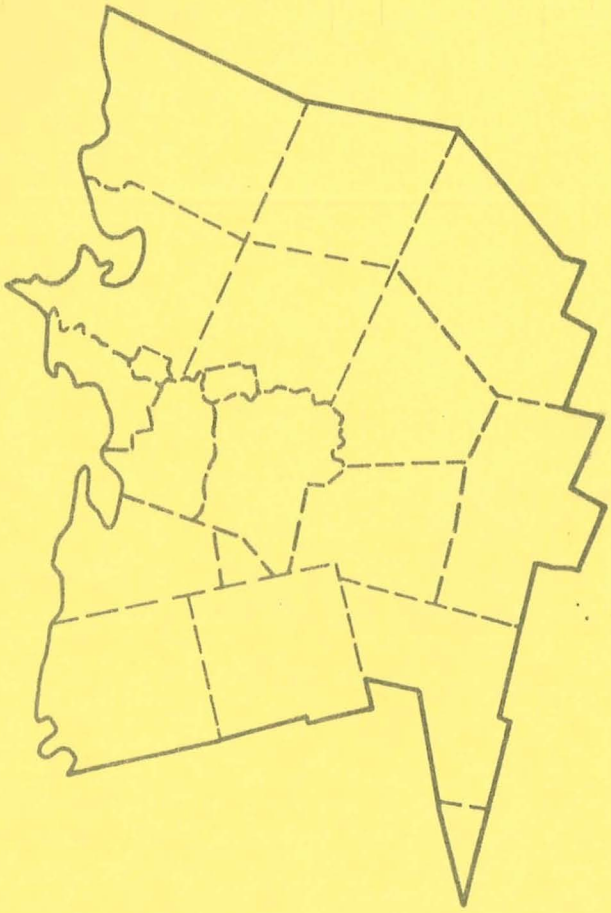
STD-90

BOLTON
BURLINGTON
CHARLOTTE
COLCHESTER
ESSEX JUNCTION
ESSEX TOWN
HINESBURG
HUNTINGTON
JERICHO
MILTON
RICHMOND
ST. GEORGE
SHELBURNE
SO. BURLINGTON
UNDERHILL
WESTFORD
WILLISTON
WINOOSKI
BUEL'S GORE

CHITTENDEN COUNTY



CHITTENDEN COUNTY

Bus Stop Location and Design Study

Prepared by
Chittenden County Regional Planning Commission

ABSTRACT

TITLE:	Bus Stop Location and Design Study
AUTHOR:	CCRPC Staff
SUBJECT:	Public Transportation - Bus Stop Location and Design Guide
DATE:	February 1988
LOCAL PLANNING AGENCY:	Chittenden County Regional Planning Commission
AGENCY SOURCE OF COPIES:	Chittenden County Regional Planning Commission.
U.M.T.A. GRANT:	VT-09-0009
NUMBER OF PAGES:	25

ABSTRACT: This report presents general guidelines and recommendations for efficient location and design of bus stops. A literature search and field survey of CCTA bus stops was used to develop this summary of recommended practices and procedures.

The preparation of this report was financially aided through contributions of eighteen communities in Chittenden County and through a grant from the U. S. Department of Transportation, Urban Mass Transportation Administration

EXECUTIVE SUMMARY

This report outlines information of specific interest to public officials responsible for transportation planning, policy, development, design and engineering. It presents the essential criteria necessary to design bus stops and facilities. This report provides a single quick reference source and an excellent supplement to AASHTO (American Association of State Highway and Transportation Officials), FHWA (Federal Highway Administration), ANSI (American National Standards Institute) and other design policies. The criteria presented in this report may be useful to local governments in developing standards.

This report is part of a CCTA bus stop inventory and evaluation conducted by Chittenden County Regional Planning Commission (CCRPC) in cooperation with Chittenden County Transportation Authority (CCTA).

Public transportation provides a vital service to many communities and cities in the United States. Properly designed and strategically located bus stops along a given route are an essential component of such a service, helping to attract riders and maintain efficient operations. The criteria presented in this report should aid in the development of such a system.

This report includes a section on accessibility for the mobility impaired. Often bus stops do not comply with federally mandated standards that provide for accessibility making these bus stops unusable or dangerous for handicapped people.

The Appendix presents diagrams and definitions for the implementation of bus stop location and development criteria.

The basic inventory and research effort was performed by Mary Adakonis, a Civil Engineering senior at the University of Vermont; her faculty advisor was Professor J. C. Oppenlander. Assistance was provided by Catherine Debo, General Manager of CCTA, and Stan Marshall who contributed technical assistance. The overall study was managed by Carol Landsman and Craig Leiner.

BUS STOP LOCATION AND DESIGN CRITERIA

This report presents criteria and objectives from the Transportation Research Board, AASHTO, ANSI, and findings from a bus stop study conducted by CCRPC. It can guide communities and developers in Chittenden County in planning and/or upgrading bus stops.

THE INITIAL PHASE of bus stop planning requires investigation into the following objectives:

1. PASSENGER DEMAND: bus stops should be located near points of major traffic generation such as central business district, shopping centers, schools, hospitals, recreation facilities, housing projects and other transportation facilities.

2. PASSENGER SAFETY: passengers should be able to board and alight from the bus safely. They should have a safe waiting area free of traffic interference, if possible, providing shelter from inclement weather. The stop should be located so that it is accessible and provides nearby pedestrian crossing in crosswalks with cross signals.

3. MINIMUM TRAFFIC IMPEDENCE: Buses approaching, departing or stopping at bus stops should not unduly interfere with moving traffic. Stopped buses should not block more than one lane of traffic and departing buses should not swing beyond one lane adjacent to these stops. In many instances an operational analysis of the intersection to determine the effects caused by bus movements should be conducted. Depending on bus stop location and intersection characteristics, signalization might need adjustment.

4. PROPERTY OWNERSHIP: Is the proposed bus stop located in the public right-of-way and is the adjacent property owner in favor of the bus stop? The question of property ownership must be determined before any infrastructure planning can proceed and arrangements regarding bus stop maintenance should be negotiated.

THE SECOND PHASE of planning a bus stop determines whether the on-street bus stop should be nearside, farside or mid-block. Farside bus stops are generally preferable, especially when there is a signal at the intersection, because this allows the bus to pass through the intersection. However, nearside bus stops at a stop sign controlled intersection allow a dual purpose stop. Mid-block stops are desired when there is a great walking distance between two intersections or a demand by passengers. Mid-block stops are generally not as safe for pedestrian crossings and may be difficult for handicapped people to use because of maintenance problems.

The following is a list of advantages and disadvantages of each type of stop developed by the Transportation Research Board in NCHRP Report 155.

ADVANTAGES
FARSIDE

1. They reduce conflicts between right-turning vehicles and stopped buses.
2. They provide additional intersection capacity by making the curb lane available for traffic.
3. They eliminate sight-distance deficiencies on approaches to intersections.
4. They encourage pedestrian crossings at the rear of the bus.
5. They require shorter maneuvering distances for the buses to enter and leave moving traffic. (This is not relevant where curb parking is prohibited.)
6. At signalized intersections, buses can find gaps for re-entry into the traffic stream. (This is not relevant where curb parking is prohibited.)
7. Waiting passengers can assemble along less-crowded sections of sidewalk.

NEARSIDE

1. They create a minimum of interference at locations where traffic is heavier on the far side than on the approach side of the intersection.
2. There is less interference with traffic turning into the bus route from a side street.
3. Passengers generally board buses close to a crosswalk.

MIDBLOCK

1. Buses create a minimum of interference with sight distance of both vehicles and pedestrians.
2. Waiting passengers assemble at less crowded sections of the sidewalk.

DISADVANTAGES
FARSIDE

1. Intersections may be blocked if other vehicles park illegally in the bus stop, thereby obstructing buses and causing traffic to back up across the intersection.
2. Stops on a narrow street or within a moving lane may block traffic on both the bus route and the cross street.
3. A bus standing at a far-side stop obscures sight distance to the right of a driver entering the bus street from the right.
4. Where the bus stop is too short for occasional heavy demands, the overflow will obstruct the cross street.

NEARSIDE

1. Heavy vehicular right turns can cause conflicts, especially where a vehicle makes a right turn from the left of a stopped bus.
2. Buses often obscure STOP signs, traffic signals, or other control devices, as well as pedestrians crossing in front of the bus.
3. A bus standing at a near-side stop obscures the signt distance of a driver entering the bus street from the right.
4. Where the bus stop is too short for occasional heavy demand, the overflow will obstruct the traffic lane.

MID-BLOCK

1. The removal of considerable curb parking may be required.
2. Patrons from cross streets must walk farther to board the bus.
3. Pedestrian jaywalking is more prevalent, thereby increasing vehicular friction, congestion, and accident potentials. (A mid-block stop should be located at the far side of a mid-block pedestrian crosswalk so standing buses will not block a motorist's view of pedestrians in the crosswalk.)

Source: NCH RP 155

THE THIRD PHASE of planning involves investigation into the following criteria:

1. SIGNING: Bus stops should be clearly designated with signs that comply with existing standards. The type and size of signs should be consistent throughout the system. In some cases it might be convenient and economical to stencil the word "bus" on a utility pole. A bus stop sign should not be located where it distracts or obscures regulatory or warning signs.

2. PARKING: Parking must be restricted at a bus stop location to ensure passenger safety, as well as unimpeded traffic flow. When buses are required to "double park" traffic congestion can occur, boarding or alighting passengers cannot see or be seen by oncoming traffic and general bus stop visibility is lost.

3. FREQUENCY: Bus stop spacing should not exceed seven stops in one mile. (Spacing should be about every 750 feet.) Greater spacing may be appropriate in low density areas. Spacing might be shorter in areas that experience severe winter weather conditions or where demand is great, as long as it does not unneccessarily slow bus travel or eliminate more potential parking spaces than is necessary.

4. MAINTENANCE: Bus stops should be maintained on a regular basis. They must be kept clear of snow and ice during the winter and, if necessary, landscaped during the other months. Repairs should be made to amenities that suffer vandalism or weather damage.

5. SAFETY: To provide for passenger convenience and safety the bus stops should provide the following:

   A. Lighting: Sufficient roadway lighting should be provided for night-time passengers. Street lights should be located no more than 100 feet from bus stop and preferably within 25 feet.

   B. Accesible Route. Handicapped accessibility as outlined by the ANSI standards is mandated by Federal and Vermont state law in all public projects. Sidewalks and curb cuts conforming to ANSI standards should be provided along streets leading to the bus stop location. Curb ramps and signage should also be illuminated in accordance with ANSI standards.

The following amenities should be considered where a shelter is located.

A. Information on bus scheduling and bus routes.
B. Public telephone.
C. Trash recepticles.
D. Heating at main terminal and transfer points.

6. SHELTERS: A bus shelter's main function is to provide protection from weather. Shelters enhance the attractiveness of a system and can be used as a system stop location identifier.

Bus shelters should be provided, if feasible, at major terminals or transfer points, at locations of high passenger volumes, and at locations where waiting is likely to occur. Installation priority should depend on an economic analysis ratio of person-minutes benefited/dollar of annual cost. (See appendix)

Bus stop shelter designs should have the following characteristics.

A. Be of contemporary design and complement the surrounding landscape/architecture.

B. Provide maximum visibility for safety and secureness.

C. Be constructed of highly durable weather and vandal resistant materials.

D. Provide handicapped accessibility including appropriate turning room and entrance width as mandated by ANSI standards.

Shelter capacity should be based on the maximum daily passenger accumulation at the bus stop. Shelters should have a minimum service life of 15 years. Installation and maintenance costs should be minimized.

7. ACCESSIBILITY: A well-planned and constructed bus stop should provide convenience, safety and accessibility for disabled people in compliance with American National Standards Institute (ANSI) standards.

The guidelines for accessible stops include:

A. The stop should provide an adequate surface loading area for a wheelchair to maneuver onto a hydraulic lift. This surface area should be at least a 5 x 12 foot level space.

B. Sidewalks and ramps should provide a common surface to avoid producing a lip. If a lip greater than 1/4" exists, it becomes difficult or even impossible for a wheelchair to use the sidewalk.

C. Routes to bus stops as well as the stops themselves should be accessible. Sometimes bus stops are located in a convenient place and do provide for the handicap, but because there is no accessible route to the stops the mobility impaired people cannot use them.

D. Curb cuts must comply with ANSI standards to ensure that they are usuable and safe. Standards to consider include:

1) Maximum running slope shall not exceed 1:12 or (8.33%) (ANSI 4.7.2 and 4.8.2)
2) Maximum slopes of adjoining gutters, road surface immediately adjacent to the curb ramp, or accessible routes shall not exceed 1:20.
3) Maximum rise for any run shall not exceed 2'6" (ANSI 4.7.2 and 4.8.2)
4) Ramps and curb ramps shall have a minimum clear width of 3'00" exclusive of edge protection or flared sides. (ANSI 4.7.3 and 4.8.3).
5) Provide flared sides if a circulation path crosses any part of the ramp or curb ramp not protected by hand rails or guardrails; flared slope shall not exceed 1:10 where a 4'00" landing is provided at the top of the curb ramp. If less than 4 feet is provided the flared slope shall not exceed 1:12.

E. A curb cut is unusable if it lacks a curb cut to match it across the street or at the next block. A curb cut is well-planned only if it is an integral part of an accessible route.

F. If a shelter is to be installed it should be accessible to wheelchairs. The entrance to the shelter should be at least 3' inside and the shelter should be located on an accessible path. It should provide an area inside at least 5' x 5' for turning. These criteria vary, however, depending on the type of shelter.

Good maintenance is an important element of an accessible stop. It should be cleared of snow and ice during the winter months. An accessible route must be cleared to the bare surface so that the wheels of a wheelchair will not lose traction and the surface be maneuverable without difficulty. The Appendix presents illustrations and standards for providing handicapped accessibility.

8. BUS TURNOUTS: Bus turnouts are useful along streets with high traffic volumes, high travel speeds, and long bus dwell times. They should be considered when economically feasible under the following conditions:

A. There are at least 500 vehicles in the curb lane during the peak hour.

B. Bus volumes are inadequate to justify an exclusive bus lane.

C. Right-of-way is adequate for construction.

Bus turnout designs are included in the appendix for single bus loading-unloading conditions. Turnouts should allow buses to enter and exit traffic flow without impeding it.

Design criteria for a bus turnout include:

A. A minimum 10 foot width.

B. Near-side turnouts should be at least 50 feet long for a single bus, plus 60-80 foot transition distance. The curves used should be of 100 foot radius, separated by a short tangent distance.

C. Far-side bus turnouts should provide a 50 foot loading area plus 40 to 60 feet of transition distance. A 25-50 foot radius curve should be used on an initial exit from the bus bay, followed by a short tangent and a 50 to 100 foot radius curve on entry to main roadway.

C. Mid-block bus turnouts include a composite of transition requirements for near and far side bus turnouts. Total impacted area for a single bus bay would range from about 150-200 feet, suggesting a minimum 400 to 600 foot block for application.

9. MAKING ROADS ACCESSIBLE FOR BUSSES - To ensure that an area may receive bus service, roads and streets must be designed so that a 30-40 foot vehicle can maneuver. The Appendix presents the recommended turning radii needed to accommodate a city bus on streets.

CONCLUSION

The ideal bus stop is described as follows: the bus stop would provide sufficient space for passengers to wait for the bus and a shelter and bench. It would include parking restrictions and ample street lighting. It would provide accessibility with standard curb cuts. Roadside characteristics would allow the bus to pull over and complete the stop without interferring with traffic flow. Roads would be constructed to allow bus access. It would also provide crosswalks and crosslights to insure safe pedestrian crossing. The stop would permit a walking distance of no more than 750 feet for a passenger. It would be well maintained and provide other amenities such as: telephone, trash recepticle and posted schedules. However, due to economical and environmental conditions an ideal bus stop is not always feasible. With realistic compromises a bus stop can be designed and located according to standards to serve the community in a safe and efficient manner.

APPENDIX

ECONOMIC ANALYSIS OF BUS SHELTER PRIORITY

$$I = \frac{P\,T\,(D_1 + R\,D_2)}{K_i\,C_a + C_m}$$

in which:

P = number of passengers;
T = average waiting time per passenger, in minutes;
D_1 = days of inclement weather;
D_2 = days of noninclement weather;
R = a discount factor (a factor that can be used to reflect the effect of waiting during normal weather; $0 < R < 1$);
K_i = capital recovery factor;
C_a = capital (installation) costs; and
C_m = annual maintenance cost.

A benefit-cost ratio can be derived by imputing a value of time to the numerator in Eq. 9.

BUS STOP SHELTER ON-SITE INSTALLATION INSTRUCTIONS

Customer:

Wall sections are marked as follows: RIGHT SIDE, RIGHT REAR, LEFT SIDE, LEFT REAR, WINDSCREEN (optional). A wall section may have one or more panels, depending on bus shelter model. Wall sections must be installed with the glazed panels flush to the outside of the shelter. Concrete surface should be level with a maximum of 3″ vertical variation.

CONNECTING WALL SECTIONS

Start with right side and right rear wall sections. Set vertical posts into anchor flanges with flanges oriented as shown in drawing. Engage top and bottom horizontal mullions of rear wall section over "U" channels at top and bottom of rear corner post of side wall. Chase through pre-drilled holes on top and bottom horizontal mullion of rear wall section into the "U" channels with a "G" size drill bit (.257″ dia.). Fasten with supplied 1/4″ drive rivets, driving rivets with hammer. Repeat for balance of wall sections and the front top horizontal mullion. If windscreen is included, attach two top front horizontal mullions to both sides of windscreen and front top corners of side wall sections.

With a pop rivet gun, secure vertical panel sub-frames to all vertical posts where wall sections are field connected with supplied short 3/16″ dia. pop rivets. (Note: It is not required to chase holes into vertical posts for these rivets — posts are factory slotted to readily accept rivets for fast field installation).

ROOF

Set roof assembly onto wall sections. Make sure the majority of the drain holes inside roof fascia are towards rear of the shelter. From inside shelter, chase through pre-drilled holes on inside lip of roof fascia into the top horizontal mullions of wall sections including top front horizontal mullion. Use # 11 drill bit. (.191″ dia.). Fasten with supplied long 3/16″ dia. pop rivets.

LEVELING SHELTER

With shelter in correct location on concrete surface, put bubble leveler on bottom horizontal mullions. If surface is not level, shim shelter to a maximum of 3″ vertically with wedges, bumber jack, etc. to obtain and hold level position. Chase through two pre-drilled holes on each anchor flange into vertical posts with a "G" drill bit (.257″ dia.). Fasten with supplied 1/4″ drive rivets, two per flange. Remove leveling devices.

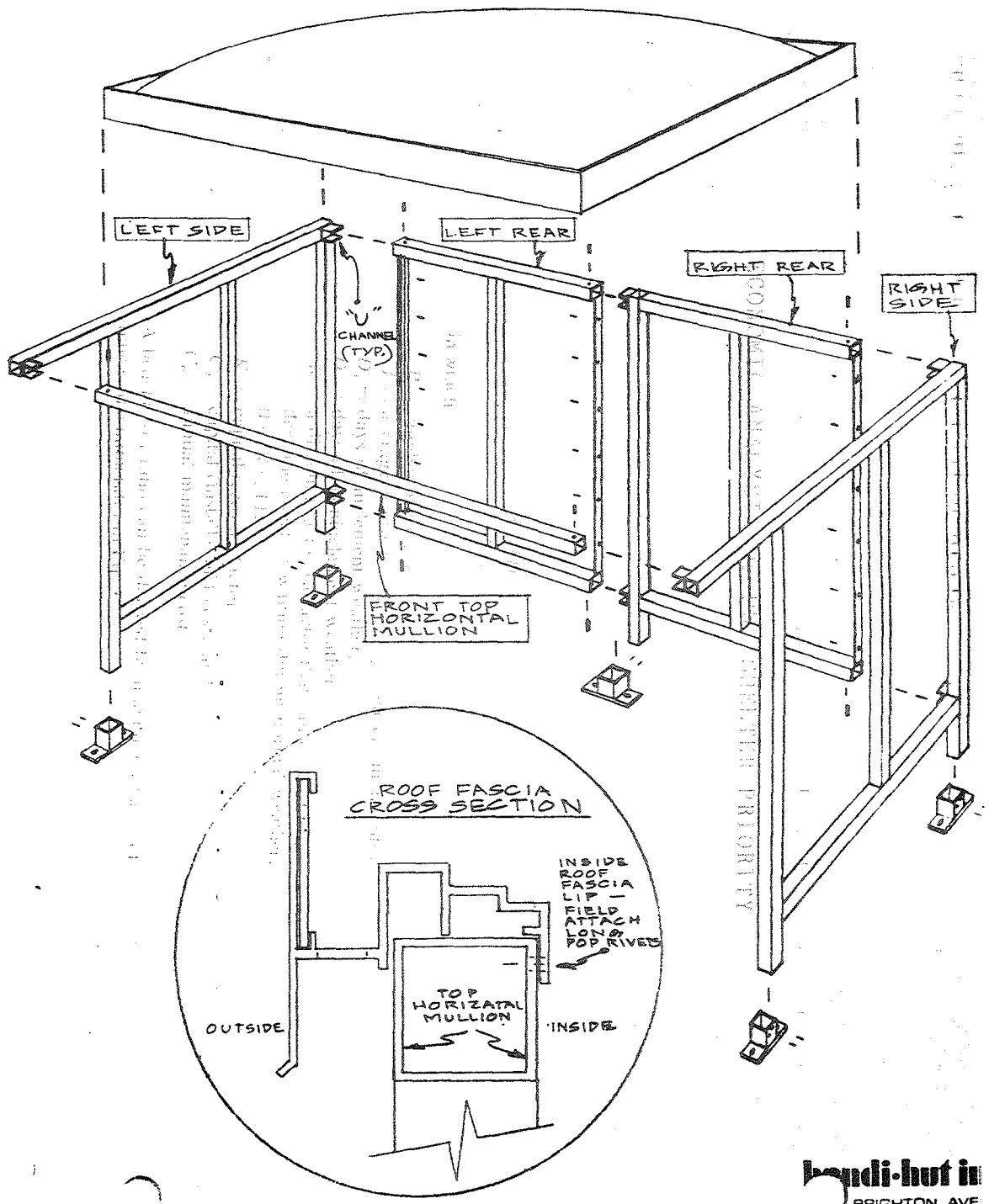
SECURING TO CONCRETE SURFACE

Make sure all wall sections are plumb and square. Mark concrete surface through anchor flange holes. Move shelter to provide room to drill 1/2″ dia. holes into concrete surface. An electric drill hammer is required. Hammer supplied 1/2″ dia. expansion bolts into holes leaving no less than 3/4″ exposed thread above surface. Set shelter over exposed expansion bolts and secure with supplied washers and nuts turning nuts till tight. Peen exposed thread.

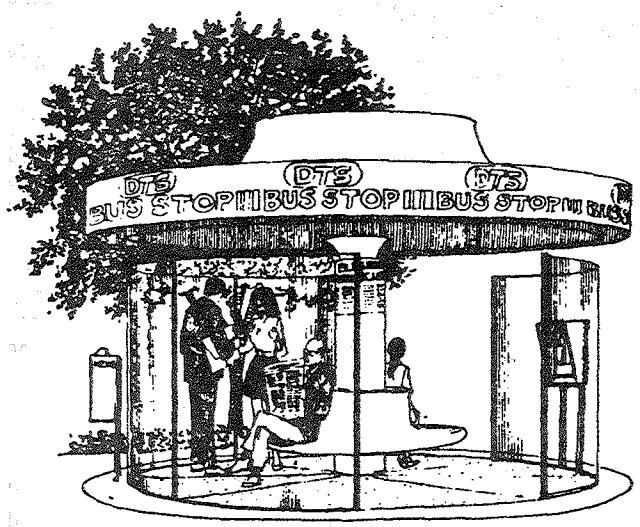
BENCH / BACKREST

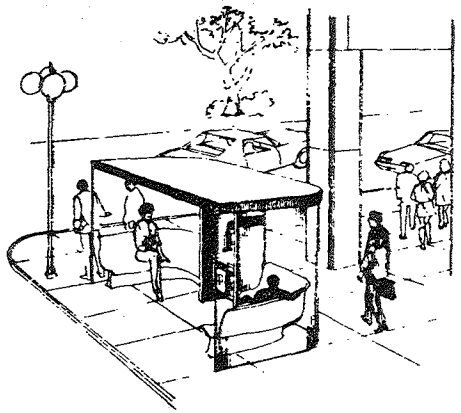
See attached for securing bench/Backrest.

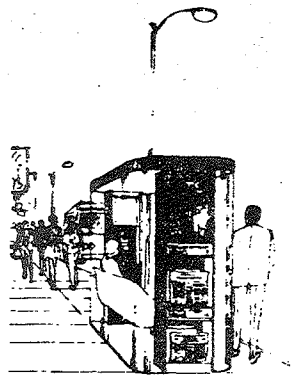
HYPOTHETICAL BUS SHELTER SHOWN

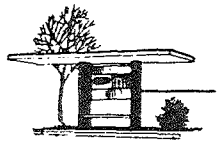


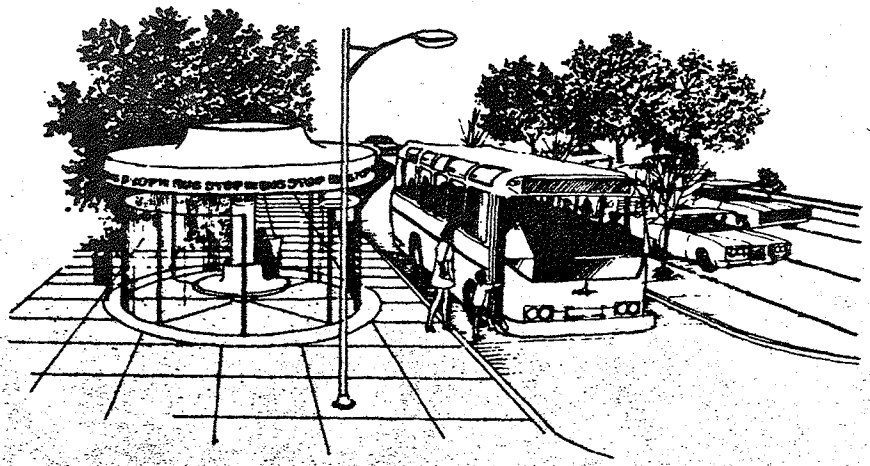
bendi-hut inc
BRIGHTON AVE
PASSAIC, N.J. 07055

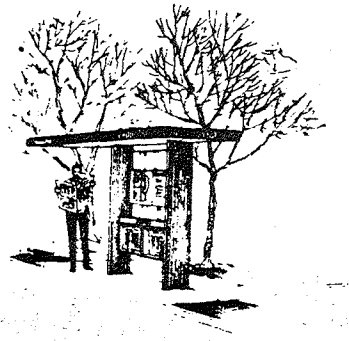












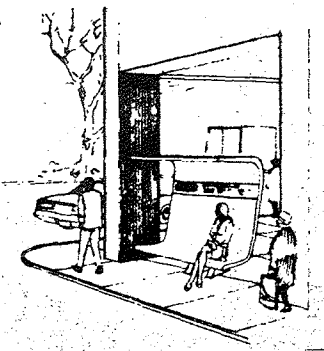
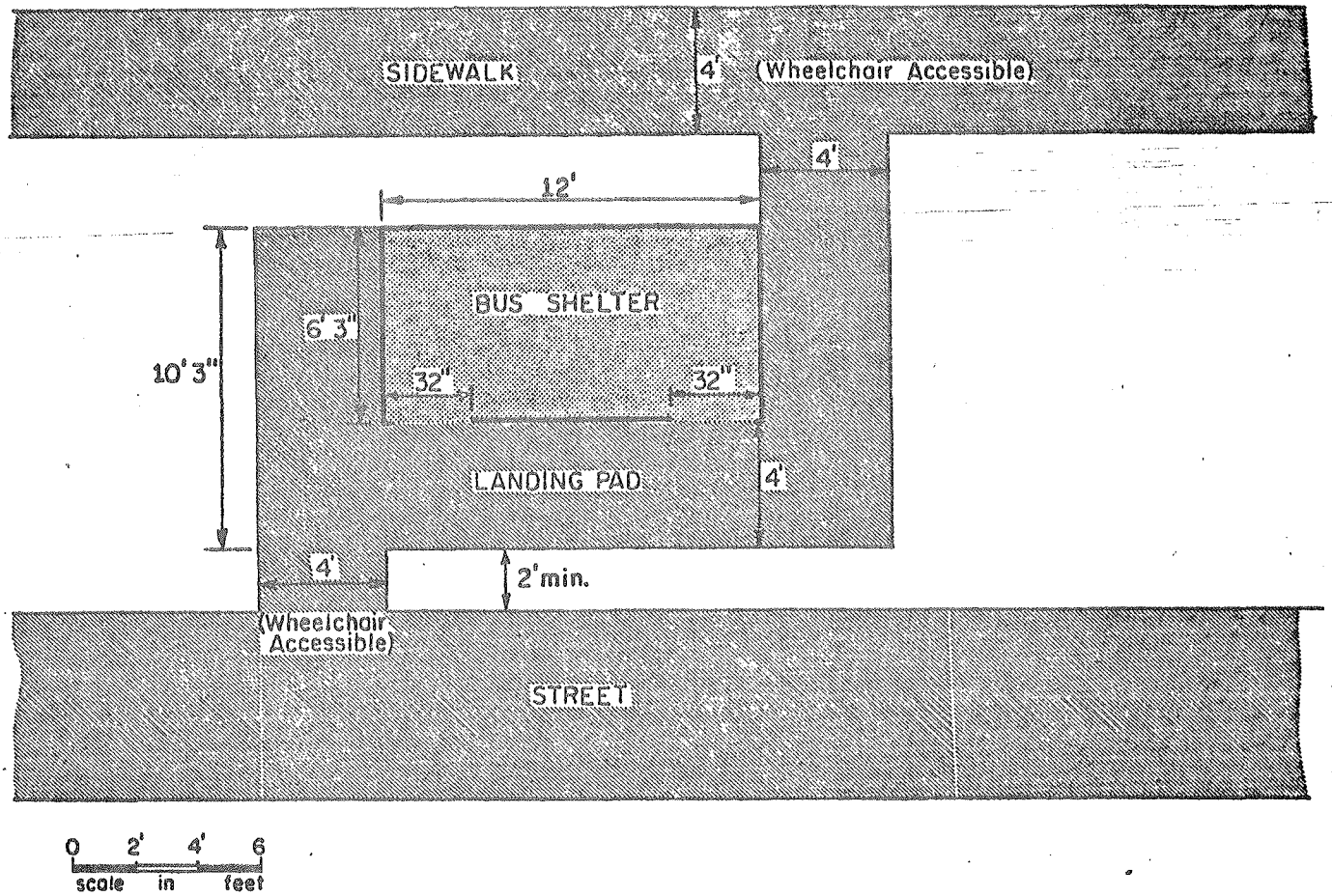


Figure 93. Bus shelter design concepts.



PASSENGER SHELTER SPACE REQUIREMENTS

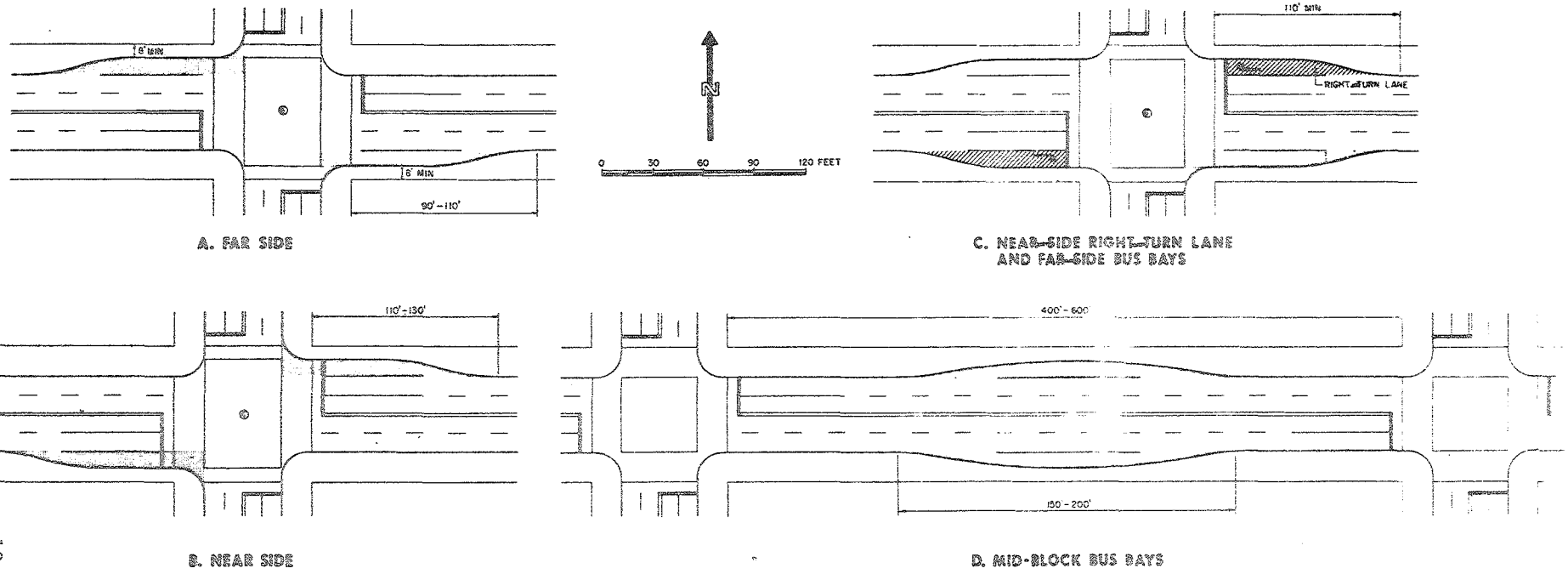


Figure 90. Arterial bus bay location options.

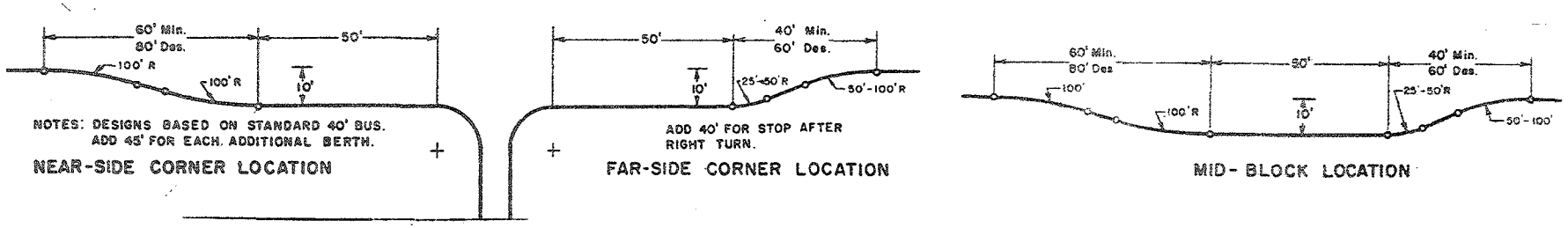
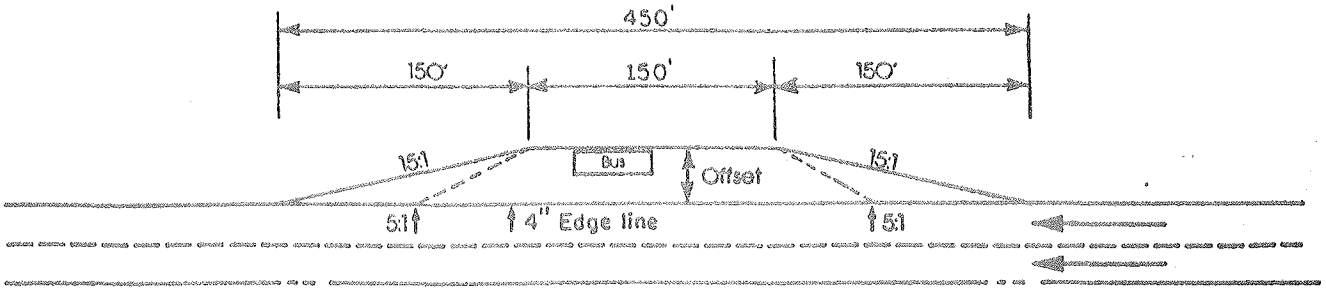
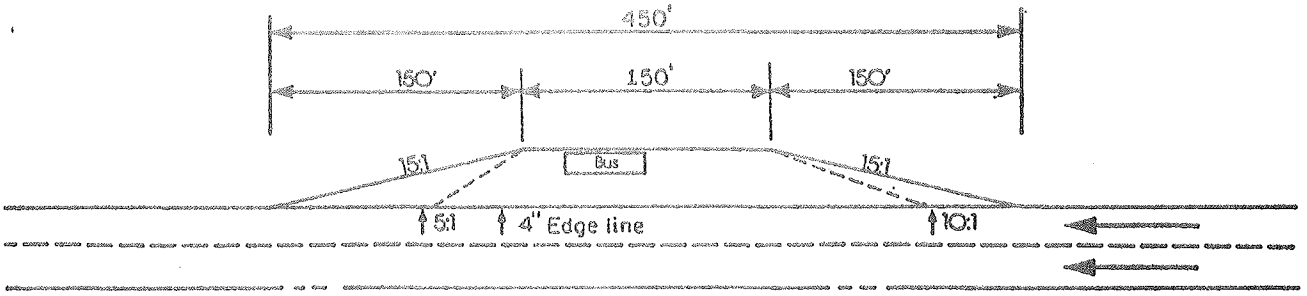


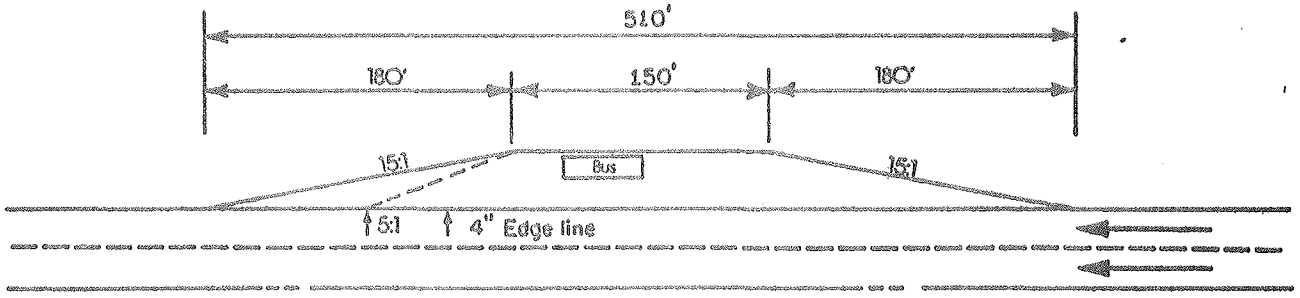
Figure 91. Bus stop turnouts, arterial streets.



LOCAL STREET
1 to 20 MPH
(10' Offset)



MINOR ARTERIAL
20 to 30 MPH
(10' Offset)



MAJOR ARTERIAL
30 to 40 MPH
(12' Offset)

BUS TURNOUT DIMENSIONS

3.4 General Terminology

comply with. Meet one or more specifications of this standard.

if, if. . .then. Denotes a specification that applies only when the conditions described are present.

may. Denotes an option or alternative.

shall. Denotes a mandatory specification or requirement.

should. Denotes an advisory specification or recommendation.

3.5 Definitions. The following terms shall, for the purpose of this standard, have the meaning indicated in this section.

access aisle. An accessible pedestrian space between elements such as parking spaces, seating, and desks, that provides clearances appropriate for use of the elements.

accessible. Describes a site, building, facility, or portion thereof that complies with this standard and that can be approached, entered, and used by physically disabled people.

accessible element. Part of an accessible route or accessible functional space; an item specified by this standard (for example, telephone, controls, and the like).

accessible route. A continuous unobstructed path connecting all accessible elements and spaces in a building or facility that can be negotiated by a severely disabled person using a wheelchair and that is also safe for and usable by people with other disabilities. Interior accessible routes may include corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures. Exterior accessible routes may include parking access aisles, curb ramps, walks, ramps, and lifts.

adaptability. The ability of certain building elements, such as kitchen counters, sinks, and grab bars, to be added to, raised, lowered, or otherwise altered so as to accommodate the needs of either the disabled or nondisabled, or to accommodate the needs of persons with different types or degrees of disability.

administrative authority. A governmental agency that adopts or enforces regulations and standards for the design, construction, or operation of buildings and facilities.

assembly area. A room or space accommodating fifty or more individuals for religious, recreational, educational, political, social, or amusement purposes, or for the consumption of food and drink, including all connected rooms or spaces with a common means of egress and ingress. Such areas as conference rooms would have to be accessible in accordance with other parts of this standard but would not have to meet all of the criteria associated with assembly areas.

automatic door. A door equipped with a power-operated mechanism and controls that open and close the door automatically upon receipt of a momentary actuating signal. The switch that begins the automatic cycle may be a photoelectric device, floor mat, or manual switch mounted on or near the door itself (see *power-assisted door*).

children. People below the age of twelve (that is, elementary school age and younger).

circulation path. An exterior or interior way of passage from one place to another for pedestrians, including, but not limited to, walks, hallways, courtyards, stairways, and stair landings.

clear. Unobstructed.

common use. Refers to those interior and exterior rooms, spaces, or elements that are made available for the use of a restricted group of people (for example, residents of an apartment building, the occupants of an office building, or the guests of such residents or occupants).

coverage. The extent or range of accessibility that a particular administrative authority adopts and requires.

cross slope. The slope of a pedestrian way that is perpendicular to the direction of travel (see *running slope*).

curb ramp. A short ramp cutting through a curb or built up to it.

detectable. Perceptible by one or more of the senses.

disability. A limitation or loss of use of a physical, mental, or sensory body part or function.

dwelling unit. A single unit of residence which provides a kitchen or food preparation area, in addition to rooms and spaces for living, bathing, sleeping, and the like. A single family home is a dwelling unit, and dwelling units are to be found in such housing types as townhouses and apartment buildings.

egress, means of. A path of exit that meets all applicable code specifications of the regulatory building agency having jurisdiction over the building or facility.

emergency. Refers to facilities resulting from or anticipating unforeseen combinations of circumstances, for example, storm shelters, bomb shelters, and comparable refuges.

functional spaces. The rooms and spaces in a building or facility that house the major activities for which the building or facility is intended.

handicapped. Those with significant limitations in using specific parts of the environment.

housing. A building, facility, or portion thereof, excluding inpatient health care facilities, that contains one or more dwelling units or sleeping accommodations. Housing may include, but is not limited to, one- and two-family dwellings, apartments, group homes, hotels, motels, dormitories, and mobile homes.

marked crossing. A crosswalk or other identified path intended for pedestrian use in crossing a vehicular way.

multifamily dwelling. Any building containing more than two dwelling units.

operable part. A part of a piece of equipment or appliance used to insert or withdraw objects, or to activate, deactivate, or adjust the equipment or appliance (for example, coin slot, pushbutton, handle).

power-assisted door. A door with a mechanism that helps to open the door, or relieve the opening resistance of a door, upon the activation of a switch or a continued force applied to the door itself. If the switch or door is released, such doors immediately begin to close or close completely within 3 to 30 seconds (see *automatic door*).

principal entrance. An entrance intended to be used by the residents or users to enter or leave a building or facility. This may include, but is not limited to, the main entrance.

public use. Describes interior and exterior rooms or spaces that are made available to the general public. Public use may be provided at a building or facility that is privately or publicly owned.

ramp. A walking surface in an accessible space that has a running slope greater than 1:20.

reasonable number. A number that is sufficient to accommodate the disabled users of a site, building facility, or element.

running slope. The slope of a pedestrian way that is parallel to the direction of travel (see *cross slope*).

service entrance. An entrance intended primarily for delivery or service.

signage. Verbal, symbolic, and pictorial information.

site. A parcel of land bounded by a property line or a designated portion of a public right-of-way.

site improvements. Landscaping, paving for pedestrian and vehicular ways, outdoor lighting, recreational facilities, and the like, added to a site.

sleeping accommodations. Rooms in which people sleep, for example, dormitory and hotel or motel guest rooms.

tactile. Describes an object that can be perceived using the sense of touch.

tactile warning. A standardized surface texture applied to or built into walking surfaces or other elements to warn visually impaired people of hazards in the path of travel.

temporary. Applies to facilities that are not of permanent construction but are extensively used or essential for public use for a given (short) period of time, for example, temporary classrooms or classroom buildings at schools and colleges, or facilities around a major construction site to make passage accessible, usable, and safe for everybody. Structures directly associated with the actual processes of major construction, such as porto potties, scaffolding, bridging, trailers, and the like, are not included.

vehicular way. A route intended for vehicular traffic, such as a street, driveway, or parking lot.

walk. An exterior pathway with a prepared surface intended for pedestrian use, including general pedestrian areas such as plazas and courts.

walking aid. A device used by a person who has difficulty walking (for example, a cane, crutch, walker, or brace).

4. Accessible Elements and Spaces

4.1 Minimum Requirements

4.1.1 Accessible Sites and Exterior Facilities. An accessible site shall meet the following minimum requirements:

(1) At least one accessible route complying with 4.3 shall be provided from public transportation stops, accessible parking spaces, accessible passenger loading zones if provided, and public streets or sidewalks to an accessible building entrance.

(2) At least one accessible route complying with 4.3 shall connect accessible buildings, facilities, elements, and spaces that are on the same site.

(3) All objects that protrude from surfaces or posts into circulation paths shall comply with 4.4.

4.2.4* Clear Floor or Ground Space for Wheelchairs

4.2.4.1 Size and Approach. The minimum clear floor or ground space required to accommodate a single, stationary wheelchair and occupant is 30 in by 48 in (760 mm by 1220 mm) (see Fig. 4(a)). The minimum clear floor or ground space for wheelchairs may be positioned for forward or parallel approach to an object (see Fig. 4(b) and (c)). Clear floor or ground space for wheelchairs may be part of the knee space required under some objects.

4.2.4.2 Relationship of Maneuvering Clearances to Wheelchair Spaces. One full unobstructed side of the clear floor or ground space for a wheelchair shall adjoin or overlap an accessible route or adjoin another wheelchair clear floor space. If a clear floor space is located in an alcove or otherwise confined on all or part of three sides, additional maneuvering clearances shall be provided as shown in Fig. 4(d) and (e).

4.2.4.3 Surfaces of Wheelchair Spaces. Clear floor or ground spaces for wheelchairs shall comply with 4.5.

4.2.5 High Forward Reach. If the clear floor space only allows forward approach to an object, the maximum high forward reach allowed shall be 48 in (1220 mm) (see Fig. 5(a)). If the high forward reach is over an obstruction, reach and clearances shall be as shown in Fig. 5(b).

4.2.6 Side Reach. If the clear floor space allows parallel approach by a person in a wheelchair, the maximum high side reach allowed shall be 54 in (1370 mm) and the low side reach shall be no less than 9 in (230 mm) above the floor (Fig. 6(a) and (b)). If the side reach is over an obstruction, the reach and clearances shall be as shown in Fig. 6(c)).

4.3 Accessible Route

4.3.1* General. All walks, halls, corridors, aisles, and other spaces that are part of an accessible route shall comply with 4.3.

4.3.2 Location

(1) At least one accessible route shall be provided from public transportation stops, accessible parking and accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve.

(2) At least one accessible route shall connect accessible buildings, facilities, elements, and spaces that are on the same site.

(3) At least one accessible route shall connect accessible building or facility entrances with all accessible spaces and elements and with all accessible dwelling units within the building or facility.

(4) An accessible route shall connect at least one accessible entrance of each accessible dwelling unit with those exterior and interior spaces and facilities that serve the accessible dwelling unit.

4.3.3 Width. The minimum clear width of an accessible route shall be 36 in (915 mm) except at doors (see 4.13.5). If a person in a wheelchair must make a turn around an obstruction, the minimum clear width of the accessible route shall be as shown in Fig. 7.

4.3.4 Passing Space. If an accessible route has less than 60-in (1525-mm) clear width, then passing spaces at least 60 in by 60 in (1525 mm by 1525 mm) shall be located at reasonable intervals not to exceed 200 ft (61 m). A T-intersection of two corridors or walks is an acceptable passing place.

4.3.5 Head Room. Accessible routes shall comply with 4.4.2.

4.3.6 Surface Texture. The surface of an accessible route shall comply with 4.5.

4.3.7 Slope. An accessible route with a running slope greater than 1:20 is a ramp and shall comply with 4.8. Nowhere shall the cross slope of an accessible route exceed 1:50.

4.3.8 Changes in Level. Changes in level along an accessible route shall comply with 4.5.2. If an accessible route has changes in level greater than 1/2 in (13 mm), then a curb ramp, ramp, elevator, or platform lift shall be provided that complies with 4.7, 4.8, 4.10, or 4.11, respectively. Stairs shall not be part of an accessible route.

4.3.9 Doors. Doors along an accessible route shall comply with 4.13.

4.3.10* Egress. A reasonable number, but always at least one, of accessible routes serving any accessible space or element shall also serve as a means of egress for emergencies or connect to an accessible place of refuge. Such accessible routes and places of refuge shall comply with the requirements of the administrative authority having jurisdiction.

4.4 Protruding Objects

4.4.1* General. Objects projecting from walls (for example, telephones) with their leading edges between 27 in and 80 in (685 mm and 2030 mm) above the finished floor shall protrude no more than 4 in (100 mm) into walks, halls, corridors, passageways, or aisles (see Fig. 8(a)). Objects mounted with their leading edges at or below 27 in (685 mm) above the finished floor may protrude any amount (see Fig. 8(a) and (b)). Free-standing objects mounted on posts or pylons may overhang 12 in (305 mm) maximum from 27 in to 80 in (685 mm to 2030 mm) above the ground or finished floor (see Fig. 8(c) and (d)). Protruding objects shall not reduce the clear width of an accessible route or maneuvering space (see Fig. 8(e)).

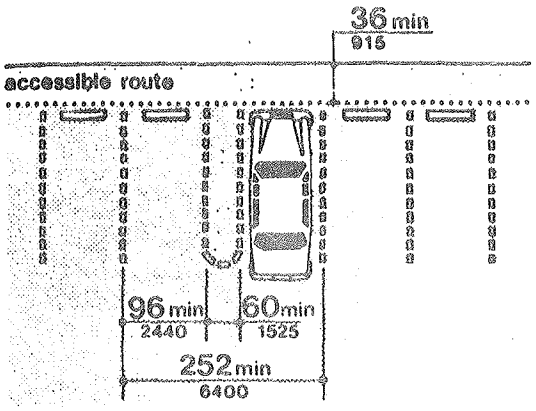


Fig. 9
Dimensions of Parking Spaces

4.4.2 **Head Room.** Walks, halls, corridors, passageways, aisles, or other circulation spaces shall have 80 in (2030 mm) minimum clear head room (see Fig. 8(a)).

4.5 **Ground and Floor Surfaces**

4.5.1* **General.** Ground and floor surfaces along accessible routes and in accessible rooms and spaces, including floors, walks, ramps, stairs, and curb ramps, shall be stable, firm, and relatively nonslip under all weather conditions and shall comply with 4.5.

4.5.2 **Changes in Level.** Changes in level up to 1/4 in (6 mm) may be vertical and without edge treatment. Changes in level between 1/4 in and 1/2 in (6 mm and 13 mm) shall be beveled with a slope no greater than 1:2. Changes in level greater than 1/2 in (13 mm) shall be accomplished by means of a ramp that complies with 4.7 or 4.8.

4.5.3* **Carpet.** If carpet or carpet tile is used on a ground or floor surface, then it shall be securely attached; have a firm cushion, pad, or backing or no cushion or pad; and have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. The maximum pile height shall be 1/2 in (13 mm). Exposed edges of carpet shall be fastened to floor surfaces and have trim along the entire length of the exposed edge. Carpet edge trim shall comply with 4.5.2.

4.5.4 **Gratings.** If gratings are located in walking surfaces, then they shall have spaces no greater than 1/2-in (13-mm) wide in one direction. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

4.6 **Parking and Passenger Loading Zones**

4.6.1 **Minimum Number.** If parking spaces are provided, a reasonable number, but always at least one, of accessible spaces shall comply with 4.6.2 through 4.6.4. If passenger loading zones are provided, a reasonable number, but always at least one, of passenger loading zones shall comply with 4.6.5.

4.6.2 **Location.** Parking spaces for disabled people and accessible passenger loading zones that serve a particular building shall be located on the shortest possible accessible circulation route to an accessible entrance of the building. In separate parking structures or lots that do not serve a particular building, parking spaces for disabled people shall be located on the shortest possible circulation route to an accessible pedestrian entrance of the parking facility.

4.6.3* **Parking Spaces.** Parking spaces for disabled people shall be at least 96-in (2440-mm) wide and shall have an adjacent access aisle 60-in (1525-mm) wide minimum (see Fig. 9). Parking access aisles shall be part of the accessible route to the building or facility entrance and shall comply with 4.3. Two accessible parking spaces may share a common access aisle. Parked vehicle overhangs shall not reduce the clear width of an accessible circulation route.

4.6.4* **Signage.** Accessible parking spaces shall be designated as reserved for the disabled by a sign showing the symbol of accessibility (see 4.30.5). Such signs shall not be obscured by a vehicle parked in the space.

4.6.5 **Passenger Loading Zones.** Passenger loading zones shall provide an access aisle at least 48-in (1220-mm) wide and 20-ft (6-m) long adjacent and parallel to the vehicle pull-up space (see Fig. 10). If there are curbs between the access aisle and the vehicle pull-up space, then a curb ramp complying with 4.7 shall be provided.

4.7 **Curb Ramps**

4.7.1 **Location.** Curb ramps complying with 4.7 shall be provided wherever an accessible route crosses a curb.

4.7.2 **Slope.** Slopes of curb ramps shall comply

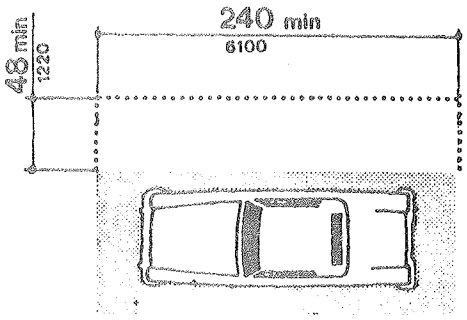


Fig. 10
Access Aisle at Passenger Loading Zones

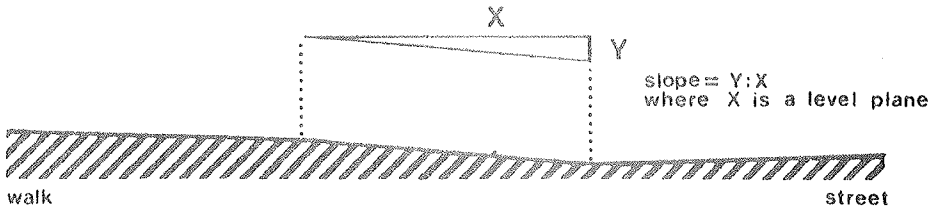
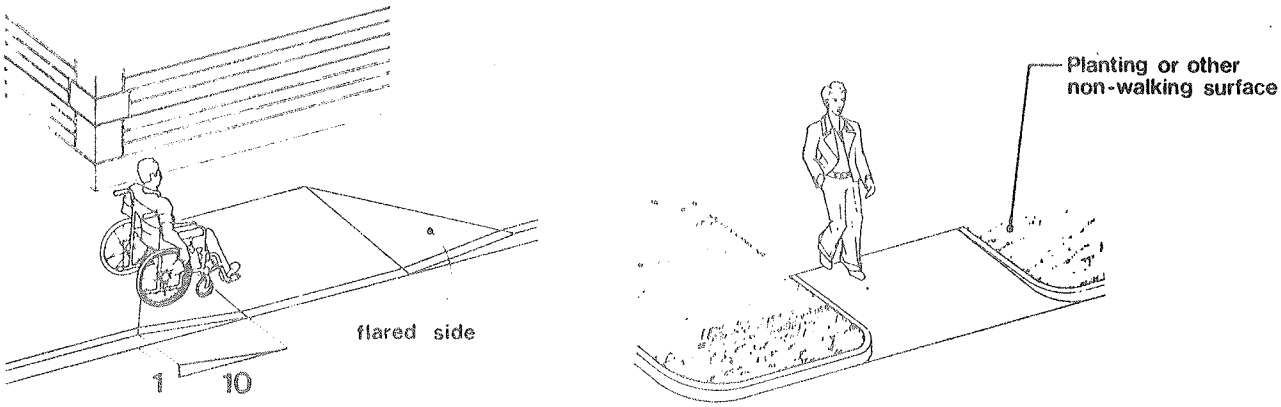


Fig. 11
Measurement of Curb Ramp Slopes



(a)
Flared Sides

(b)
Returned Curb

Fig. 12
Sides of Curb Ramps

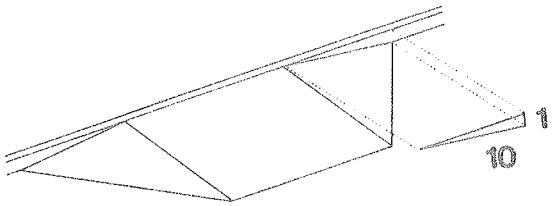


Fig. 13
Built-Up Curb Ramp

with 4.8.2. The slope shall be measured as shown in Fig. 11.

4.7.3 Width. The minimum width of a curb ramp shall be 36 in (915 mm), exclusive of flared sides.

4.7.4 Surface. Surfaces of curb ramps shall comply with 4.5.

4.7.5 Sides of Curb Ramps. If a curb ramp is located where pedestrians must walk across the ramp, then it shall have flared sides; the maximum slope of the flare shall be 1:10 (see Fig. 12(a)). Curb ramps with returned curbs may be used where pedestrians would not normally walk across the ramp (see Fig. 12(b)).

4.7.6 Built-Up Curb Ramps. Built-up curb ramps shall be located so that they do not project into vehicular traffic lanes (see Fig. 13).

4.7.7 Warning Textures. A curb ramp shall have a

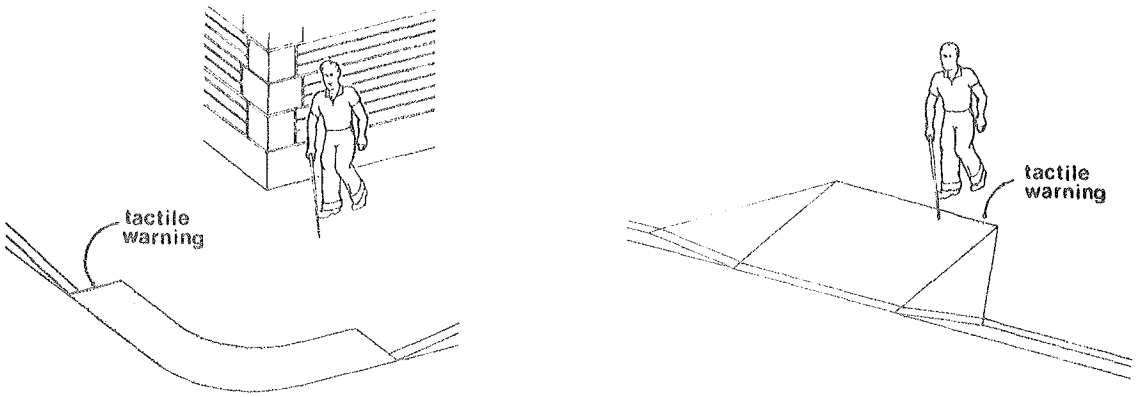


Fig. 14
Warning Signals at Curb Ramps

tactile warning texture complying with 4.29 and extending the full width and depth of the curb ramp, including any flares (see Fig 14).

4.7.8 **Obstructions.** Curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

4.7.9 **Location at Marked Crossings.** Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides (see Fig. 15).

4.7.10 **Diagonal Curb Ramps.** If diagonal (or corner type) curb ramps have returned curbs or other well defined edges, such edges shall be parallel to the direction of pedestrian flow. The bottom of diagonal curb ramps shall have 48-in (1220-mm) minimum clear space as shown in Fig. 15(c) and (d). If diagonal curb ramps are provided at marked crossings, the 48-in (1220-mm) clear space shall be within the markings (see Fig. 15(c) and (d)). If diagonal curb ramps have flared sides, they shall also have at least a 24-in (610-mm) -long segment of straight curb located on each side of the curb ramp and within the marked crossing (see Fig. 15(c)).

4.7.11 **Islands.** Any raised islands in crossings shall be cut through level with the street or have curb ramps at both sides and a level area at least 48-in (1220-mm) long in the part of the island intersected by the crossings (see Fig. 15(a) and (b)).

4.7.12 **Uncurbed Intersections.** If there is no curb at the intersection of a walk and an adjoining street, parking lot, or busy driveway, then the walk shall have a tactile warning texture complying with 4.29.5 at the edge of the vehicular way.

4.8 **Ramps**

4.8.1* **General.** Any part of an accessible route with a slope greater than 1:20 shall be considered a ramp and shall comply with 4.8.

4.8.2* **Slope and Rise.** The least possible slope shall be used for any ramp. The maximum slope of a ramp in new construction shall be 1:12. The maximum rise for any ramp run shall be 30 in (760 mm) (see Fig. 16). Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as shown in Table 2 if space limitations prohibit the use of a 1:12 slope or less.

4.8.3 **Clear Width.** The minimum clear width of a ramp shall be 36 in (915 mm).

4.8.4 **Landings.** Ramps shall have level landings at the bottom and top of each run. Landings shall have the following features:

(1) The landing shall be at least as wide as the widest ramp run leading to it.

(2) The landing length shall be a minimum of 60 in (1525 mm) clear.

(3) If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

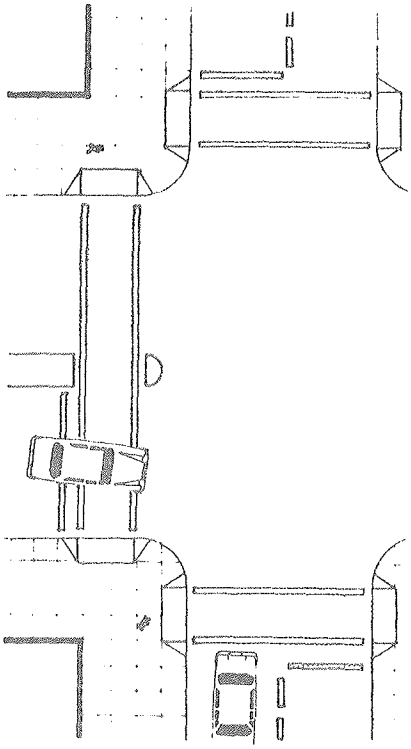
(4) If a doorway is located at a landing, then the area in front of the doorway shall comply with 4.13.6.

4.8.5* **Handrails.** If a ramp run has a rise greater than 6 in (250 mm) or a horizontal projection greater than 72 in (1830 mm), then it shall have handrails on both sides. Handrails are not required on curb ramps. Handrails shall comply with 4.26.2 and shall have the following features:

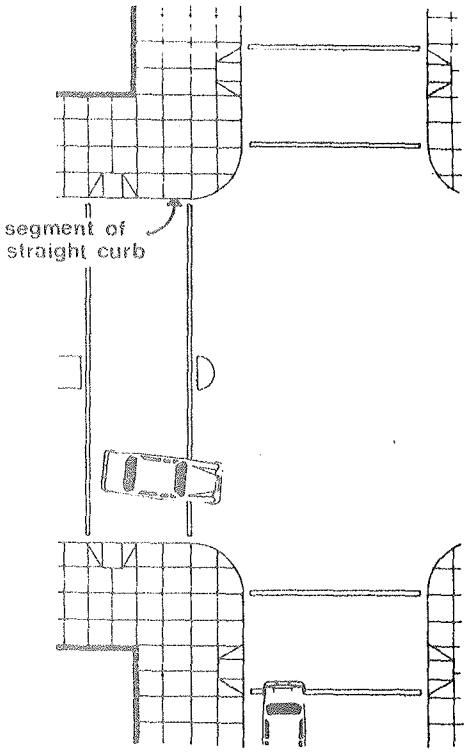
(1) Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall always be continuous.

(2) If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface.

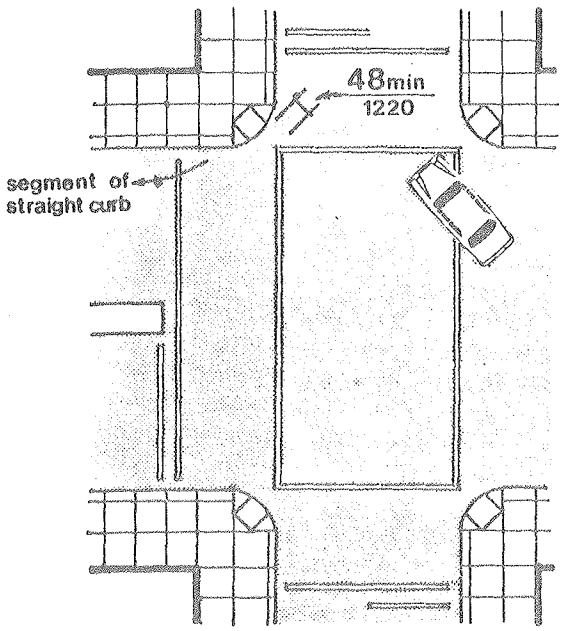
(3) The clear space between the handrail and the wall shall be 1-1/2 in (38 mm).



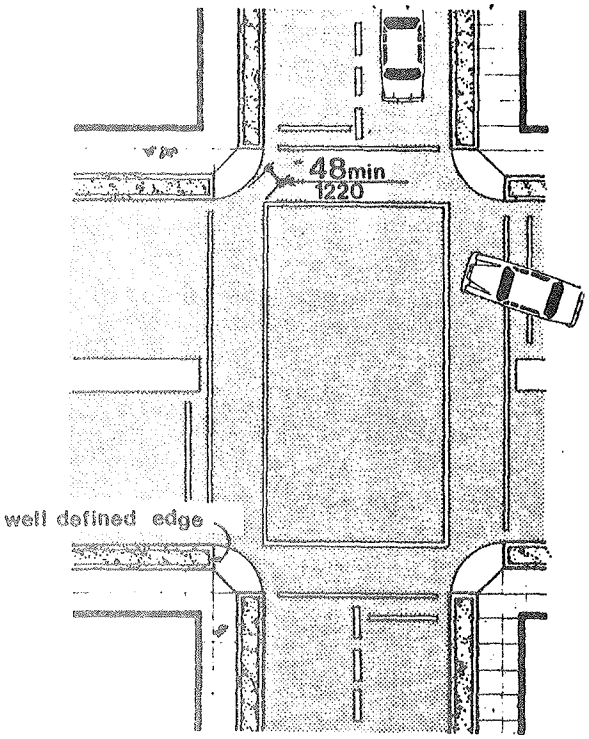
(a)



(b)

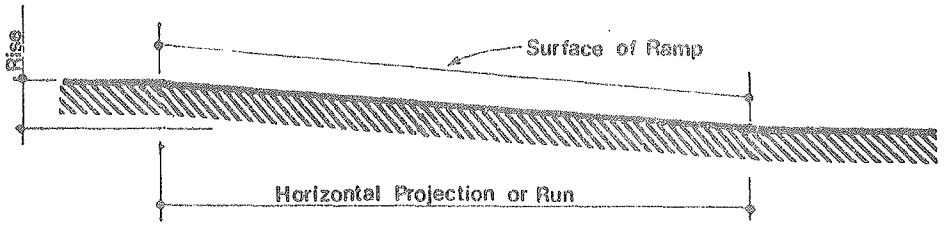


(c)



(d)

Fig. 15
Curb Ramps at Marked Crossings



	Maximum Rise		Maximum Horizontal Projection	
Slope	in	mm	ft	m
1:12	30	760	30	9
1:16	30	760	40	12
1:20	30	760	50	15

Fig. 16
Components of a Single Ramp Run and Sample Ramp Dimensions

Table 2
Allowable Ramp Dimensions for Construction in Existing Sites, Buildings, and Facilities

	Maximum Rise		Maximum Run	
Slope*	in	mm	ft	m
Steeper than 1:10 but no steeper than 1:8	3	75	2	0.6
Steeper than 1:12 but no steeper than 1:10	6	150	5	1.5

*A slope steeper than 1:8 not allowed.

(4) Gripping surfaces shall be continuous.

4.8.6 **Cross Slope and Surfaces.** The cross slope of ramp surfaces shall be no greater than 1:50. Ramp surfaces shall comply with 4.5.

4.8.7 **Edge Protection.** Ramps and landings with drop-offs shall have curbs, walls, railings, or projecting surfaces that prevent people from slipping off the ramp. Curbs shall be a minimum of 2-in (50-mm) high (see Fig. 17).

4.8.8 **Outdoor Conditions.** Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces.

4.9 Stairs

4.9.1 **Minimum Number.** Stairs connecting levels not connected by an elevator shall comply with 4.9. These specifications are not mandatory for stairs within dwelling units.

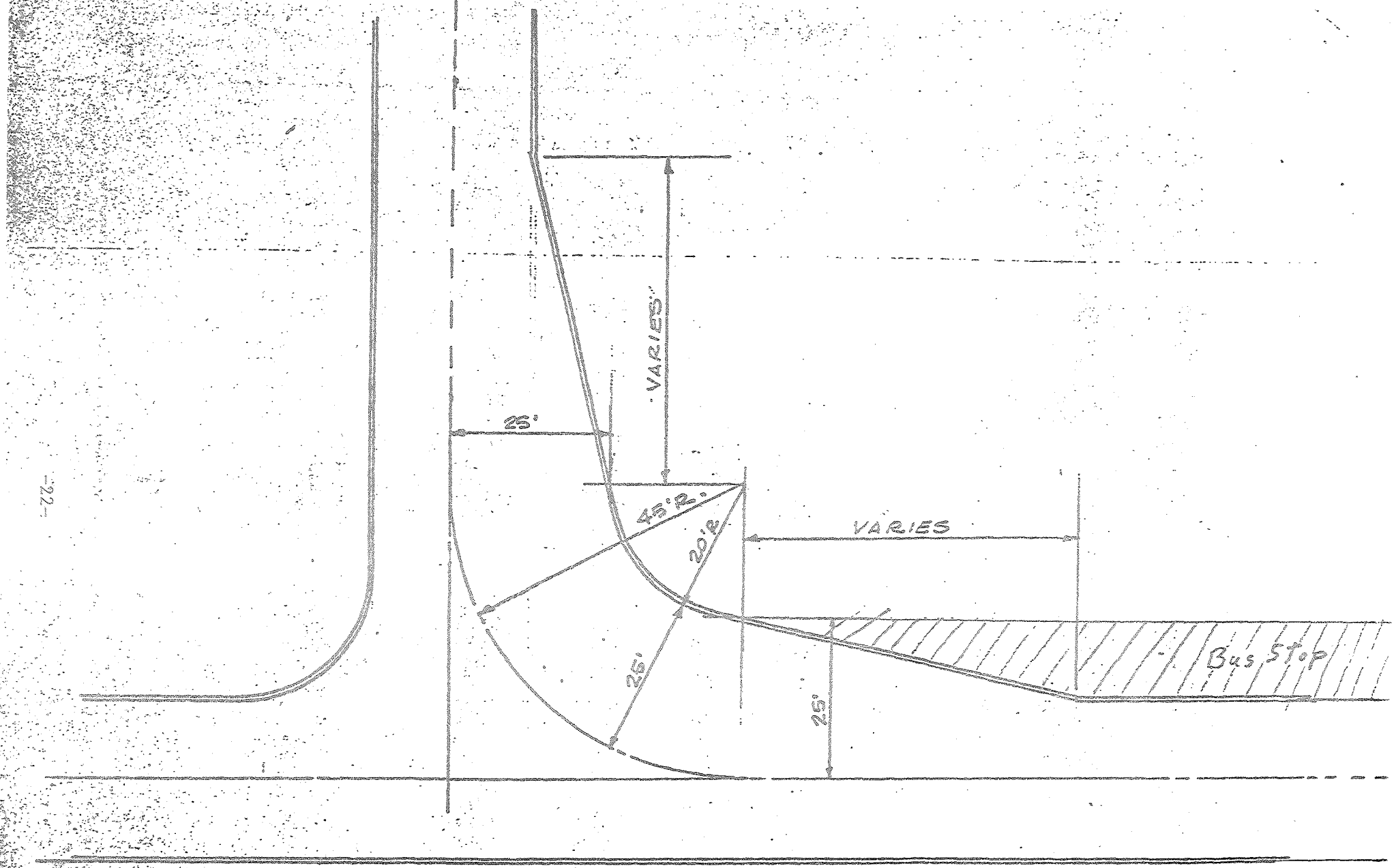
4.9.2 **Treads and Risers.** On any given flight of stairs, all steps shall have uniform riser heights and uniform tread widths. Stair treads shall be no less than 11-in (280-mm) wide, measured from riser to riser (see Fig. 18(a)).

4.9.3 **Nosings.** The undersides of nosings shall not be abrupt. The radius of curvature at the leading edge of the tread shall be no greater than 1/2 in (13 mm). Risers shall be sloped or the underside of the nosing shall have an angle not less than 60 degrees from the horizontal. Nosings shall project no more than 1-1/2 in (38 mm) (see Fig. 18).

4.9.4 **Handrails.** Stairways shall have handrails at both sides of all stairs. Handrails shall comply with 4.26 and shall have the following features:

(1) Handrails shall be continuous along both sides of stairs. The inside handrail on switchback or dogleg stairs shall always be continuous (see Fig. 19(a) and (b)).

(2) If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top riser and at least 12 in (305 mm) plus the width of one tread beyond the bottom riser. At the top, the extension shall be parallel with the floor or ground surface. At the bottom, the handrail shall continue to slope for a distance of the width of one tread from the bottom riser; the remainder of the extension shall be horizontal (see Fig. 19(c) and (d)). Handrail extensions shall comply with 4.4.



RECOMMENDED TURN FOR CITY BUS

SCALE: 1" = 20'

are an integral part of the modern transit system, yet their origin dates back to interurban and street railway operations (*42*). Their primary function is to provide passenger protection from weather without compromising passenger safety or involving excessive installation and maintenance costs. Shelters provide a distinct identity to

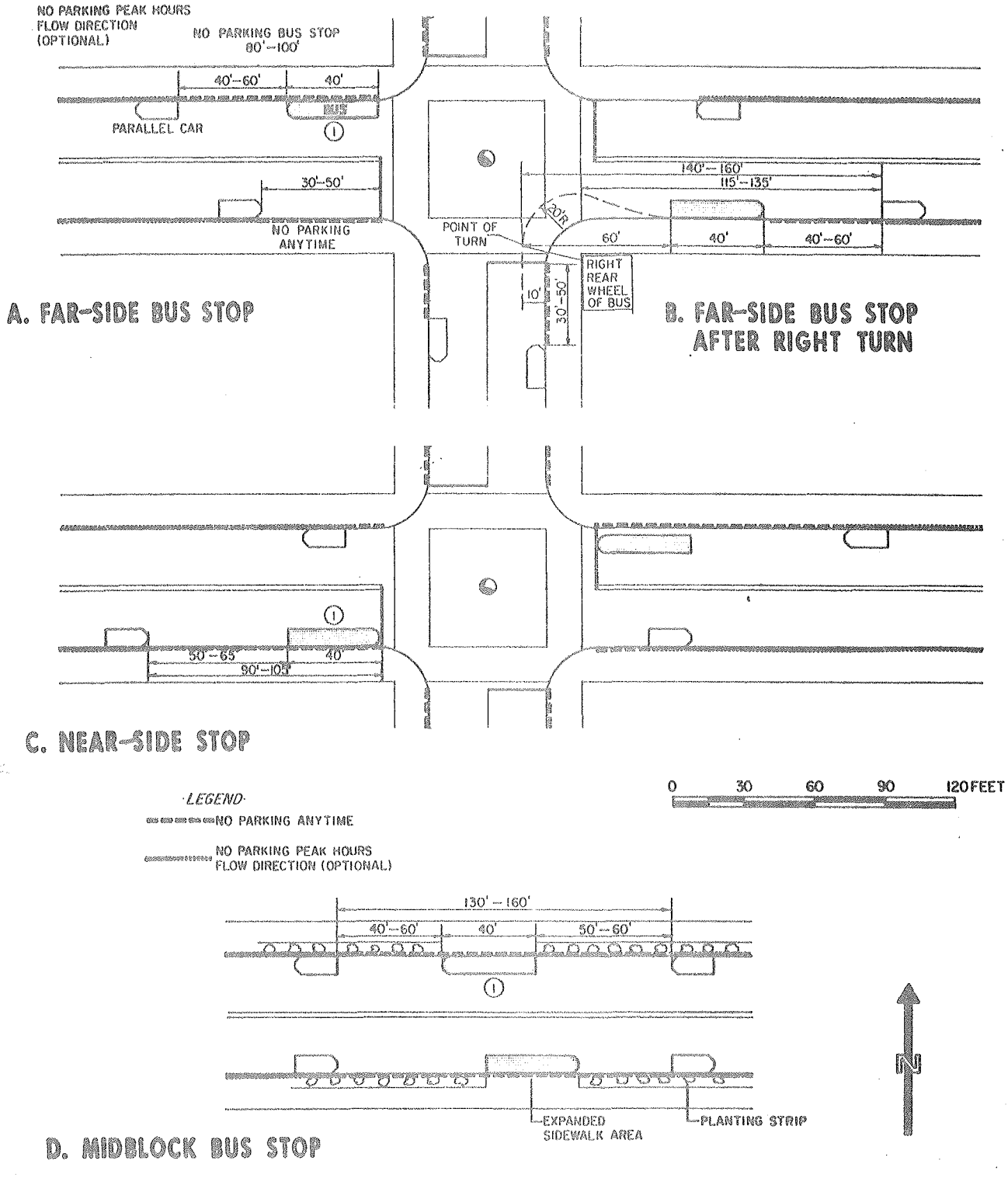
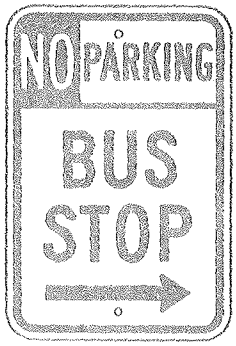


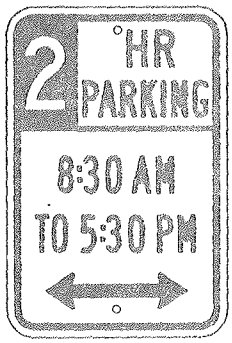
Figure 89. Bus stop design standards.

R7-1
12" x 18"

R7-3
12" x 18"



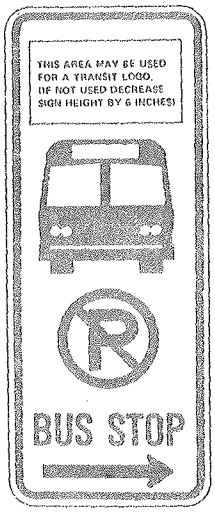
R7-107
12" x 18"



R7-108
12" x 18"

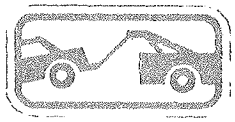
R7-2a
12" x 18"

R7-4
12" x 18"



R7-107a
12" x 30"

R7-201
12" x 6"



R7-201a
12" x 6"

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