although urban municipalities generally have wider sidewalks. The width of sidewalks varied greatly, from 4 ft in residential areas to 20 ft in large CBDs. Many residential areas had sidewalks on only one side of the street.

Problems 2, 4, and 6 can be eliminated by enforcing quality control in the construction of curb ramps. The remaining problems are related to standards and policy regarding curb ramps; these problems are addressed in the guidelines.

CURB RAMP LIP

Although a lip was desired as an aid for blind persons and to maintain drainage, it was found to be an obstacle to wheelchair users. This section discusses the use of a curb ramp lip.

In a telephone conversation with the assistant executive director of the Braille Institute of America, the need for a 0.5-in. lip as an aid for the blind was discussed. The Institute endorsed the use of a 0.5-in. lip to aid cane users in identifying curb ramps based on the observation of orientation and mobility instructors. The instructors also indicated that some blind persons become disoriented when they step on a curb ramp.

In a laboratory study conducted by Templer (9), the majority of blind persons had little difficulty in detecting a variety of ramps that had different slopes and lips. The observations of mobility training students for the blind at the Virginia Rehabilitation Center for the Blind were consistent with the findings by Templer.

The elimination of the lip presents no problem for the visually impaired. The problem of disorientation caused by the curb ramps can be minimized with consistent placement of the ramps.

When curb ramps were introduced, a 0.5-in. lip was accepted as a compromise between a 1-in. lip to maintain drainage and no lip to avoid an obstacle for wheelchair users. (Note that these data are from a December 23, 1981, memorandum from E.S. Coleman, Jr. of the Locations and Design Division, VDH&T.) The major problem for wheelchair users was that a 0.5-in. lip made it difficult to move up a ramp. In the survey of state DOTs and traffic engineering units in urban areas, no drainage problems were noted by the 11 respondents that did not use a lip. The consensus was that a small lip did not make much of a difference in drainage. Some additional water and debris may accumulate without a lip, but not enough to be considered a problem.

The purpose of curb ramps is to provide accessibility to the handicapped, and wheelchair users benefit from the elimination of the lip. The worst problems with drainage are caused by ice and snow in the winter months when wheelchair users are less likely to use the sidewalk for travel than during other seasons. In areas where there is a low velocity of the runoff water, water and debris accumulate at curb ramps regardless of the presence of a lip.

Based on the above comments, it is concluded that a lip is not necessary to aid the visually impaired or to maintain drainage.

GUIDELINES

The guidelines are divided into four parts: general practices, design, placement, and miscellaneous notes. Before the guidelines are discussed, the goals and objectives of curb ramps are defined.

Goals and Objectives of Curb Ramps

The goal of curb ramps is to provide the physically handicapped, especially persons confined to wheelchairs, access to and from sidewalks so that they are able to traverse streets. There are five objectives related to this goal:

1. Provision of a curb ramp, in respect to design and placement, that is usable by the physically handicapped;
2. Provision of design and placement alternatives for a range of sidewalk and street conditions;
3. Provision of minimal impedance to able-bodied pedestrians;
4. Placement of curb ramps in uniform and consistent locations; and
5. Provision of curb ramps without a lip that are detectable by the blind with no adverse effects.

These objectives have established the framework for the guidelines. There is a trade-off between objectives 2 and 4 in that the design and placement alternatives are limited in order to maintain uniformity and consistency.

General Practices

Five items are included in the guidelines under the heading of general practices.

1. Concrete ramp surfaces shall have a nonskid, broom finish transverse to the slope of the ramp. All concrete shall be class A-3. Ramp surfaces other than concrete do not require a broom finish. Portland cement concrete is the only material referenced in the Road and Bridge Specifications for Curbs and Sidewalks (10). The other most commonly used material--brick--does not lend itself to a broom finish.
2. Matching curb ramps should be provided at all corners of an intersection, or on both sides of a midblock location, to establish a continuous network for ramp users. If curb ramps are not placed at all corners of an intersection, then the ramp user's accessibility is restricted to the paths connecting the ramps. Access to all pedestrian paths should be provided.
3. On new construction projects, utility poles, fire hydrants, and drop inlets should be located so as to provide an unobstructed path to the curb ramp located on the middle of the curb return (also called the diagonal). Because the location of curb ramps may be adversely affected by obstructions, the location of the curb ramp should have priority over the location of potential obstructions.
4. Curb ramps should not be constructed as part of curb projects where no sidewalk exists. As mandated by the Code of Virginia (1) and Section 228 of the Highway Safety Act of 1973 (11), curb ramps are constructed where curbs are constructed or replaced without consideration of the presence of a sidewalk. Some engineers consider this as a form of incremental planning in that a sidewalk and ramp may be added later. However, unpaved surfaces in rough terrain present a potential hazard for handicapped persons. Also, erosion occurring along the curb ramp causes the unpaved surface material to be deposited in the gutter and roadway and creates holes in the unpaved surface.
5. In the event that a situation arises where the guidelines are not applicable, the use of sound engineering judgment is recommended.

Design of Curb Ramps

Three standard curb ramp designs were developed for the guidelines: two to accommodate different sidewalk widths for the middle of the curb return and one to accommodate parallel curb ramps. The designs are based on a curb height of 6 in.

Design note 1: Except at certain locations as defined later, curb ramps shall be located on the middle of the curb return. The location on the middle of the curb return provides the minimal potential for conflicts with obstacles such as utility poles, signal poles, and so on.

Design note 2: The curb ramps shall have no lip with a +0.125-in. tolerance.

The standard curb ramp design for sidewalk widths greater than or equal to 8 ft is shown in Figure 5. The slope of the flares is equal to the slope of the ramp (1:12) to permit ramp users to turn left or right by traversing the flares. The ramp is tapered from 4 ft at the bottom to 3 ft at the top (8).

The standard design for sidewalk widths less than 8 ft is shown in Figure 6. The flares and ramp have a slope of 1:10. Many sidewalks in residential areas are 5 ft wide and cannot accommodate a 6-ft-long ramp. The designs in Figures 5 and 6 are similar except for the slopes of the flares and ramp.

The standard design for parallel curb ramps is shown in Figure 7. This curb ramp is used where the ramp is placed parallel to pedestrian paths in locations such as jogged and T intersections, midblock crossings, and medians. The design dimensions are similar to the dimensions in Figures 5 and 6 in that they are based on sidewalk width. Also shown in Figure 7 is the design to be used when the middle of the curb return is unpaved on sidewalks less than 6 ft wide (12).

Figure 5. Standard design for sidewalk widths greater than 8 ft.

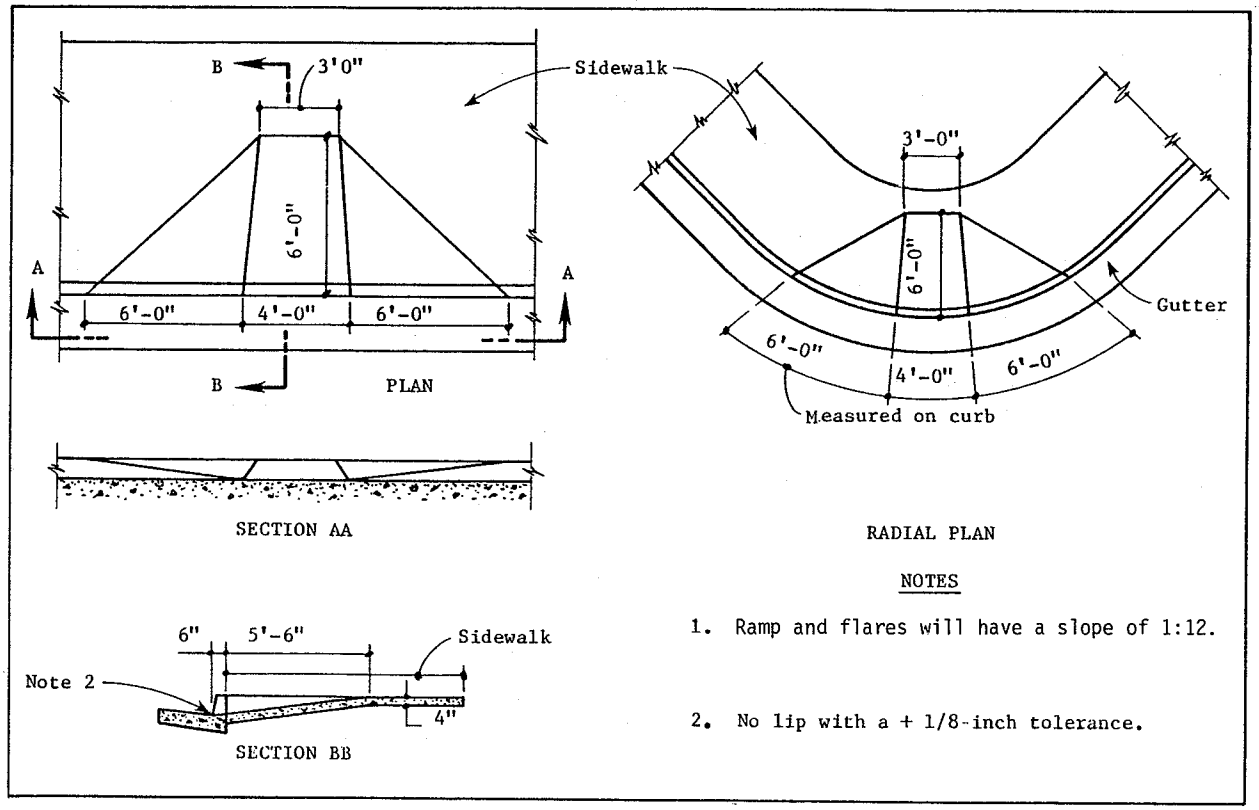


Figure 6. Standard design for sidewalk widths less than or equal to 8 ft.

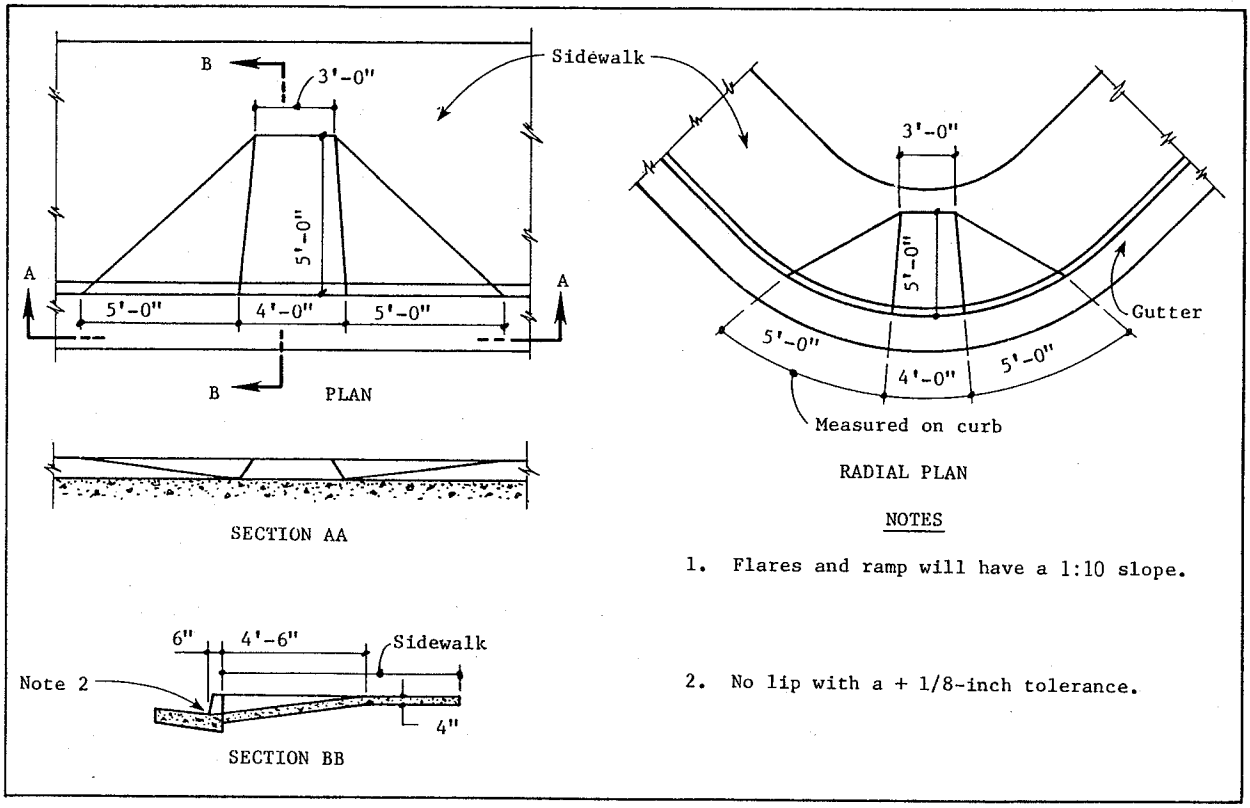
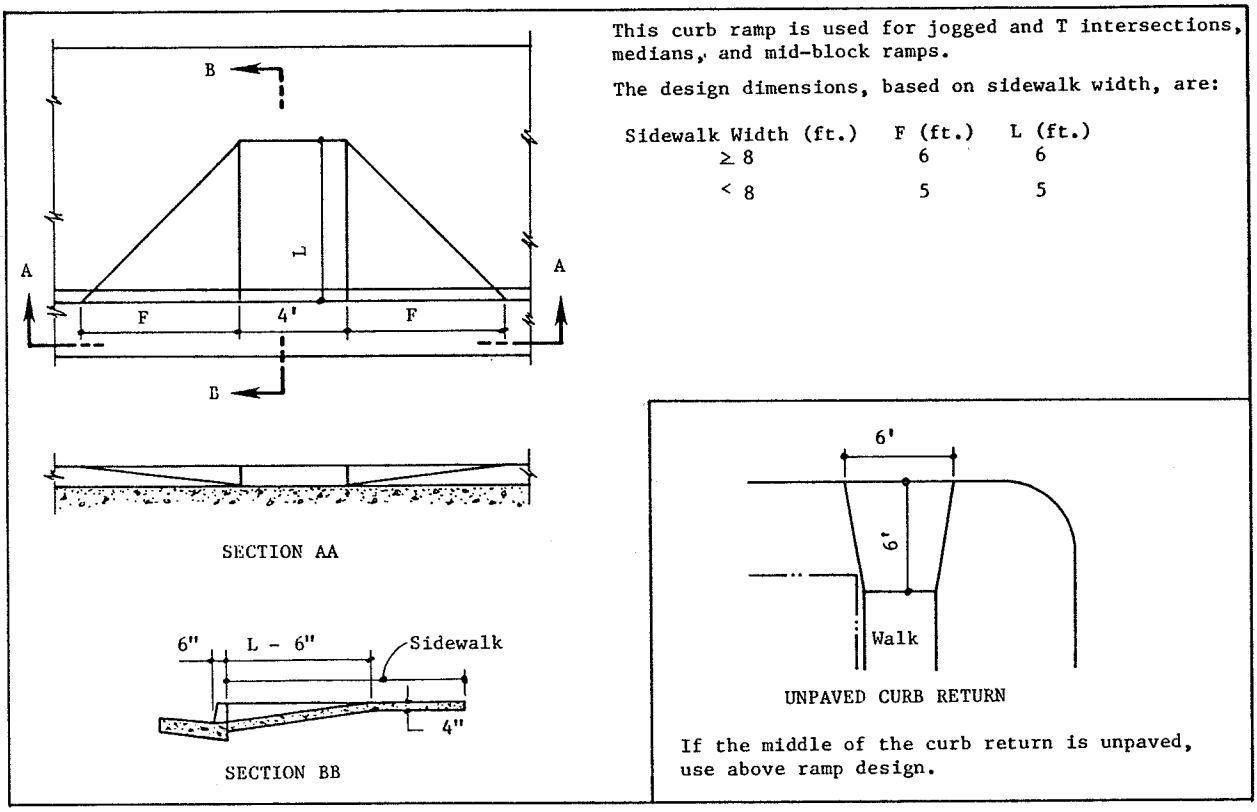


Figure 7. Standard design for parallel curb ramp.



Placement of Curb Ramps

The placement of curb ramps is as critical to their effectiveness as the design. The three placement issues are placement with respect to obstructions, crosswalks, and intersection types.

Two placement situations, relative to obstructions, are shown in Figure 8. The objective is to maintain consistent and effective placement. When obstructions are located 6 ft or less from the middle of the curb return, the ramp is placed as shown in Figure 8a. It is assumed that the majority of curb ramp users travel in the same directions as the majority of pedestrians. When a drop inlet is located 6 ft or less from the middle of the curb return, the placement of the curb ramp depends on the curb radius (Figure 8b). When there is a radius greater than 20 ft, two parallel ramps are used. The parking restrictions accompanying parallel ramps increase the visibility of curb ramp users to motorists.

Curb ramp placement in conjunction with crosswalks is shown in Figure 9. Where crosswalk markings exist or are planned, curb ramps shall be located within the crosswalks. This may necessitate the widening of a crosswalk. Curb ramps shall be located in front of vehicle stop lines. Crosswalk markings are used to guide pedestrians in the proper paths and are often used where there is substantial conflict between vehicle and pedestrian movements (13). Curb ramp users deserve the same benefits of crosswalks as other pedestrians.

When ramps are located on the middle of the curb return, a minimum of 2 ft of curb shall be located on each side of the ramp for use by the blind and pedestrians who may prefer to use the curb (7). A 4-ft clearance space shall be located within the crosswalk (7). These two items are shown in Figure 9a. The locations of parallel curb ramps relative to crosswalks are shown in Figure 9b. Where crosswalks and walkways through medians are less than 12 ft wide, the curb ramp should be centered in the walk or median (Figure 9c); otherwise the curb ramp should be located to one side with one flare outside of the crosswalk (Figure 9d). Curb ramps in a median should be at least 4 ft apart in order to provide a level section for wheelchair users. When the median is not wide enough to accommodate two curb ramps, a break or gap in the median equal to the width of the crosswalk should be constructed. Parking shall be restricted at least 10 ft (20 ft preferred) from the parallel curb ramps.

Curb ramp placements are presented for oblique angle intersections, multileg intersections, and T and jogged intersections (see Figure 10). Curb ramps on small radii may require that the corner be rounded off to obtain the required 4-ft-wide ramp. The use of oblique angle and multileg intersections is discouraged because they cause problems for the blind, who tend to walk in straight lines perpendicular to the curb.

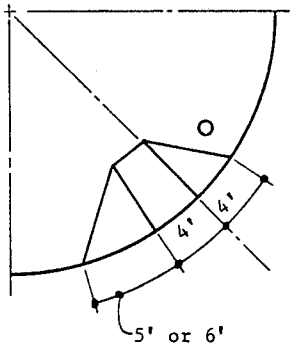
At least one parallel curb ramp should be installed at T and jogged intersections. If one parallel curb ramp is installed, then it should be located in the path of the lightest turning movements from the cross street.

Miscellaneous Notes

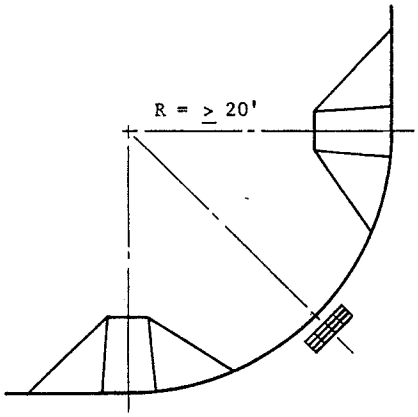
Five concerns that deserve mention are curb radius, maintenance of curb ramps, curb height, repavement of streets, and sidewalk slope.

1. Curb radius: The shape of the curb ramp is

Figure 8. Placement relative to obstructions.



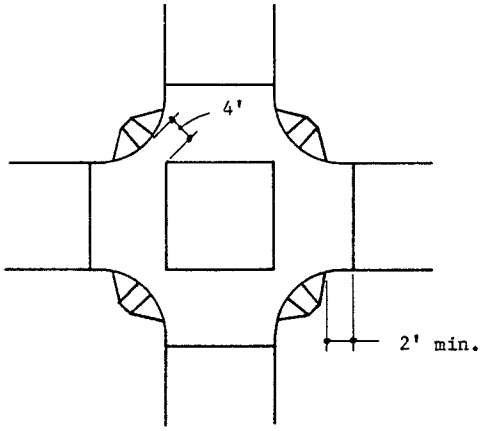
a. If the obstruction is located 0'-6' from the middle of the curb return, offset the ramp in the direction of the major pedestrian movement.



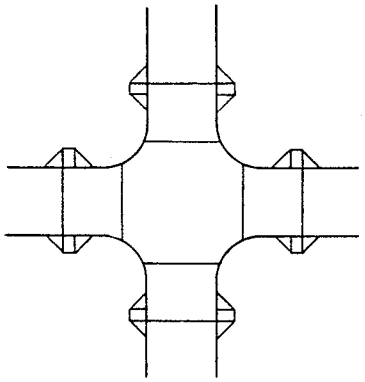
b. If a drop inlet is located 0'-6' from the middle of the curb return with a radius greater than or equal 20', parallel curb ramps should be installed. Parking should be restricted at least 10 ft. (20 ft. preferred) from the curb ramps.

If the curb radius is less than 20', the ramp should be offset in the direction of the major pedestrian movement as in part of this figure.

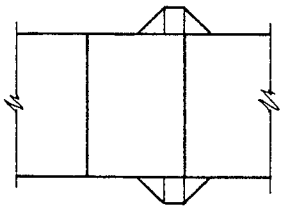
Figure 9. Placement in conjuction with crosswalks.



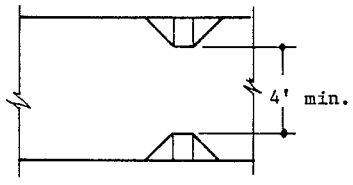
a. Middle of curb return (or diagonal) curb ramps.



b. Parallel curb ramps.



c. Parallel curb ramps located within crosswalks greater than or equal to 12 ft. in width.



Parallel curb ramps in a median. Medians may be made accessible by providing a break in the median or a crosswalk in front of the median.

For crosswalks or medians less than 12 ft. wide, center the ramp in the walk or median.

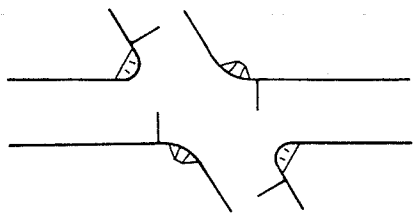
Parking should be restricted within 10 ft. (20 ft. preferred) of the curb ramp.

influenced by the curb radius, as shown in Figure 11. Different curb radii are illustrated to indicate to the engineer that the shape of the curb radius is likely to be different than the shapes shown in Figures 5 and 6.

2. Maintenance of curb ramps: Where there is low or no velocity of the storm runoff water, debris accumulates at the base of the ramp. There is no cost-effective way to overcome this problem from a design and placement perspective. It is recommended that a periodic maintenance schedule be determined by the engineer.

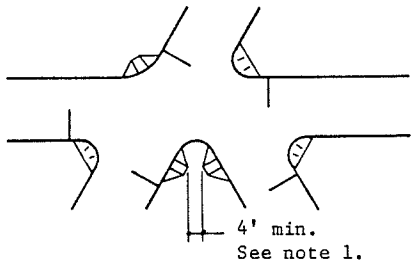
3. Curb height: The design guidelines are based on a curb height of 6 in. In locations where 8-in.

Figure 10. Placement at intersections.



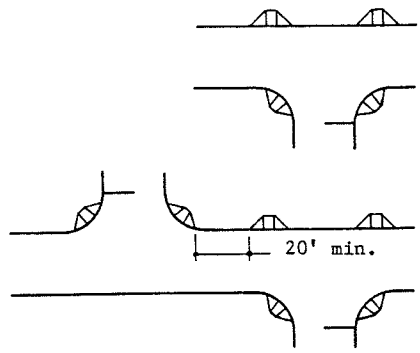
— Curb ramp dimensions may require that the corner be rounded off (4-ft. wide ramp required).

a. Oblique angle intersections.



Note 1. If the spacing between ramps is less than 4', then curb height should be reduced or ramp slope increased to maximum of 10:1. This is similar to a median (Figure 7c).

b. Multi-leg intersections.



T intersection

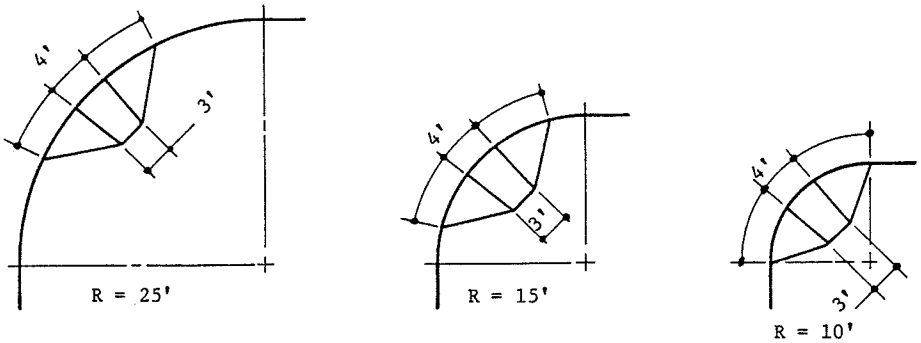
At least one parallel curb ramp should be installed. If one parallel curb ramp is used, then it should be located in the path of the lightest turning movements from the cross street.

Jogged intersection

(The above note is applicable.)

c. T and jogged intersections.

Figure 11. Curb ramps with various curb radii.



curbs are the standard, an asphalt wedge approximately 1 ft long and 2 in. high should be added to the bottom of the ramp if the sidewalk is less than 11 ft wide. Another suggestion is to have sidewalks that slope down (maximum of 1:20) to a 6-in. curb height at the beginning of the ramp.

4. Repavement of streets: Special care should be taken to ensure that the bottom of the curb ramp is not affected when the street is repaved. The city of Charlottesville uses an 8-in. curb (and an asphalt wedge on ramps) so that a 6-in. curb is retained after the street is repaved.

5. Sidewalk slope: Where there is a sidewalk slope to permit drainage from the sidewalk to the curb, the ramp length should be increased to maintain the slope specified in the design. The following equation should be used to calculate the ramp length:

$$L = \{(ECH/RS)/[1 - (SS/RS)]\} + CW \quad (1)$$

where

L = ramp length (ft);
RS = ramp slope;
SS = sidewalk slope;
CW = curb width (ft); and
ECH = effective curb height (ft) = CH - (CW * RS), where CH is the curb height (ft).

CONCLUSION

The guidelines for the design and placement of curb ramps presented in this paper are comprehensive. Curb ramp design dimensions based on sidewalk width and placement relative to obstructions, crosswalks, and types of intersections are addressed.

ACKNOWLEDGMENT

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Abridgment

Operational Effects of Two-Way Left-Turn Lanes on Two-Way, Four-Lane Streets

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One method of relieving excessive congestion on a two-way street that has a substantial number of midblock left turns is the construction of a two-way left-turn lane (TWLTL). Although the safety effectiveness of the TWLTL has been the subject of many studies, few studies have been made of its operational effectiveness. The objective of this study was to quantify the effects of a TWLTL on the efficiency of traffic flow on a two-way, four-lane street. By using computer simulation models specifically developed and validated for the purpose of this study, traffic operations were simulated over a range of traffic volumes and driveway densities. The reductions in stops and delays that result from a TWLTL were computed from the outputs of these simulation runs. Isograms of stops and delay reductions were prepared to facilitate the use of the results of this study to evaluate the potential cost-effectiveness of TWLTL installations.

The two-way left-turn lane (TWLTL) is recognized as a possible solution to the safety and operational problems on two-way streets that are caused by the conflict between midblock left turns and through traffic. The extent to which a TWLTL can improve the efficiency of traffic operations depends on the traffic volumes and driveway densities involved. Although the principle of the complex relation between these factors and the operational effectiveness is intuitively apparent, it has yet to be quantitatively expressed for two-way, four-lane streets. McCoy, Ballard, and Wiyaya (1) have reported on the