GUIDELINES FOR THE DESIGN AND PLACEMENT OF CURB RAMPS

by

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Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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INTRODUCTION AND PROBLEM

In providing physically handicapped people the accessibility to public facilities mandated by federal and state governments, emphasis has been on access to buildings and public transportation with only limited attention being given to the pedestrian system. Specifications for the design of curb ramps — also called curb cuts, handicapped ramps, and wheelchair ramps — are intended to facilitate the efforts of the responsible authorities to meet the provisions of the legislative mandate. However, the specifications often promote confusion through ambiguity and the inclusion of several conflicting designs. Consequently, several problems are encountered by the authorities.

A summary of the findings of a subcommittee of the Traffic Research Advisory Committee for the Virginia Highway and Transportation Research Council is given below. (1) The summary examines the Code of Virginia and several design standards.

SUMMARY OF STUDY SUBCOMMITTEE FINDINGS

Code of Virginia

Section 15.1-381 of the Code of Virginia sets forth the specifications for ramps on curbs of certain streets. (2) (See Appendix A.) Three major provisions of the statute are as follows:

1. There be constructed not less than two ramps per lineal block leading to the crosswalks at intersections.

2. Such ramps have a gradient not greater than five percent, unless the difference between the sidewalk and the paved right-of-way is such as to make a five percent grade impractical.

3. Such ramps shall be located at intersections diagonally.

There are problems in interpreting these provisions. The definition of a lineal block is in question, no maximum gradient is specified for cases where a five percent grade is impractical, a steep grade may make it difficult for a wheelchair-bound person to climb up the ramp or to stop after descending it, and it may not be possible to place a ramp diagonally at an intersection because of utility poles or a lawn. Additionally, the Code states that curb ramps shall be installed upcn the replacement of curbs with or without sidewalks. However, curb ramps should be installed with caution because pedestrian activity should be discouraged where there are curbs without sidewalks.

Design Standards

There are numerous sets of standards for the design of curb ramps. 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% slope for the ramp. The ramp width varies from 3.0 ft. (0.92m) to 4.0 ft. (1.23m) 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 that the lower half of the factors consider the placement of the curb ramp in relation to its environment. Most of the standards address placement partially, like those of the Virginia Department of Highways and Transportation (see Appendix B), or not at all. While 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 impact of curb ramps on drainage; and (e) lack of maintenance. Special considerations are necessary for the visually handicapped who use curbs as a guide.

OBJECTIVE AND SCOPE

In light of the above, it is clear that there is a need for guidelines for the design and placement of curb ramps, and the objective of this research was to develop such guidelines.

The scope of the research was influenced by a research report by Templer [10] and standards recommended by municipalities and other states.

The research comprised the six tasks listed below.

A. Review of literature on the policies and design guidelines for curb ramps

ABSTRACT

The need for guidelines for the design and placement of curb ramps is evident from the confusing and contradicting 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 through surveys of ten state departments of transportation, four large U. S. cities, and eighteen departments of public works in Virginia. A sample inventory of curb ramps was made in 15 municipalities in Virginia. Interviews with representatives of agencies serving the handicapped and with engineers in charge of planning and constructing curb ramps were conducted to identify their problems and experiences. Observations were made of mobility classes for the blind and wheelchair users.

From the information obtained, guidelines for the design and placement of curb ramps were developed. It is recommended that these guidelines be adopted by the Virginia Department of Highways and Transportation and that amendments proposed in the report be made to the Code of Virginia and Section 228 of the Highway Safety Act of 1973 for Federal-Aid Highways.

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B. A survey of ten state departments of transportation, four U. S. urban areas, and eighteen departments of public works in Virginia to obtain design standards and information on experiences with curb ramps

C. An inventory of curb ramps in selected areas of Virginia

D. Interviews with agencies representing the handicapped as curb ramp users, and interviews of municipal department of public works engineers and others involved with standards for curb ramp design

E. Considerations for the visually handicapped with emphasis on pedestrian training

F. Establishment of guidelines for the design and placement of curb ramps

LITERATURE REVIEW

A search of available literature was conducted through the facilities of the Highway Research Information Service. The references used by the study committee were obtained. Additional references were identified by the persons interviewed and transportation professionals. Information derived from the literature review is documented throughout the report.

SURVEYS

A telephone survey was conducted of ten state departments of transportation (DOTs), four urban areas, and eighteen departments of public works in Virginia. The form shown in Table 2 was used.

Survey of State DOTs and Urban Areas

A summary of the information obtained in the survey of state DOTs and urban areas is given in Table 3. Six of the respondents (42.9%) used three or more types of curb ramps (including diagonal, parallel, and offset parallel). Five of the respondents (35.7%) used two types of curb ramps, and three (21.4%) used one type. The selection of the type of curb ramp to use was often dependent on the sidewalk design and type of intersecting streets.

Eleven of the respondents (78.6%) omitted or will soon omit a lip at the bottom of the curb ramp. The reason for omitting the lip is to benefit the wheelchair users who perceive a lip as a barrier. No drainage problems were noted to be caused by the absence of the lip. The length of the flares ranged from 1 to 6 ft. (0.305 to 1.83 m). Fifty percent of the respondents used a broom finish and 14.0% used a grooved surface texture. All except two of the respondents (14.3%) considered placement conditions to some degree. In general,

Table 1. Standards for the Design of Curb Ramps

Types of Ramps	Standards							
	Code of Va.[2]	VDH&T[3]	AASHTO[4]	HUD[5]	GSA[6]	ANSI[7]	FHWA[8]	APWA[9]
	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 (max)	8.33 (max)	8.33(max)	8.33(preferred) 5.0 16.67 (max)
Ramp Width (feet)	4.0	4.0	4.0	4.0	3.0 (min) 3.5 (preferred)	4.0	one-way 3.0 (min) two-way 5.5 (min)	3.0 (min) 4.0 (preferred)
Lip (inches)		0.5		$\leq$ 0.5		none	none	0.5
Surface Texture (for blind) Nonslip		nonslip	nonslip	nonslip	color contrast and texture	nonslip	brush broom finish and grooves	wood float or other rough finish
Ramp Located Within Crosswalks		offset from crosswalk and in front of stop line	x		x			x
Adapt Ramp to Site			x					x
Dealing with Obstructions		x	x may require ramp offset from crosswalk					x alternatives
Drainage Concerns			x					x
Pedestrian Conflicts			x		x			
Other			refers to ANSI	Corner ramps mid-block ramps ramp alignment access to ramps (parking)				

Note: Numbers in parentheses denote reference numbers.

Conversion factors: 1.0 ft. = 0.308 m
1.0 in. = 2.54 cm

Table 2. Curb Ramp Survey

City: _____ Phone: _____

Name: _____

1. What design standard do you use for curb ramps?

   your own (request a copy)
   other (specify)_____(if unfamiliar, request)

2. Have you encountered problems with curb ramps in your local experience?

   _____Yes _____No (If yes, explain)

   What about problems with the following:

   a. complaints (from the elderly and handicapped, in particular)

   b. conflicting standards for utility poles, mailboxes, hydrants, etc.

   c. hazardous curb ramp locations for pedestrians (or indirect paths)

   d. drainage

   e. construction (i.e., discrepancies between the design and the end product)

   f. maintenance

   g. continuity and consistency throughout the pedestrian network

3. At what locations are curb ramps installed?

   Do you have warrants for crosswalks? _____Yes _____No

VIRGINIA ONLY

4. Would you mind if your area was considered for an inventory of curb ramps?

   _____Yes _____No

   Are there any comments that you'd like to make regarding curb ramps?

THANK YOU FOR YOUR TIME. YOUR COMMENTS WILL BE VERY HELPFUL TO US IN OUR RESEARCH.

Table 3. Summary From Survey of State DOTs and Urban Areas

	Caltrans	Florida DOT	Georgia DOT	Kentucky DOT	Michigan DOT	New York DOT	N. Carolina DOT
Types of Ramps	1. parallel 2. diagonal 3. builtup ramp	1. diagonal 2. parallel	1. parallel 2. diagonal a. paved walk b. unpaved area on walk c. end of walk	1. parallel 2. offset parallel 3. diagonal	1. parallel 2. offset parallel 3. diagonal	1. parallel 2. offset parallel 3. diagonal	1. parallel 2. diagonal
Ramp Slope	12:1	12:1	12:1	12:1	12:1; max. 18:1	12:1; max. 18:1	12:1
Ramp Width (ft.)	4	3	min. 3.5	min. 4	min. 4	min. 4	3.3
Flare Width (ft.)	variable	2	4; min. 2	variable	variable	variable	4
Lip (in.)	none	none	none	none	none	0-5/8	none
Surface Texture	grooves 1/4" x 1/4" on 3/4" centers at the top of the curb ramps 12" wide extending the width of ramp and flares	tined finish	tamps, wood floats and broom finish	broom finish	coarse broom finish	deep grooved 1/2" wide by 1/4" deep on 1" centers transverse to ramp	non-skid type finish
Located Within Crosswalk	X		X	X	X		crosswalk width = 10'; no parking within 20' of ramp
Adapt Ramp to Site	5 variations for walk depression or widening	3 alternatives with varying flares depending on walk design	3 types (above) subject to engineer	5 variations based on types of streets and traffic control	5 variations based on types of streets and traffic control	subject to engineer	based on 3- & 4-legged intersections; subject to engineer
Dealing with Obstructions			subject to engineer			subject to engineer	subject to engineer
Drainage Concerns			catch basins should be at least 10' from ramps; drop inlets out of line with ramp	alternate locations identified	structures out of line with ramp	drainage pickups upstream from ramp; grates are used in the area of the ramps	subject to engineer
Date	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	for walks 11' wide, walks are sloped 24:1 to accommodate ramp	

Table 3 continued

	Penn DOT	Tennessee DOT	Texas DOT	Albequerque, NM	Chicago, IL	Los Angeles, CA	Washington, D.C.
Types of Ramps	1. parallel offset 2. parallel offset 3. diagonal 4. median ramp	1. diagonal 2. parallel	unspecified	diagonal	1. parallel without paved diagonal 2. parallel	1. diagonal 2. mid-block	1. parallel 2. median
Ramp Slope	12:1; min. 8:1	12:1; min. 8:1	12:1	10:1	12:1; max. 18:1	12:1; min. 8:1	12:1
Ramp Width (ft.)	min. 4; 3 at top	min. 4	min. 4	4 at curb face; 3 at top	4 min. 4	4	5 at curb face 3 at top
Flare Width (ft.)	4	variable	min. 5		variable	6	1
Lip (in.)	none	none	1/2 (see Other)	1/2	max. 5/8	1/2	none
Surface Texture	coarse broom	coarse broom		heavy brooming	broom		steel broom finish
Located Within Crosswalk	X; no parking within 20' of crosswalk	X; in front of stop line				X	X
Adapt Ramp to Site	subject to engineer; consider use of driveways	alternate design if curb radius 25'		subject to engineer		subject to engineer	subject to engineer
Dealing with Obstructions	variable slope near poles					reduce flare length	location with respect to light post
Drainage Concerns	structures out of line with ramps	structures out of line with ramps		no conflict with ramp			
Date	6/76	2/75		11/79	1/79	11/75	
Other	min. 3' landing area at top of ramp	Revised version of NCDOT standard	plan to eliminate the lip; also a bicycle ramp		information was obtained from the literature		also a bicycle ramp

NOTE: 1.0 ft. = 0.305 m
1.0 in. = 2.54 cm

site-specific considerations were subject to engineering judgement. Three of the standards (21.4%) were identified as a bicycle and wheelchair ramp, which promote dual use of the ramp. The problems cited were (1) incompatibility between the needs of the blind and those of handicapped persons in wheelchairs, (2) conflicting standards for utility poles, etc., and (3) minor drainage concerns.

This survey provided information on the state of the art for curb ramp standards.

Survey of Municipal Departments of Public Works in Virginia

Seventeen municipalities in Virginia with populations over 20,000 and one county were surveyed. Ten municipalities (55.6%), Hampton, Hopewell, Lynchburg, Newport News, Roanoke, Salem, Staunton, Suffolk, Virginia Beach, and Winchester, use the Virginia Department of Highways and Transportation standard. Seven municipalities and one county use standards similar to the Department's (see Table 4). The diagonal ramp is the primary type used. Two municipalities base their ramp slope on the Code of Virginia, that is, 5.0% slope (20:1), whereas all others use an 8.33% slope (12:1). Flare lengths range from 2 ft. (0.61m) to 6 ft. (1.83m). Only two standards did not have a lip.

Minor differences from the Department's standards include the addition of a mid-block design and design variations based on the curb radius or presence of an obstruction. In general, only a few problems were cited. The most common problems were (1) conflicting standards for utility poles, mailboxes, hydrants, etc., (2) enforcement of quality control during construction, and (3) curb ramp usage by bicycles and motor vehicles. It is noted that one point of controversy is whether or not bicyclists should be encouraged to use curb ramps.

This survey obtained information on the variations in curb ramp standards and curb ramp experiences by departments of public works throughout the state.

As a follow-up to the survey, interviews were conducted with public works engineers for the cities of Charlottesville and Richmond to obtain information on the planning, design, and construction of curb ramps. Additionally, other engineers were contacted for information on the standard location of possible obstructions and the need for a lip.

Concerns of Public Works Engineers

William G. Eley, city engineer for Charlottesville, and Garland Roberts, city administrator of streets and sewers for Richmond, were interviewed. Additional information on signal pole placement and drainage was provided by other engineers.

Table 4. Summary From Survey of Virginia Municipalities

	Alexandria	Arlington Co.	Charlottesville	Chesapeake	Norfolk	Petersburg	Portsmouth	Richmond
Types of Ramps	diagonal	diagonal	diagonal	diagonal	diagonal	1. diagonal 2. parallel	1. diagonal 2. parallel	diagonal
Ramp Slope	12:1; min. 8:1	12:1	20:1	12:1	20:1	12:1	12:1	12:1
Ramp Width (ft.)	4; min. 3	4	4	4	min. 3	4	4	4
Flare Width (ft.)	6; min. 4	6		4	5	2	6	1.5
Lip (in.)	1/2 ± 1/8	1/2	none; asphalt wedge	1/2	1/2	1/2	none	1/2
Surface Texture		rough broom finish		non-skid finish	coarse broom	brick in downtown area		broom finish
Located Within Crosswalk	midblock crossings; jogged intersections			not behind vehicle stop line				
Adapt Ramp to Site						slight offset	parallel ramp; curb ramp for unpaved curb radii	
Dealing with Obstructions					alternatives with obstructions placed to the right	slight offset		
Type of Guideline	standard	standard	state code	standard		standard	standard	standard
Other	landing area provided when available						design variations based on the corner radius	

1.0 ft. = 0.305 m
1.0 in. = 2.54 cm

NOTE: The VDH&T standard is used by Hampton, Hopewell, Lynchburg, Newport News, Roanoke, Salem, Staunton, Suffolk, Virginia Beach, and Winchester.

Charlottesville

Curb ramps are constructed as part of new construction projects and community development requests. Sidewalk widths are an average of 5 ft. (1.64 m), except in the central business district, where they are 10 ft. (3.05 m). There is no standard curb radius but 10 ft. (3.05 m) is most common. An 8-in. (20.3-cm) curb is constructed on new sidewalks and an asphalt wedge is used to eliminate the 2-in. lip on a curb cut ramp with a slope 12:1 (see Figure 1). The 8-in. (20.3-cm) curb permits one resurfacing of the pavement while retaining a 6-in. (15.2-cm) curb.

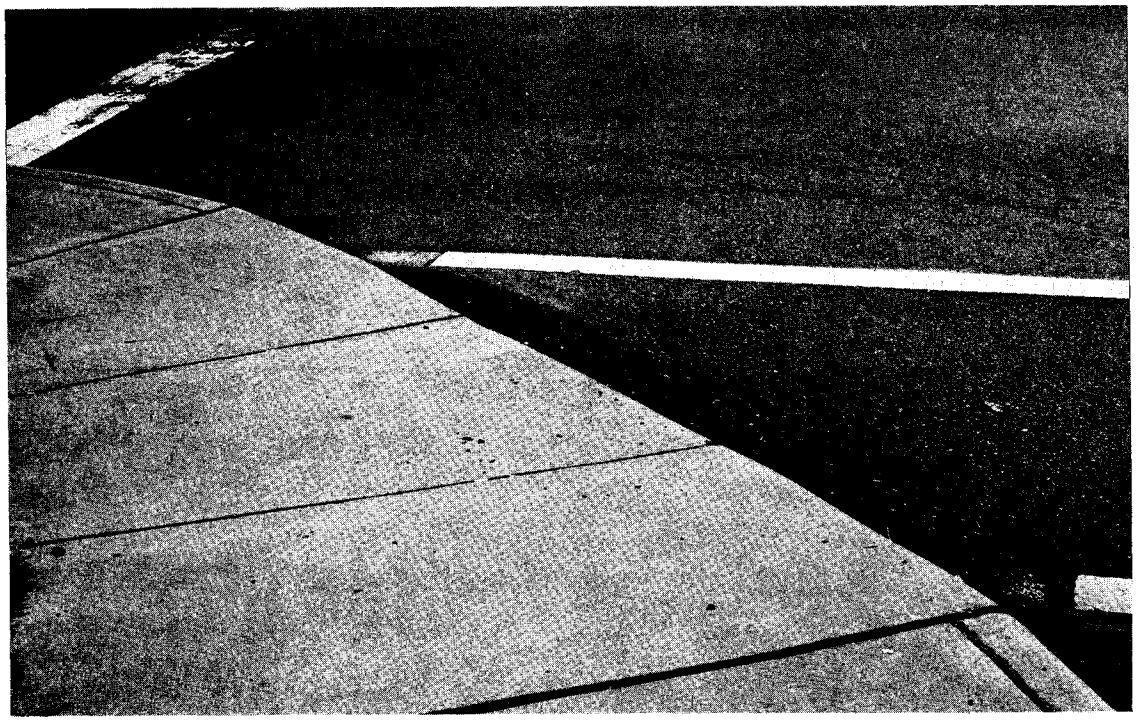


Figure 1. Curb ramp with an asphalt wedge.

Richmond

Requests for curb ramps are made by agencies or persons and the ramps are funded through miscellaneous accounts. The majority of requests are from agencies. Curb ramps are installed as part of any sidewalk project in the downtown area. If funds are available, matching ramps are provided. When curb ramps are offset due to an obstruction, they are offset in the direction of the heaviest pedestrian movement.

When a request for curb ramps is made by an individual, his needs for the ramps are determined by investigating his physical disability and primary routes of travel. Yellow pavement markings are used at some ramps to provide detectability for motorists at night and to provide partially blind persons with color contrast. The pavement marking tape is replaced every 5 to 10 years.

In older areas with granite curbs and brick sidewalks, it is desirable to maintain these. A short built-up asphalt ramp with a drain pipe inserted underneath in the gutter is used. Periodic maintenance is required on this rarely used design.

Cost of Curb Ramp Construction

The cost of a curb ramp ranges from $90 to $125 for new concrete construction (same as the cost of the sidewalk) and $200 to $250 for new brick construction. It costs about $250 to remove the curb and sidewalk and replace them with a curb ramp. Both cities have inspectors to check for quality control. Charlottesville has no standard tolerance level, whereas Richmond uses a slope of 5:1 as the maximum acceptable.

Signal Pole, Utility Pole, and Drop Inlet Placement

The placement of signal poles suggested by the Virginia Department of Highways and Transportation is behind the sidewalk.[11] However, right-of-way limitations or other restraints may necessitate placement on the sidewalk. The positions for sign assemblies are more flexible than those for signal poles.

Municipalities commonly locate utility poles and drop inlets near the end of curb returns for convenience, but there is no standard location.

No Lip for Wheelchair Users versus A Lip for Drainage

When curb ramps were originally introduced, a $\frac{1}{2}$-in. (1.27-cm) lip was accepted as a compromise between a 1-in. (2.54-cm) lip to maintain drainage and no lip to avoid an obstacle for wheelchair users.[12] Additionally, a lip was provided for physical delineation for the blind (this is discussed in the next section). In the survey of state DOTs and urban areas, no drainage problems were noted by the eleven respondents that did not employ a lip. The consensus was that a small lip did not make much of a difference in the drainage situation. Some additional water and debris may accumulate without a lip, but not enough to be considered as a problem. Moreover, the purpose of the curb ramps is to provide accessibility to the handicapped, and wheelchair users benefit greatly by 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 sidewalks for travel than during other seasons. In areas where there is a low velocity on the runoff water, water and debris would 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 maintain drainage.

INVENTORY OF CURB RAMPS

Fifteen areas were selected for the inventory with the purpose of identifying effective and ineffective design and placement conditions. Additionally, the scope of the problem of curb ramp design and placement was defined. Fourteen areas were selected from the municipalities and county surveyed, and Fairfax City and County were added as one area. The inventory focused on locations where curb ramps were expected such as central business districts, public buildings, and residential areas where curb and gutter or sidewalk projects were recently completed. Over 200 sites were reviewed and 124 were documented in the inventory.

The inventory consisted of the following steps:

a. Sketch the intersection or mid-block site including all objects (such as utility poles, drop inlets, trash cans, fire hydrants, and crosswalk markings) near the curb ramp

b. Measure the width of the sidewalk and the dimensions of the curb ramp

c. Measure the distance from the curb ramp to the obstructions, if any are present

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 1/2 in. (1.27 cm) and a wide range in lip heights (see Figure 2)

3. Slight problems with obstruction by utility posts and manhole or conduit covers

4. Ramps offset from the diagonal (or middle of the curb return) with no apparent reason

5. No median breaks for ramp users or divided highways (Figure 2)

6. Steep flare and ramp slopes

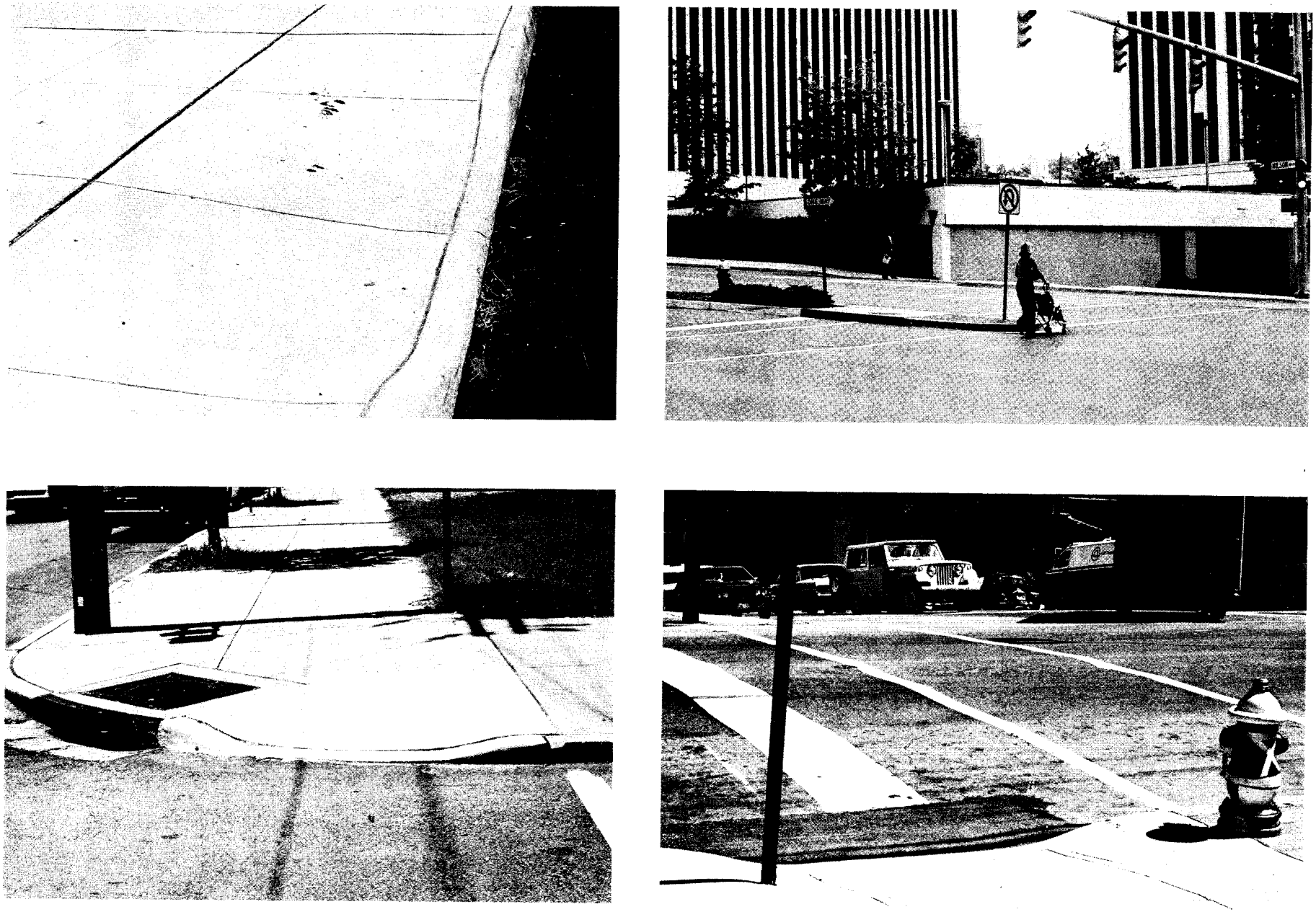


Figure 2. Curb ramp design and placement problems. Upper left, high lips; upper right, no median break; lower left, drainage affecting placement; and lower right, ramps located out of crosswalks.

7. Presence of drainage structures (i.e. drop inlets) affecting curb ramp placement (Figure 2)

8. Curb ramps located outside of marked crosswalks (Figure 2)

9. Absence of a clearance area (level area) above ramps for turning by wheelchair users

10. Parked vehicles blocking the curb ramps

There appeared to be no distinctions between the curb ramp treatments in rural municipalities and urban municipalities. Urban municipalities generally have wider sidewalks. The width of sidewalks varied greatly from 4 ft. (1.22 m) in residential areas to 20 ft. (6.1 m) in large central business districts. Many residential areas had sidewalks on only one side of the street.

Problems 2, 4, and 6 can be eliminated to a large degree by enforcing quality control in the construction of curb ramps. The remaining ones are related to standards and policy regarding curb ramps and will be addressed in the guidelines.

INTERVIEWS ON CURB RAMPS

The objective of the interviews was to determine the needs and problems of the handicapped as curb ramp users. The interviews are grouped as concerns of the visually handicapped and the physically handicapped.

Concerns of the Visually Handicapped

Virginia Rehabilitation Center for the Blind (VRCB)

At the VRCB, an interview was conducted with the director of mobility training, Marge Owens. Information was also obtained from two instructors during observations of training classes.

Of the more than 12,500 legally blind persons in Virginia, roughly 50% are over 65 years old, 15% are under 16 years old, and 35% (about 4,200) are independently mobile (i.e. travel unescorted). Depth perception deteriorates with age. Consequently, the elderly (persons over 65 years old) generally dislike the use of curb ramps. The three classes of blindness are the totally blind and the low and high partial blindness (based on the degree of partial vision). [10] A person with 20/200 corrected vision or worse is classified as legally blind.

Ms. Owens preferred the parallel offset placement of curb ramps to diagonal placement, because the flares of diagonal curb ramps tend to be located in the path of pedestrians. The major cues that indicate to a blind person that he is

coming to the end of the sidewalk are the curb, curb ramp slope and lip, traffic noise, time-distance relationships from familiarity with the pedestrian network, and a textured surface or a color contrast. Unless a blind person has neuropathy (a degenerative nervous system), he should be able to detect the slope of a curb ramp. The small percentage of blind persons that do have neuropathy generally use laser canes. The seeing eye dogs are trained to stop at hazards such as a curb but a curb ramp is not considered a hazard. Blind persons using guide dogs must detect the curb and stop.

The major problem is the lack of consistency and uniformity in the placement of curb ramps. A blind person may become confused and disoriented when a curb ramp is unexpectedly detected. The uniform and consistent placement of curb ramps is very beneficial to the blind.

Concerns of the Physically Handicapped

Woodrow Wilson Rehabilitation Center (WWRC)

The director of special services of the WWRC, Marianne Cashatt, was interviewed. Mrs. Cashatt, who is confined to a wheelchair, conducts accessibility surveys and technical services. The major problems with curb ramps for wheelchair-confined persons is the 1/2-in. (1.27-cm) lip. The lip appears as an obstacle by making it difficult to move up a curb ramp from the street. Moreover, as mentioned in the inventory, matching curb ramps (curb ramps at all crossing paths) are desired. Persons confined to a wheelchair find it degrading to ask for assistance. The use of driveways as curb ramps is not recommended because (1) it is hazardous if moving vehicles are on the ramp, (2) the access may be blocked by a parked vehicle, and (3) it may be necessary to travel some distance in the street outside of the crosswalk. Surfaces such as cobblestone and brick are not desired because of the constant bumping experienced as a wheelchair crosses over them. No conditions were defined for prohibiting the installation of curb ramps. If an able-bodied pedestrian can walk on a sidewalk, then a curb ramp should be installed. Some wheelchair users move faster than able-bodied pedestrians. In order to use the pedestrian network, a wheelchair user should not have to violate the state code article on protection for pedestrians [13] by traveling in the street when curb ramps do not exist or are ineffective.

A mobility training (part of physical therapy) session was observed at the WWRC. Total self-independence was stressed. Wheelchair-confined persons practiced mounting simulated curb heights of 2, 4, and 6 in. (5.1, 10.2, and 15.2 cm). A wheelie, a position in which the wheelchair is balanced on the large rear wheels, was the recommended position for accelerating up to and over the curb. Advanced wheelchair mobility is strongly encouraged. Weight lifting is done to build upper body strength. A 1/2-in. (1.27-cm) lip is no obstacle to advanced mobility persons. However, older people are less

inclined to be very active or mobile; therefore, the lip is still an obstacle.

An Activist for the Rights of the Handicapped

Peggy Bendrick has been active in the cause for rights of the handicapped for 11 years. She has been confined to a wheelchair for 16 years due to a spinal cord injury received in an accident. Mrs. Bendrick and the author toured part of downtown Richmond near the state office buildings, where she pointed out accessibility problems for the physically handicapped in buildings as well as at curb ramps. Mrs. Bendrick stated that (1) the diagonal location was the best possible and least costly, (2) obstructions were not a major problem, (3) problems with lip height can be minimized with quality control, (4) an 8:1 flare slope is too steep for crossing in a wheelchair, (5) a 5-ft. clearance area is desired above the ramp, and (6) some sidewalks are not usable by wheelchair users because of the steep slope.

CONSIDERATIONS FOR THE VISUALLY HANDICAPPED

The Traffic Research Advisory Committee's study found conflicts between providing curb ramps for the physically handicapped and providing directional cues for the visually handicapped at the ramps. This conflict was also mentioned by representatives from the VRCB and WWRC. In order to gain further insight into the directional needs of blind persons, the pedestrian training techniques for the blind were reviewed. "The two principal cane techniques are the touch technique, where the cane arcs from side to side and touches points outside both shoulders, and the diagonal technique, where the cane is held in a stationary position diagonally across the body with the cane tip touching or just above the ground at a point outside one shoulder and the handle or grip extending to a point outside the other shoulder. The touch technique is used primarily in uncontrolled areas, while the diagonal technique is used primarily in certain limited, controlled, and familiar environments. Cane users are often trained to use both techniques." [7] These techniques are effective in identifying hazardous objects in the path of the cane user. The touch technique is especially important since it is used in uncontrolled (unfamiliar) areas. By using the touch technique a blind person may detect the change in sidewalk slope on the curb ramp with the cane before detecting the slope by sensing the change physically. This detection would occur before the lip is reached, if the person is going down a curb ramp. In traversing up a curb ramp, the lip would be detected first only if the cane's position is low enough to detect it.

Guide dogs are trained to recognize and avoid hazards such as a curb. A curb ramp is not defined as a hazard; therefore, a blind person using the guide dog must detect the slope of the curb ramp if he is to stop before entering the street.

Many blind persons do not use an aid for walking, but depend upon their familiarity with the travel path along with auditory cues, and limited vision if they are not totally blind.

Curb Ramp Lip

In a telephone conversation with the assistant executive director of the Braille Institute of America , the need for a $\frac{1}{2}$-in. (1.27-cm) lip as an aid for the blind was discussed. The Braille Institute of America endorsed the use of a $\frac{1}{2}$-in. (1.27-cm) lip to aid cane users in identifying curb ramps based on the observation of orientation and mobility instructors. The instructors also noted that some blind persons become disoriented when they step on the curb ramp.

In a laboratory study conducted by Templer, the majority of blind persons had little difficulty in detecting a variety of ramps with different slopes and lips.(10) The majority of the study participants accurately identified the top and bottom of the curb ramps. These results are shown in Table 5. "Providing a lip on the ramps at the bottom was shown to have more disadvantages than advantages, in that the lip becomes a trip hazard, and does not materially improve the ramp detectability." (10) The observations of blind mobility training students at the VRCB were consistent with these findings by Templer.

The elimination of the lip has no adverse impact on the visually impaired. The problem of disorientation caused by the curb ramps can be minimized with consistent placement of curb ramps and by placing flare edges parallel to the direction of pedestrian movements.

Textured Surfaces

Textured surfaces are an alternative technique by which blind persons detect curb ramps. Such surfaces have been used as tactile guide strips to aid the blind and persons with low vision in crossing hazardous or complex areas and to detect the presence of curb ramps. Among the materials used to provide textured surfaces are thermoplastics, grooved (or ruled) concrete, exposed aggregate, kushionkote (a tennis court covering), paving brick, and various types of concrete finishes. (10) Concrete finishes such as broom or wood float are commonly used to provide a nonslip or nonskid finish and not a textured surface for detection by the blind. Surfaces such as exposed aggregate and paving brick adversely affect wheelchair-confined persons. In the current Virginia Department of Highways and Transportation curb ramp standard, a nonskid finish (usually a broom finish) is required.

Also, there are two problems that prevent further consideration of textured surfaces in this study. The need for textured surfaces should be thoroughly defined and a systemwide application of textured surfaces should be recommended as opposed to textured surfaces at curb ramps only, because textured surfaces are potentially useful throughout the pedestrian network. Moreover, since textured surfaces would probably increase the construction and maintenance costs of curb ramps, the cost-effectiveness of textured surfaces should be examined.

Table 5. Ramp Detection by Visually Impaired

Ramp No.	Grade	Lip	Direction	Totally Blind			Low Partial			High Partial		
				Yes	No	%Fail	Yes	No	%Fail	Yes	No	%Fail
11	8:1	½"	up	18	0	0	5	0	0	8	0	0
2	12:1	1"	up	18	0	0	5	0	0	8	0	0
4	12:1	—	up	18	0	0	5	0	0	8	0	0
10	16:1	—	up	18	0	0	5	0	0	8	0	0
1	20:1	—	up	17	0	0	4	1	20.0	7	1	12.5
13	Mountable Curb Length 12" Curb Ht. 1 3/4"		up	13	0	0	3	0	0	6	0	0
11	8:1	½"	dn	18	0	0	4	1	20.0	7	0	0
2	12:1	1"	dn	18	0	0	5	0	0	8	0	0
4	12:1	—	dn	18	0	0	5	0	0	8	0	0
10	16:1	—	dn	17	1	5.5	5	0	0	8	0	0
1	20:1	—	dn	17	1	5.5	4	0	0	8	0	0
13	Mountable Curb Length 12" Curb Ht. 1 3/4"		dn	13	0	0	2	1	33.3	6	0	0

Source: Reference 10

Conversion factor: 1 in. = 2.54 cm

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 the curb ramps are defined in the next section.

Goals and Objectives of Curb Ramps

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

1. Provide a curb ramp design and placement that is usable by the physically handicapped.

2. Provide design and placement alternatives for a range of sidewalk and street conditions.

3. Provide a minimal impact to able-bodied pedestrians.

4. Place curb ramps in uniform and consistent locations.

5. Provide curb ramps without a lip and 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 notes are included in this section.

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 and bituminous concrete are the only materials referenced in the Road and Bridge Specifications for curbs and sidewalks.[14] 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 mid-block location to establish a continuous network for the ramp users. If curb ramps are not placed at all corners of an intersection, then the curb ramp user's accessibility is restricted to the paths connecting curb 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 curb ramp location 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 [2] and Section 228 of the Highway Safety Act of 1973, [16] 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 present a potential hazard for handicapped persons due to the rough terrain. 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 judgement is recommended.

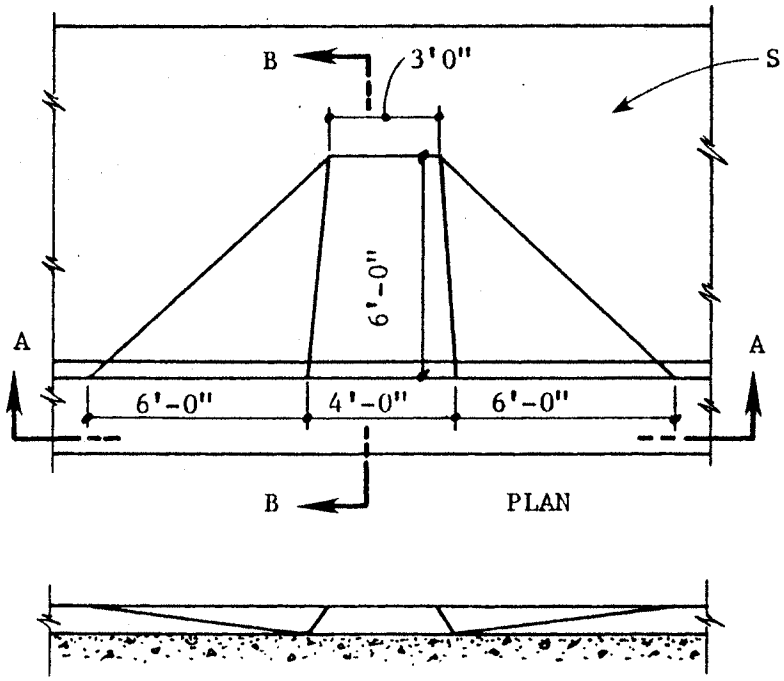
Design of Curb Ramps

Three standard curb ramp designs were developed; two to accommodate different sidewalk widths for middle of the curb return and one to accommodate parallel curb ramps. The designs are based on a curb height of 6 in. (15.2 cm).

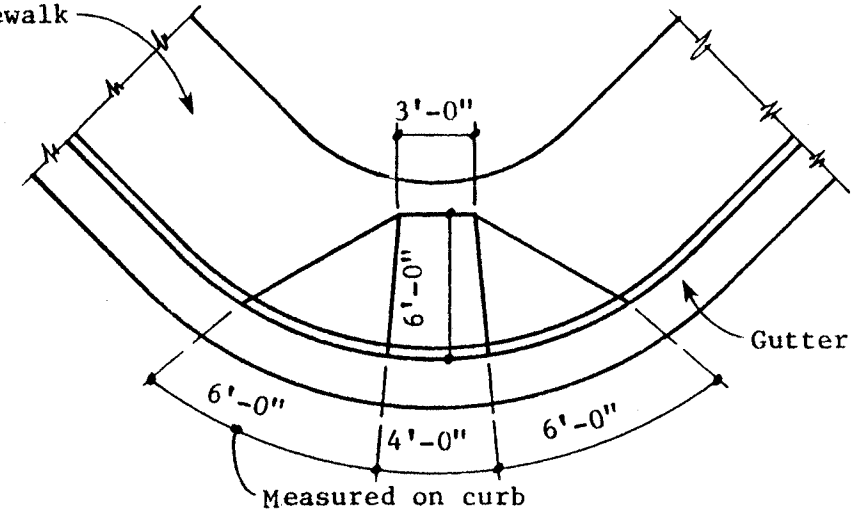
Design Note 1. Except at certain locations as defined later, curb ramps shall be located on the middle of the curb return (also called the diagonal). The location on the middle of the curb return provides the minimal potential for conflicts with obstacles such as utility poles, signal poles, etc. Also, this location maintains consistency with the existing curb ramps in Virginia.

Design Note 2. The curb ramps shall have no lip with a + 1/8-in. (0.32-cm) tolerance. The elimination of the $\frac{1}{2}$-in. (1.27-cm) lip is beneficial to wheelchair users without adversely affecting the blind pedestrian or drainage.

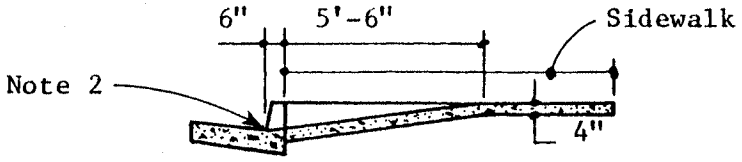
Figure 3 displays the standard curb ramp design for sidewalk widths greater than 8 ft. (2.44 m). The slope of the flares is equal to the slope of the ramp, 12:1, to permit ramp users to turn left or right by traversing the flares. If use of the flare is obstructed by poles, an unpaved area, or other items, a slope of 8:1 is acceptable. This discourages the curb ramp user from approaching the obstruction. The ramp is tapered from 4 ft. (1.22 m) at the bottom to 3 ft. (.92 m) at the top. [9] By having the flare sides parallel to pedestrian paths, fewer able-bodied and blind pedestrians would cross the flares.



SECTION AA



RADIAL PLAN



SECTION BB

NOTES

1. Flares will have a slope of 12:1 unless a flare is obstructed by poles or an unpaved area (refer to Figure 6).

2. No lip with a + 1/8-inch tolerance.

Figure 3. Standard design for sidewalk widths greater than 8 feet.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.

The standard design for sidewalk widths less than or equal to 8 ft. (2.44 m) is shown in Figure 4. The flares and ramp will have a slope of 10:1 unless a flare is obstructed, in which case the slope of the obstructed flare is 8:1. Many sidewalks in residential areas are 5 ft. (1.53 m) wide and are not able to accommodate a 6 ft. (1.83 m) long ramp. Figures 3 and 4 are similar except for the slope of the flares and ramp.

The standard design for parallel curb ramps is shown in Figure 5. This curb ramp is used where the ramp is placed parallel to pedestrian paths in locations such as jogged and T intersections, mid-block crossings, and medians. The design dimensions are similar to the dimensions for Figures 3 and 4 in that they are based on sidewalk width. A flare that is obstructed has a slope of 8:1. Also displayed in Figure 5 is the design to be used when the middle of the curb return is unpaved on sidewalks less than 6 ft. (1.8 m) wide.(17)

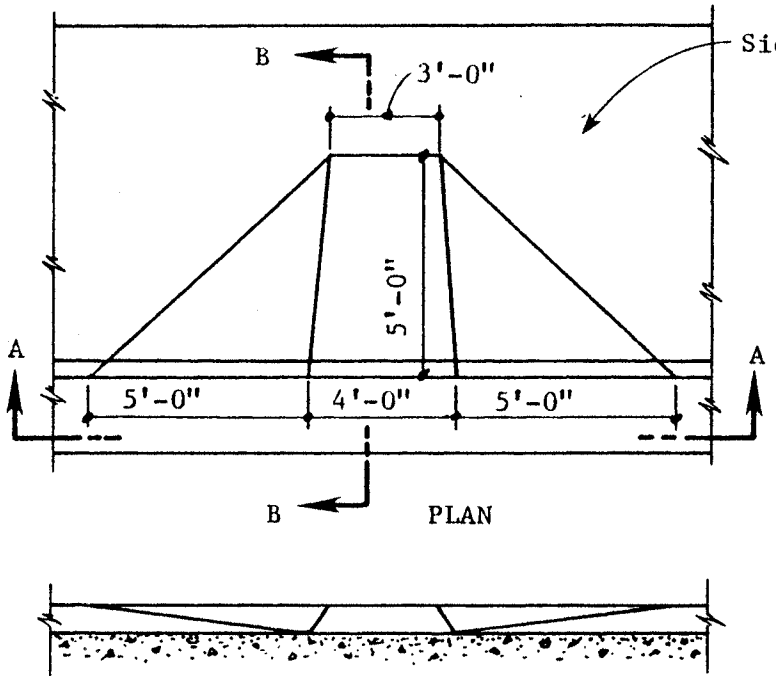
Placement of Curb Ramps

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.

Figure 6 displays three placement situations relative to obstructions. The objective of placement relative to obstructions is to maintain consistent and effective placement. For obstructions located 0 to 6 ft. (0 to 1.8 m) from the middle of the curb return, placement is illustrated in Figure 6a. It is assumed that the majority of curb ramp users travel in the directions as the majority of pedestrians. When the obstruction is located 6 to 10 ft. (1.8 to 3.0 m) from the middle of the curb return, the side opposite to the obstruction is the optimal location for the curb ramp. Both Figures 6a and 6b have an 8:1 slope for the flare closest to the obstruction. The curb ramp placement when a drop inlet is located 0 to 6 ft. (0 to 1.8 m) from the middle of the curb return depends on the curb radius (Figure 6c). For a radius greater than 20 ft. (6.1 m), two parallel ramps are used. The parking restriction accompanying parallel ramps increases the visibility of curb ramp users to motorists.

Curb ramp placement in conjunction with crosswalks is shown in Figure 7. 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 employed to guide pedestrians in the proper paths and are often used where there is substantial conflict between vehicle and pedestrian movements.(15) Curb ramp users deserve the same benefits of crosswalks as other pedestrians.

For ramps located on the middle of the curb return, a minimum of 2 ft. (0.61 m) 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.(8) A 4-ft. (1.22-m) clearance space shall be located within the crosswalk.(8) Both of these items are displayed in Figure 7a. The locations of parallel curb ramps relative to crosswalks are shown in Figure 7b.



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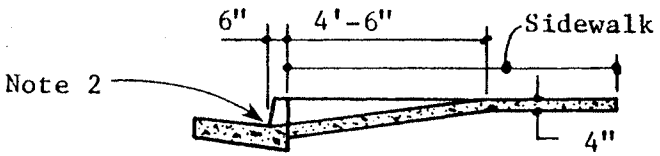

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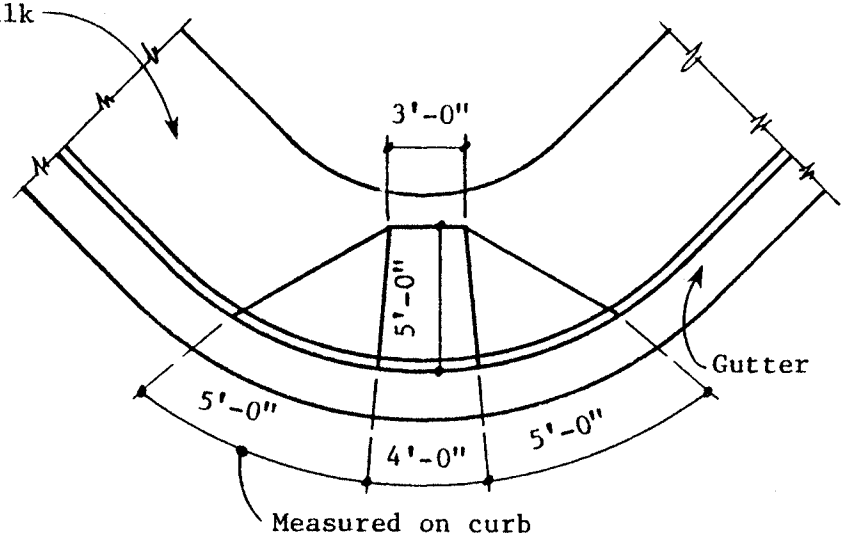


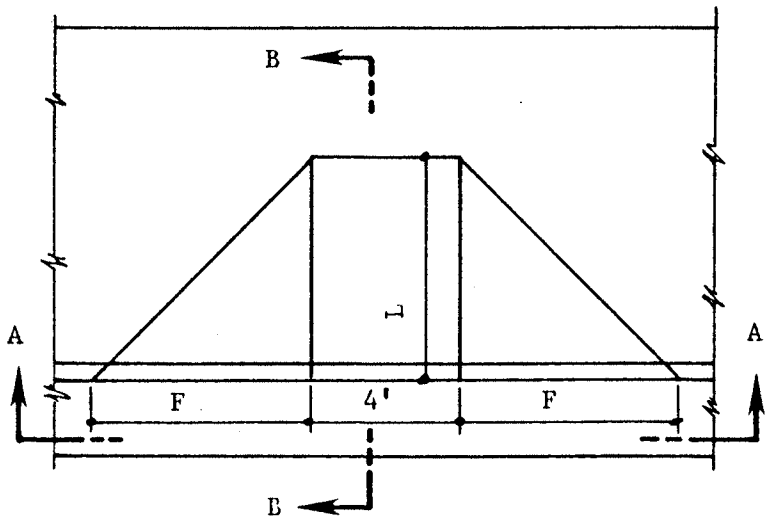
RADIAL PLAN

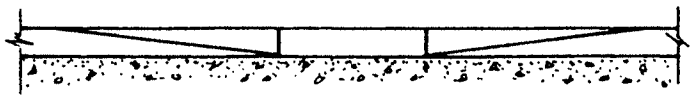
NOTES

1. Flares and ramp will have a 10:1 slope. If a flare is obstructed by a pole or unpaved area, use a maximum slope of 8:1 (a 4 ft. wide flare).

2. No lip with a + 1/8-inch tolerance.

Figure 4. Standard design for sidewalk widths less than or equal to 8 feet.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.





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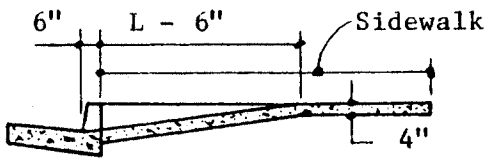


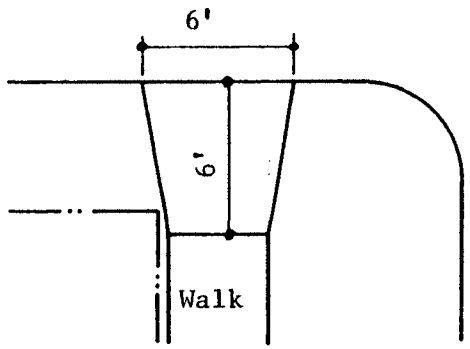
SECTION BB

This curb ramp is used for jogged and T intersections, medians, and mid-block ramps.

The design dimensions, based on sidewalk width, are:

Sidewalk Width (ft.)	F (ft.)	L (ft.)
> 8	6	6
≤ 8	5	5

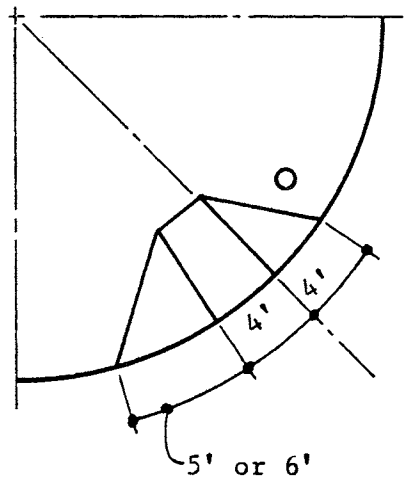
If a flare is obstructed by a pole or unpaved area, use a maximum slope of 8:1 (i.e. a 4 ft. wide flare).



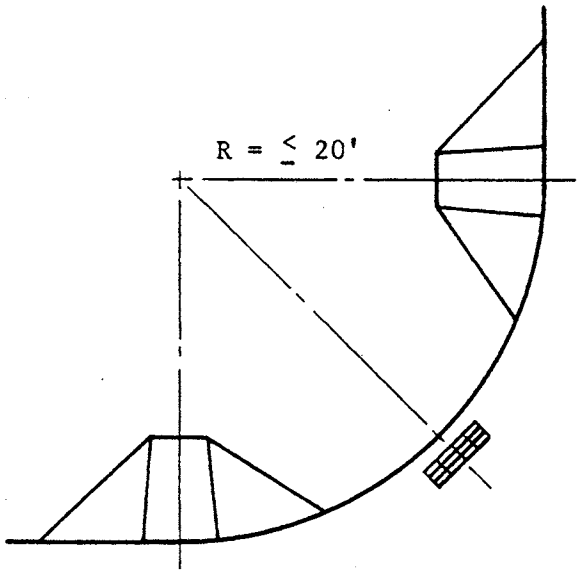
UNPAVED CURB RETURN

If the middle of the curb return is unpaved, use above ramp design.

Figure 5. Standard design for parallel curb ramp.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.



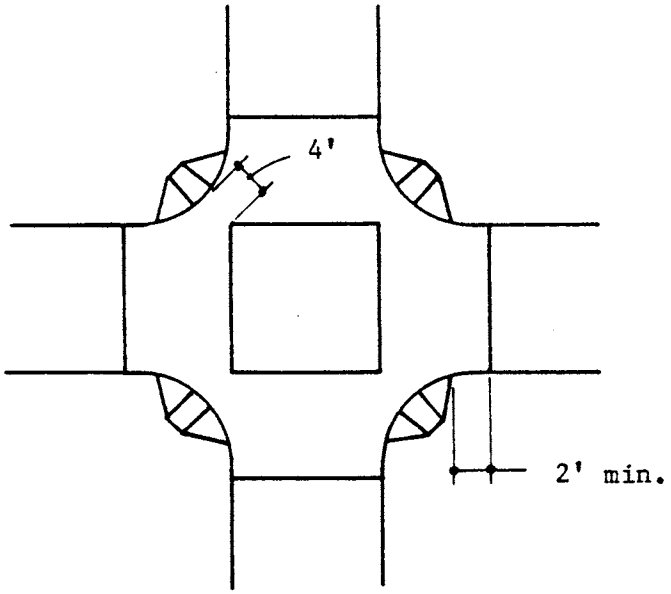
a. If the obstruction is located 0'-6' from the middle of the curb return, offset the ramp in the direction of the major pedestrian movement. The slope of the flare nearest to the obstruction should be increased to 8:1.



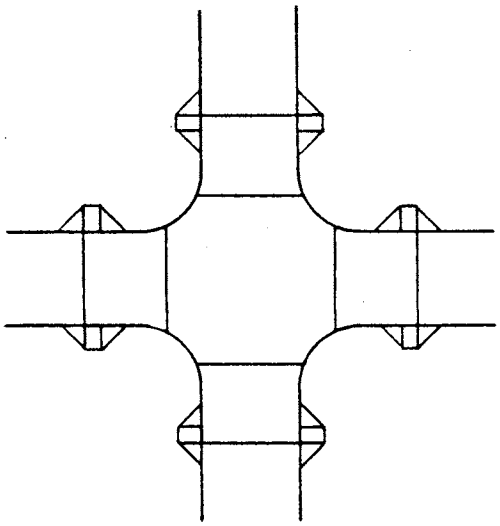
b. If a drop inlet is located 0'-6' from the middle of the curb return with a radius greater than or equal 20', parallel curb ramps should be installed. Parking should be restricted at least 10 ft. (20 ft. preferred) from the curb ramps.

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.

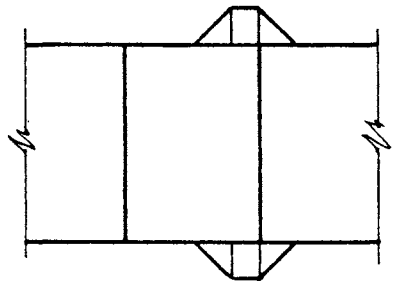
Figure 6. Placement relative to obstructions.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.



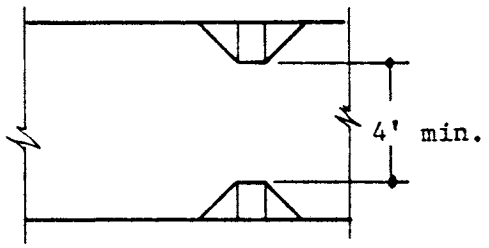
a. Middle of curb return (or diagonal) curb ramps.



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.

Figure 7. Placement in conjunction with crosswalks.
Conversion factor: 1 ft. = 0.305 m.

For crosswalks and walkways through medians less than 12 ft. (3.66 m) wide, center the curb ramp in the walk or median (Figure 7c). Otherwise, locate the curb ramp to one side with one flare outside of the crosswalk (Figure 7c). Curb ramps in a median should be at least 4 ft. (1.22 m) apart in order to provide a level section for wheelchair users. If the median is not wide enough to accommodate two curb ramps, then 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. (3.0 m), with 20 ft. (6.1 m) preferred, from the parallel curb ramps.

Curb ramp placements are presented for oblique angle intersections, multi-leg intersections, and T and jogged intersections (see Figure 8). Curb ramps on small radii may require that the corner be rounded off to obtain the 4 ft. (1.22 m) wide ramp that is required. The use of oblique angle and multi-leg intersections is discouraged since 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

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

Curb Radius— The shape of the curb ramp is influenced by the curb radius. This is displayed in Figure 9. Different curb radii are illustrated to indicate to the engineer that the shape of the curb radius is likely to be different than the shape displayed in Figures 3 and 4.

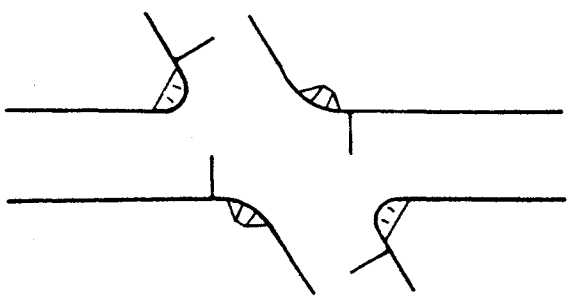
Maintenance of Curb Ramps—Where there is a low or no velocity on the storm runoff water, debris accumulates at the base of the ramp. Not much can be done cost-effectively to overcome this from a design and placement perspective. A periodic maintenance schedule that is determined by the engineer is recommended.

Curb Height— The design guidelines are based on a curb height of 6 in. (15.2 cm). In locations where 8-in. (20.3-cm) curbs are the standard, an asphalt wedge approximately 1 ft. (0.3 m) long and 7 in. (5.1 cm) high should be added to the bottom of the ramp if the sidewalk is less than 11 ft. (3.4 m) wide. Another suggestion is to have sidewalks that slope down (max 20:1) to a 6-in. (15.2-cm) curb height at the beginning of the ramp.

Repavement of Streets—Special care should be taken to ensure that the bottom of the curb ramp is not affected by repaving of the street. The city of Charlottesville employs an 8-in. (20.3-cm) curb (and an asphalt wedge on ramps) so that a 6-in. (15.2-cm) curb is retained after the street is repaved.

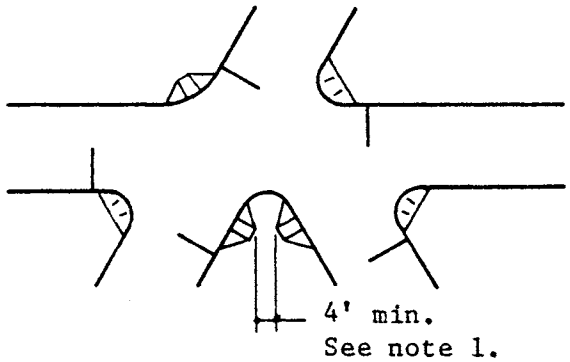
Summary

The guidelines are included in Appendix B in an adaptable form. The current



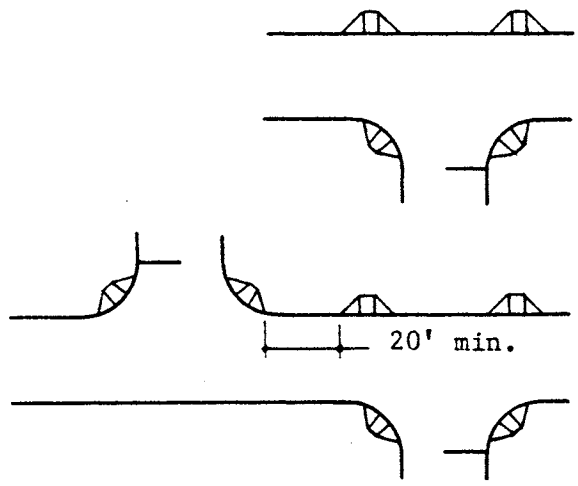
a. Oblique angle intersections.

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



b. Multi-leg 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).



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 8. Placement at intersections.
Conversion factor: 1 ft. = 0.305 m.

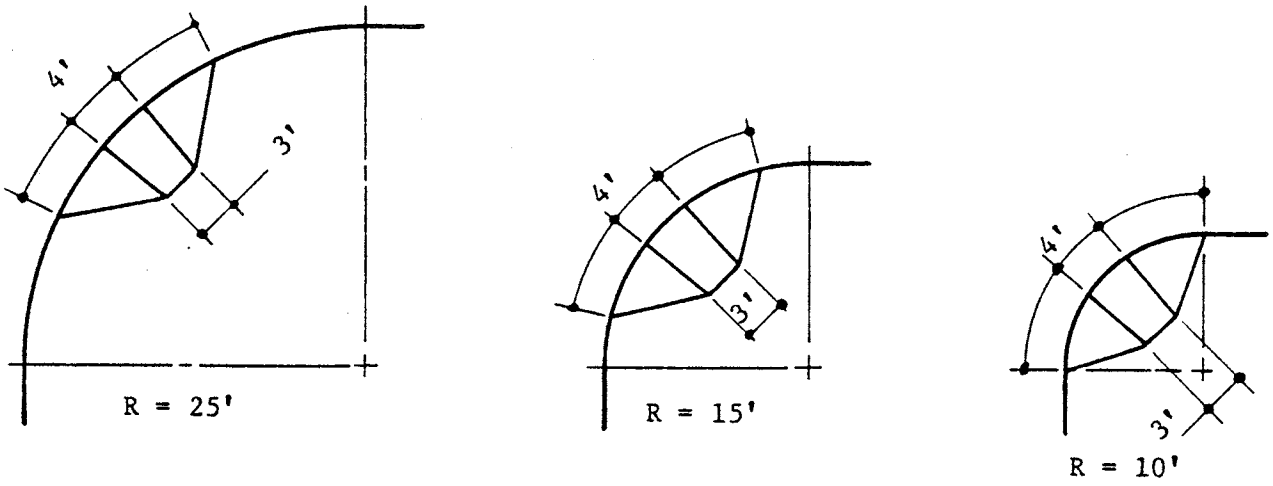


Figure 9. Curb ramps with various curb radii.
Conversion factor: 1 ft. = 0.305 m.

Virginia Department of Highways and Transportation standard is also in Appendix B. The draft guidelines were reviewed by all of the persons interviewed and the Traffic Research Advisory Committee's subcommittee on curb ramps. The general consensus was that the guidelines were comprehensive and acceptable. Some revisions were made to the draft guidelines based on their comments.

RECOMMENDATIONS

It is recommended that the guidelines developed in this study (see Appendix B) be adopted for use by the Virginia Department of Highways and Transportation as an aid in the design and placement of curb ramps.

Further, to maximize the effectiveness of the guidelines, it is recommended that Section 15.1-381 of the Code of Virginia be amended as proposed in Appendix A, and that Section 228 of the Highway Safety Act of 1973 to Federal-Aid Highways be amended to eliminate the requirement to construct curb ramps where no sidewalks are in existence.

ACKNOWLEDGEMENTS

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Marianne Cashatt—director of special services, Woodrow Wilson Rehabilitation Center

William G. Eley—city engineer of Charlottesville

Marge Owens—director of mobility training, Virginia Rehabilitation Center for the Blind

Harry E. Patterson—traffic engineer for the city of Norfolk

Garland Roberts—city administrator of streets and sewers for the city of Richmond.

The services provided by the staff of the Virginia Highway and Transportation Research Council are acknowledged, especially the drafting work by Allen Baker.

The research was financed from Highway Planning and Research Funds administered through the Federal Highway Administration.

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APPENDIX A

CURRENT AND PROPOSED SECTION 15.1-381 OF THE CODE OF VIRGINIA

SECTION 15.1-381 OF THE CODE OF VIRGINIA [1]

§15.1-381. Ramps on curbs of certain streets; specifications. - The governing bodies of every county, city and town, requiring curbs along its streets, shall require that there be constructed not less than two ramps per lineal block leading to the crosswalks at intersections for use of handicapped persons. No ramps shall be required for curbs in place on January one, nineteen hundred seventy-five or for curbs where no sidewalks are in existence; however, ramps shall be required on all replacement of such curbs or adjoining sidewalks at intersections leading to crosswalks. Such ramps, constructed after July one, nineteen hundred seventy-six, shall be at least forty-eight inches wide and have a gradient not greater than five percent, unless the difference between the sidewalk and the paved right-of-way is such as to make a five percent grade impractical, in which case the ramp shall be installed so as to adjust to the grade of the street and sidewalk. Such ramps shall be located at intersections diagonally so as to preserve curbs for use by the blind, at the crosswalk itself, where curbs exist; provided, however, this section shall not apply where finalized plans for replacement of curbs had been advertised for bid, contracts awarded and work commenced prior to June thirty, nineteen hundred seventy-five. (1974, c. 169; 1975, c. 74; 1976, c. 477)

****

The 1975 amendment added the third and fourth sentences.

The 1976 amendment inserted "or for curbs where no sidewalks are in existence" and "or adjoining sidewalks" in the second sentence, substituted "nineteen hundred seventy-six" for "nineteen hundred seventy-five" near the beginning of the third sentence and added the language beginning with "unless the difference between" at the end of the third sentence. In the fourth sentence the amendment inserted "diagonally" near the beginning of the sentence and "curbs" following "preserve," deleted "curbs" following "blind" and added the proviso.

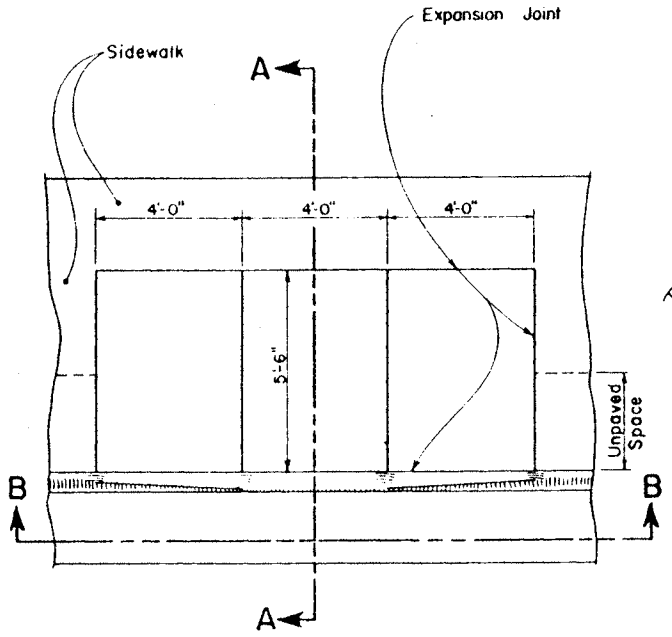
Law Review. - For survey of Virginia municipal corporations for the year 1973-1974, see 60 Va. L. Rev. 1563 (1974).

PROPOSED AMENDMENTS TO
SECTION 15.1-381 OF THE CODE OF VIRGINIA

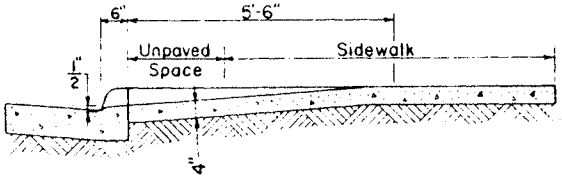
§15.1-381. Ramps on curbs of certain streets; specifications. - The governing bodies of every county, city and town, requiring curbs along its streets, shall require that there be constructed at intersections curb ramps for use of handicapped persons. No ramps shall be required for curbs adjoining sidewalks in place on January one, nineteen hundred seventy-five; however, ramps shall be required on all replacement of such curbs adjoining sidewalks at intersections leading to crosswalks. Such ramps, shall comply with the standards prescribed by the Department of Highways and Transportation on Design Dimensions and Placement conditions. This section shall not apply where finalized plans for replacement of curbs had been advertised for bid, contracts awarded and work commenced prior to June thirty, nineteen hundred seventy-five. (1974, c. 169; 1975, c. 74; 1976, c. 477)

APPENDIX B
CURRENT STANDARD AND PROPOSED GUIDELINES FOR THE DESIGN AND PLACEMENT OF CURB RAMPS

CG-12

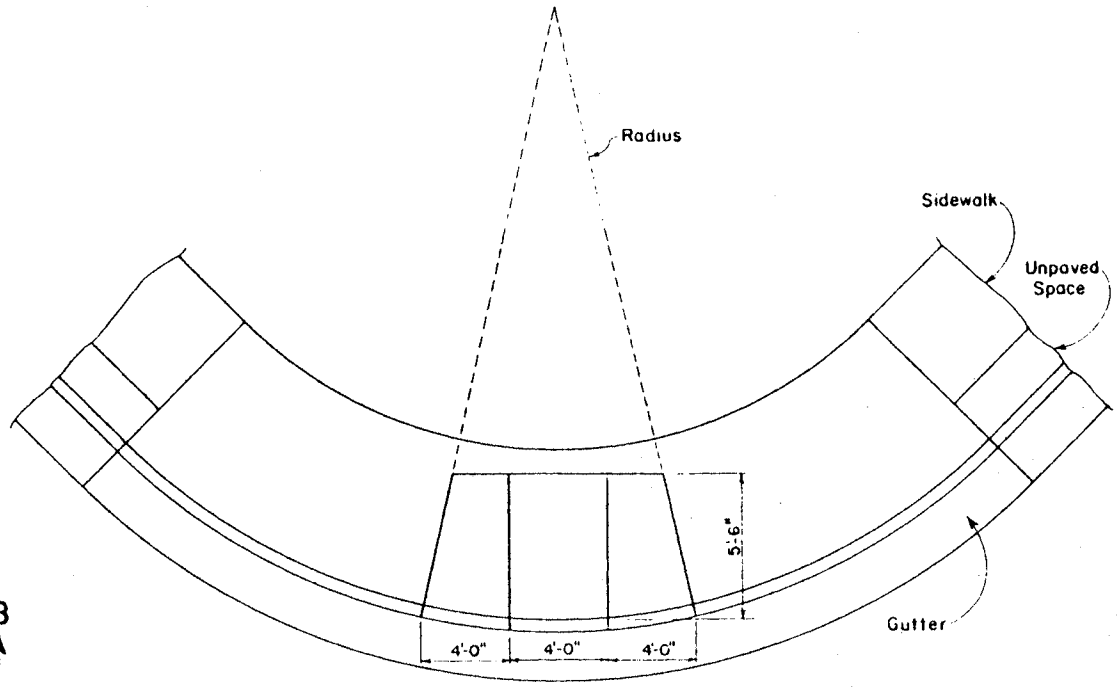


PLAN



SECTION A-A

SECTION B-B



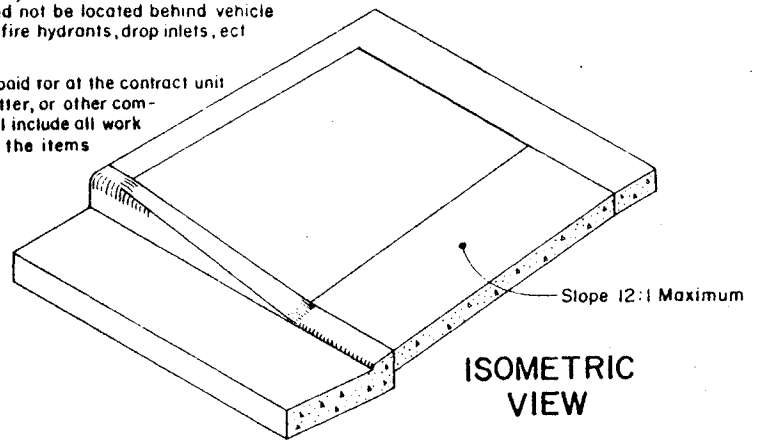
RADIAL PLAN

NOTES All concrete to be class A-3.

Ramp surface shall be constructed with a non-skid finish. Ramp shall not exceed a maximum slope of 12:1.

Curb cut ramps are to be located as shown on the plans or as directed by the Engineer. They should be offset from pedestrian crosswalks but should not be located behind vehicle stop lines. Existing light poles, fire hydrants, drop inlets, ect will also affect placement.

Cut ramps will be measured and paid for at the contract unit prices for sidewalk, curb and gutter, or other components thereof which price shall include all work necessary to shape or modify the items as required.



ISOMETRIC VIEW

CURB CUT RAMP

(FACILITY FOR PHYSICALLY HANDICAPPED)

VIRGINIA DEPARTMENT

of

SPECIFICATION REFERENCE

503
505

Figure B-1. Existing curb cut ramp standard.

GUIDELINES FOR THE DESIGN AND PLACEMENT OF CURB RAMPS

General Practices

1. Concrete ramp surfaces shall have a 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.

2. Matching curb ramps should be provided at all corners of an intersection or on both sides of a mid-block location to establish a continuous network for the ramp users.

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.

4. Curb ramps should not be constructed as part of curb projects where no sidewalks exist.

5. In situations where these guidelines are not applicable, the use of sound engineering judgement is recommended.

Design of Curb Ramps

1. Whenever possible, curb ramps shall be located on the middle of the curb return (also called the diagonal or corner).

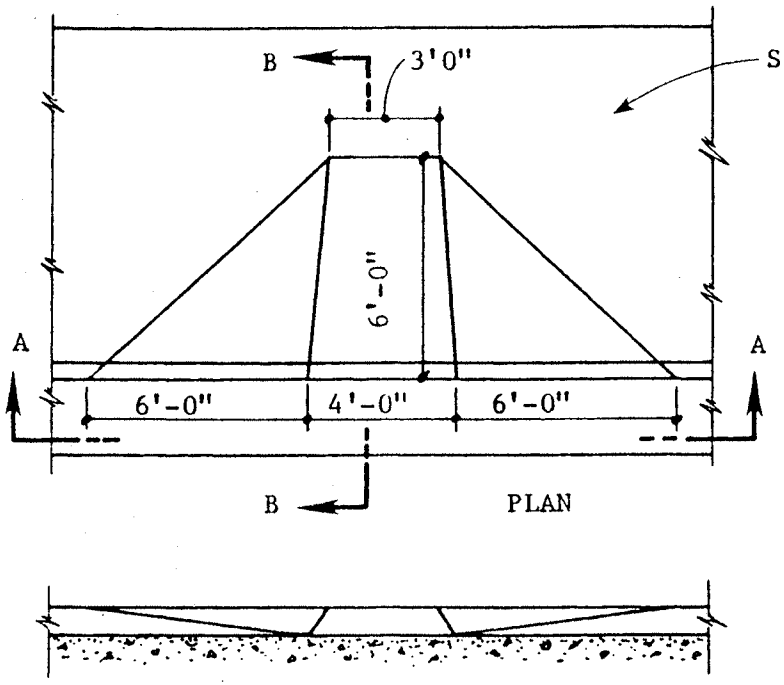
2. The curb ramps shall have no lip with a +1/8-in. (0.32-cm) tolerance.

3. The three curb ramp designs are for:

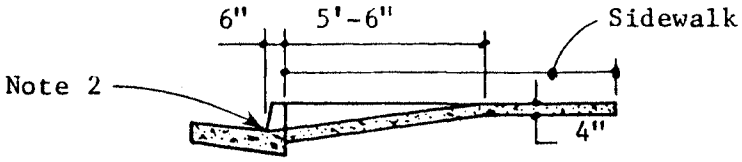
   a. Sidewalk widths greater than 8 ft. (2.44 m) (Figure B-2)

   b. Sidewalk widths less than or equal to 8 ft. (2.44 m) (Figure B-3), and

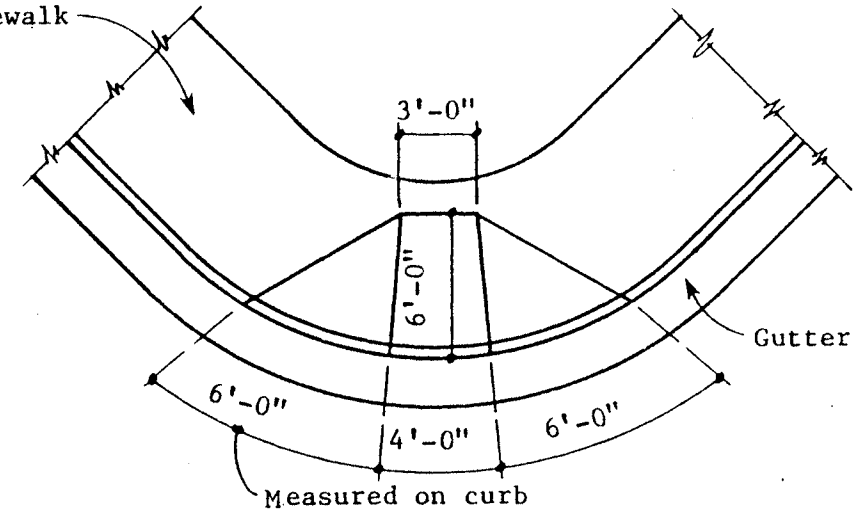
   c. Parallel curb ramps (Figure B-4)



SECTION AA



SECTION BB



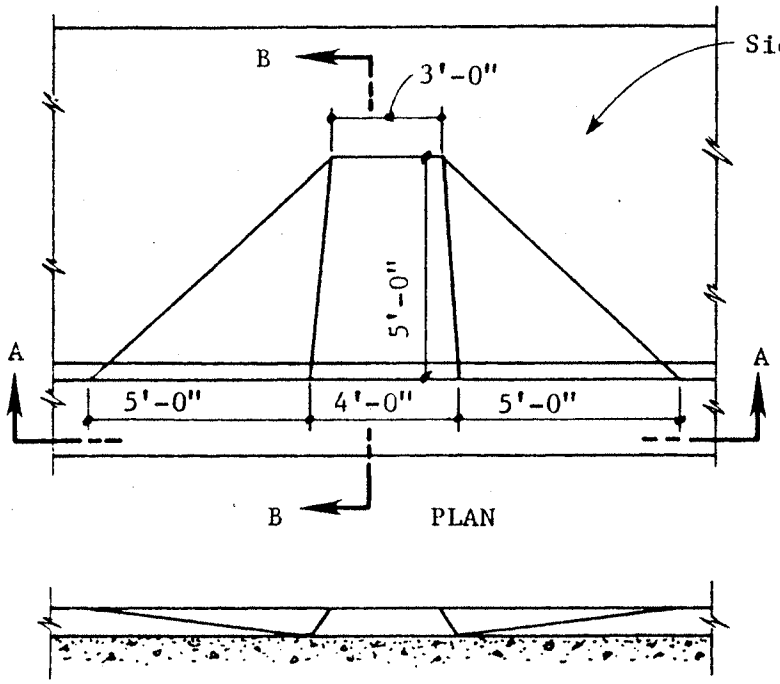
RADIAL PLAN

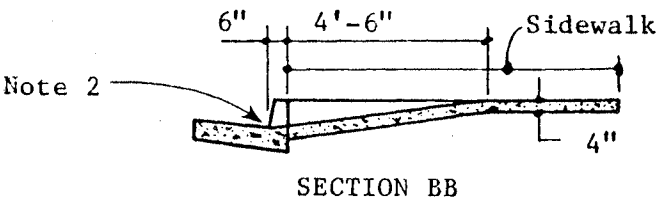
NOTES

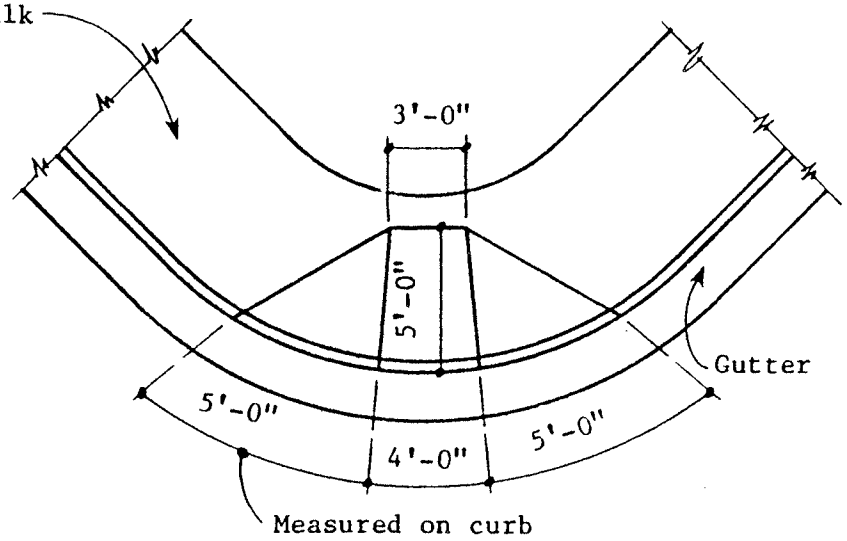
1. Flares will have a slope of 12:1 unless a flare is obstructed by poles or an unpaved area (refer to Figure 6).

2. No lip with a + 1/8-inch tolerance.

Figure B-2. Standard design for sidewalk widths greater than 8 feet.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.





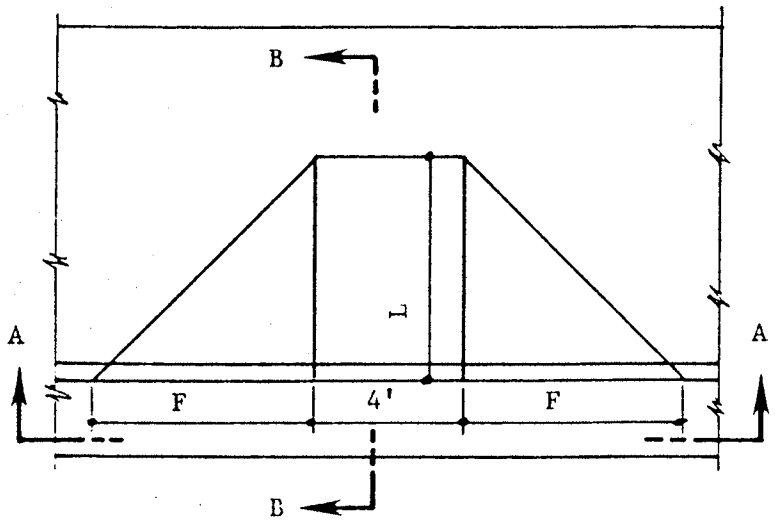


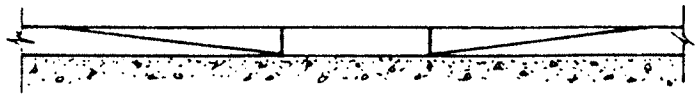
NOTES

1. Flares and ramp will have a 10:1 slope. If a flare is obstructed by a pole or unpaved area, use a maximum slope of 8:1 (a 4 ft. wide flare).

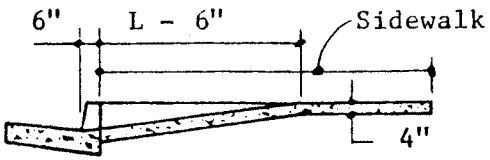
2. No lip with a + 1/8-inch tolerance.

Figure B-3. Standard design for sidewalk widths less than or equal to 8 feet.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.





SECTION AA



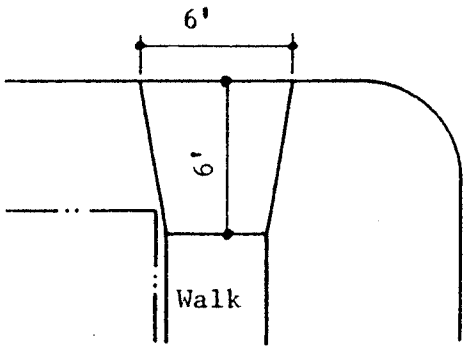
SECTION BB

This curb ramp is used for jogged and T intersections, medians, and mid-block ramps.

The design dimensions, based on sidewalk width, are:

Sidewalk Width (ft.)	F (ft.)	L (ft.)
> 8	6	6
≤ 8	5	5

If a flare is obstructed by a pole or unpaved area, use a maximum slope of 8:1 (i.e. a 4 ft. wide flare).



UNPAVED CURB RETURN

If the middle of the curb return is unpaved, use above ramp design.

Figure B-4. Standard design for parallel curb ramp.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.

Placement of Curb Ramps

1. The placement conditions of curb ramps are presented with respect to:

   a. obstructions (Figure B-5)

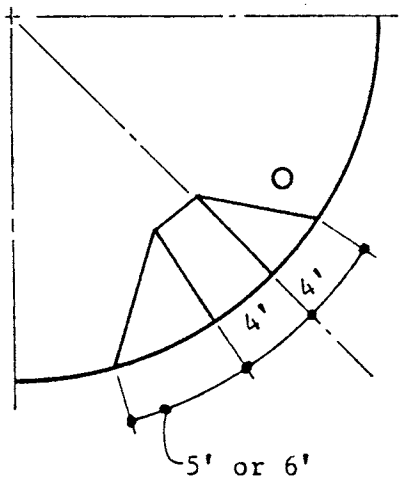
   b. crosswalks (Figure B-6), and

   c. intersections (Figure B-7)

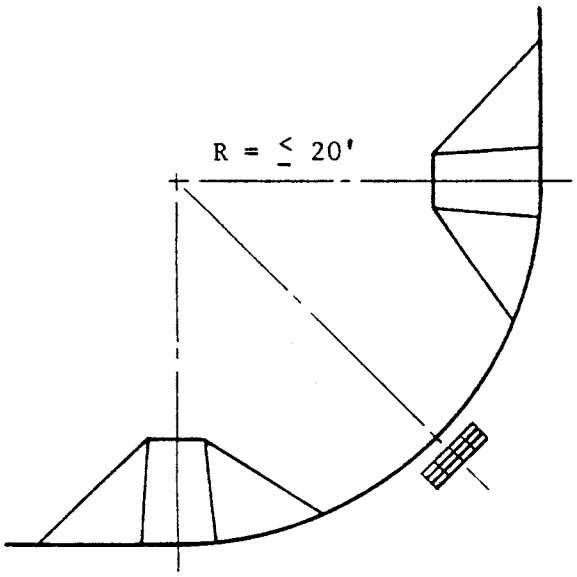
      i. oblique angle intersections

      ii. multi-leg intersections, and

      iii. T and jogged intersections



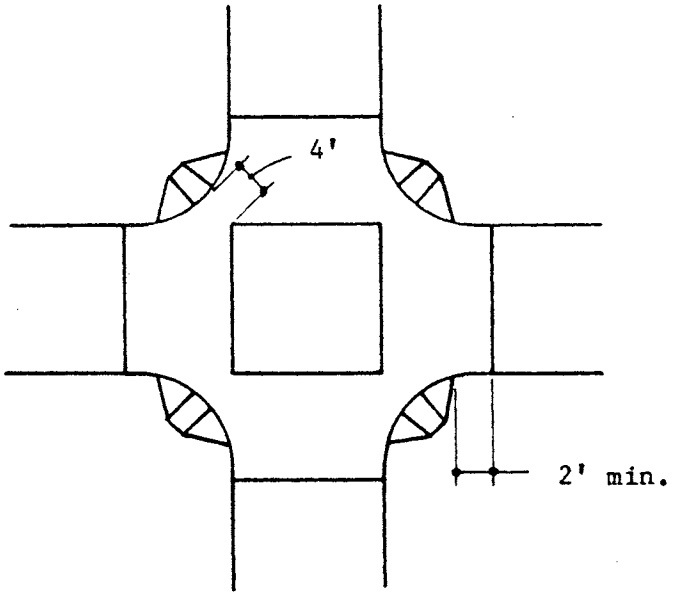
a. If the obstruction is located 0'-6' from the middle of the curb return, offset the ramp in the direction of the major pedestrian movement. The slope of the flare nearest to the obstruction should be increased to 8:1.



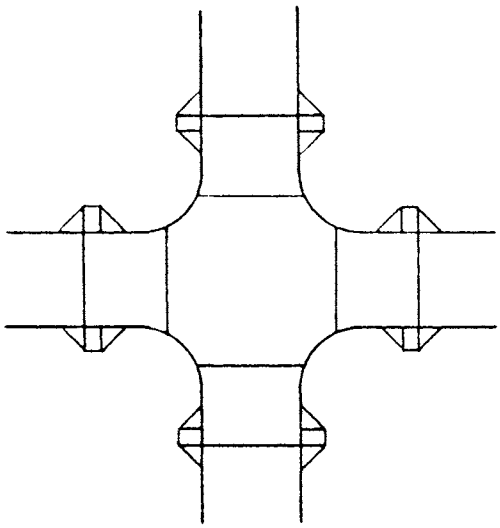
b. If a drop inlet is located 0'-6' from the middle of the curb return with a radius greater than or equal 20', parallel curb ramps should be installed. Parking should be restricte at least 10 ft. (20 ft. preferred) fron the curb ramps.

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

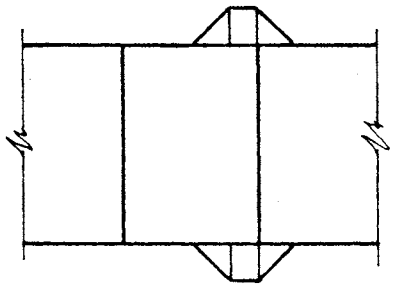
Figure B-5. Placement relative to obstructions.
Conversion factors: 1 in. = 2.54 cm.
1 ft. = 0.305 m.



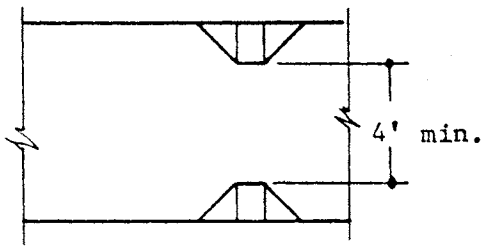
a. Middle of curb return (or diagonal) curb ramps.



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.

Figure B-6. Placement in conjunction with crosswalks.
Conversion factor: 1 ft. = 0.305 m.

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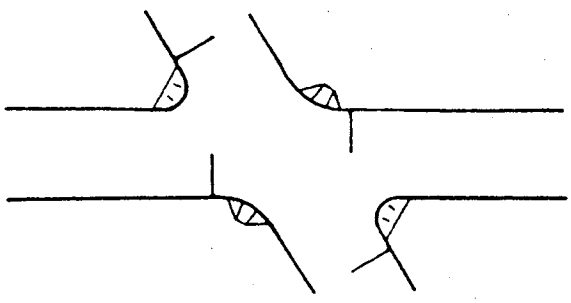
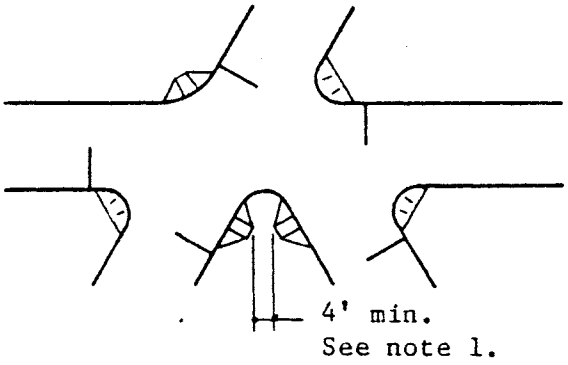


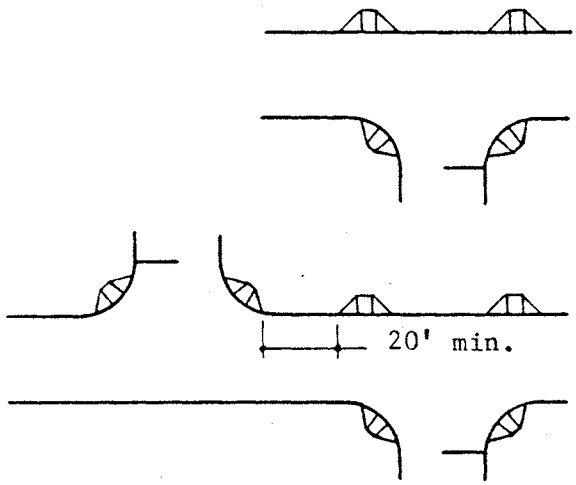
— Curb ramp dimensions may require that the corner be rounded off (4-ft. wide ramp required).

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 B-7. Placement at intersections.
Conversion factor: 1 ft. = 0.305 m.

Miscellaneous Notes

Curb Radius — The shape of the curb ramp is influenced by the curb radius. Different curb radii are illustrated in Figure B-8 to indicate that the shape of the curb radius is likely to be different than the shape displayed in Figures B-2 and B-3.

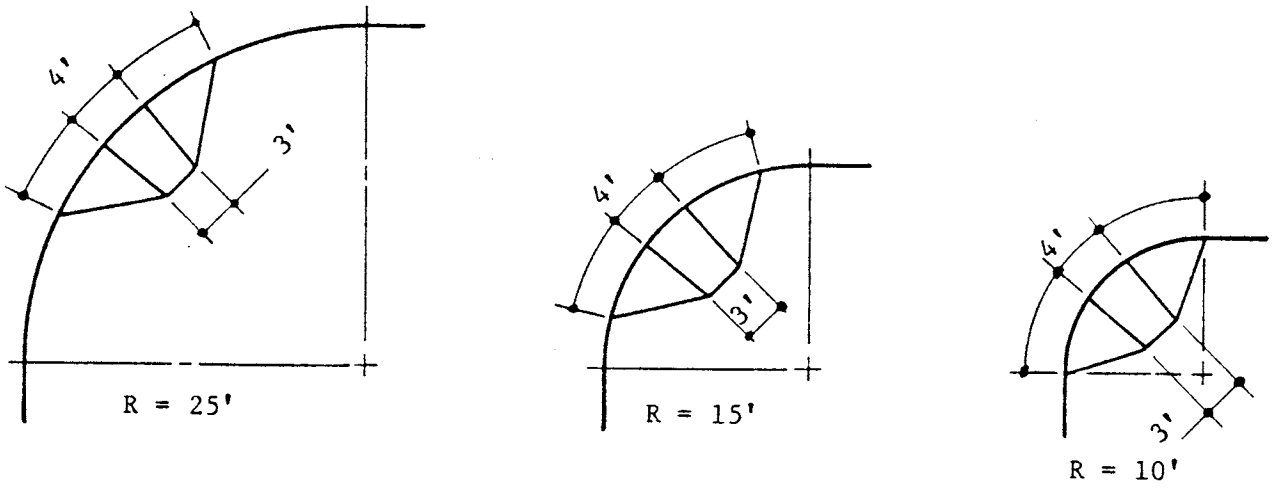


Figure B-8. Curb ramps with various curb radii.
Conversion factor: 1 ft. = 0.305 m.

Maintenance of Curb Ramps — Where there is no or a low velocity in the runoff water, debris accumulates at the base of the ramp. Not much can be done cost-effectively to overcome this from a design and placement perspective. A periodic maintenance schedule that is determined by the engineer is recommended.

Curb Height — The design guidelines are based on a curb height of 6 in. (15.2 cm). In locations where 8-in. (20.3-cm) curbs are the standard, an asphalt wedge 1 ft. (0.3 m) long and 2 in. (5.1 cm) high should be added to the bottom of the ramp if the sidewalk is less than 11 ft. (3.35 m) wide. Another suggestion is to have sidewalks that slope down (max. 20:1) to 6-in. (15.2-cm) curb height at the beginning of the ramp.

Repavement of Streets — Special care should be taken to ensure that the bottom of curb ramps are not affected by repaving of streets. The city of Charlottesville employs an 8-in. (20.3-cm) curb and an asphalt wedge on ramps so that a 6-in. (15.2-cm) curb is retained after repaving the street.