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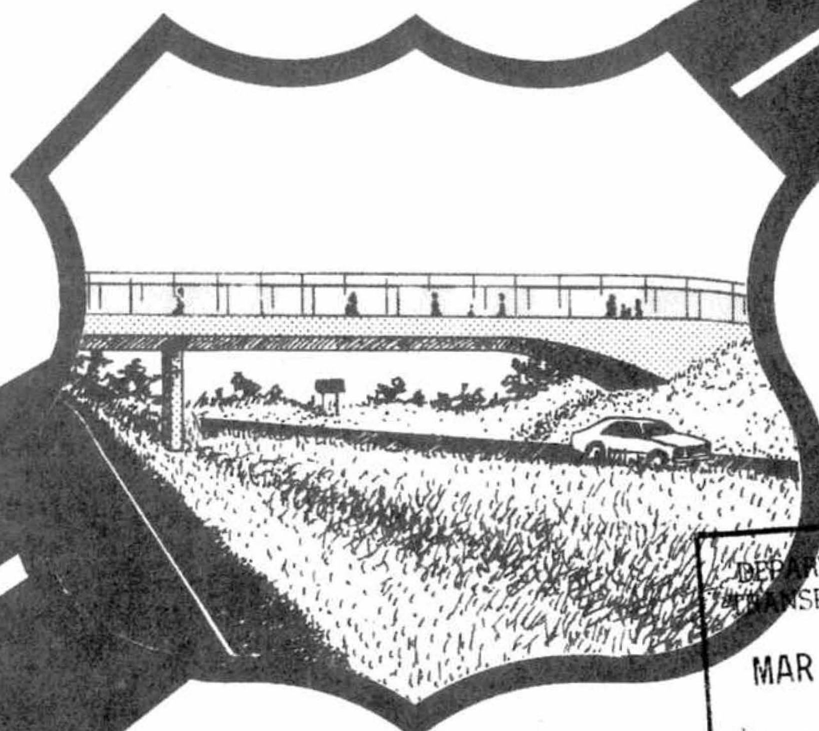
HE FEASIBILITY OF ACCOMMODATING PHYSICALLY ANDICAPPED INDIVIDUALS ON PEDESTRIAN OVER AND UNDERCROSSING STRUCTURES

September 1980

Final Report



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Prepared for
FEDERAL HIGHWAY ADMINISTRATION
Offices of Research & Development
Environmental Division
Washington, D.C. 20590

FOREWORD

This report describes the evaluation of a sampling of over- and undercrossing structures to identify major and minor access barriers for the physically handicapped. From this evaluation, it was determined that it is feasible to accommodate the physically handicapped on crossing structures. However, further research on specific design problems (ramp gradients, lengths, etc.) is needed before recommendations for the design or retrofitting of over- and undercrossing structures can be developed.

Research in pedestrian safety is included in the Federally Coordinated Program of Highway Research and Development as Task 1 of Project 1E, "Safety of Pedestrians and Abutting Property Occupants." Mr. John C. Fegan is the Project Manager.

One copy of this report is being distributed to each FHWA regional and division office.

for D. Solomon
Charles F. Scheffey
Director, Office of Research
Federal Highway Administration

NOTICE

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16. Abstract

The objective of this study was to determine the feasibility of accommodating the physically handicapped on over- and undercrossing structures. Based upon the evaluation of 124 crossing structures, 86 percent of these structures had at least one major access barrier. Alternative solutions for identified major access barriers were developed and examined for cost effectiveness. These identified solutions must be field tested before wide scale implementation. It was concluded that both major and minor access barriers can be eliminated. However, research is needed on specific design problems (ramp gradients, lengths, etc.) before recommendations for the design or retrofitting of crossing structures can be developed. When recommended design guidelines have been determined, it is feasible that alternative solutions can be developed for making existing and new structures accessible to the physically handicapped.

17. Key Words

Pedestrians, Elderly, Handicapped, Major Access Barriers, Over- and Under-crossings, Accessibility, Barriers, Ramps, Curbs, Wheelchairs.

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GENERAL ACKNOWLEDGEMENTS

We would like to acknowledge the extraordinary assistance that we received from a very large number of organizations and individuals in carrying out this study. Invaluable assistance was afforded by members of the Federal Highway Administration, especially Phebe Howell. Special appreciation is extended to the following cities for their cooperation: Atlanta, GA; Baltimore, MD; Boston, MA; Denver, CO; Dallax, TX; Fort Worth, TX; Davis, CA; Sacramento, CA; San Francisco, CA.

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INTRODUCTION

Within the past two decades there has been increasing effort to eliminate environmental barriers that prevent or limit the mobility of elderly and handicapped persons. However, these efforts have been directed largely at the elimination of barriers which exist in buildings rather than barriers in the pedestrian system. Crossing structures, as well as other pedestrian provisions such as sidewalks, streets, street crossings, public open spaces, parks and recreation areas, are often inaccessible.

This study was undertaken to determine the feasibility of accommodating physically handicapped individuals on pedestrian over- and undercrossing structures.

Definitions

The American Association of State Highway and Transportation Officials' Policy on Design of Urban Highways and Arterial Streets defines over- and undercrossings as follows: "A grade separation is defined as a crossing of two highways, or a highway and a railroad, at different levels. The terms 'overpass' and 'overcrossing' are used to designate the grade separation where the subject highway passes over an intersecting street or railroad. The terms 'underpass' and 'undercrossing' apply where the subject highway passes under the street or railroad."[1] This definition is directed toward vehicular crossings and is somewhat limited when applied to the pedestrian situation. For the purposes of this report this definition has been expanded to include crossings over or under natural features such as rivers, crossings which pass through buildings and air-rights structures. The crossings themselves are those which accommodate vehicular, bicycle, and/or pedestrian traffic.

For the purposes of this report the definition of a handicapped individual will be "any person who (a) has a physical or mental impairment which substantially limits one or more of such person's major life activities; (b) has a record of such impairment; or (c) is regarded as having such impairment." This definition appears in the Rehabilitation Act Amendments of 1974[2] U.S.C. 706(6). For a further discussion of the definition of the handicapped refer to the report, "Provisions for Elderly and Handicapped Pedestrians: Volume 2, Hazards, Barriers, Problems and the Law".[3]

Legal Requirements

Legislation directed at the elimination of architectural barriers has had little impact on the pedestrian environment because its primary emphasis has been on buildings and in particular, buildings financed with federal or state funds. Several laws contain references to the needs and rights of elderly and handicapped citizens. The

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[1] American Association of State Highway and Transportation Officials, A Policy on Design of Urban Highways and Arterial Streets, Washington, DC, 1973, p. 499.

[2] Rehabilitation Act Amendments of 1974, P.L. 93-516

[3] "Provisions for Elderly and Handicapped Pedestrians: Volume 2 Hazards, Barriers, Problems and the Law", Federal Highway Administration, FHWA-RD-79-2.

"Architectural Barriers Act" of 1968 as amended requires the establishment of minimum accessibility standards for buildings and facilities constructed with Federal funds. The requirements for elimination of barriers also include transportation systems, housing and community development (Urban Mass Transportation Act of 1964 as amended, Federal Aid Highway Act of 1973 as amended, Surface Transportation Assistance Act of 1978), and "services to assist physically and mentally impaired older people to lead more independent lives" (Older Americans Act of 1965 as amended).

The Surface Transportation Assistance Act of 1978 includes specific reference for pedestrians. It allows Federal aid highway funds to be used for construction or improvement of pedestrian walkways and grants the authority to require states to purchase adequate highway rights-of-way to accommodate bicyclist and pedestrian travel.

Although none of these laws identify crossing structures specifically, they do refer to the removal of architectural barrriers in public buildings and facilities. The Architectural and Transportation Barriers Compliance Board interprets "facilities" as defined by the "Architectural Barriers Act" (Public Law 90-480, 1968) to include pedestrian provisions such as crossing structures (see Appendix A for a full discussion of Federal Laws and Regulations which are applicable).

The Nature of the Study

In May 1978, De Leuw, Cather and Company of San Francisco conducted an analysis of over- and undercrossings with respect to their use by bicyclists, pedestrians, and the handicapped for the Federal Highway Administration. As a part of this work, project descriptions were compiled of crossing structures particularly those incorporating new or retrofitted facilities for bicycles and pedestrians. Data was collected for 47 new projects and 25 retrofit projects from 16 states in the United States. On the basis of this data some tentative conclusions were drawn about current decision-making procedures and design practices. Comprehensive evaluations were made of six sites selected as representative of promising new designs, design modifications and non-structural solutions.

The present study builds upon and develops the initial work by De Leuw, Cather and Company. The purpose of the research is to explore the feasibility of accommodating elderly and handicapped individuals on proposed and existing pedestrian over- and undercrossing structures. Specifically the objectives are:

a. to identify environmental hazards and barriers which limit or impede elderly and handicapped pedestrians in negotiating crossing structures;

b. to develop a typology of crossing structures and barriers to their use;

c. to assess the feasibility of design solutions for the retrofit of existing crossing structures and the construction of new structures;

d. to define those areas for which further research is needed in order to be able to develop specifications for accessible crossing structures.

The report that follows is subdivided into five major sections as follows:

Task 1: Review of Federal Legislation and Regulations

The first task involved a review of Federal legislation and regulations as they pertain to the provision of crossing structures for pedestrians and the accessibility of structures to handicapped individuals. The primary information source for this task was the survey of legislation previously conducted by researchers of the Pedestrian Research Laboratory entitled "Provisions for Elderly and Handicapped Pedestrians: Volume 2, Hazards, Barriers, Problems and the Law". Legislation and regulations which were enacted subsequent to this survey were also reviewed. The main function of this task was to examine which legislation (if any) is applicable to crossing structures.

Task 2: Development of a Barriers Matrix

This task involves the development of a matrix which identifies the environmental factors associated with over- and undercrossings which may pose problems or hazards to elderly and handicapped pedestrians, and provides an assessment of the extent to which persons with handicapping conditions are affected by each of these hazards or barriers. One axis of this matrix represents the functional constraints which result from physical handicaps such as bilateral amputation, congenital blindness, etc. Examples of these functional restraints are loss of balance, limited stamina, upper body restrictions, etc. The other axis of this matrix represents the environmental factors associated with over-and undercrossings which may pose problems or hazards to the handicapped, such as surfaces, ramps, railings, etc.

Task 3: Survey of a Sample of Over- and Undercrossings

In order to provide a data base of the types of crossing structures which exist, and to determine if existing structures are accessible to elderly and handicapped pedestrians, a survey of a sample of crossing structures was conducted. On the basis of this survey a typology of existing environmental hazards and barriers which prevent or impede the access of elderly and handicapped pedestrians was developed. In addition, the frequency with which each hazard or barrier occurs in the sample of structures was assessed.

Task 4: Development and Evaluation (Cost/Benefit) of Solutions

On the basis of the work completed in previous tasks, solutions are set out for both existing structures and new construction. Retrofit solutions for existing structures are proposed for the major structural problem conditions identified in Task 3. References to minor problem solutions and recommendations for the construction of new crossing structures are made in response to the problems/conditions identified in the Barriers Matrix (Task 2).

Each of the alternative problem solutions have been evaluated in terms of their costs and benefits, resulting in overall conclusions as to feasibility. However, the Barriers Solutions Matrix shows that there are some problems (which do not alter the conclusions on feasibility) for which solutions are unknown, questionable, or based on conventional wisdom. These outstanding questions are set out in Task 5.

Task 5: Conclusions and Recommendations

Overall conclusions have been drawn as to the feasibility of solutions for the retrofit of existing structures and the construction of new structures. Recommendations for further research and evaluation are set out.

TASK 1: REVIEW OF FEDERAL LEGISLATION AND REGULATIONS

In order to understand more fully the legal responsibilities of the Federal Government with respect to the provision of crossing structures for pedestrians and the accessibility of structures to handicapped individuals, a review was conducted of Federal legislation and regulations from 1960 to the present (see Appendix A). A major information source for this review was the survey of legislation previously conducted by researchers of the Pedestrian Research Laboratory entitled, "Provisions for Elderly and Handicapped Pedestrians: Vol. 2, Hazards, Barriers, Problems and the Law." Legislation and regulations which had been enacted subsequent to this survey were also reviewed.

Although none of these laws identify crossing structures specifically, they do refer to the removal of architectural barriers in public buildings and facilities. The Architectural and Transportation Barriers Compliance Board interprets "facilities" as defined by the "Architectural Barriers Act" (Public Law 90-480, 1968) to include pedestrian provisions such as crossing structures. Several significant laws have contained reference to the needs and rights of elderly and handicapped citizens. The "Architectural Barriers Act" of 1968 as amended requires the establishment of minimum accessibility standards for buildings and facilities constructed with Federal funds. The requirements for the elimination of architectural barriers also include transportation systems, housing and community development (Urban Mass Transportation Act of 1964 as amended, Federal-Aid Highway Act of 1973 as amended, Surface Transportation Assistance Act of 1978), and "services to assist physically and mentally impaired older people to lead more independent lives" (Older Americans Act of 1965 as amended). The Surface Transportation Assistance Act of 1978 includes specific reference to provisions for pedestrians. It allows Federal-aid highway funds to be used for construction or improvement of pedestrian walkways and grants authority to the states to purchase adequate rights-of-way to accommodate bicyclist and pedestrian travel.

These laws and the interpretation of "facilities" by the Architectural and Transportation Barriers Compliance Board set the precedent for the accessibility of over- and under-crossing structures.

TASK 2: DEVELOPMENT OF A BARRIERS MATRIX

The population of elderly and handicapped individuals represents a wide range of handicapping conditions. Certain features of the environment may prevent or impede access for certain subgroups of this population but not for others. A Barriers Matrix was developed in order to:

1. identify the environmental hazards and barriers that may be present in crossing structures and may affect elderly and handicapped pedestrians;

2. identify the particular target group(s) affected by each hazard or barrier;

3. determine a severity rating for the barrier for each target group affected.

A preliminary matrix was developed. This was substantiated later and refined on the basis of additional data collected from: a) the sampling of 124 crossing structures in six urban Federal Highway Adminstration regions, and b) panel discussions conducted with handicapped users in each of these regions.

One axis of this matrix (see Appendix C: Barriers Matrix) represents the specific types of environmental factors associated with over- and undercrossings which may pose problems or hazards to the handicapped, such as surfaces, ramps, railings, etc. It should be noted that the environmental barriers/hazards that have been included in this and the other matrices described in this report are not based solely on the American National Standards Institute "Specifications for making buildings and facilities accessible to, and usable by, the physically handicapped" (ANSI A117.1 - 1961 (R1971). The matrices are based on a state-of-the-art that has changed substantially over the past decade. The preliminary listing of these environmental factors, and the problems and hazards they pose for handicapped user-groups, was developed on the basis of previous research at the Pedestrian Research Laboratory,[1] the work conducted at Syracuse University on the proposed revisions to the ANSI Standards, and the work of De Leuw, Cather and Company.

From January 31 through February 2, 1979, working sessions were held with Dr. Bruce Blasch from the Department of Studies in Behavioral Disabilities at the University of Wisconson, Madison, and members of the Pedestrian Research Laboratory. During these sessions 157 potential hazards and barriers were identified. This list was then reviewed, and a number of redundant or overlapping entries were combined. The 72 case studies of over- and undercrossing structures compiled by De Leuw, Cather and Company were reviewed for additions or revisions. The final list of environmental factors contains 100 potential hazards and barriers (that may affect the use of crossing structures) within the following 14 major categories:

1. Location and end condition;
2. Walkways;
3. Surface Materials;
4. Maintenance;
5. Stairways;
6. Ramps;
7. Handrails;
8. Elevators/Escalators;
9. Guardrails, Barricades, Pedestrian/Vehicular Separation;

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[1] "Provisions for Elderly and Handicapped Pedestrians: Volume 2, Hazards, Barriers, Problems and the Law", Federal Highway Administration, FHWA-RD-79-2.

10. Rest Areas/Benches;

11. Lighting, Illumination;

12. Emergency Provisions;

13. Signage/Media Cues; and

14. Microclimatic Factors, Weather, Pollution.

The other axis of the matrix represents the functional constraints which result from physical handicaps. An individual's mobility may be limited by a variety of factors and it is necessary to consider these factors in some detail. Many earlier studies directed at environmental barriers considered only those who use wheelchairs and those with severe visual impairments.

In the initial phases of the Pedestrian Research Laboratory's study "Provisions for Elderly and Handicapped Pedestrians", the target group was sub-divided into nine sub-groups -- those with severe visual impairments; severe auditory impairments; chronic impairment of the upper extremities; wheelchair users; those with developmental disabilities in terms of size and maturity; those with chronic restrictive conditions related to agility, stamina and reaction time; those who walk using special aids; those who walk with difficulty without the use of special aids; and those with obvious confusion and/or disorientation. But even with this expanded categorization, there is a distinct probability that those handicapping conditions that do not affect large numbers of people, will tend to be neglected.

In order to generate a list of disabling causes that is reasonably inclusive and comprehensive, yet not so exhaustive that the resulting matrix would be unmanageable, a revised version of a check list developed by Blasch & Welsh[1] was developed in consultation with Dr Bruce Blasch. The original Blasch and Welsh list is presented in Table 1.

During the working sessions with Dr. Blasch, 78 functional disabilities were identified. Following review and revisions, this list was collapsed to form a final listing of 41 functional disabilities in nine categories. These nine categories of handicapping conditions are as follows:

1. sensory disorders (blindness, low vision, deafness, hearing loss, vestibular and kinesthetic disorders);

2. circulatory disorders (arteriosclerosis, heart disease);

3. orthopedic disorders (amputation, rheumatoid arthritis, degenerative joint disease);

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[1]Blasch, Bruce D. and Welsh, Richard, Generic Mobility Training for the Handicapped, Unpublished Manuscript, 1979.

Table 1 Individual Conditions
(Factors Necessary for Independent Mobility)

I. Cognitive Factors	1. Concept Development 2. Problem Solving and Decision Making Abilities 3. Orientation Abilities 4. Information Processing Abilities
II. Psychomotor Factors	5. Perceptual Abilities 6. Body Awareness (Body Image, Body Concepts and Body Schema) 7. Posture and Postural Sway 8. Balance 9. Gait 10. Endurance/Stamina 11. Strength 12. Flexibility 13. Agility 14. Perceptual/Motor Coordination
III. Personality Factors	15. Lack of Confidence or Overconfidence 16. Embarrassment 17. Fear 18. Anxiety 19. Self-Concept
IV. Information Acquisition Factors	20. Reading Abilities (e.g., Symbols, Signs) 21. Listening Abilities (e.g., Communicative, Warning Sounds) 22. Haptic Exploration Abilities

4. respiratory disorders (emphysema, allergy and asthma);

5. cognitive and perceptual disorders (learning disabilities, mental retardation);

6. endocrine disorders (obesity, bodily disproportion, diabetes);

7. disorders associated with age (decreased visual acuity, poor balance, slow reflexes, decline in short-term memory, etc.);

8. communicative disorders (articulation, retarded speech development, aphasia);

9. disorders of the central nervous system (neoplasms, epilepsy, cerebral palsy, multiple sclerosis, Parkinson's disease, spinal cord dysfunctions, stroke).

The final matrix contains 4,100 cells each of which represents a potential problem for someone with one (or more) of the handicapping conditions. It must be emphasized that the matrices (Barriers, Appendix C and Solutions, Appendix G) only indicate general tendencies because the items listed in the columns and row headings do not and cannot define conditions with great precision. Poor night vision is a functional disability, for example, but poor night vision can vary from being a severe to a slight impediment. Similarly an uneven and irregular surface (listed under surface materials) obviously lacks definitive precision as a barrier; that which is perceived as uneven and irregular for those who use wheelchairs may be quite different for those who are severely visually handicapped.

However, for the purposes of establishing the feasibility of access to crossing structures, we are interested in establishing, within fairly wide boundaries, the extent to which people with a particular functional disability are limited in their use of crossing structures and the extent of the limitation is indicated in the Barriers Matrix as shown by the selection of one out of four degrees of difficulty:

N = no mobility problem;

I = inconvenient;

D = causes considerable difficulty;

B = an impassible barrier.

In the example above, an uneven and irregular surface is judged to be no more than inconvenient (I) for someone with impaired night vision, whereas for someone who uses a wheelchair, the same surface may cause considerable difficulty (D). Obviously, for some people with impaired night vision, and under certain lighting conditions, an uneven and irregular surface might cause considerable difficulty, or even constitute an impassible barrier.

The barriers matrix is therefore, a tool to measure accessibility and in this case, to indicate the potential degrees of accessibility of the various elements that might exist in existing or be designed for in new typical over- and undercrossings. The information from the Barriers Matrix was used in Task 4 as input to a solutions matrix (see Appendix G) and this is discussed later.

TASK 3: SURVEY OF A SAMPLE OF OVER- AND UNDERCROSSINGS

In order to provide a data base of the types of crossing structures which exist, and to determine if existing structures are accessible to elderly and handicapped pedestrians, a survey of a sample of crossing structures was conducted. On the basis of this survey a typology of existing environmental hazards and barriers which prevent or impede the access of elderly and handicapped pedestrians was developed. In addition, the frequency with which each hazard or barrier occurs in the sample of structures was assessed.

To ensure a reasonably representative sampling of existing crossing structures, yet obtain results relatively quickly at reasonable cost, it was decided that a cluster of structures would be sampled in each of several major cities in various regions of the country. To account for possible regional variations, cities were selected from six different Federal Highway Administration regions, representing the northern, southern, eastern and western sections of the country. The State highway agencies in each state were contacted in order to identify a listing of over- and undercrossing structures in each of these cities. Each state highway agency was asked to include in its listing, over- and undercrossing structures within a 20 mile radius of the downtown area which were either for pedestrians only, pedestrians and bicycles, or pedestrians and vehicles (if the structure was located in a place with high pedestrian demand).

Three types of data were collected for each crossing structure in the sample. First, a photographic record was made at each site. This record provides information on the type of structure, i.e., on whether the structure is an over- or undercrossing; the environmental feature crossed (roadway, railroad, water body, etc.); the type of construction and major features of the structure (ramp, stairs, handrails, etc.); and the character of the immediate surroundings and the availability of space for any new construction that might be needed. Any major problems (environmental barriers) or hazards were also photographically recorded.

The second method of data collection was the measurement of certain key dimensions including: the slope and cross-slope of ramps; the length and width of walkways, ramps and stairs; height of handrails, stair tread and riser dimensions; the total height which pedestrians must mount to gain access to the structure; etc. Measurements were also made of any additional hazards and/or barriers, for example, the location and width of expansion joints, gratings, etc.

The final method of data collection was an environmental factors checklist (see Appendix B: Data Collection Form). The items on the checklist were developed from the list of environmental hazards and barriers which form the horizontal axis of the preliminary matrix. For each crossing structure evaluated, the presence or absence of each environmental hazard and/or barrier was noted. Space was also available on the data collection form for comments as to the extent of the problem and for recording critical dimensions.

In addition to site surveys, contact was made with the Governor's Committee on the Handicapped in five of the major states (Maryland, Massachusetts, Texas, Colorado, and California) to arrange a panel discussion with people who either are handicapped themselves, work with handicapped people, or who are specialists in mobility training and environmental barriers. The purpose of the panel discussions was to elicit information on the particular nature of the hazards and barriers that are present at the over- and undercrossing structures which the handicapped use, or are prevented from using. During the course of these two-hour sessions, each of the 14 major categories of hazards and barriers was discussed. As a result of these discussions several major concerns which may pose problems or hazards to the handicapped were identified:

Location and End Condition: Most often mentioned is the problem of the driver's view of the pedestrian being blocked by either parked cars, planting, or street furniture. This is a particular problem for people in wheelchairs, adults of small stature and children, and the severely visually impaired. A specific concern is where an at grade pedestrian crossing occurs on an off-ramp where cars are moving at high speed and no traffic control device is available.

Walkways: Major concerns centered on adequate provisions for pedestrians. Walkway width is important particularly for persons in wheelchairs. Structural vibration or sway is of concern to persons with balance problems or fear of high places.

Surface Materials: Surface treatment and the condition of walkway surfaces is a major concern. A particular problem is uneven or irregular surfaces, and expansion joints.

Maintenance: Disrepair from natural causes or vandalism was identified as a problem by many of the participants.

Stairways: The major problem associated with stairways is the provision of stairways as the only means of access to a structure.

Ramps: Several problems are of major concern: the lack of curb cuts, steep ramps, ramps with cross slopes and long ramps.

Handrails: The provision of handrails, and handrails of proper design, was identified as of major importance to persons in wheelchairs, persons with balance problems, the elderly, etc. Particularly desirable is a handrail that is adequate for a comfortable grasp, yet broad enough to provide easy support for someone with balance problems.

Guardrails: Of major importance is the protection of walkways designed for pedestrian use from vehicular traffic, edges, etc. In addition to a physical separation, a need was expressed for a barrier which appears visually substantial to offset fear of high places.

Signage/Media Cues: Two major concerns were expressed: the lack of orientation cues or special signage for the visually impaired to help them locate crossing structures, and traffic lights with short green cycles.

Micro-Climatic Factors, Weather, Pollution: The problem of high winds was identified as a major concern by the participants in Sacramento, Calif. and in Dallas, Texas. Walkways which were not kept clear of ice and snow was a problem of pedestrians in Boston, Mass. and Baltimore, Maryland.

Findings

A total sample of 124 crossing structures were surveyed in the nine cities. Data sheets which illustrate their hazards and/or barriers were completed for each of these case examples. The findings for each city were assembled into composite profiles (Appendix D) and then the data from all the cities were compiled into two matrices: one for overcrossing structures (Appendix E) and one for undercrossing structures (Appendix F). The latter matrices identify the occurence of particular hazards and/or barriers by city as well as in total for each crossing type.

Tables 2 and 3 show the types of crossing structures that are present in the sample surveyed. The proportion of structures in each category is not necessarily the same as that in the universe of crossing structures. Nevertheless, the figures provide an indication. The major exception is that over and undercrossings that are primarily roads (with or without provisions for pedestrians) across freeways are substantially under represented in the sample. The overwhelming majority of structures in the sample were overcrossings (103 out of 124 = 83%) that cross over roads and freeways, and accommodate pedestrians and cyclists.

Table 2 Crossing Structures Surveyed:
Traffic Accommodated and Type of Structure

Traffic Accommodated	Overcrossings		Undercrossings		Total	
	Number	% of Over	Number	% of Under	Number	% of Total
Pedestrians only	32	31.07	3	14.29	35	28.23
Pedestrians/cycles	57	55.34	11	52.38	68	54.84
Pedestrians/cycles/ vehicles	14	13.59	7	33.33	21	16.93
TOTALS	103	100.00	21	100.00	124	100.00

Table 3 Crossing Structures Surveyed:
Feature Crossed and Type of Structure

Feature Crossed	Overcrossings		Undercrossings		Total	
	Number	% of Over	Number	% of Under	Number	% of Total
Roadway	89	86.41	19	90.48	108	87.10
River/water	11	10.68	1	4.76	12	9.68
Shopping plaza	1	0.97	-	-	1	0.80
Other	2	1.94	1	4.76	3	2.42
TOTALS	103	100.00	21	100.00	124	100.00

None of the over/undercrossings from the sample are completely barrier free (using the matrix as the assessment measure). There is an average of twenty barrier type problems per structure in this sample, but the average number of problems varies considerably from city to city. City C has 16 structures with an average of 30 problems per structure; while City E has three structures with an average of only twelve problems per structure. The most likely explanation why the structures in these cities differ so extensively is that the cities have been observing different guidelines, and that some of the structures are much older than others.

Some structures had minor problems that could be modified without much difficulty. However, 107 (86.3%) of the crossings have at least one major access barrier.

A major access barrier in this context is "major" in the sense that to remedy the defect will require substantial modifications of the over/undercrossing in the form of new construction or reconstruction. The remaining (minor) barriers can usually be remedied at a comparatively small cost.

The major access barriers have been divided into those that occur on or close to the end conditions, the approaches, and the structures. The end condition is where the over/undercrossing meets the adjoining roads or walkways. The structure refers to the section of the crossing that spans over or tunnels under the road, river, etc. And the approaches are the stairs, ramps, walkways, etc. that connects the structure to the end conditions.

Twenty-one types of major access barriers have been identified and these major access barriers are described and illustrated later (in Task 4) together with alternative solutions to these barriers, and cost/effectiveness comparisons of these solutions.

If the data are examined using strict compliance with the ANSI standards as the measure, the results are somewhat different. In other words, if one examines only the over/undercrossings and not the roadways, sidewalks, etc. which immediately adjoin and connect to the structure, and if one only considers those aspects of the crossing structures that are specifically covered by the ANSI specifications, then 80 (64.5%) of the crossings investigated had at least one major access barrier. This is a smaller number than resulted from the more comprehensive evaluation list, but it shows that nearly two thirds of all the crossing structures examined are not accessible.

An examination of Appendices E and F, which are compilations of all the data from all the sites, shows that certain types of access problems are prevalent. For example, in terms of major access barriers to overcrossings:

15% have stairs as the only means of access;

49% have ramps as the only means of access;

60% have ramps that exceed 30 ft. in length without a landing;

52% have ramps that are steeper than 1:12;

28% have spanning structures whose walkway gradients are steeper than 1:12, and whose length exceeds 30 ft. in length without a landing;

48% cannot be accessed from the adjoining roads or walkways because no curb cuts, etc. have been provided;

96% would be difficult for severly visually handicapped people to find and to locate the end points.

In terms of minor access barriers to overcrossings, we find, for example, that:

37% have large, deep expansion joints that would be a barrier to some;

28% have poorly lit steps, stairs, and ramps;

43% have poor artificial illumination. In almost every case, light fittings are no longer operative and are not maintained in working condition;

27% are in a state of disrepair that makes access difficult for some;

30% of ramps exit directly into a street or parking area in a way that might be dangerous;

32% have handrails that are too high;

37% have no handrails, where handrails are needed;

58% have handrails that may be too hot or cold to use in summer and winter;

33% have handrails that are not continuous;

28% have handrails that do not extend far enough;

72% do not have places to stop and rest;

95% do not have any provision in the case of an emergency.

This is only a selection of problems that are prevalent in overcrossings. A similar range of problems have been found in the sample of undercrossings. The following is a summary of the findings from the sample of over- and undercrossings:

TYPOLOGY

87% of the structures cross roads;

55% accommodate pedestrians and cycles, 28% accommodate pedestrians only; the remainder accommodate pedestrians, cycles, and vehicles;

83% of the structures are overcrossings;

ACCESSIBILITY

None of the crossing structures surveyed are barrier free;

86% of the structures surveyed have at least one major access barrier;

Certain types of major access barriers are prevalant. In particular ramps are commonly too steep and too long; sometimes only stairs or only ramps are provided; frequently the structures are not useable to all because the roadways and walkways leading to them are not connected in a way that provided access -- typically no curb cuts and crosswalks are provided; many crossing structures are difficult for severely visually handicapped people to locate within the walkway system;

Certain types of minor accessibility problems occur in many of the crossing structures. Walk surfaces, etc. on the sides of the crossing structures and ramps frequently have abrasive surfaces that might cause severe abrasions to cyclists or wheelchair users that brush against it; there are large expansion joints in many structures; there are no curb ramps in the walkways connecting to the crossing structures; handrails are too high, not continuous, not long enough, too hot or cold to the touch, or are not provided at all, etc.

TASK 4: DEVELOPMENT AND EVALUATION OF SOLUTIONS

In Task 4 the feasibility (and cost/effectiveness) of retrofitting existing crossing structures to make them accessible, and the feasibility of accommodating handicapped people wishing to use new structures, is examined in terms of solutions to the problems that have been found.

Retrofit Solutions for Existing Structures

In the discussion that follows the retrofitting of existing structures is considered, as before, in terms of major and minor access barriers. The minor access barriers have been identified in the Barriers Matrix (Appendix C) and in the city matrices (Appendices D, E, and F). The current state-of-the-art in terms of solutions (or the absence of known solutions) to these minor barriers is shown in the Barriers Solutions Matrix (Appendix G) which is discussed later.

In general, it can be concluded that there are available solutions to the minor access barriers and that it is feasible to correct these deficiences in existing structures. For example:

- handrails can be fitted, raised or lowered as needed;
- structural expansion joints can be reformed so that they no longer prevent wheelchair users from using the walkway surface;
- curb cuts at linking access roads can be constructed;
- artificial illumination can be improved and made more vandal proof, etc.

Nevertheless, as will be seen from the Barriers Solutions Matrix (Appendix G), there are still problems for which solutions must be developed, and the problems about which too little is known in order to be able to develop satisfactory solutions. These knowledge gaps are discussed later.

Solutions for Major Access Barriers

The major access barriers demand a much more extensive scrutiny than the minor barriers. Solutions for these barriers must be developed and then evaluated and compared. From the case studies described in Task 3, 21 major access barriers which occur frequently in the sample have been extracted. Table 4 sets out these typical problems in terms of the part of the crossing facility where the barrier occurs (end condition, approach, or structure), the type of barrier problem, and the site constraints that limit the space available for constructing modifications.

From Table 4, it can be seen that most of the barriers (17 out of 21) occur as a result of the design of the approach structures: ramps have been made too large and too steep, or ramp access has not been provided at all.

Rectifying these major access barriers necessitates the development of solutions that are practical and effective in terms of costs and benefits. For each of the 21 major barriers, several alternative retrofit solutions were discussed during strategy design sessions in August 1979 held at the Pedestrian Research Laboratory with the participation of Mr. Charles De Leuw of DKS Associates of Oakland, California.

Many of the alternative solutions are based on the ANSI specifications for ramps — ramps should not be steeper than 1:12 and should have landings after thirty feet of travel, etc. These criteria are in need of careful scrutiny; none of the research studies on ramps are comfortably applicable to crossing structures, and this is taken up later.

The evaluation of these (retrofit) solutions was carried out in two major steps. First, the cost of adapting (or reconstructing) the part of the crossing structures where the barriers occurred was estimated by DKS Associates based on current costs for the San Francisco area. It must be noted here that the purpose of this subtask is to compare competing alternative solutions, not to estimate the cost of retrofitting over- and undercrossings. The present study is not intended to show the magnitude of the problems nationally.

Secondly, the alternative solutions were checked to determine whether any negative effects on the various segments of the handicapped population might ensue. For this process, the solutions were evaluated using the Barriers Matrix (Appendix C) as the instrument. Obviously, field testing of the solutions finally recommended will be necessary to check these theoretical evaluations.

The 21 Major Access Barriers are described and illustrated in the pages that follow. The alternative solutions are shown and their costs indicated; details of these costs are provided in Appendix H. The recommended solutions in terms of cost/effectiveness are also shown.

Table 4 Types of Major Access Barrier

Segment of Crossing	Major Access Barrier No.	Type of Barrier Problem	Site Constraints
End	1	Barriers between access paths and the end condition.	Existing roads and sidewalks.
End	2	Pathway leading to over crossing too long and steep.	Existing topography.
Approach	3	Stairs only leading to overcrossing.	Space for modification available on both sides and end.
Approach	4	Stairs only leading to overcrossing.	Space for modification available on both sides only.
Approach	5	Stairs only leading to overcrossing.	Space for modification available on one side and the end only.
Approach	17	Stairs only leading to undercrossing.	Space for modification available on both sides only.
Approach	18	Stairs only leading to undercrossing.	Space for modification available (but restricted) on end only.
Approach	6	Straight ramp too long and too steep.	Space for modification available at one side and the end only.
Approach	7	Straight ramp too long and too steep.	Space for modification available on one side only.
Approach	8	Straight ramp too long and too steep.	Space for modification available at end only.
Approach	9	Ramp too long.	Space for modification available at end only.
Approach	10	Dogleg ramp too long and too steep.	Space for modification available at ends only.
Approach	11	Dogleg ramp too long and too steep.	Space for modification available at one side and one end only.

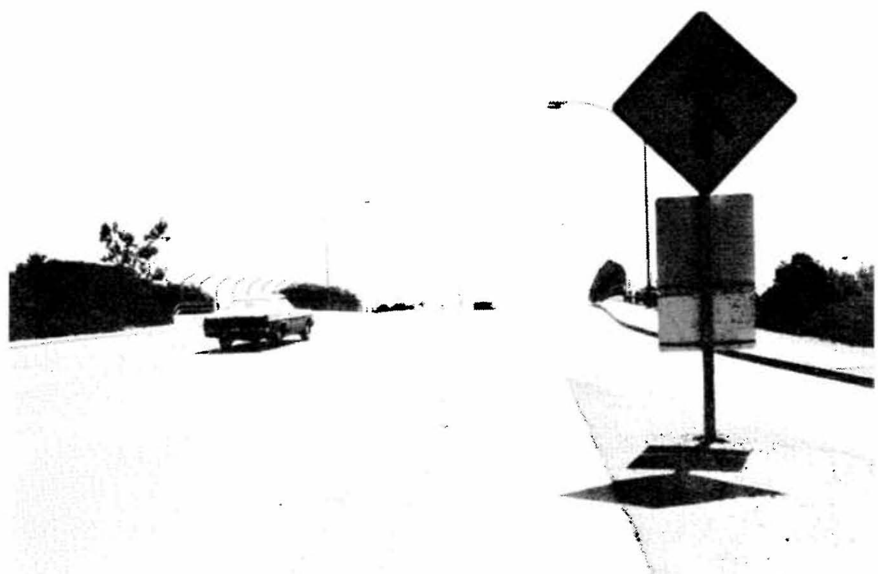
Table 4 Types of Major Access Barrier (continued)

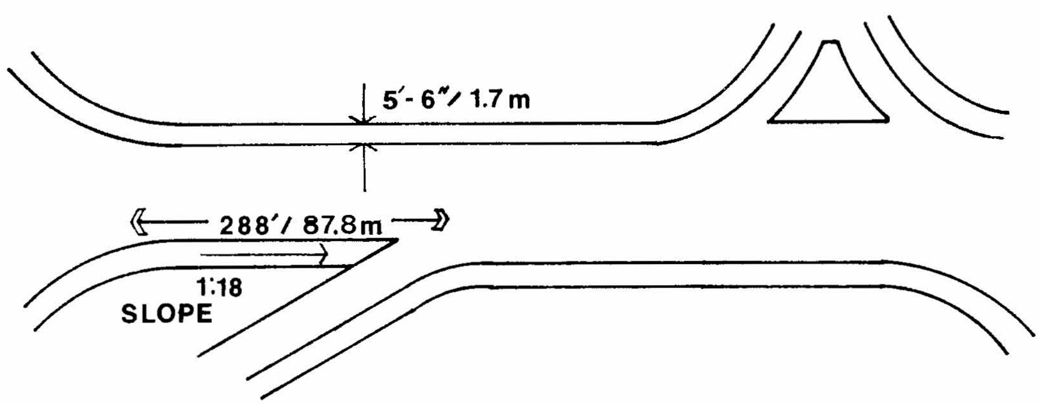
Segment of Crossing	Major Access Barrier No.	Type of Barrier Problem	Site Constraints
Approach	12	Multilevel dogleg ramps too long and too steep.	Space for modification available at both ends only.
Approach	13	Multilevel dogleg ramps with helical turns.	Space available for modifications at one end only.
Approach	14	Ramp on grade too long and steep.	Existing topography.
Approach	15	Helical ramp too long and too steep.	Space for modification available on one side only.
Approach	16	Cross slope on ramp is too great.	Not applicable.
Approach	19	No stairs provided; only a ramp.	Space available for modification on one side only.
Structure	20	Sidewalk on structure too narrow.	Not applicable.
Structure	21	Ramped walkway on structure too long.	Not applicable.

Major Access Barrier (1)

Description

Impediments to Reaching End Condition.





The Problem

This situation occurs typically where local roads cross over freeways, and off- and on-ramps are provided for access to and from the freeway. The ensuing roads and intersections may (or may not) have pedestrian sidewalks, but there are no special provisions for the handicapped.

Handicapped pedestrians who wish to use the overpass may not be able to negotiate curbs, and may be afraid to cross the roads if there are no traffic signals and if no crosswalks have been marked.

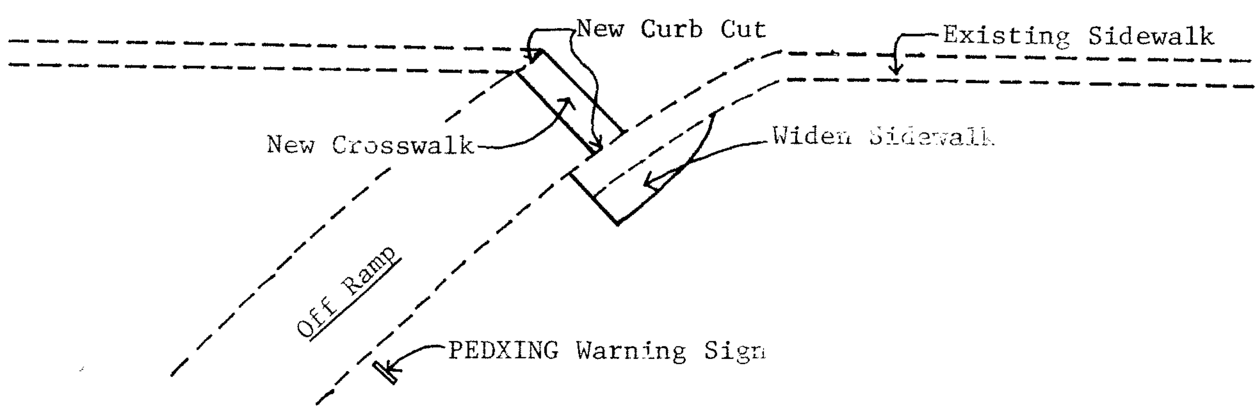
Alternative Solutions

- Install signing, striping and curb cuts.
- Install traffic signal.
- Construct ramp undercrossing.

Alternative No. 1

Install Signing, Striping, and Curb Cuts

Basic to providing an accessible route to persons who might wish to utilize the overcrossing include curb cuts and wheelchair ramps as well as crosswalk delineation and traffic signs warning drivers of a pedestrian crossing. Prototypical solution 1 is an example of a pedestrian crosswalk at a freeway off-ramp.



Cost

$2100 (see Appendix H for breakdown of cost estimates).

Other Costs

Skateboard riders, roller skaters, and cyclists may use the curb ramps provided. This may make sidewalk use somewhat more hazardous and uncomfortable for pedestrians, and may increase vehicular/pedestrian accidents at the bottom of ramps where these wheeled devices run out into traffic. On the other hand, the curb ramps may discourage skaters from using the streets.

Additional maintenance costs will be incurred.

Alternative No. 2

Install Traffic Signal

A pedestrian actuated traffic signal placed to control vehicular traffic at an intersection or midblock location will facilitate pedestrian crossings where volumes are heavy. The pedestrian actuation could be added to an existing traffic signal or be specifically designed for a new installation. Existing signals which already provide a pedestrian phase should be checked to assure the timing is adequate for the type of users anticipated.

Cost

$10,000, $15,000, $20,000 depending on type (see Appendix H for breakdown of cost estimates).

Other Costs

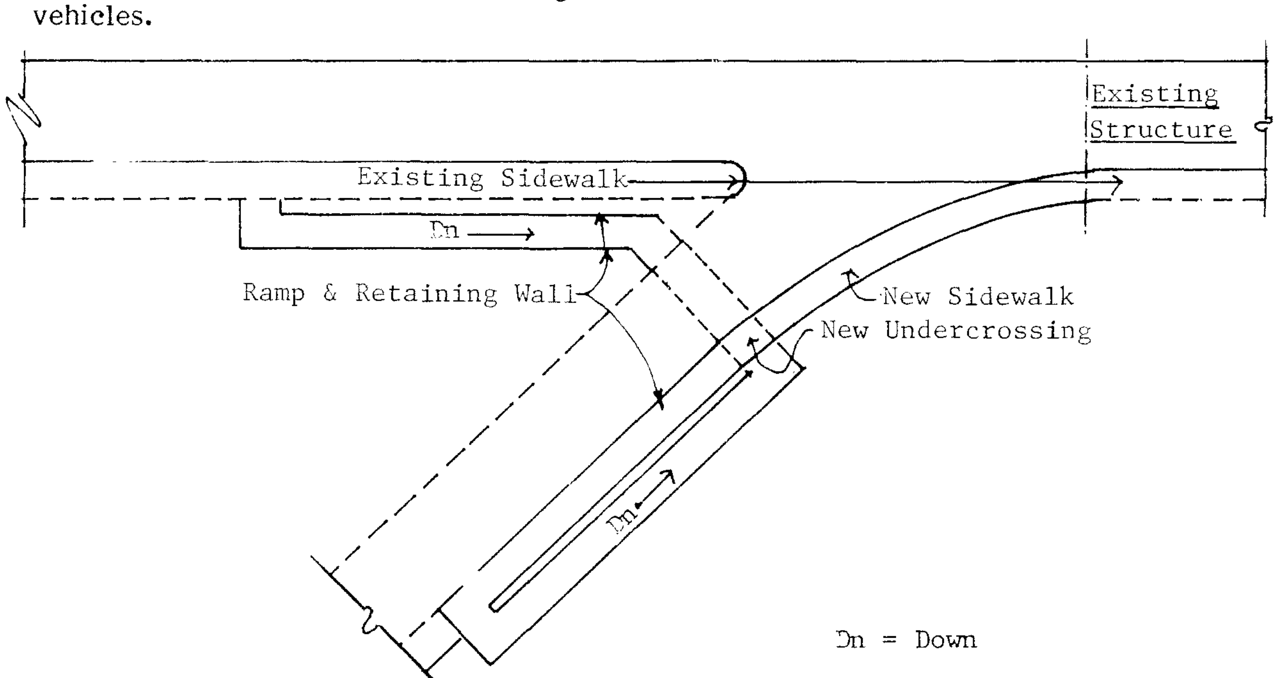
Increased gasoline consumption and time costs for vehicle users.

Increased maintenance costs.

Alternative No. 3

Construct Ramp Undercrossing

Physical grade separation can be achieved by constructing an undercrossing of the roadway ramp. The obvious advantage is that there need be no conflicts with motor vehicles.



Cost

$200,000 (see Appendix H for breakdown of cost estimate).

Other Costs

This solution requires the pedestrian (or the vehicles) to travel significantly further to make the grade changes. Also, undercrossings are thought to be the loci of increased criminal activity, and to require increased maintenance.

Summary of Alternative Costs

Alternative	Construction Cost
1 Install signing striping and curb cuts	$ 2,100
2 Install traffic signal	10,000
3 Construct ramp undercrossing	200,000

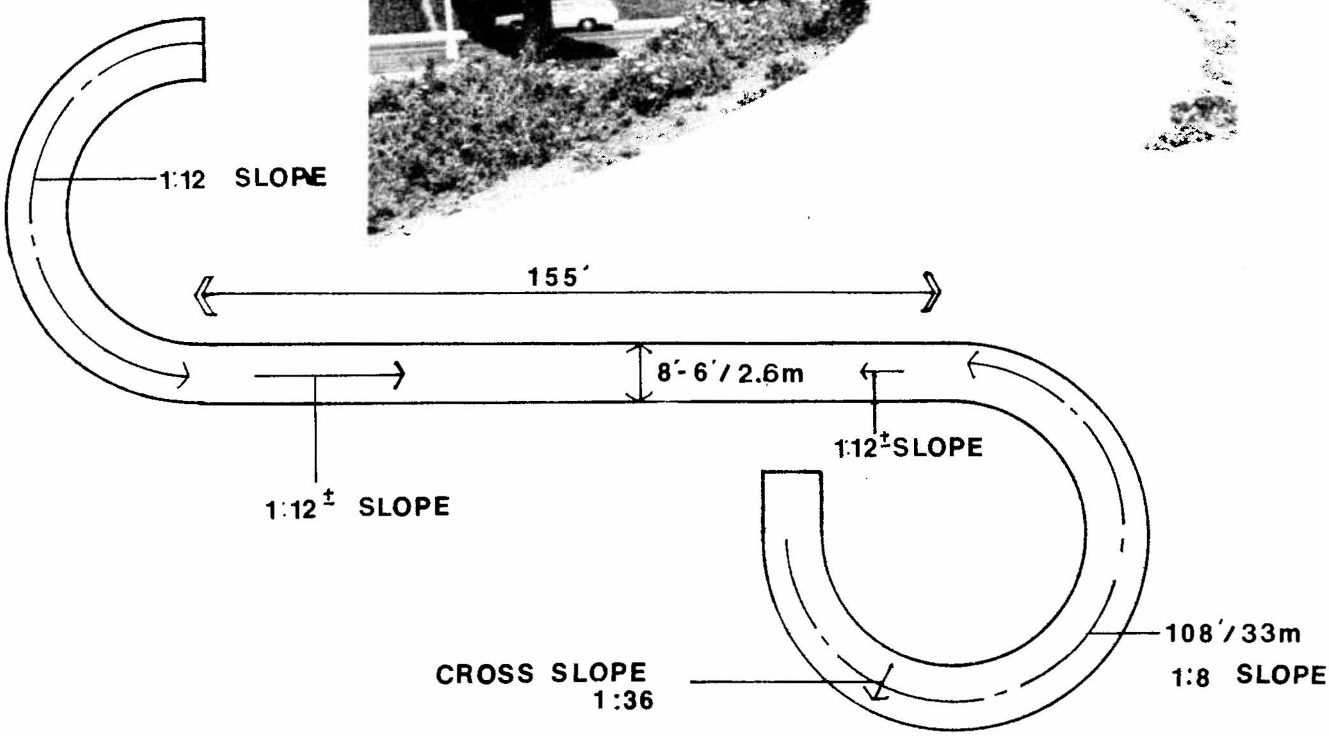
Recommendations

In most locations it will be sufficient to provide signing, striping and curb ramps (Alternative No. 1). In some locations a traffic signal will also be required. Alternative No. 3 will seldom be a viable or sensible option.

Major Access Barrier (2)

Description

Pathway Leading to Overcrossing too Long and Steep.



The Problem

This is a situation in which the approach to the structure is a sloping pathway. The 108' approach pathway is too long (greater than 30') and the approach pathways are too steep (slopes greater than 1:12).

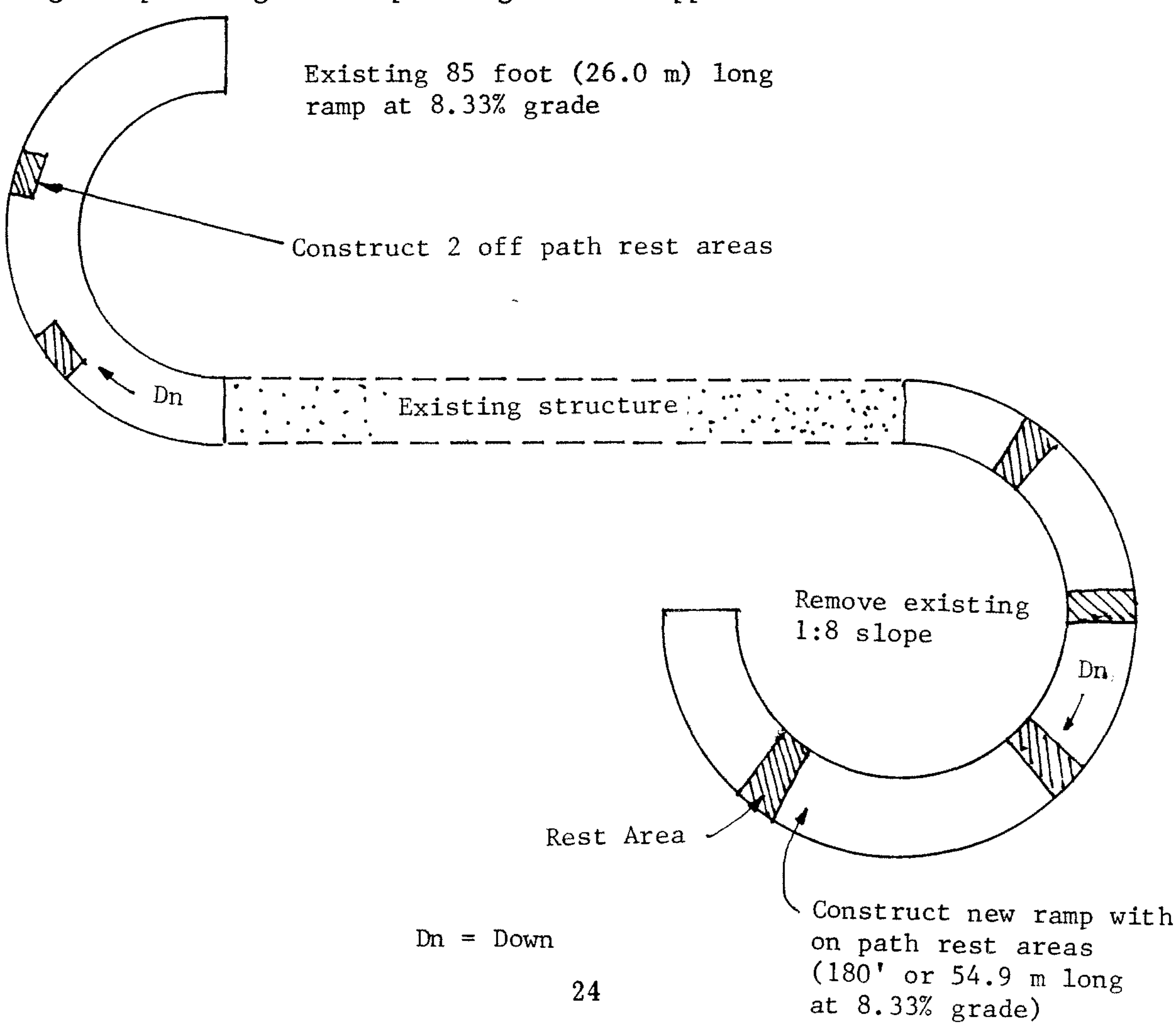
Alternative Solutions

- Construct new ramp with rest areas.
- Overlay and extend ramp with rest areas.
- Install elevator.

Alternative No. 1

Construct New Ramp with Rest areas

The major advantages of new ramp construction are that the desired grade can be obtained and that the same terminus point can be maintained at the bottom if desired. The gentler ramp grade results in a longer ramp length. However, this effect can be lessened by constructing rest areas (for details of rest area alternatives see Appendix I), at 30-foot (9.14 m) intervals along ramps with grades of 5 - 8.33 percent. Continuous handrailing is also necessary on both sides of the new ramp as well as on the existing 8.33 percent grade ramp serving the other approach.



Cost

$17,100 (see Appendix H for breakdown of cost estimates)

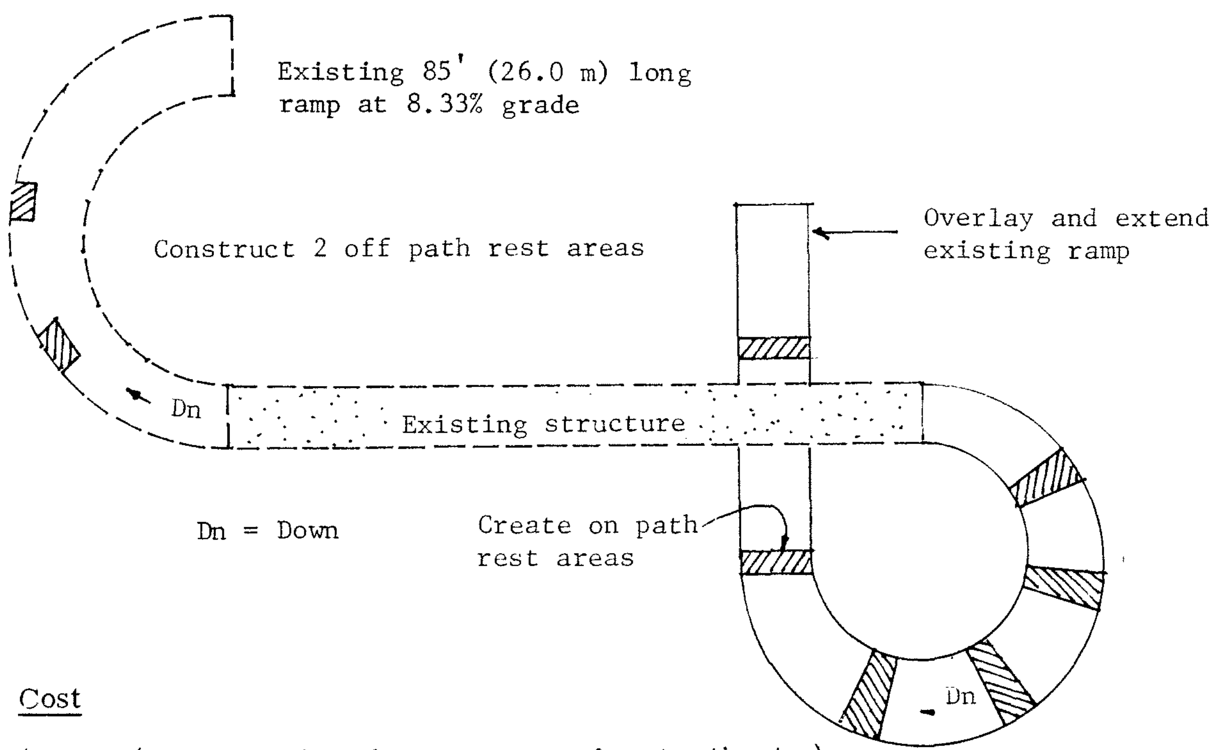
Other Costs

The gentler ramp grade results in a longer total ramp length. The extended ramp length may also mean that the ramp end location is less convenient. The added ramp length will result in increased maintenance costs.

Alternative No. 2

Overlay and Extend Ramp with Rest Areas

The major advantage is that the same alignment can be utilized with the extension occurring at the end. As with all ramps revised to gentler grades, the length increases. Construction of rest areas serves to mitigate this problem. Continuous handrailing is also necessary on both sides of both approach ramps even if handrails exist along the steep ramp. The increased height of the overlay will require handrail modifications.



Cost

$17,400 (see Appendix H for breakdown of cost estimates).

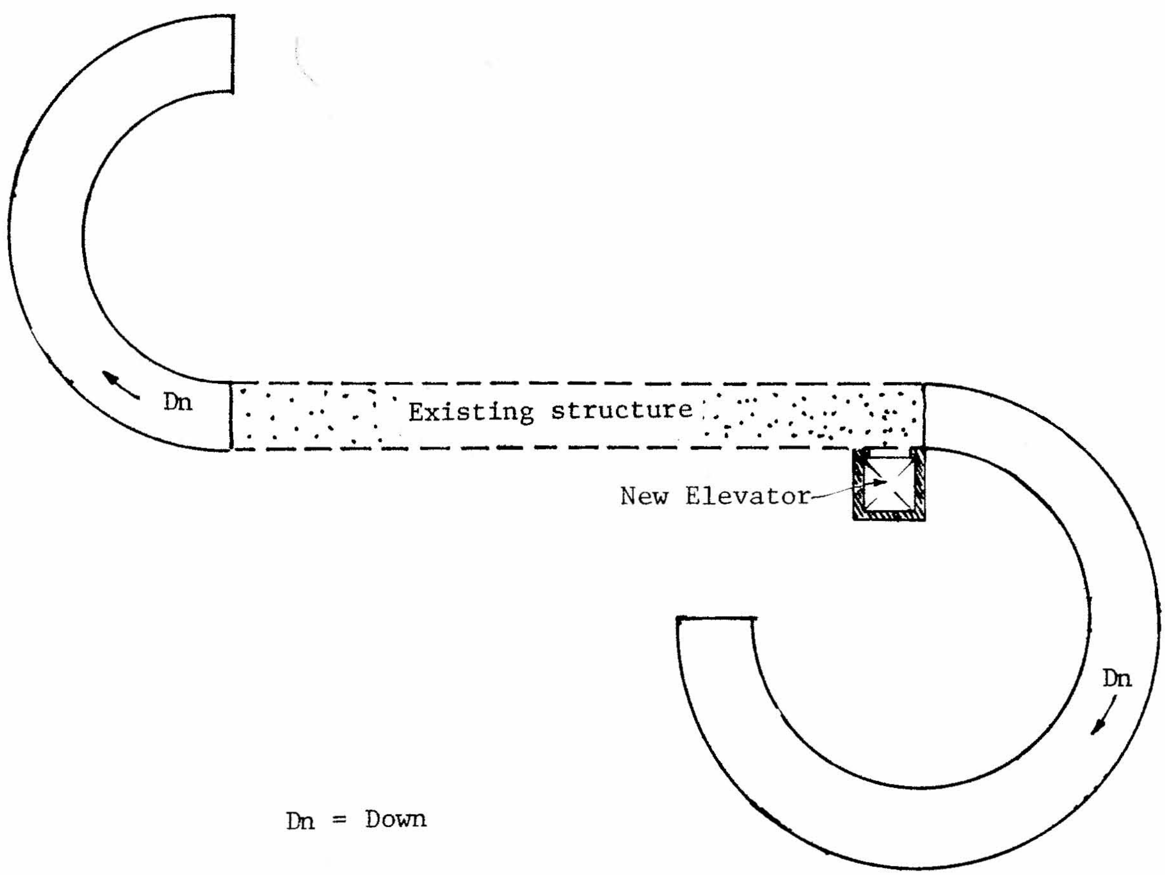
Other Costs

The gentler ramp grade results in a longer total ramp length. The extended ramp length may also mean that the ramp end location is less convenient. The added ramp length will result in increased maintenance costs.

Alternative No. 3

Install an Elevator

The major advantage is that an elevator directly connects the bottom of the steep ramp with the existing overcrossing structure. This solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility. Consideration must also be given to the other end of the existing overcrossing to confirm that persons likely to use the elevator are capable of ascending that ramp. If not, a second elevator would be required to complete the system.



Cost

$51,000 (see Appendix H for breakdown of cost estimates).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct new ramp with rest areas	$17,100
2 Overlay and extend ramp with rest areas	17,400
3 Install elevator	51,000

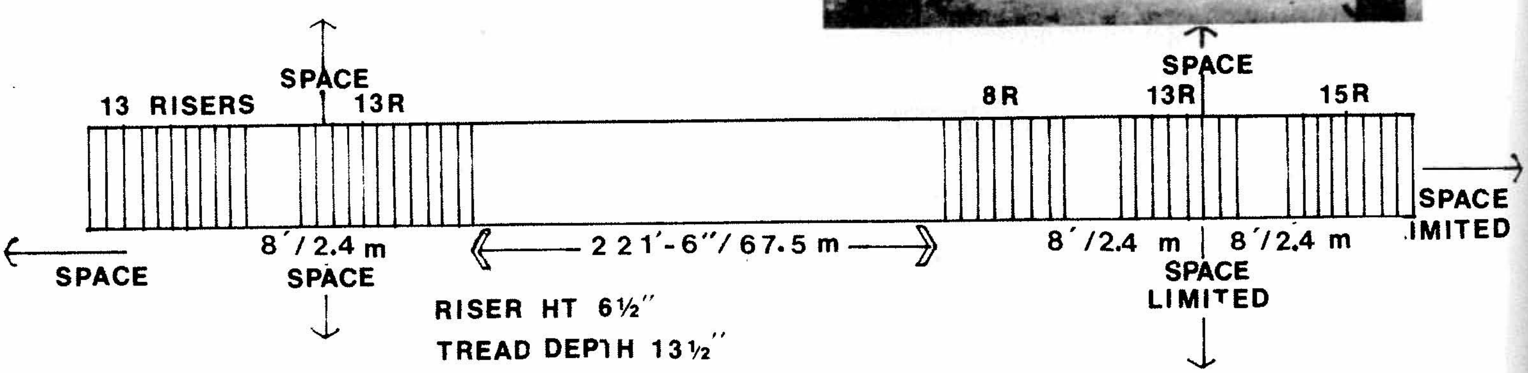
Recommendations

Since the installation of an elevator is a significant cost and is accompanied by significant maintenance and surveillance requirements, it is not a recommended solution except in rare cases. The retrofit of an existing ramp or construction of a new ramp are very similar in cost and the choice of solution will depend upon existing conditions.

Major Access Barrier (3)

Description

Stairs only on Approach to Overcrossing: Straight Flight; Space for Ramp on Three Sides.



The Problem

In this situation, only stairs have been provided at the approach to the overcrossing. Space within which to construct ramps exists on three sides - in front and on either side of the straight flight of stairs.

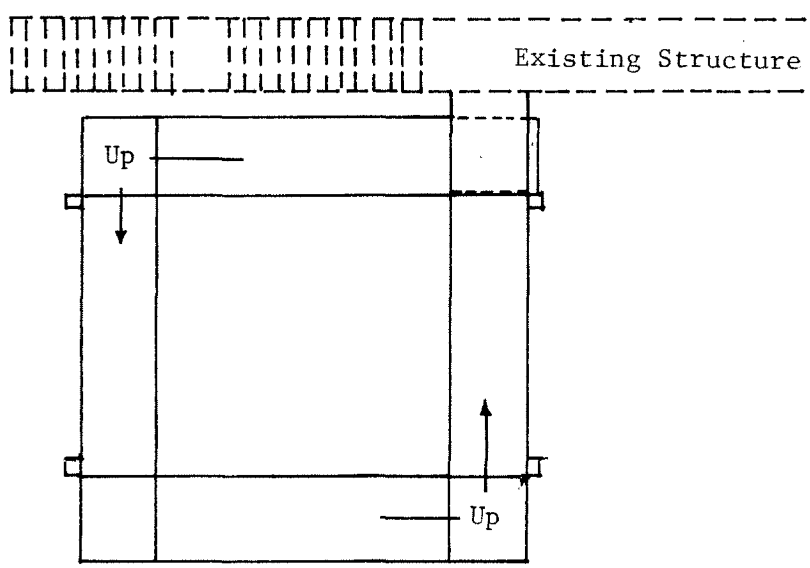
Alternatives

- Construct ramp to supplement stairs.
- Install elevators to supplement stairs.

Alternative No. 1

Construct ramp to supplement stairs

The most efficient ramp configuration to supplement long flights of stairs such as those serving the overcrossing described by Problem 3 results in an open box design with a 30-foot long ramp between landings. The new ramp begins on the structure adjacent to the top of the stairs and ends near the bottom of the stairs thereby providing a very convenient choice to potential users.



Cost

$111,500 (see Appendix H for breakdown of cost estimates).

Other Costs

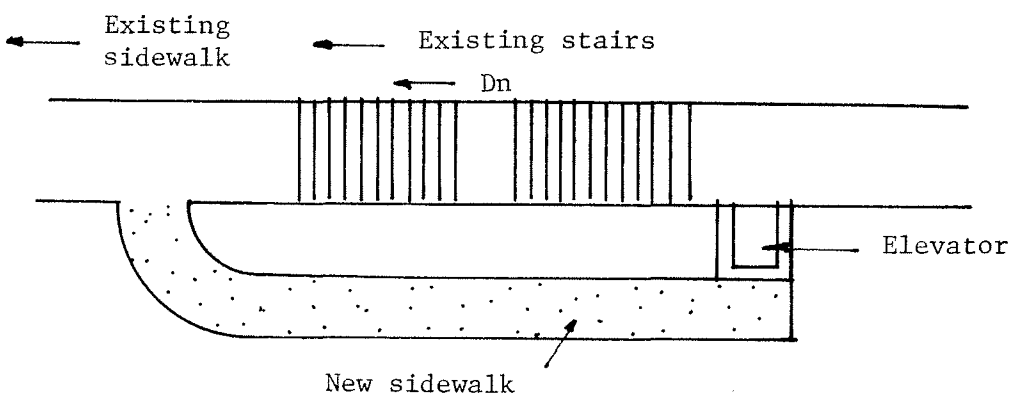
The addition of a ramp will require some increased maintenance costs.

Cyclists and other wheeled devices will use the overcrossing with perhaps some danger and discomfort to other pedestrians.

Alternative No. 2

Install Elevators to Supplement Stairs

Installation of elevators provides a direct connection from ground level to the overcrossing structure. While new sidewalk will be required, the additional walking parallels the stairs and therefore does not represent a distance of psychological detour. The solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility.



Cost

$101,000 (see Appendix H for breakdown of cost estimates).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct ramp to supplement stairs	$111,500
2 Install elevator to supplement stairs	101,000

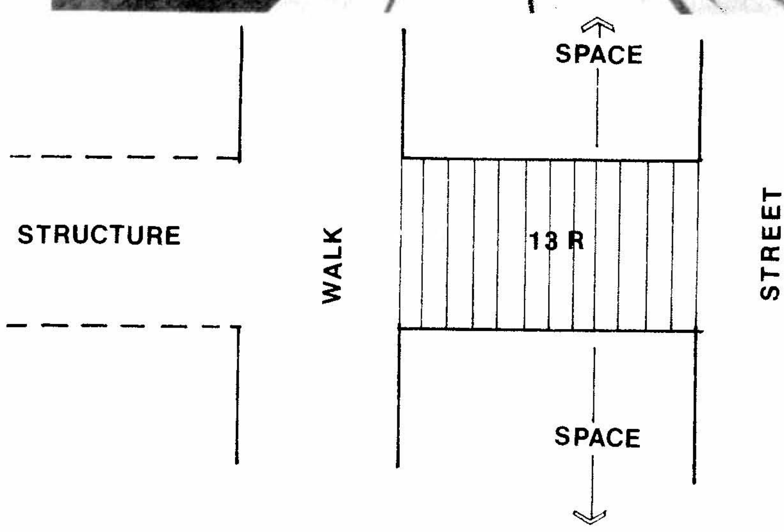
Recommendations

Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator.

Major Access Barrier (4)

Description

Stairs only on Approach to Overcrossing: Straight Flight; Space for Ramp on Both Sides Only.



The Problem

Like Problem No. 3, only stairs have been provided for access to this overcrossing. However, because the sidewalk and street meets the top of the stairs, there is space for a ramp on either side of the stairs only.

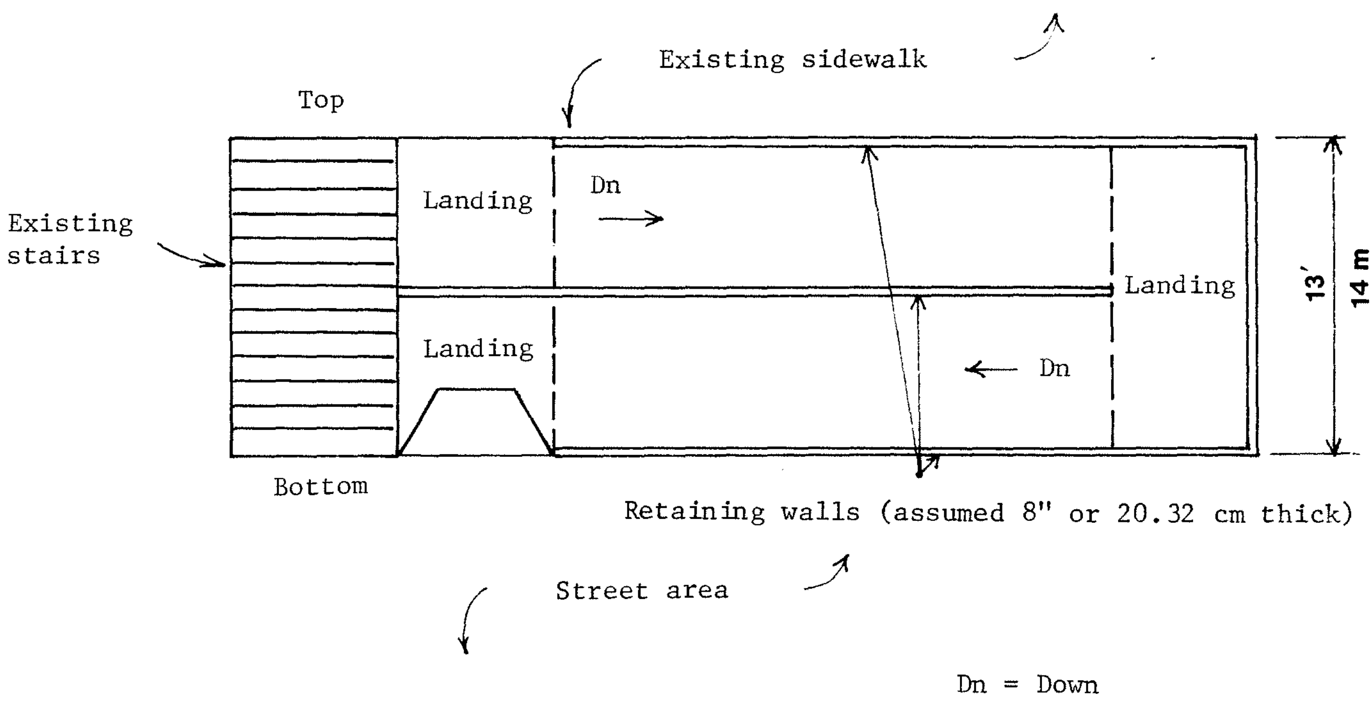
Alternatives

Construct ramp to supplement stairs.

Alternative No. 1

Construct Ramp to Supplement Stairs

Construction of a ramp with its landings adjacent to the top and bottom of the stairs provides a readily accessible alternative. Handrails are provided to ensure proper physical separation of the ramp from the sidewalk, the street and the stairs. The example shows only a 13-foot (4.0 m) space available for the ramp. For situations where more space is available or can be made available by realigning the sidewalk or bulbing into the street, a wider ramp could be obtained.



Cost

$26,100 (see Appendix H for breakdown of cost estimate).

Other Costs

The addition of ramps will require some increased maintenance costs.

Cyclists and other wheeled devices will use the overcrossing with perhaps some danger and discomfort to other pedestrians.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct ramp to supplement stairs	$26,100

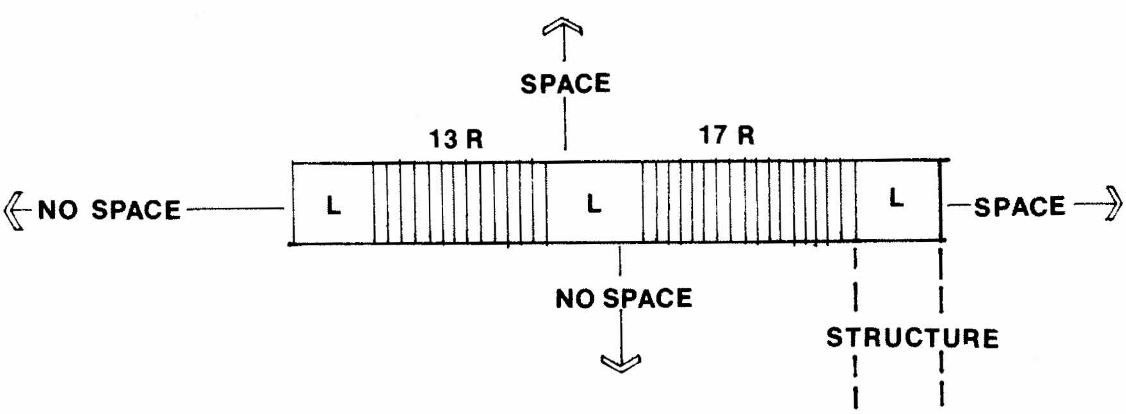
Recommendations

Construction of a ramp to supplement the stairs seems to be the most viable solution to this problem.

Major Access Barrier (5)

Description

Stairs only on Approach to Overcrossing: Straight Flight; Space for Ramp on one End and one Side.



The Problem

In this situation as in Access Barriers 3 and 4, a straight flight of stairs is the only available access to the overcrossing. However, because of the two intersecting streets, space to build a ramp is restricted to the side away from the street, and the end behind the stairs.

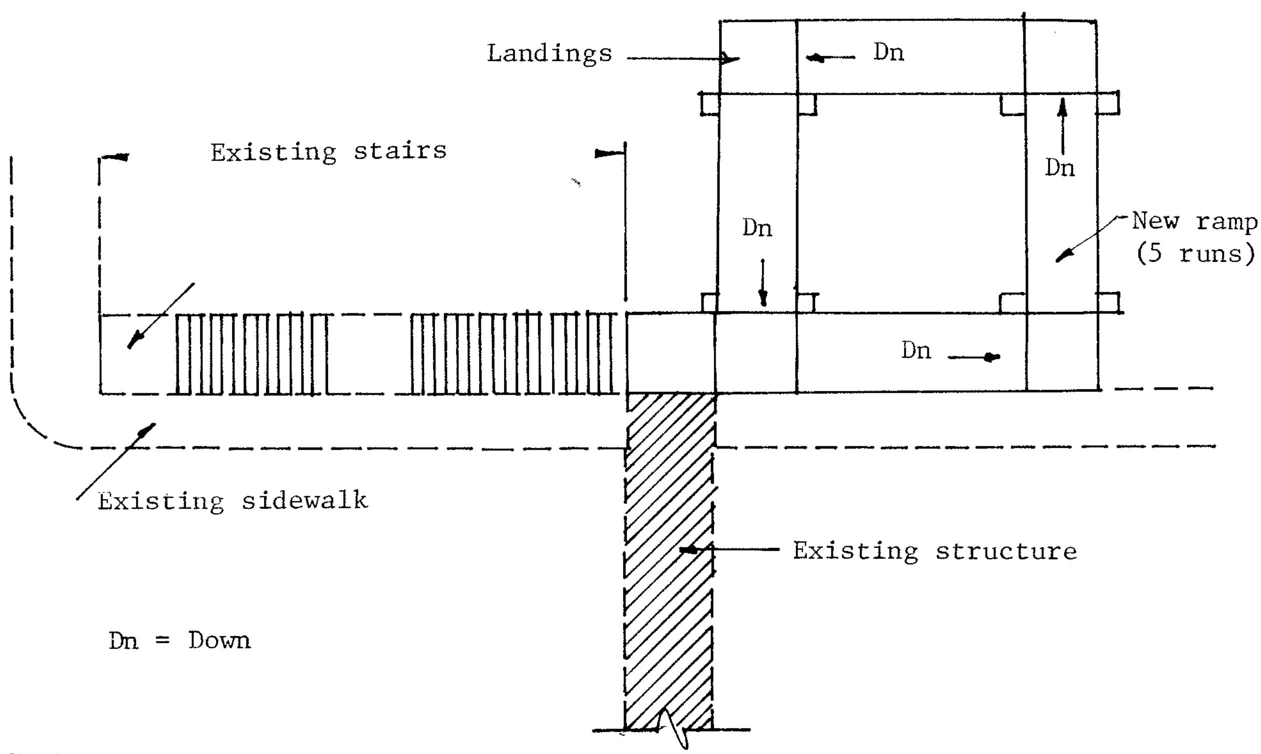
Alternative Solutions

- Construct ramp to supplement stairs.
- Install elevator to supplement stairs.

Alternative No. 1

Construct Ramp to Supplement Stairs

This prototypical problem is similar to Problem 3 - Alternative 1 except with less flexibility for ramp placement. Again, the most efficient ramp configuration results in an open box design with 30-foot (9.1 m) long ramps between landings. The ramp begins adjacent to the top of the stairs; however, the bottom landing is located some distance from the bottom of the stairs. If this presents an accessibility problem, the ramp design can be modified, at some additional cost, to terminate near the stair entrance.



Cost

$65,000 (see Appendix H for breakdown of cost estimates).

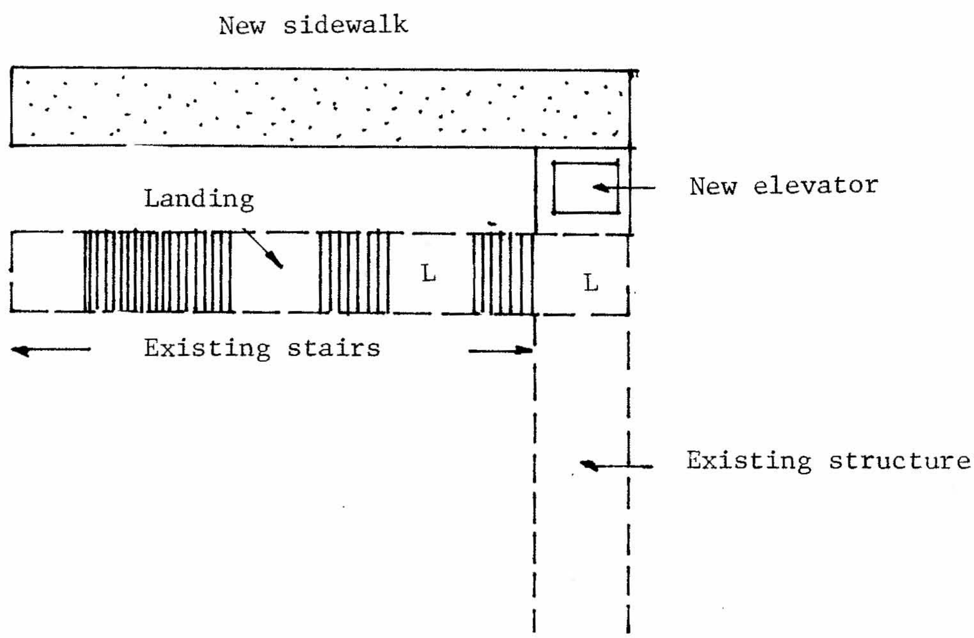
Other Costs

The addition of ramps will require some increased maintenance costs. Cyclists and other wheeled devices will use the overcrossing with perhaps some danger and discomfort to other pedestrians.

Alternative No. 2

Install Elevator to Supplement Stairs

An elevator would provide a direct connection from the landing adjacent to the top of the stairs to the sidewalk below. In the case of the prototypical example the elevator could provide access directly to the existing sidewalk. Since the sidewalk parallels the stairs and is accessible from two directions, access would be the same or improved compared to the stairs. This solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility. This alternative assumes only one elevator is required and that the other end of the structure does not require modification.



Cost

$51,000 (see Appendix H for breakdown of cost estimates).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative	Construction Costs
1 Construct ramp to supplement stairs	$65,000
2 Install elevator to supplement stairs	51,000

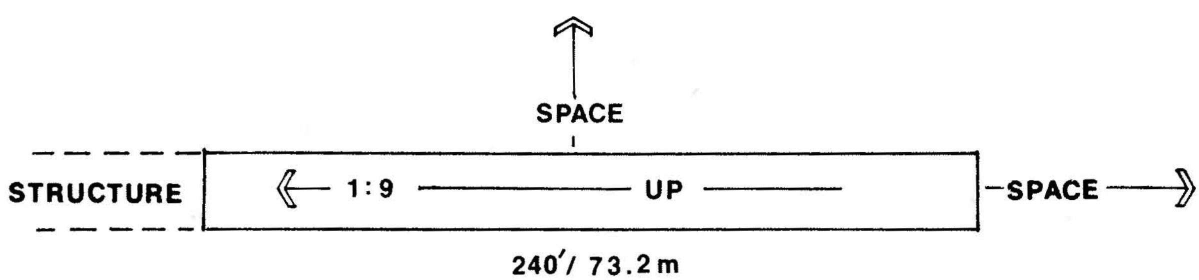
Recommendations

Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator. Therefore, for most retrofit solutions, Alternative 1, the ramp addition, is recommended.

Major Access Barrier 6

Decsription

Ramps on Approach too Long and Steep: Straight Ramp; Space at End and at Least one Side.



The Problem

This is a situation where a straight ramp leads to the structure which is both too long (over 30' or 9.1 m in a single run) and too steep (over 1:12 slope). In this example, the ramp is 240' (73.2 m) in a single run, and has a slope of 1:9. There is plenty of space to retrofit or reconstruct the ramp at the end and to one or more sides of the ramp.

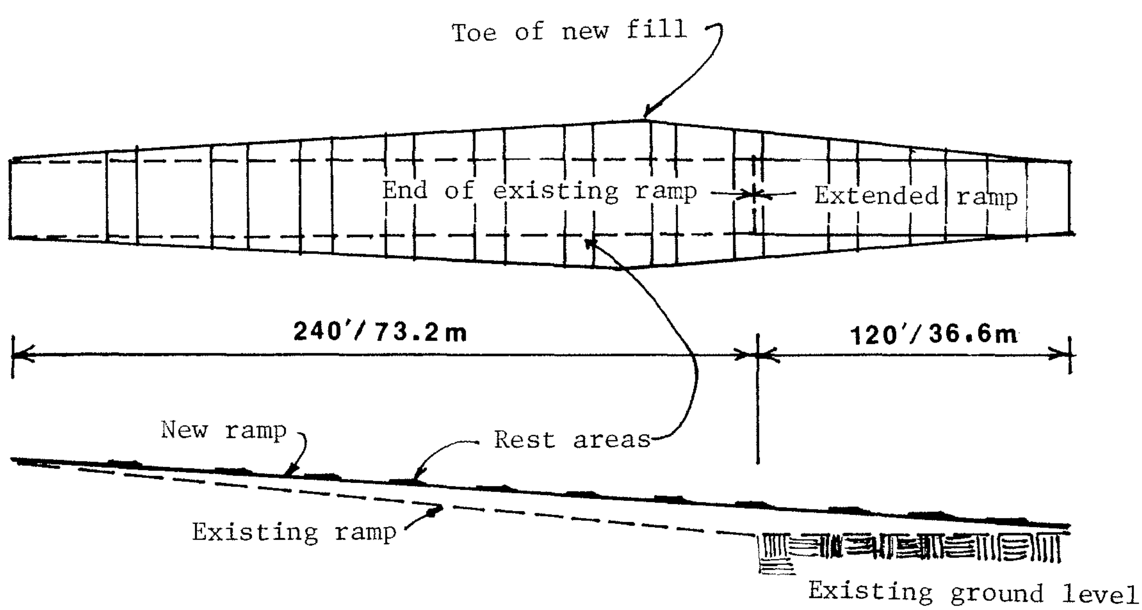
Alternative Solutions

- Overlay and extend ramp.
- Overlay and extend ramp with off-ramp rest areas.
- Construct new ramp with rest areas.

Alternative No. 1

Overlay and Extend Ramp

The major advantage to this solution is that the same alignment can be utilized with the extension occuring at the end. As with all ramps revised to gentler grades, the length increases. Construction of rest areas serves to mitigate this problem. In this solution, rest areas will be built on the ramp. Continuous handrailing is also necessary on both sides of both approach ramps. Even if handrails exist along the steep ramp the increased height of the overlay will require handrail modifications (concept is similar to Alternative 1 - Problem 2).



Cost

$23,000 (see Appendix H for breakdown of cost estimate).

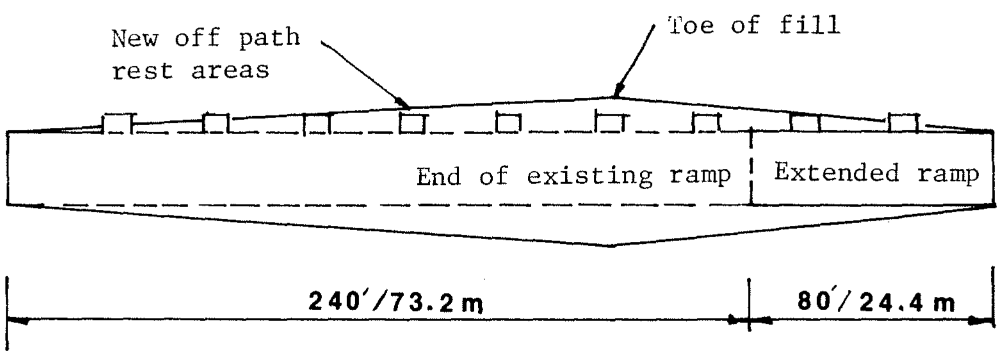
Other Costs

The gentler ramp grade results in a longer total ramp length. The extended ramp length may also mean that the ramp end location is less convenient. The added ramp length will result in increased maintenance costs.

Alternative No. 2

Overlay and Extend Ramp with Off-Ramp Rest Areas

Off path rest areas are built in this example adjacent to the overlaid ramp. This decreases the length of ramp required. Rest areas are only located on one side of the ramp or alternating in some fashion (see Appendix I for details of rest area alternatives). Handrailing is necessary along both sides of the ramp as well as around each rest area.



Cost

$24,000 (see Appendix H for breakdown of cost estimate).

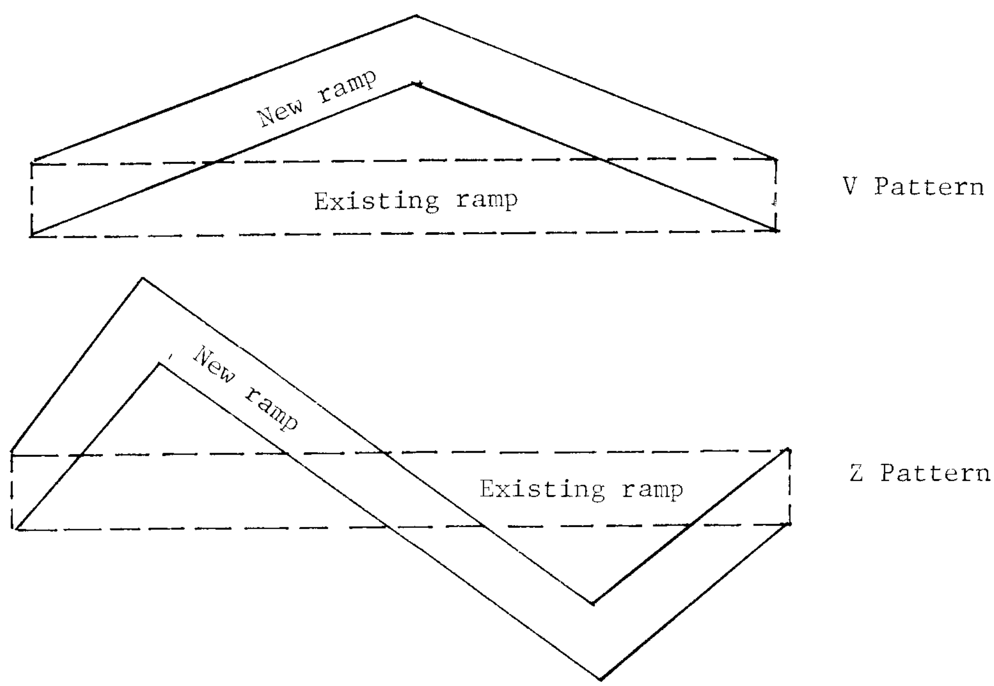
Other Costs

Although the off-ramp rest areas help to decrease the added length resulting from a gentler slope, the retrofit ramp will still be too long. The extended ramp length may also mean that the ramp end location is less convient, and will result in increased maintenance costs. The location of the rest areas may be a disadvantage to some users, particularly those with impaired vision.

Alternative No. 3

Construct New Ramp with Rest Areas

Construction of a new ramp allows a choice of alignments which utilize the orignial beginning and ending points. Rest areas can be constructed within the ramp and handrails will be required for ramps exceeding 5 percent grade. V or Z pattern alignments would result where beginning and ending points remain constant with the original design. A more direct alignment could be used where usage patterns can be served more directly.



Cost

$20,500 (See Appendix H for breakdown of cost estimates).

Other Costs

The gentler ramp grade results in a longer total ramp length. The extended ramp length will result in increased maintenance costs.

Summary of Alternative Costs

Alternative	Construction Cost
1 Overlay and extend ramp	$23,000
2 Overlay and extend ramp with off-ramp rest areas	24,000
3 Construct new ramp with rest areas	20,500

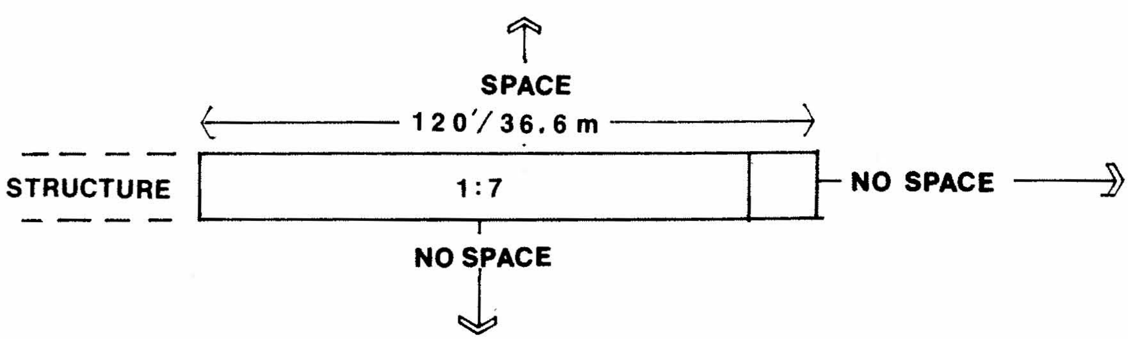
Recommendations

The decision to retrofit or reconstruct the existing ramp will depend upon existing conditions - location, usage, etc. However, because the retrofit solutions create new problems that would not occur in new construction, and they are also more expensive, Alternative No. 3, a new ramp, is the recommended solution for most cases.

Major Access Barrier 7

Description

Ramps on Approach too Long and Steep: Straight Ramp; Space on One Side Only.



The Problem

Like Major Access Barrier No. 6, this is a problem in which the straight ramp leading to the overcrossing is too long (over 30' or 9.1 m in a single run) and steep (over 1:12 slope). In this example, the ramp is 120' (36.6 m) and has a slope of 1:7. However, this problem has a more stringent space restriction: there is available space for construction on only one side of the ramp.

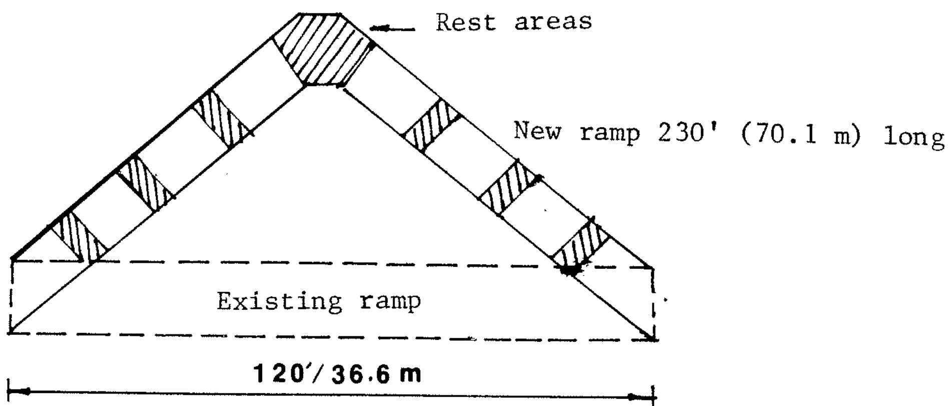
Alternative Solutions

- Construct new ramp (V pattern).
- Construct new ramp (M pattern).

Alternative No. 1

Construct New Ramp: V Pattern

Construction of a new ramp is accomplished on one side of the original ramp. The original ramp is assumed to remain in service or at least is not removed. Rest areas are built into the new ramp and new handrailing is also required.



Costs

$13,600 (see Appendix H for breakdown of cost estimates).

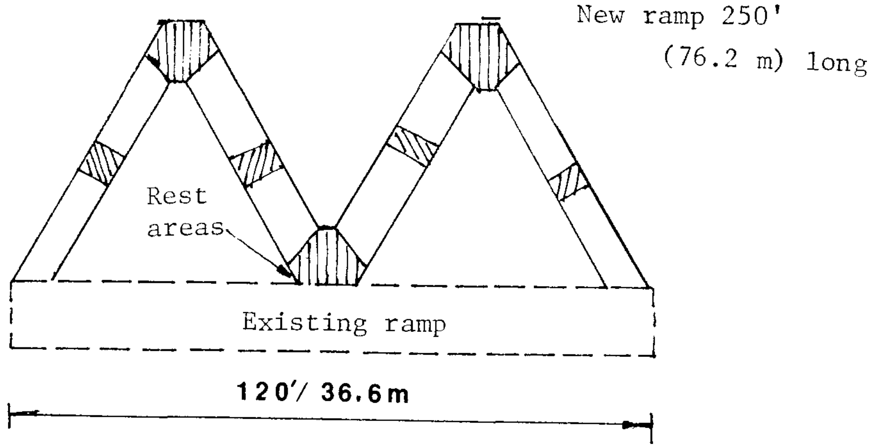
Other Costs

The new ramp's gentler grade results in a longer total ramp length. The added ramp will result in increased maintenance costs. Bicyclists will probably continue to use the old straight ramp. Care should be taken to ensure collisions between bicyclists and pedestrians will not occur where the V ramp meets the straight ramp.

Alternative No. 2

Construct New Ramp: M Pattern

A variation of Alternative No. 1, this solution involves construction of a new ramp, this time in an "M" pattern, on one side of the original ramp. The original ramp is assumed to remain in service or at least is not removed. Rest areas are built into the new ramp and new handrailing is also required.



Cost

$13,900 (See Appendix H for breakdown of cost estimates).

Other Costs

The new ramp's gentler grade results in a longer total ramp length. The added ramp will result in increased maintenance costs. Bicyclists will probably continue to use the old straight ramp. Care should be taken to ensure collisions between bicyclists and pedestrians will not occur where the M ramp meets the straight ramp.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct new ramp (V pattern)	$13,600
2 Construct new ramp (M pattern)	13,900

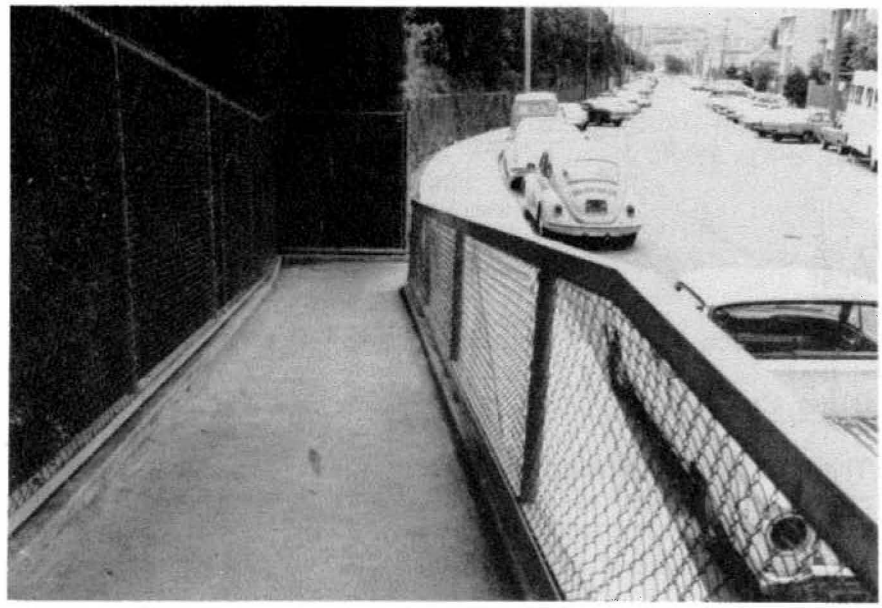
Recommendations

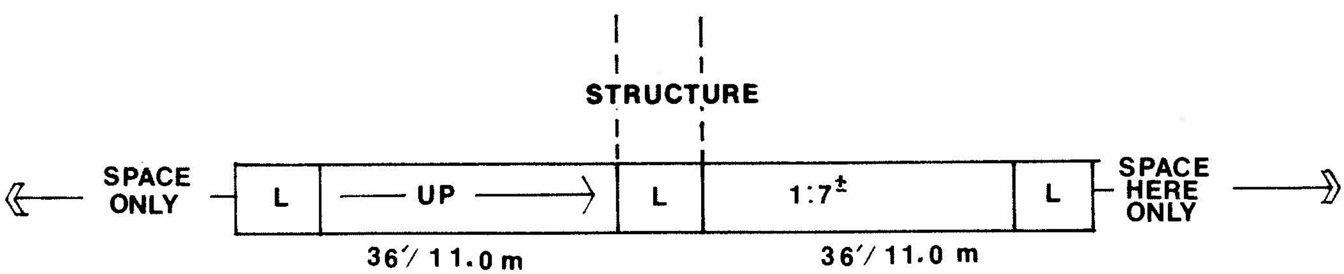
Although Alternative No. 1 requires more space for construction, it may be easier to construct and also easier for some people to negotiate than Alternative No. 2. Therefore, if space limitations allow for this solution, it is the recommended alternative.

Major Access Barrier (8)

Description

Ramps on Approach too Long and Steep: Straight Ramp; Space at End Only.





The Problem

Similar to Problems No. 6 and 7, in this situation the straight ramp leading to the overcrossing is too long (over 30' or 9.1 m in a single run) and steep (over 1:12 slope). In this example both ramps approaching the structure are 36' (11.0 m) long and have a slope of 1:7.2. Because the ramps parallel a secondary street on one side and the freeway on the other, construction space is limited to the ends of the ramps.

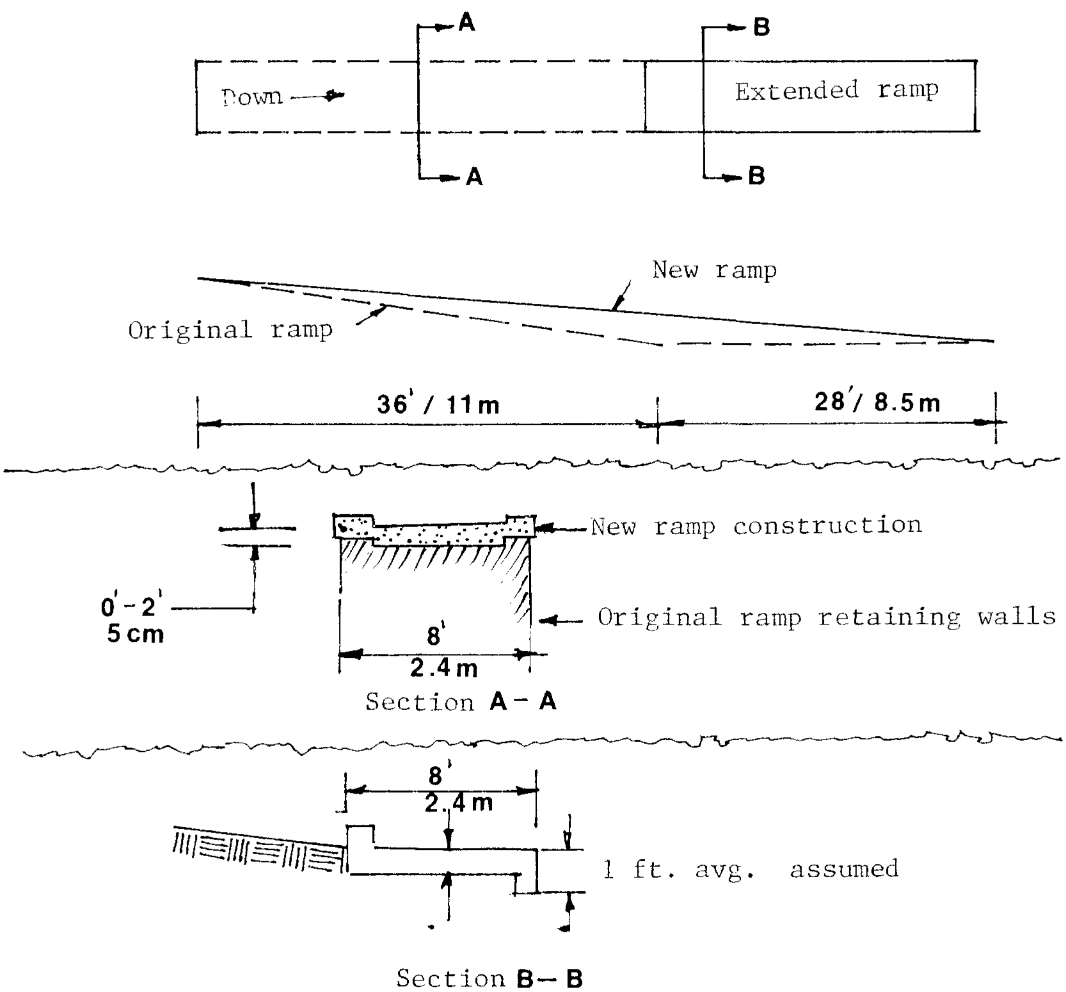
Alternative Solutions

- Construct new ramp over existing ramp.
- Demolish existing ramp and construct new ramp.

Alternative No. 1

Construct New Ramp Over Existing Ramp

Construction of a new ramp on top of the original ramp is a practical method for modification of short ramps since large retaining walls can be avoided. The ramp extention would also be relatively short thereby not creating long detours for users. Handrailing must be replaced to reestablish proper height relationships.



Cost

$7,300 (See Appendix H for breakdown of cost estimate).

Other Costs

The gentler ramp grade results in a longer total ramp length. Although the ramp extention will not be as great as it is in other alternatives, it may still result in the ramp end location being less convenient. The additional ramp length will result in increased maintenance costs.

Alternative No. 2

Demolish Existing Ramp and Construct New Ramp

The major advantage of this alternative is that the new ramp will not be affected by any structural alignment or deficiencies of the existing facility.

Costs

$13,100 (See Appendix H for breakdown of cost estimate).

Other Costs

The gentler grade of the new ramp will result in a longer total ramp length, and may result in a less convenient end location. Increased maintenance costs will be sustained as a result of the additional length.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct new ramp over existing ramp	$ 7,300
2 Demolish existing ramp and construct new ramp	13,100

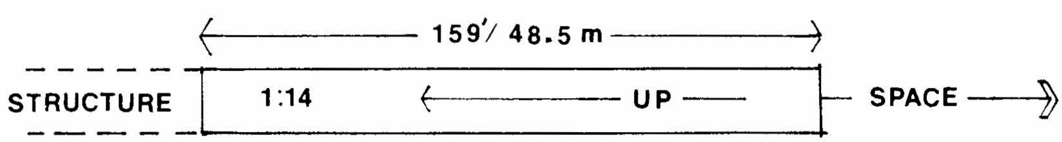
Recommendations

Although the total expense of construction for Alternative No. 2 is greater, the dollar differential is relatively small for shorter ramps. Therefore, if the original structure has considerable design deficiencies, the greater flexibility of this Alternative may cause it to be the preferred solution. However, if these structural problems do not exist, the retrofit ramp described in Alternative No. 1 is the recommended solution.

Major Access Barrier 9

Description

Ramps on Approach too Long (not too Steep).



The Problem

This is a situation in which the ramp leading to the structure is too long (over 30' or 9.1 m in a single run), but does not have a slope that is over 1:12 (in this example, the slope is 1:14.4).

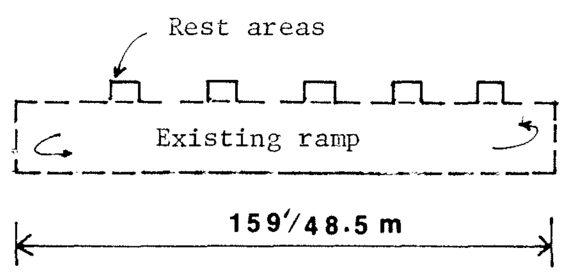
Alternative Solutions

- Construct off-ramp rest areas.
- Overlay existing ramp to create rest areas.
- Construct on-ramp rest areas (partial width).

Alternative No. 1

Construct Off-Ramp Rest Areas

Off-ramp rest areas may be constructed where ramps are too long but not too steep. Rest areas can be constructed to offer those in need a level space on which to pause (see Appendix I for details of rest area alternatives). Handrails should be placed around the edges of the rest area as well as along both sides of ramps exceeding 5 percent grade.



Cost

$8,200 (see Appendix H for breakdown of cost estimate).

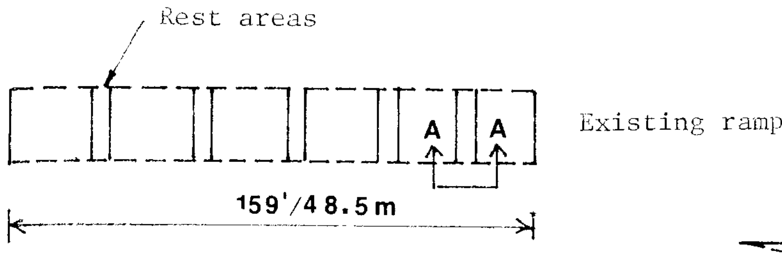
Other Costs

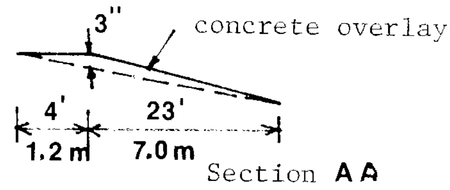
The major disadvantage of off-path rest areas is that they are typically located on one side - which may be inconvenient for some users - or they require twice as many to serve both directions of travel equally. Secondly, the user of the rest area must detour from the direct path and then drop down the slope again after resting in order to ascend further. Addition of these rest areas will increase maintenance costs.

Alternative No. 2

Overlay Existing Ramp to Create Rest Areas

Localized overlaying of existing long ramps creates rest areas within the pathway. Where the entire ramp width is treated, these level plateaus service both directions of travel. As this solution effectively increases the gradient of the ramp, this option is only viable to the extent that the new ramp does not exceed 1:12 slope (as in this case). Handrails should be placed along both sides of ramps exceeding 5 percent grade.





Cost

$7,100 (see Appendix H for breakdown of cost estimate).

Other Costs

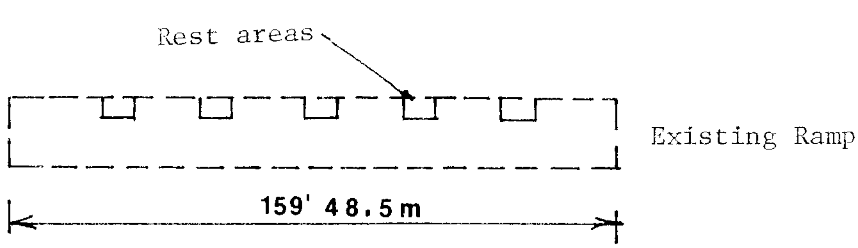
Although this type of rest area is composed of closely spaced breaks in grade, they should not adversely effect slow moving bicycles and wheelchairs. However, riders of fast moving wheeled conveyances (bicycles, wheelchairs, skate boards) may be jolted or require extra attention to maintain their balance.

The addition of rest areas will result in a longer total ramp length, and will result in increased maintenance costs. It may also mean that the ramp end location is less convenient.

Alternative No. 3

Construct On-Ramp Rest Areas (Partial Width)

A third alternative for rest area construction is to construct rest areas within the pathway but using only part of the total width. The minimum rest area width would be 3.75 feet (1.1 m). Handrails should be constructed to provide a positive barrier to stop users from falling off the sides or end of the rest area. This technique would probably only be considered where wide ramps exist. The absolute minimum ramp width for this treatment would be 8 feet (2.4 m) with the desirable minimum being about 12 feet (3.7 m), so that at least 8 feet (2.4 m) is available for two way bicycle travel. Handrails should be placed along both sides of ramps exceeding 5 percent grade and the resulting grade of the new half of the ramp would not exceed 1:12.



Cost

$7,500 (see Appendix H for breakdown of cost estimate).

Other Costs

The location of the rest areas may be inconvenient to some users. Increased maintenance costs will also be sustained.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct off-ramp rest areas	$8,200
2 Overlay existing ramp to create rest areas	7,100
3 Construct on-ramp rest areas (partial width)	7,500

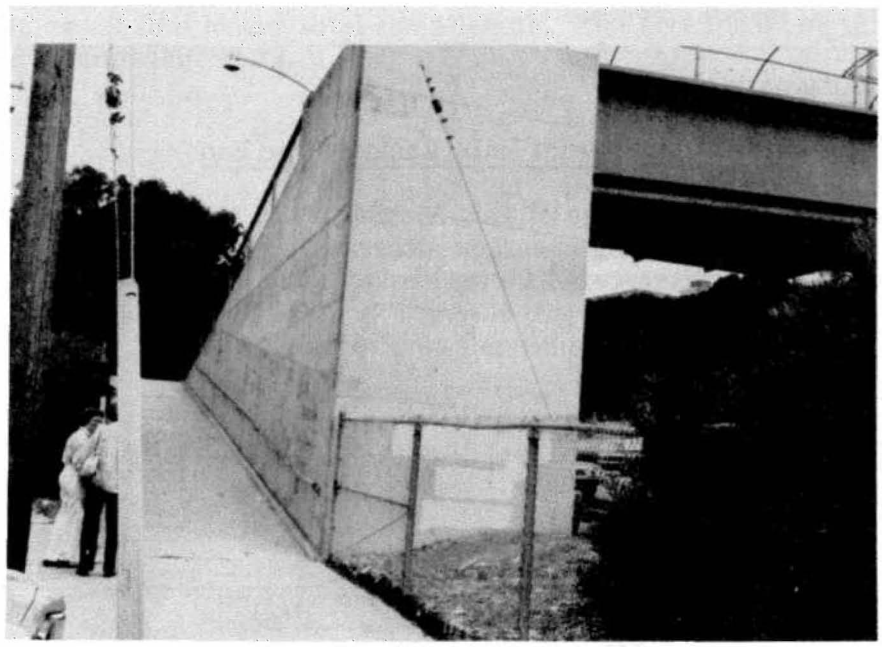
Recommendations

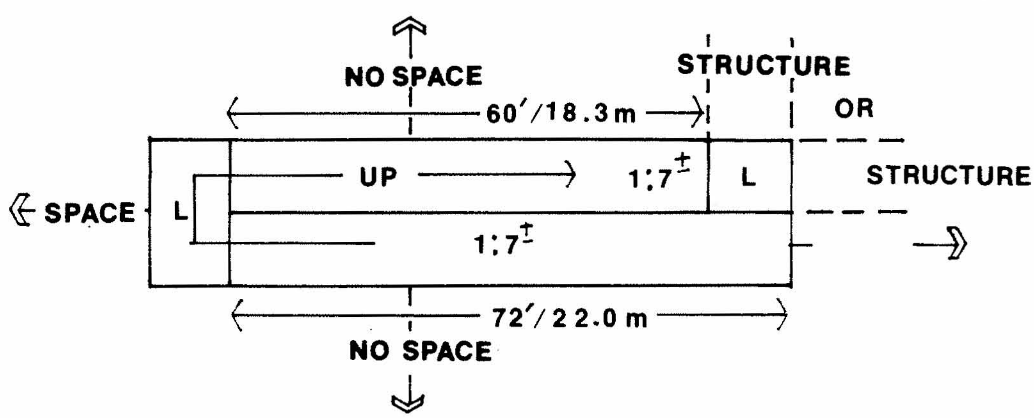
Alternative No. 2 - overlaying the existing ramp to create rest areas is the cheapest solution and its disadvantages are not considered to be so great as to rule it out. Therefore, this solution is recommended over the others.

Major Access Barrier (10)

Description

Ramps on Approach too Long and Steep: Dogleg Ramp; Space at Ends Only.





The Problem

The problem entails a dogleg ramp which parallels a secondary road on one side, and the freeway on the other. Therefore, retrofit of the existing ramp which is too long (over 30' or 9.1 m in a single run) and steep (slope greater than 1:12) can be made only at the ends. The ramp in the prototypical example has a 72' (22.0 m) single run with a slope of 1:7.2.

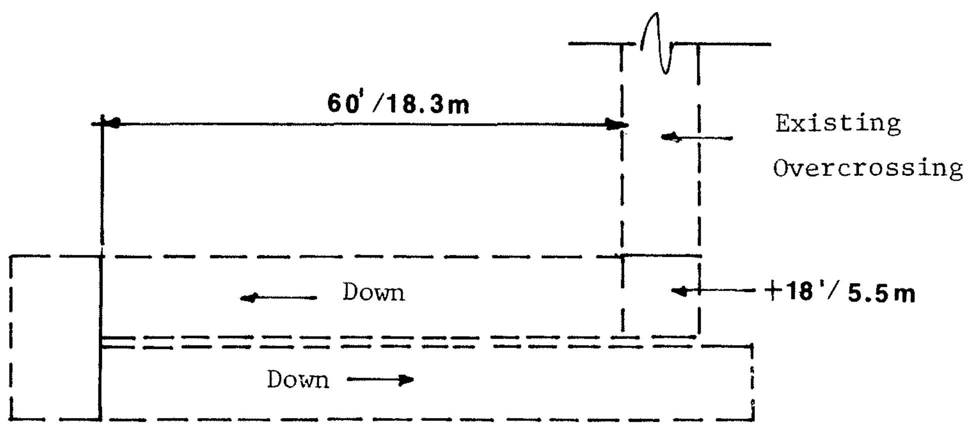
Alternative Solutions

- Demolish and rebuild ramp at one end.
- Rebuild existing ramp.
- Install elevator.

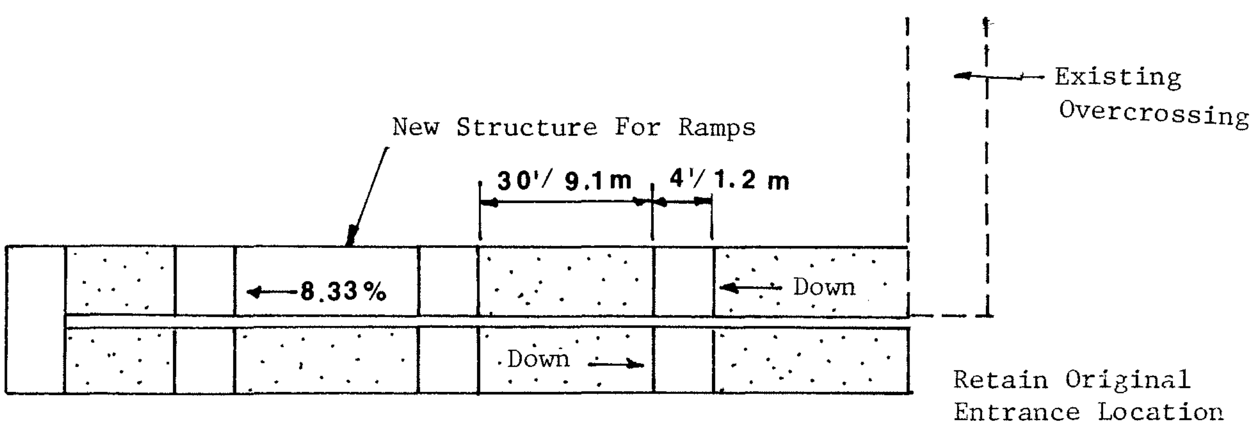
Alternative No. 1

Demolish and Construct New Ramp at One End

The major advantage of this Alternative is that the new ramp will not be affected by any structural, alignment, or other deficiencies of the existing facility. Rest areas would be incorporated in the design to facilitate persons requiring stopping places on the longer ramp.



Existing Ramps



New Ramps

Cost

$194,000 (See Appendix H for breakdown of cost estimate).

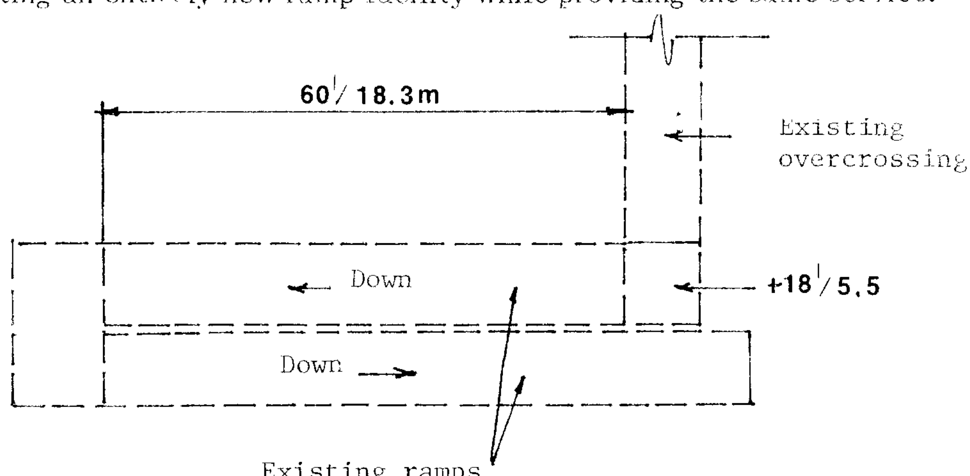
Other Costs

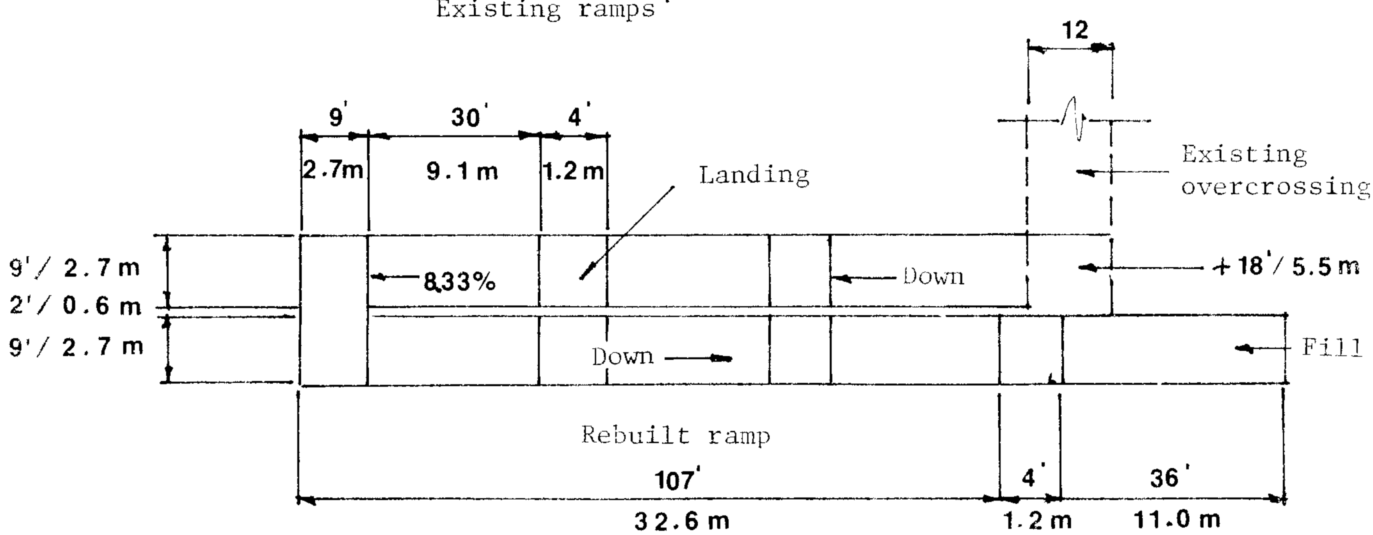
The gentler ramp grade will result in a longer total ramp length. The additional length will also result in increased maintenance costs.

Alternative No. 2

Rebuild Existing Ramp

Rebuilding the existing ramp can create a gentler slope although a longer total ramp distance would result. Construction of rest areas will provide intermediate resting points. An advantage of rebuilding the existing ramp is that it costs less than constructing an entirely new ramp facility while providing the same service.





Cost

Approximately $100,000 (see Appendix H for breakdown of cost estimate).

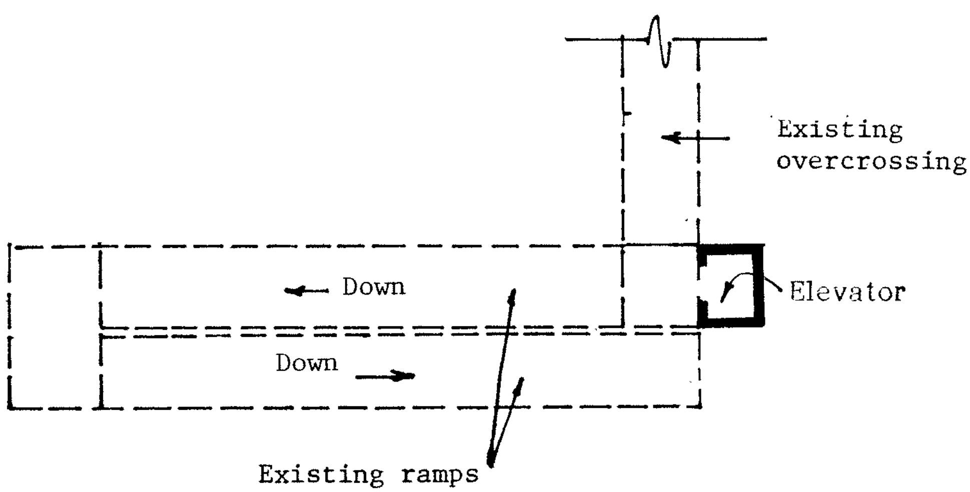
Other Costs

The gentler slope will result in a longer total ramp length which may mean that the ramp end location is less convenient. The added length will also result in increased maintenance costs.

Alternative No. 3

Install an Elevator

Installation of an elevator provides a direct connection between the top and bottom of the ramps. This solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility.



Cost

$51,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure security, and access when the elevator is not functioning.

Summary of Alternative Costs

Alternative	Construction Costs
1 Demolish and rebuild ramp at one end	$194,000
2 Rebuild existing ramp	100,000
3 Install elevator	51,000

Recommendations

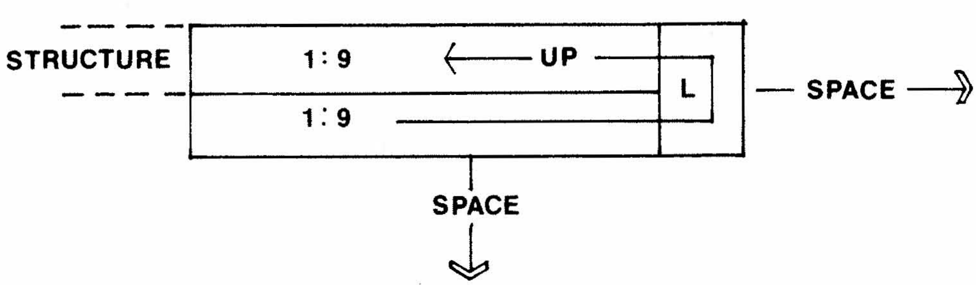
Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator.

Decision of whether to retrofit or reconstruct the existing ramp will depend upon existing conditions - location, usage, etc. Although Alternative No. 2 is cheaper, it has the disadvantage that deficiencies in existing structural alignments or aesthetics may be incorporated into the final product unless special care is taken to conduct a thorough investigation prior to design selection. Although it is more expensive, Alternative No. 1 may be preferred if these structural deficiencies cannot be overcome. For most circumstances Alternative No. 2 is recommended.

Major Access Barrier (11)

Description

Ramps on Approach too Long and Steep: Dogleg Ramp; Space at One End Only and One Side.



The Problem

Like Problem No. 10, this is a situation in which a dogleg ramp is too steep (slope over 1:12) and too long (over 30' or 9.1 m in a single run). The ramp has a 1:9 slope, and a 69' (21.0 m) single run. Space limitations are governed by the adjacent parallel and perpendicular roads preventing new construction on one side and one end, leaving space on the other side and other end.

Alternative Solutions

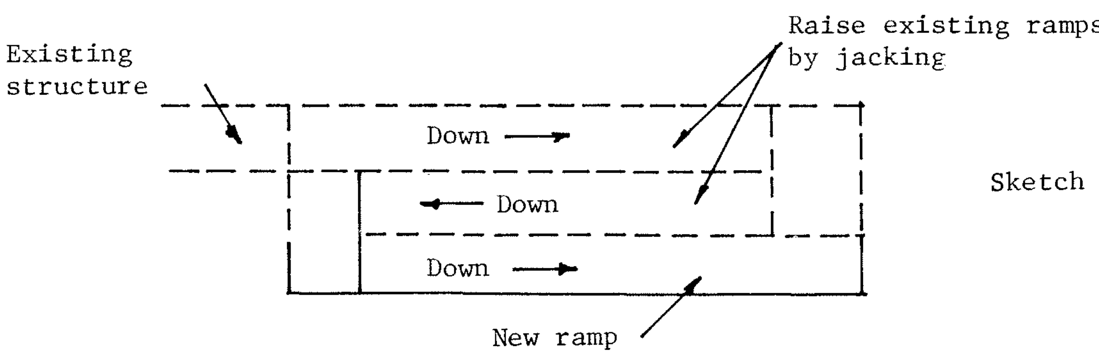
- Jack up existing ramps and add new ramp.
- Demolish and rebuild ramps.
- Install elevator.

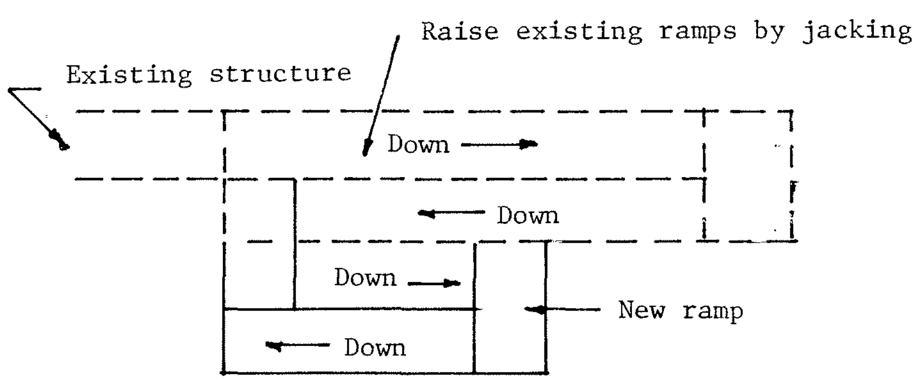
Alternative No. 1

Jack End of Existing Ramp

Jacking is a technique which can be utilized in this case to lessen the grade of an existing ramp. The process includes shoring up the ramp and then demolishing the existing columns. New columns are then constructed to support the raised ramps. Additional fill is added to support the new ramp extension connecting the raised ramp with ground level. Rest areas can be installed as required along the modified ramp system.

The termination of the extended ramp could be different than the original ramp, as shown in Sketch A below, or could be adjacent to the original ramp by adding a switch back to the extended ramp (see Sketch B).





Cost

$86,000 (see Appendix H for breakdown of cost estimate).

Other Costs

The total ramp length will increase due to the gentler slope obtained from the jacking and extension. Increased maintenance costs will therefore be incurred. In addition, the new ramp end location may be more inconvenient.

Alternative No. 2

Demolish and Rebuild Ramp

Where jacking is not feasible, it may be necessary to demolish and rebuild the ramps to acceptable grade standards. Rest areas would be included as a basic component of the new construction. This strategy is similar to the solution described in Problem 10 - Alternative 1.

Cost

$194,000 (see Appendix H for breakdown of cost estimate).

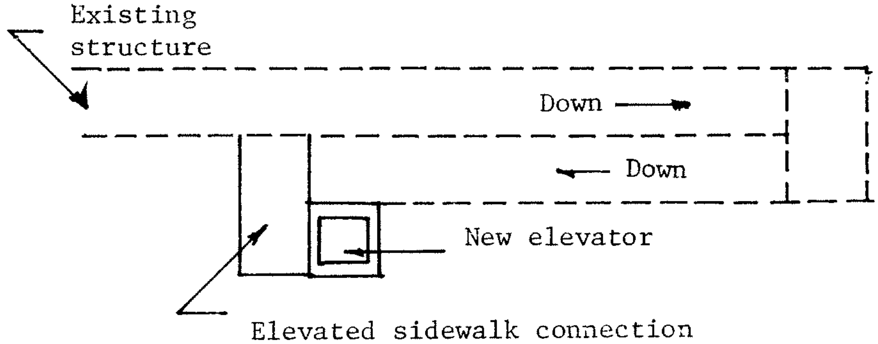
Other Costs

The gentler ramp grade will result in a longer total ramp length and therefore increased maintenance costs.

Alternative No. 3

Install an Elevator

Installation of an elevator connects the structure directly with the existing sidewalk below. In the case of the prototypical example the elevator entrances can be conveniently located adjacent to the ramp entrances. This solution is practical only where problems of vandalism and security don't immediately rule it out as a possibility.



Cost

$51,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative		Construction Cost
1	Jack up existing ramps and add new ramp	$ 86,000
2	Demolish and rebuild ramps	194,000
3	Install elevator	51,000

Recommendations

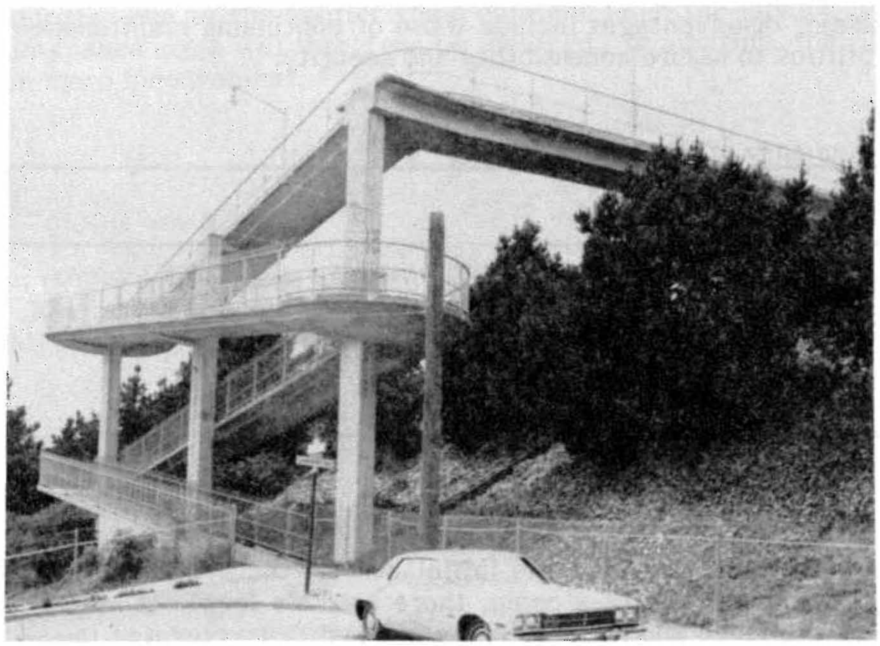
Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator.

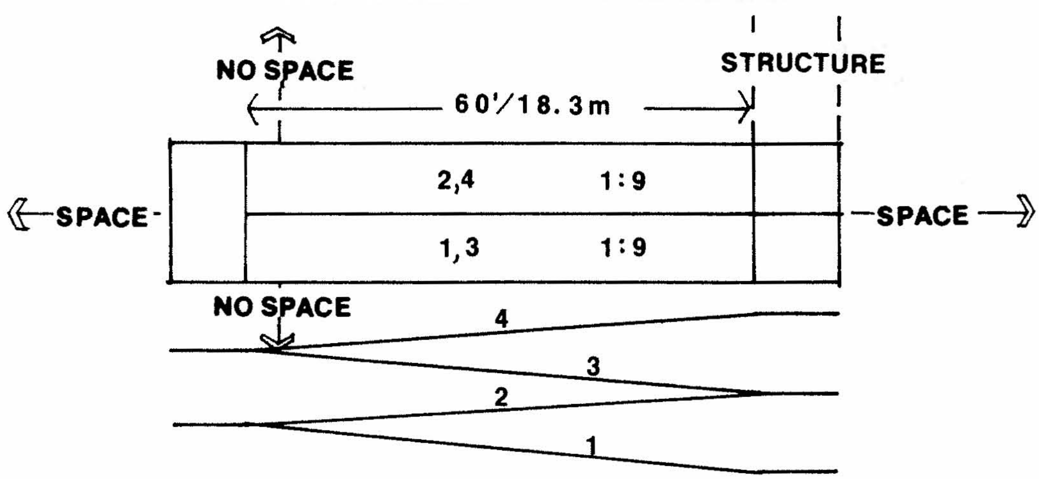
The relative flexibility of Alternative No. 2 may be necessary in certain circumstances. If structural considerations will allow for it, implementation of Alternative No. 1 is more cost-effective than Alternative No. 2, and is recommended for most situations.

Major Access Barrier (12)

Description

Ramps on Approach too Long and Steep: Multilevel Dogleg Ramp; Space at Both Ends.





The Problem

Again, the dogleg ramp is both too long (in this example 60' or 18.3 m in a single run) and steep (1:9 slope). Space limitations are governed by the parallel road on one side and steep terrain on the other. This leaves space for new construction at both ends only.

Alternative Solutions

- Demolish and rebuild.
- Install elevator.

Alternative No. 1

Demolish and Rebuild Ramps

Where the ramps are both too long and too steep, one alternative is to demolish the existing ramps and rebuild new ones to the desired standards. The major advantage of this alternative is that the new ramp will not be affected by any structural alignment, or deficiencies of the existing facility. Rest areas would be incorporated into the design to facilitate persons requiring stopping places on the longer ramp.

Cost

$349,200 (see Appendix H for breakdown of cost estimate).

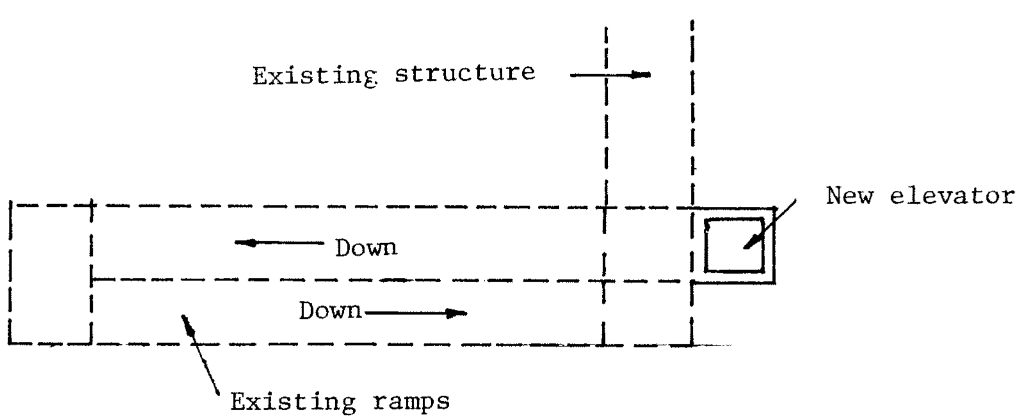
Other Costs

The gentler ramp grade will result in a longer total ramp length, and therefore, will also incur increased maintenance costs.

Alternative No. 2

Install an Elevator

Installation of an elevator provides a direct connection between the top and bottom of the ramps. This solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility. This might include areas such as a school, downtown shopping area, etc.



Cost

Approximately $59,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Major disadvantages include the continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative	Construction Cost
1 Demolish and rebuild	$349,200
2 Install elevator	59,000

Recommendations

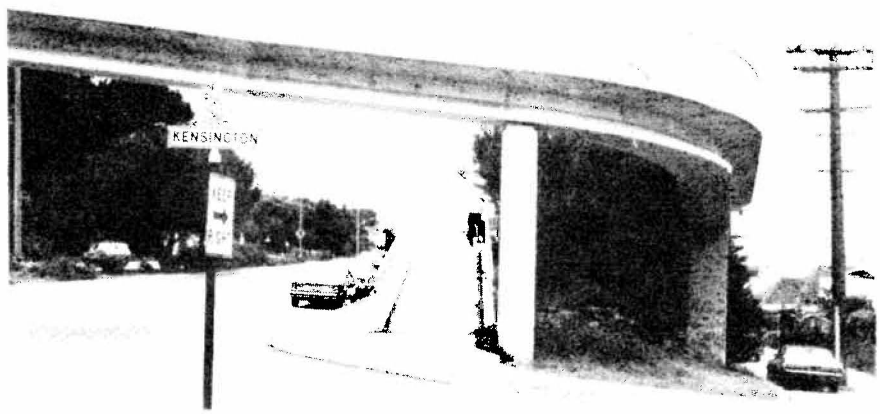
Despite the fact that the initial cost of the installation of an elevator is substantially cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator.

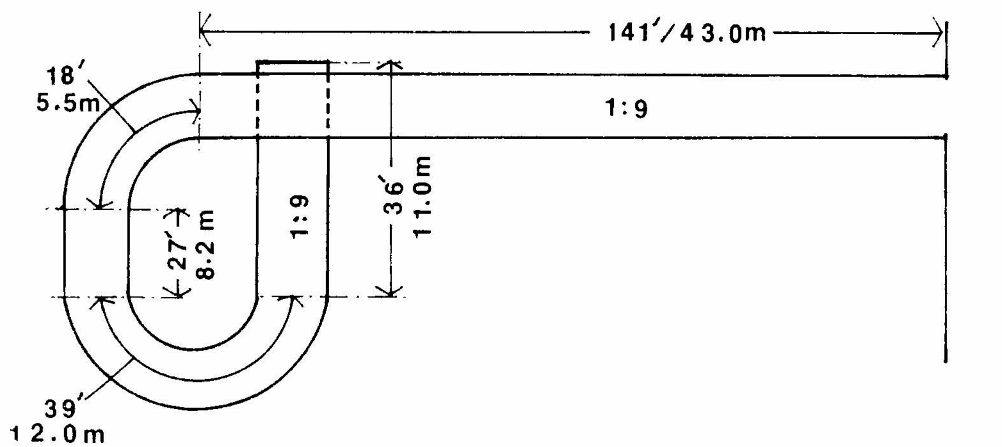
Because of the extreme height of this structure, Alternative No. 1, demolish and rebuild, is an extremely expensive solution. Before such a task is undertaken, consideration should be given to its need. Is the overcrossing used with any regularity? Is there an alternative crossing available? Certainly an analysis of cost-effectiveness is merited in this instance. Alternative No. 1 is the recommended solution.

Major Access Barrier 13

Description

Ramps on Approach too Long and Steep: Dogleg Ramps with Helical Ends Instead of Landings.





The Problem

In this situation, in addition to a dogleg ramp which is too steep (this example has a slope of 1:9) and long (one run is 39' or 12.0 m), the ends are not level rest areas, but helical in design. Therefore, there are no landings on which to stop and rest.

Alternative Solutions

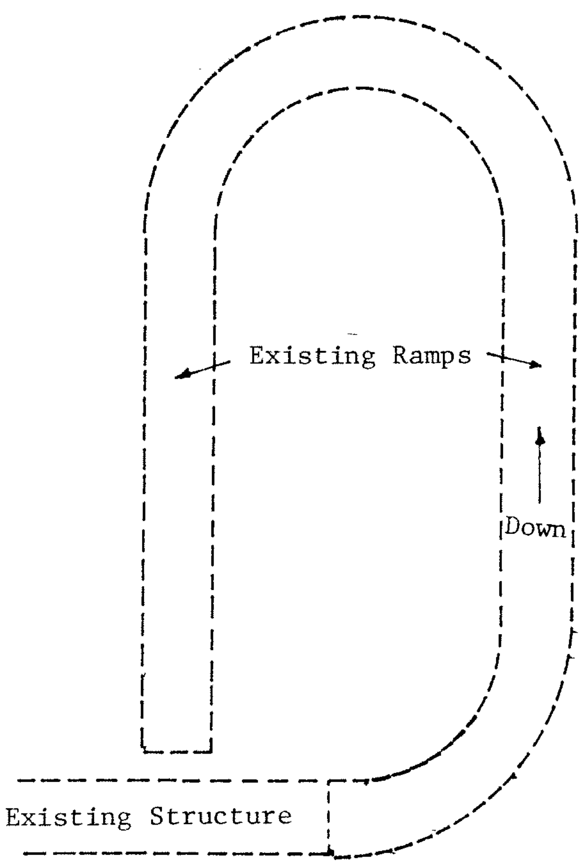
. Demolish and rebuild.

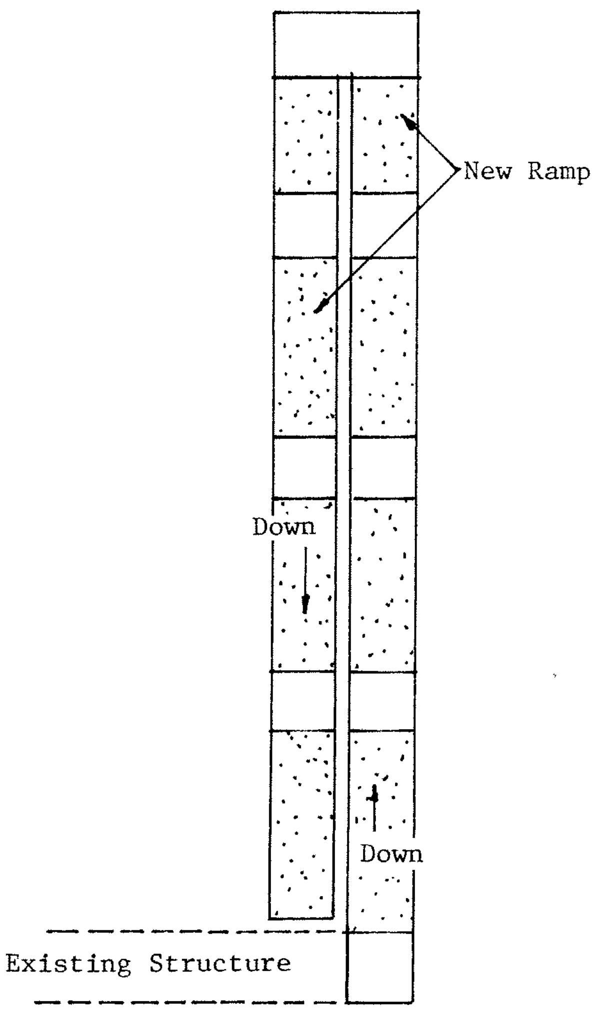
. Install an elevator.

Alternative No. 1

Demolish and Rebuild

The major advantage of this alternative is that the new ramp will not be affected by any structural, or alignment deficiencies of the existing facility. Rest areas would be incorporated in the design to facilitate persons requiring stopping places on the longer ramp.





Cost

$194,000 (see Appendix H for breakdown of cost estimate).

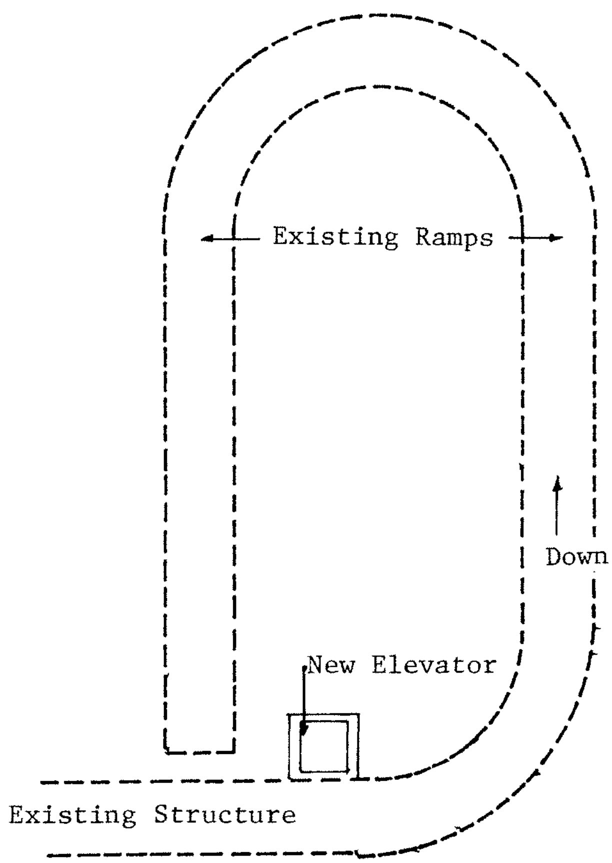
Other Costs

The gentler ramp grade will result in a longer total ramp length which will also result in increased maintenance costs.

Alternative No. 2

Install an Elevator

Installation of an elevator provides a direct connection between the top and bottom of the ramps. This solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility.



Cost

$51,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibilty and secuity.

Summary of Alternative Costs

Alternative	Construction Cost
1 Demolish and rebuild	$194,000
2 Install an elevator	51,000

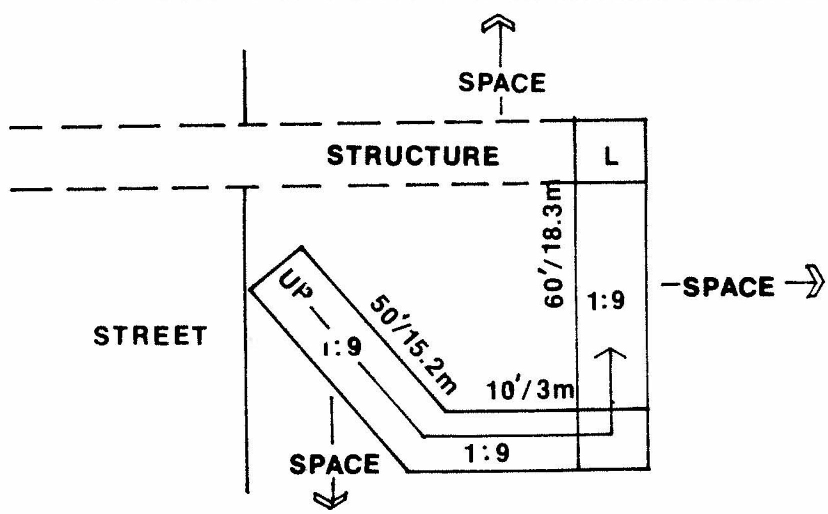
Recommendations

Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator. Alternative No. 1 is recommended.

Major Access Barrier (14)

Description

Ramps on Approach too Long and Steep: Random Ramp Configuration; Sometimes Follows Ground Contour.



The Problem

The ramp in this situation is again too long (over 30' or 9.1 m) and steep (slope over 1:12). In the example, the ramp follows the ground contour approximately.

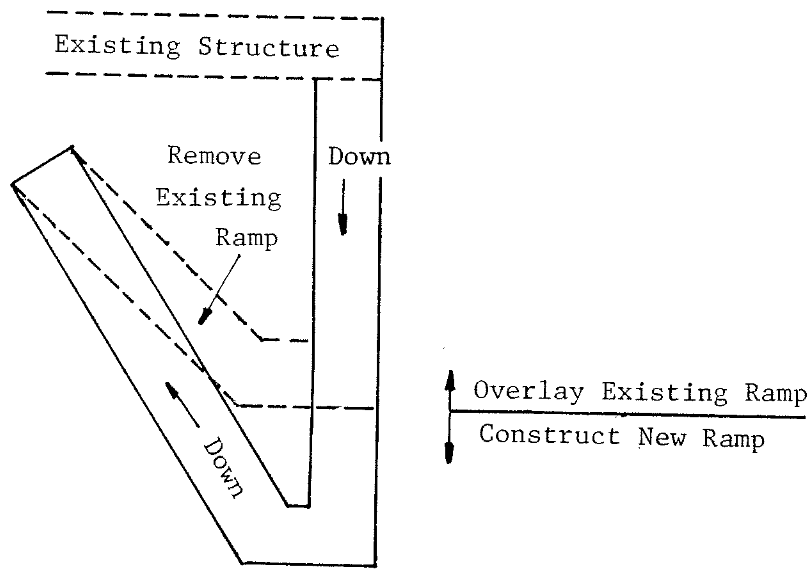
Alternative Solutions

- Overlay portion of existing ramp and construct a new ramp extention.
- Install elevator.

Alternative No. 1

Overlay Portion of Existing Ramp and Construct New Ramp Extension

The upper portions of the existing ramp can be treated with an overlay to reduce the grade and develop rest areas. The lower portion of the ramp must be constructed new since a ramp extension is necessary to accommodate the longer, though gentler grade, ramp. Existing handrailing must be replaced and the lower portions of the original ramp must be removed. The lower ramp entrance is maintained at the same location as the original situation.



Cost

$18,400 (see Appendix H for breakdown of cost estimate).

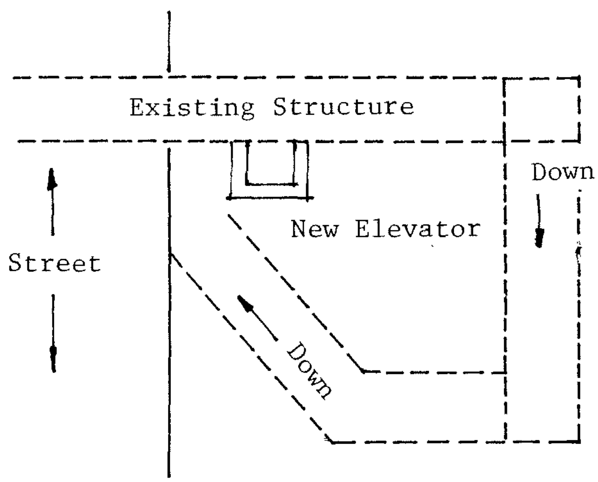
Other Costs

The gentler ramp grade will result in a longer total ramp length. The additional length will also result in increased maintenance costs.

Alternative No. 2

Install an Elevator

The major advantage is that an elevator directly connects the bottom of the steep ramp with the existing overcrossing structure. Consideration must also be given to the other end of the existing overcrossing to confirm that persons likely to use the elevator are capable of ascending that ramp. If not, a second elevator would be required to complete the system. This solution is practical only where problems of vandalism and security don't immediately rule it out as a possibility.



Cost

$51,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Summary of Alternative Costs

Alternative	Construction Cost
1 Overlay portion of existing ramp and construct new ramp extension	$18,400
2 Install elevator	51,000

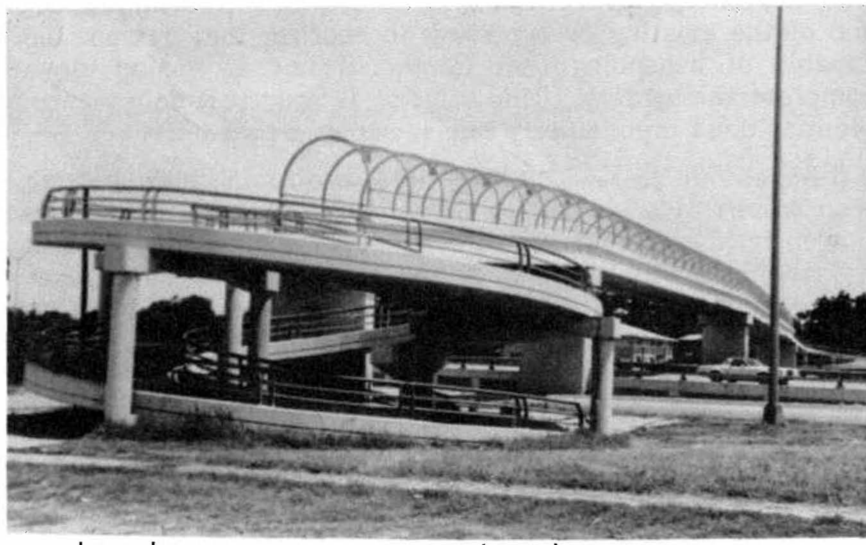
Recommendations

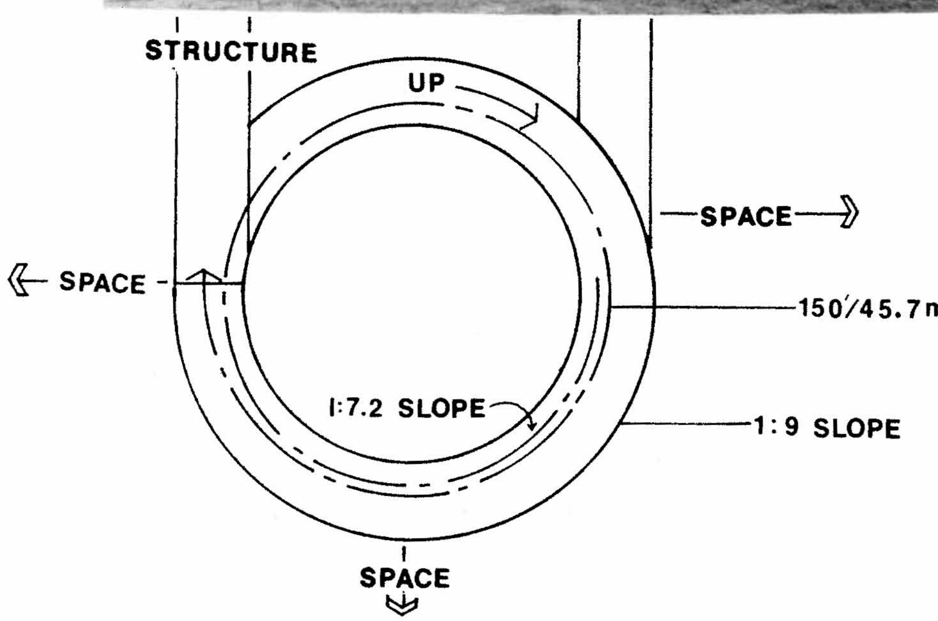
Alternative No. 1 is recommended.

Major Access Barrier 15

Description

Helical Approach Ramps too Long and Steep.





The Problem

Another common design is the helical ramp. In this situation, the ramp forms a continuous spiral, with no places to stop and rest, and is therefore too long (150' or 45.7 m). In this case, it also has a steep slope (1:9 on the outside of the spiral and 1:7.2 on the inside).

Alternative Solutions

- Demolish and rebuild helical ramp (one side).
- Install elevator.
- Construct new ramp to supplement existing helical ramp.

Alternative No. 1

Demolish and Rebuild Helical Ramp

Cost

$221,000 (see Appendix H for breakdown of cost estimate).

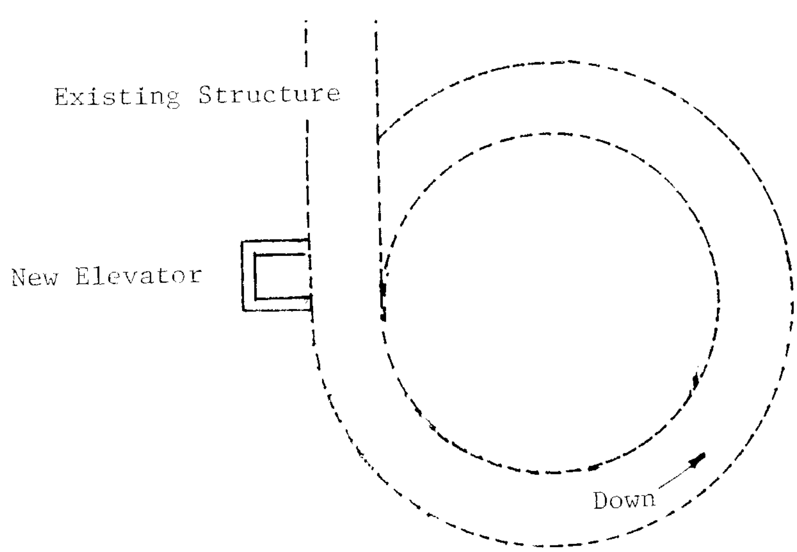
Other Costs

The gentler slope will result in a longer total ramp length which will also mean increased maintenance costs.

Alternative No. 2

Install an Elevator

An elevator can be installed to provide a direct connection between the top and the bottom of the ramp. It could be conveniently located on the outside or on the inside of the helical ramp. As previously mentioned, this solution is practical only where problems of vandalism and security do not immediately rule it out as a possibility.



Cost

Approximately $59,000 (See Appendix H for breakdown of cost estimate).

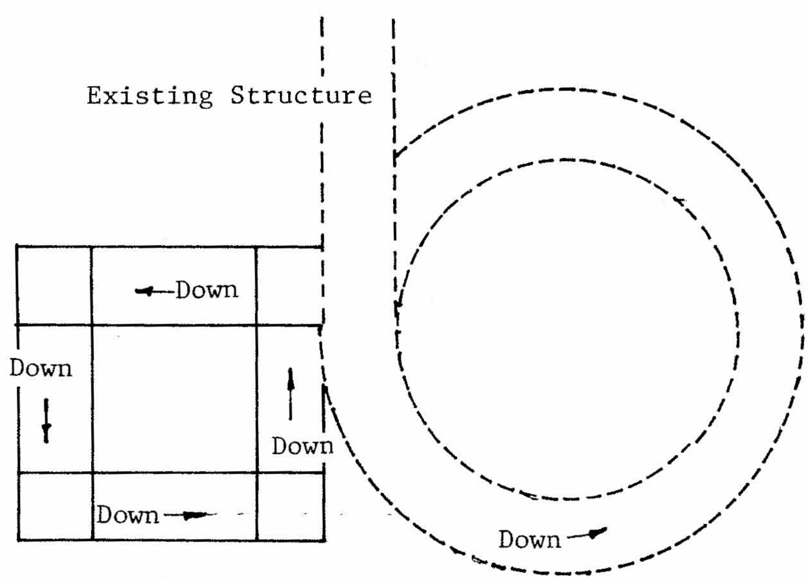
Other costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and secuity.

Alternative No. 3

Construct New Ramps to Supplement Existing Helical Ramp

Rather than demolishing the existing steep helical ramp, a new box ramp can be constructed to provide supplementary service. The new ramp would normally be located outside of the existing helical ramp with the entrance and exit points adjacent to existing ramp termini. The advantage of this strategy is that it does not require demolition, thereby reducing cost and allows for continuous access during construction.



Cost

$200,000 (see Appendix H for breakdown of cost estimate).

Other Costs

Because the second ramp is to be added to the existing ramp, unless designed carefully, a massive combined structure which is aesthetically unsatisfactory may result.

Summary of Alternative Costs

Alternative		Construction Cost
1	Demolish and rebuild ramp (one side)	$221,000
2	Install elevator	59,000
3	Construct new ramp to supplement existing helical ramp	200,000

Recommendations

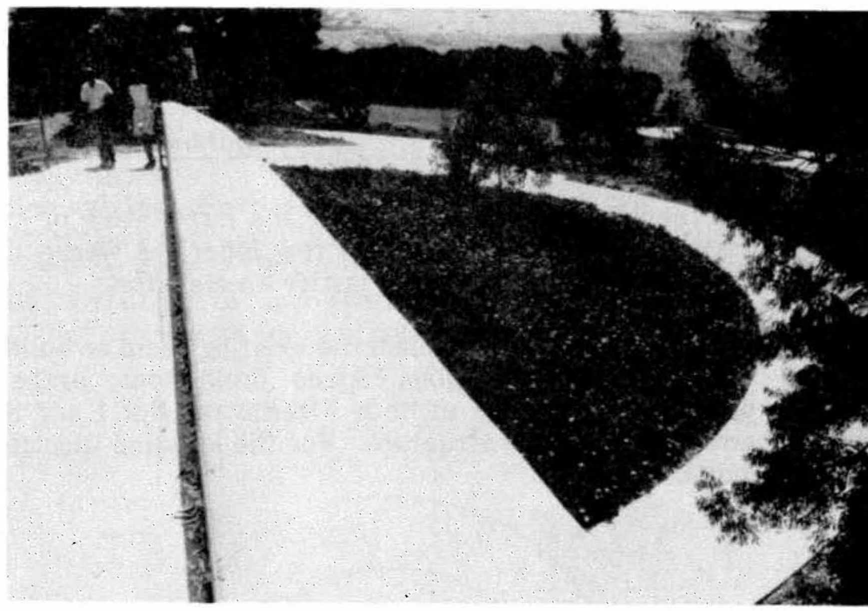
Despite the fact that the initial cost of the installation of an elevator is cheaper than the construction of a ramp, there are few locations where the substantial increase in maintenance and security costs will justify an elevator.

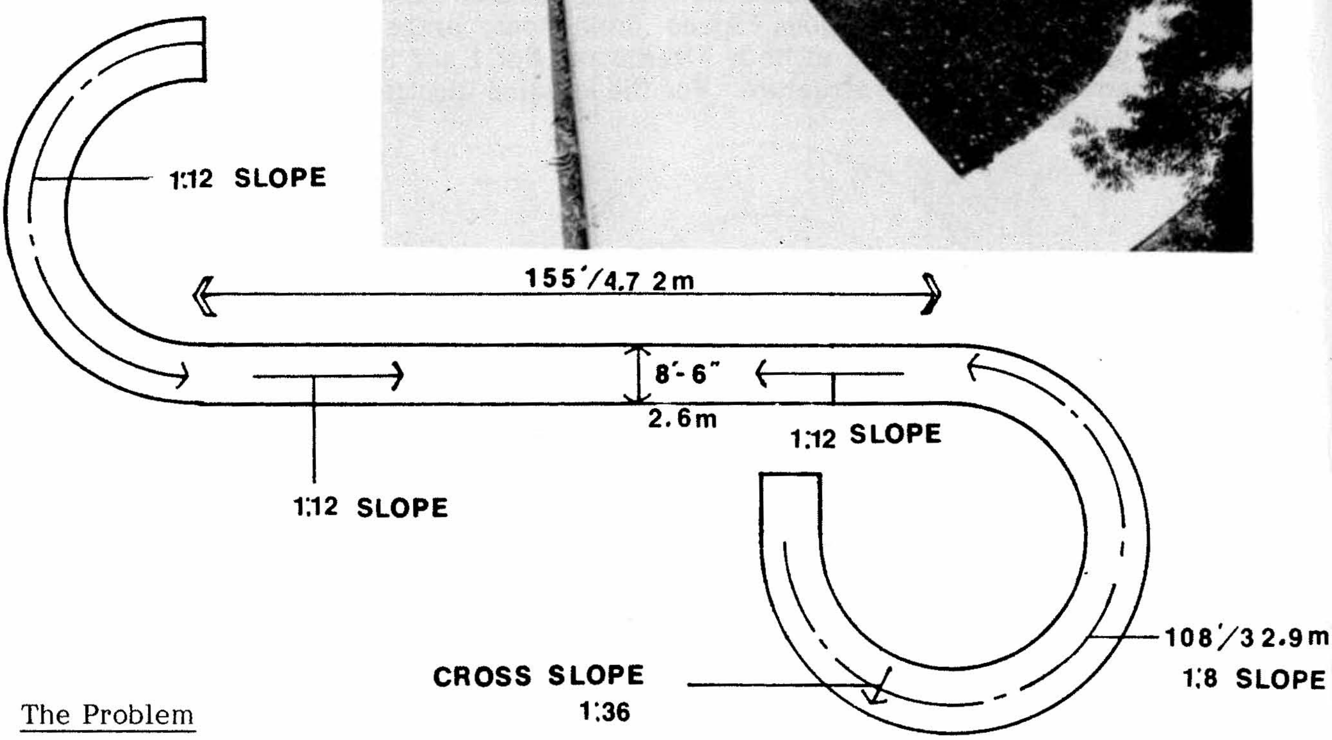
The decision of whether to demolish the existing ramp or build a supplemental ramp will depend upon existing conditions - space limitations, usage warrants, etc. Again, because of the extreme cost of both Alternative No. 1 and No. 3 an analysis should be made of actual need of the structure. For the location illustrated, Alternative No. 3 is recommended.

Major Access Barrier (16)

Description

Street Cross Slope on Ramp.





The Problem

Typically found in spiral ramp design, this is a problem in which the cross slope exceeds 1:50 - in the prototypical example the ramp has a cross slope of 1:36.

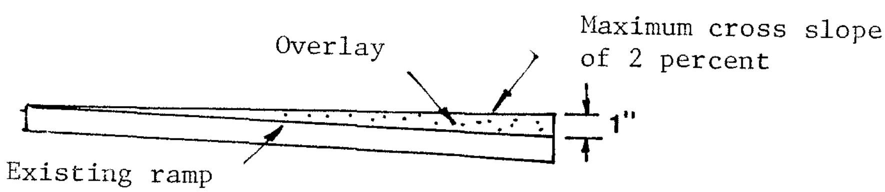
Alternative Solutions

Construct overlay to existing ramp.

Alternative No. 1

Construct Overlay to Existing Ramp

Ramps with cross slopes in excess of two percent would be candidates for modifications. In most instances a thin pavement overlay can be constructed to lessen the cross slope. However, there may be cases where the cross slope is a result of super elevation such as may occur around a curve and therefore requires a more extensive treatment with thicker overlay and even handrail modifications.



Costs

Not determinable

Other Costs

None

Summary of Alternative Costs

Alternative	Construction Costs
1 Construct overlay to existing ramp	not determinable (see Appendix H)

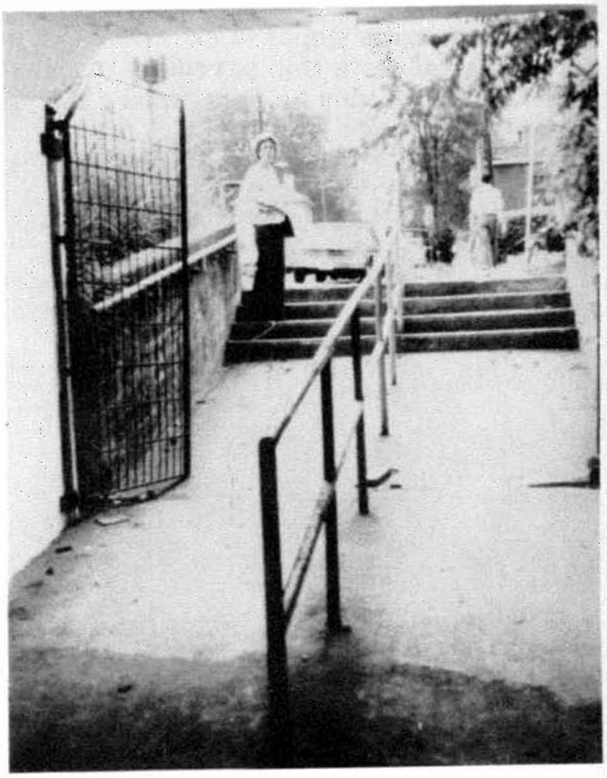
Recommendations

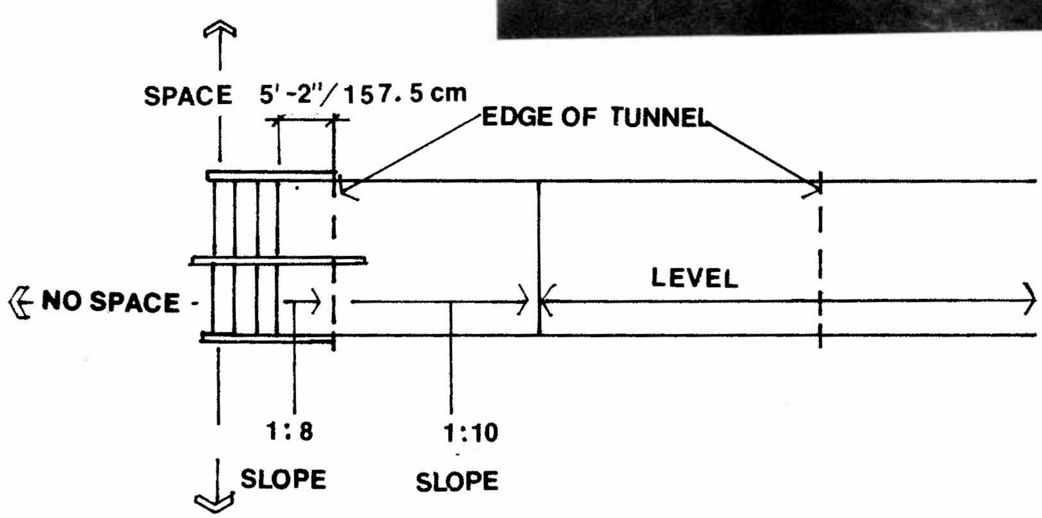
This alternative seems to be the most viable solution to the problem.

Major Access Barrier (17)

Description

Stairs only on Approach to Undercrossing (Room for Ramp).





The Problem

In this situation only stairs have been provided at the approach to the undercrossing. There is room to construct a supplmental ramp on one side only.

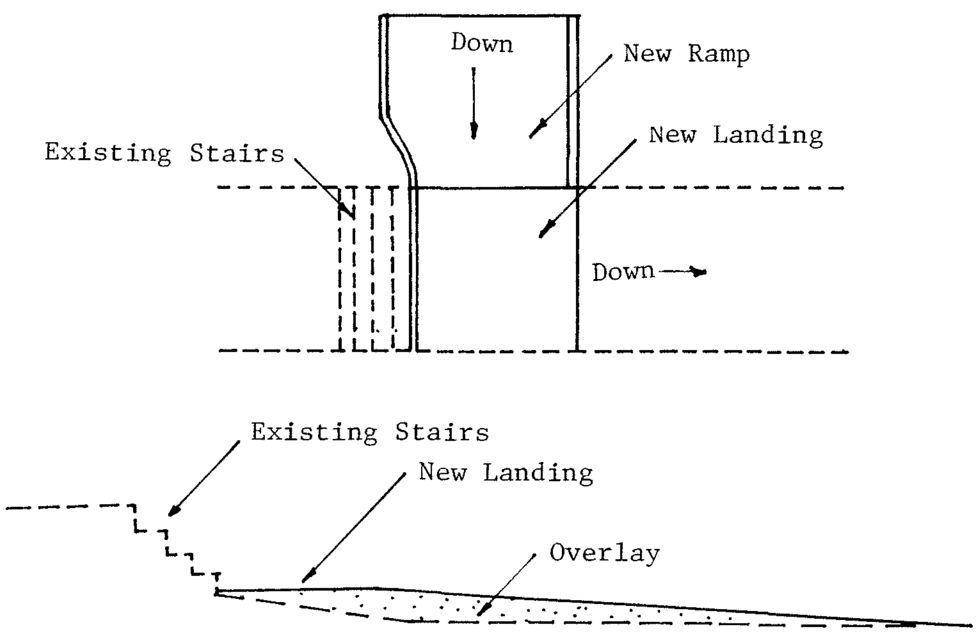
Alternative Solutions

Construct new ramp to supplement stairs.

Alternative No. 1

Construct New Ramp to Supplement Stairs

Since the prototypical problem shows no space available at the end, a side ramp is feasible. This requires excavation and demolition of part of the wall. The ramp into the undercrossing is too steep thereby requiring an overlay to reduce the grade to an acceptable 8.33 percent. A landing should be constructed at the bottom of the stairway to serve as a rest area. The design should be evaluated to assure that vertical clearance will be adequate after construction of the overlay. Handrailing is utilized along both sides of the new side ramp.



Cost

$4,300 (see Appendix H for breakdown of cost estimate).

Other Costs

Construction of the new ramp will result in increased maintenance costs, and may result in an inconvenient ramp end location. In addition, cyclists and other wheeled devices will be able to use the undercrossing with perhaps some danger and discomfort to other pedestrians.

Summary of Alternative Costs

Alternative	Construction Cost
1 Construct new ramp to supplement stairs	$4,300

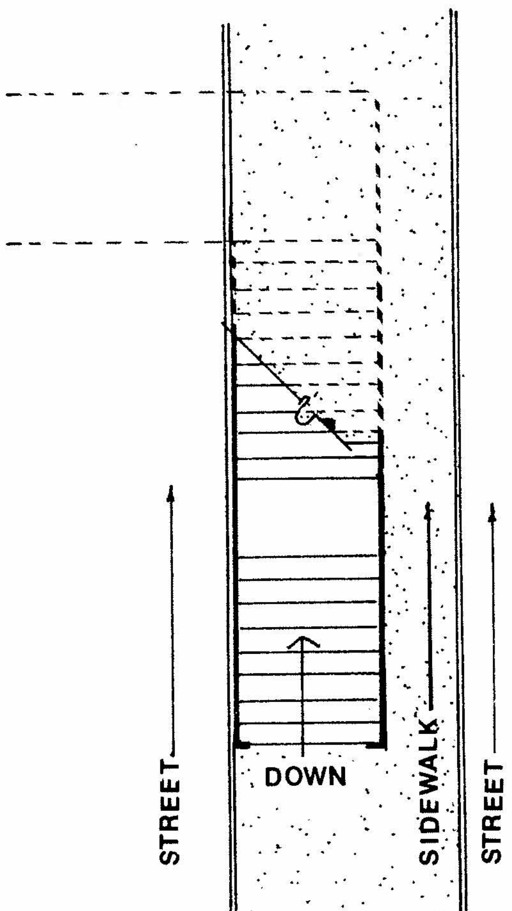
Recommendations

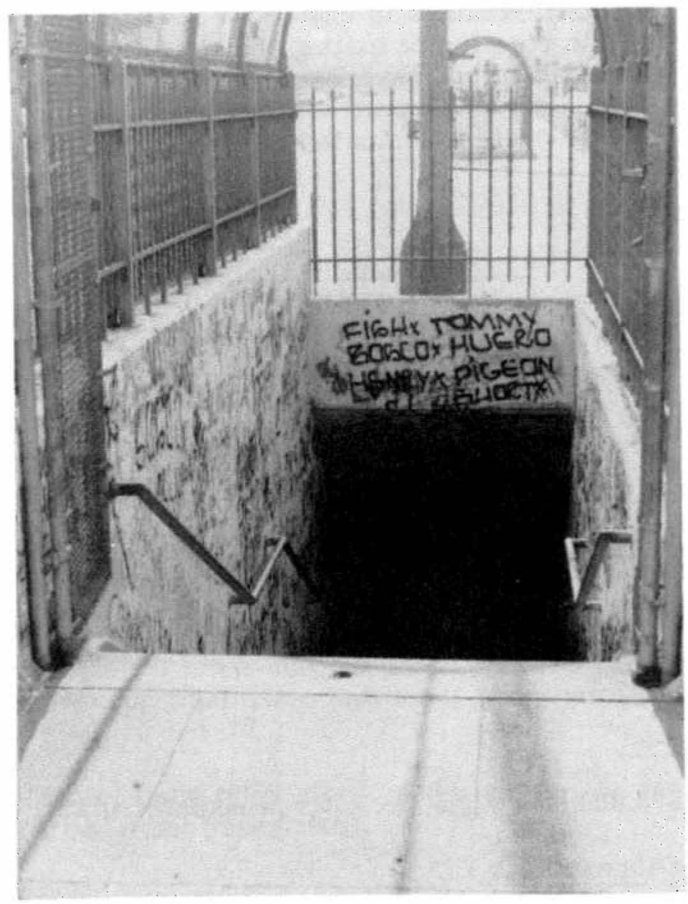
Alternative No. 1 appears to be a viable solution to this problem.

Major Access Barrier (18)

Description

Stairs only on Approach to Undercrossing (Restricted Space).





The Problem

Like Problem No. 17, this undercrossing is accessible only by a staircase. However, in this case, space available for new construction is limited to the area in front or behind the existing stairs.

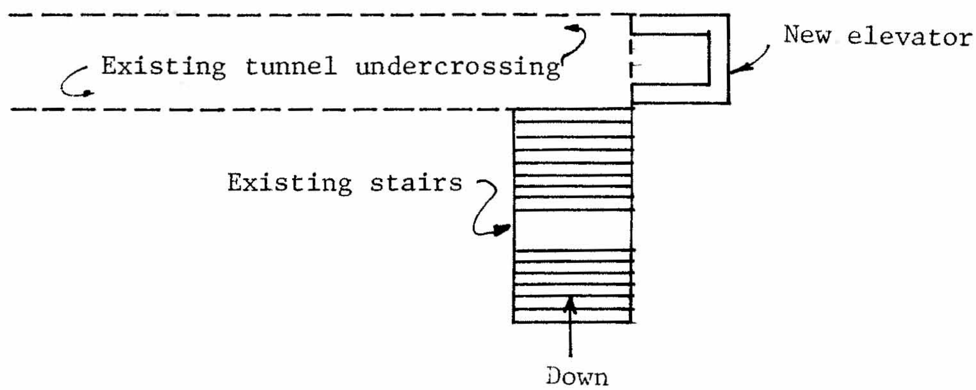
Alternative Solutions

- Install elevator.
- Replace stairs with new ramp.
- Install pedestrian actuated traffic signal.

Alternative No. 1

Install Elevator to Supplement Stairs

Installation of an elevator will provide direct access from the sidewalk down to the undercrossing; thereby providing an alternative to the stair-only access. The undercrossing creates a special problem with regard to security and may require additional features to enable the user to view the undercrossing tunnel and approaches prior to entering or exiting the elevator. This solution is practical only where problems of vandalism and securitv do not immediately rule it out as a possibility. The cost estimate assumes construction of one elevator. However, it is understood that the entire crossing must be evaluated and treated to eliminate impediments to travel.



Cost

$73,000 (see Appendix H for breakdown of cost estimate).

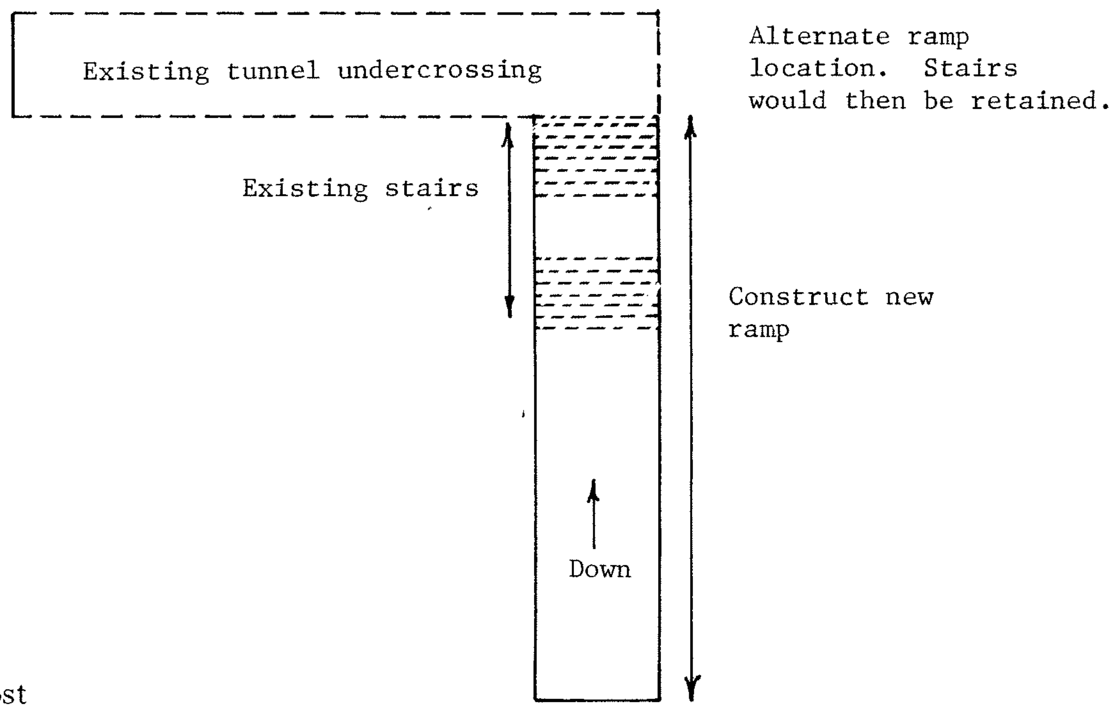
Other Costs

Major disadvantages include those of continuing maintenance and surveillance responsibilities to assure accessibility and security.

Alternative No. 2

Replace Stairs with New Ramp

Construct a ramp to replace the stairs.



Cost

$174, 000 (see Appendix H for breakdown of cost estimate).

Other Costs

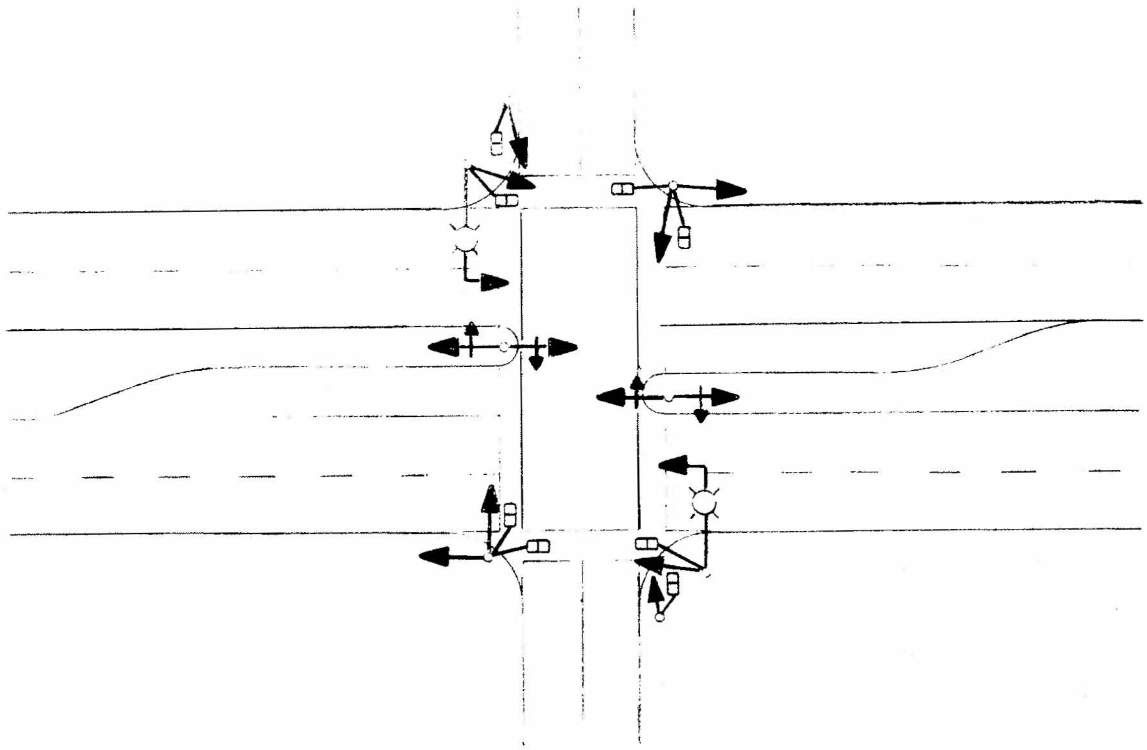
Construction of a ramp that has a gentle enough slope may result in the ramp's end location being some distance away from the original stair entrance, and therefore, inconvenience some users.

The addition of a ramp will also enable cyclists and other wheeled devices to use the undercrossing with perhaps some discomfort to other pedestrians.

Alternative No. 3

Install Pedestrian Actuated Traffic Signal

While the undercrossing was constructed originally to provide a grade-separated crossing for pedestrians, usage characteristics may warrant exploration of an entirely new treatment. Control of an intersection with a pedestrian-actuated traffic signal may be found to serve pedestrian crossings better than alternatives modifying the undercrossing.



Cost

Approximately $64,000 (See Appendix H for breakdown of cost estimate).

Other Costs

Installation of a traffic signal at this location may result in increased gasoline consumption and time costs for vehicle users. This may also increase vehicular/pedestrian accidents.

The addition of a pedestrian-way on grade will incur increased maintenance costs for that immediate area. However, this obviously decreases by a vast amount, the costs of maintaining a safe undercrossing.

Summary of Construction Costs

Alternative	Construction Cost
1 Install elevator	$ 73,000
2 Replace stairs with new ramp	174,000
3 Install pedestrian activated traffic signal	64,000

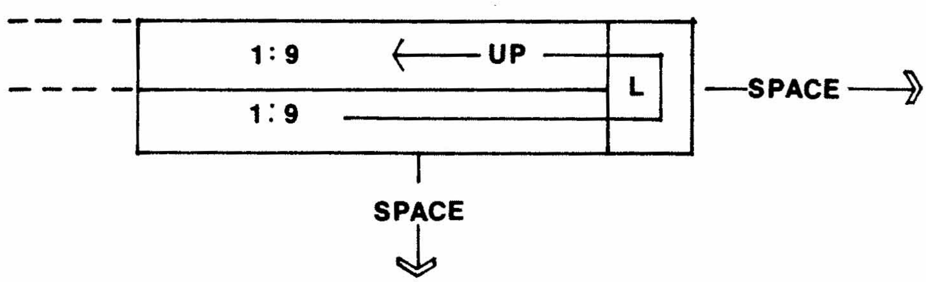
Recommendations

Alternative No. 3 is the most cost-effective. However, if grade separation is warranted then solution number 2 must be recommended. There are few locations where the substantial increase in maintenance and security costs will justify Alternative No. 1.

Major Access Barrier (19)

Description

Ramp only on Approach (No Stairs).



The Problem

This structure has no stairs as a means of access for those who cannot use ramps.

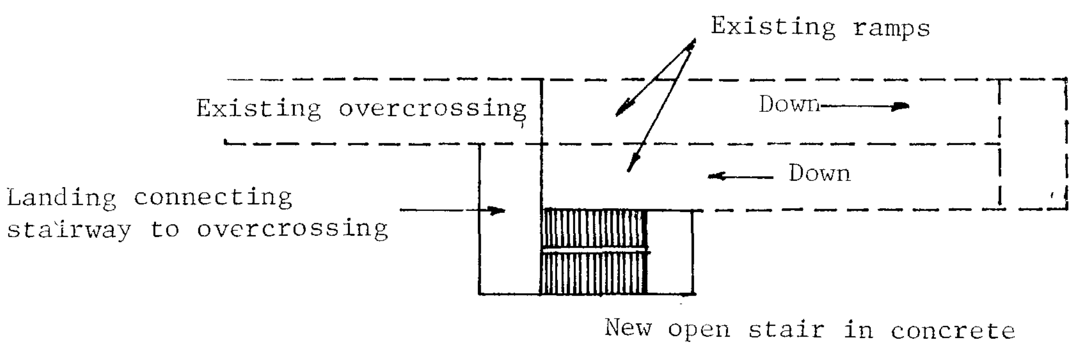
Alternative Solutions

Construct stairs to supplement ramp.

Alternative No. 1

Construct Stairs to Supplement Ramp

While a ramp with grades between 5 and 8.33 percent is generally considered satisfactory, there are some persons who feel more comfortable or are better able to negotiate stairs rather than ramps. Where a significant number of users would benefit, supplemental stairs should be considered as an alternative to the ramp. The cost estimated details the cost for constructing stairs to supplement a ramp on one end of an overcrossing.



Cost

$44,000 (see Appendix H for breakdown of cost estimate).

Other Costs

The stair end location may be less convenient than the ramp. Increased maintenance costs will be sustained.

Summary of Alternative Costs

Alternative		Construction Cost
1	Construct stairs to supplement ramp	$44,000

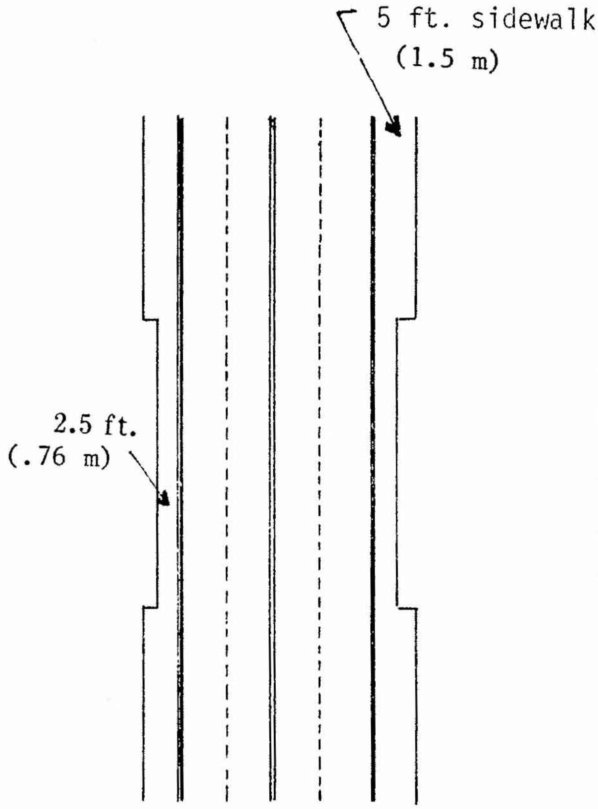
Recommendations

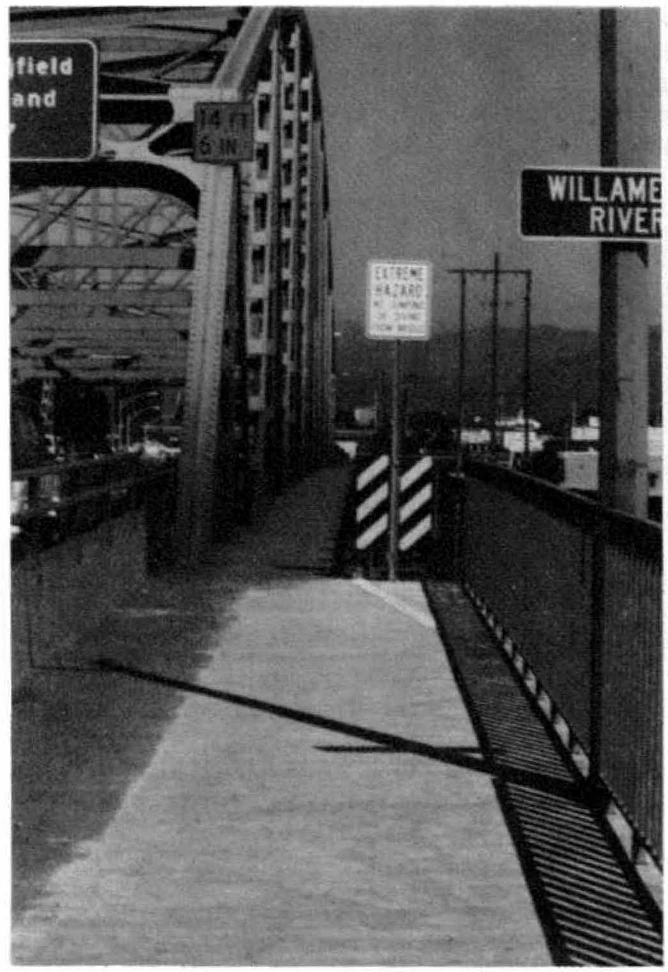
The recommended solution involves construction of new stairs to supplement the existing ramp.

Major Access Barrier (20)

Description

Sidewalk too Narrow Across Overcrossing.





The Problem

In order for a walkway to be usable by a person in a wheelchair, it must be at least 36" in width. In this situation, the walkway narrows considerably below this width as it crosses the bridge.

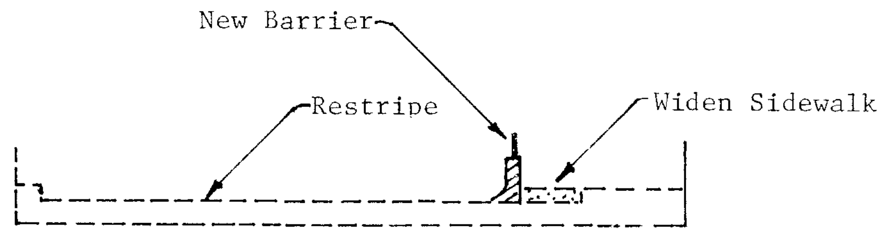
Alternative Solutions

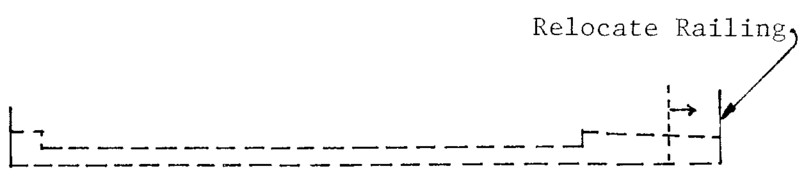
- Widen sidewalk within original structure by modifying safety curbs and railing.
- Widen original structure to accommodate sidewalk.

Alternative No. 1

Widen Sidewalk Within Original Structure

Reoganization of space on the structure is one alternative for obtaining increased sidewalk width. This could be achieved by narrowing and restriping the lanes and/or modifying the existing curbs and railing to obtain the required space. Physical separation, such as railing or New Jersey barrier, is also desirable. Where possible sidewalks should exist along both sides of a vehicular bridge and be compatible with the non-motorized facilities of the approach to the overcrossing.





Cost

$7,300 - $9,500 (see Appendix H for breakdown of cost estimate).

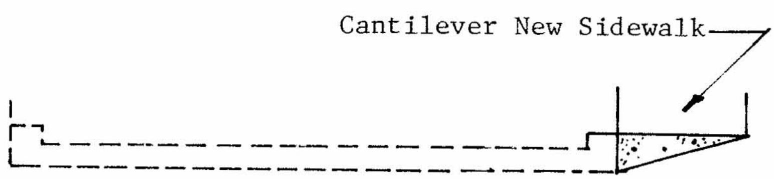
Other Costs

Widening of the walkway in this way will result in decreasing the width of the roadway.

Alternative No. 2

Widen Original Structure to Accommodate Sidewalk

Widening of an original overcrossing by cantilevering is a proven technique used to obtain additional space for non-motorized travel. The cantliver can widen existing walkways or create new walkways where none existed before. Where a new walkway is created, often times the original bridge railing can be retained and provides physical separation from traffic. It should be noted, however, that each structure should be thoroughly analyzed to determine if it is structurally competent to support the additional weight.



Cost

$30,600 (see Appendix H for breakdown of cost estimate).

Other Costs

The cantilever configuration may isolate the walkway from the regular roadway, and maintenance costs may be increased.

Summary of Alternative Costs

Alternative	Construction Cost
1 Widen sidewalk within original structure by modifying safety curbs and railing	$ 7,300 - $9,500
2 Widen original structure to accommodate sidewalk	30,600

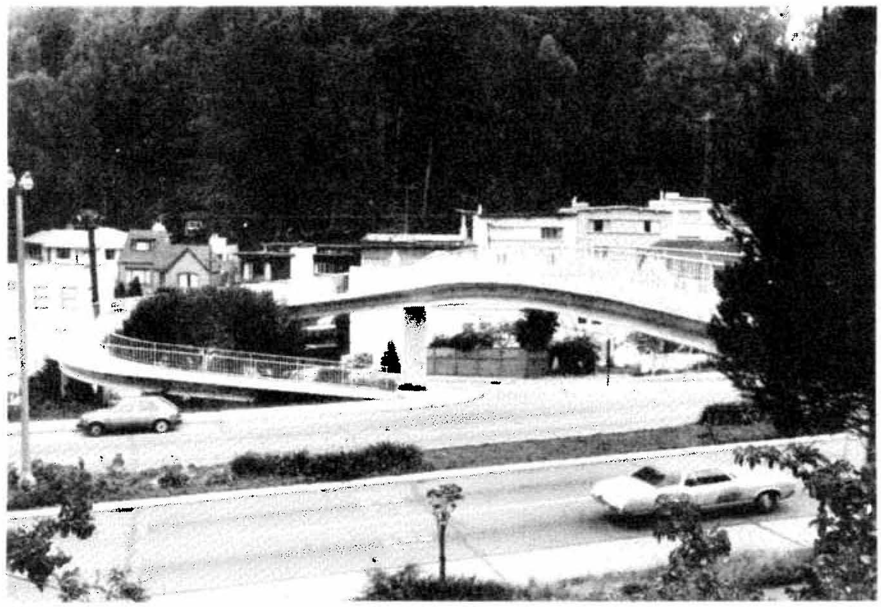
Recommendations

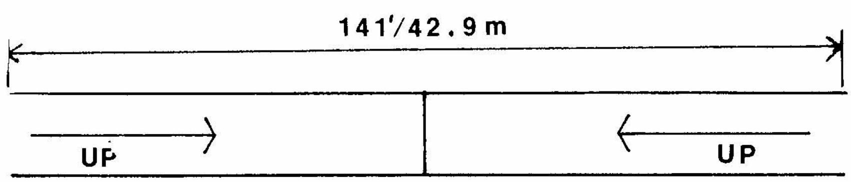
Alternative No. 1 is recommended if its implementation is deemed safe and acceptable.

Major Access Barrier (21)

Description

Ramped walkway across structure too long.





The Problem

This problem defines a situation in which the structure ramps but no landings (at 30' intervals) have been provided.

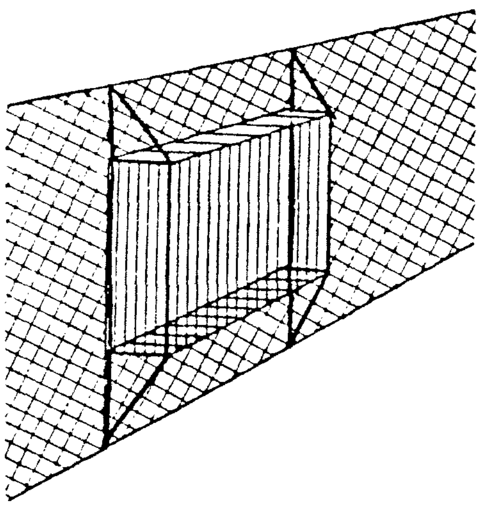
Alternative Solutions

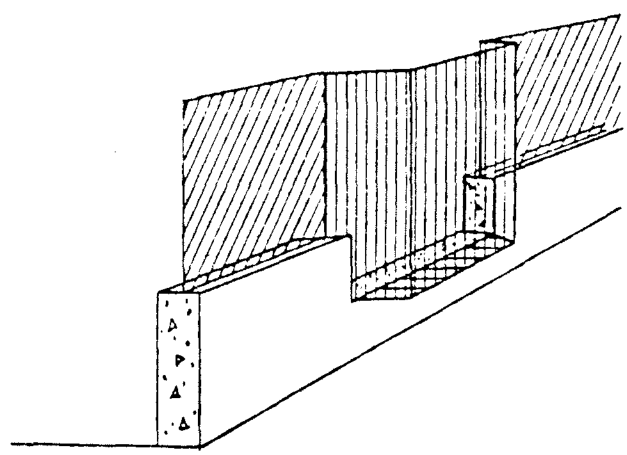
- Construct off-ramp rest areas.
- Overlay existing ramp to create rest areas.
- Construct on-ramp rest areas (partial width).
- Demolish and rebuild.

Alternative No. 1

Construct Off-Ramp Rest Areas

Construction of rest areas on the structure provides a place for persons to rest. One technqiue would be to modify the sidewalk or fencing to create an alcove with a bench, a cantilevered landing or a combination there-of which is recessed from the normal travel surface.





Cost

$2100 - $2400 each x 5 rest areas needed = $10,500-$12,000 Total Cost (see Appendix H for breakdown of cost estimate).

Other Costs

Increased maintenance costs will be sustained.

Alternative No. 2

Overlay Existing Ramp to Create Rest Areas

Localized overlaying of existing long ramps creates rest areas within the pathway. Where the entire ramp width is treated, these level plateaus service both directions of travel.

Cost

$200 each x 5 rest areas needed = $1,000 Total Cost (see Appendix H for breakdown of cost estimate).

Other Costs

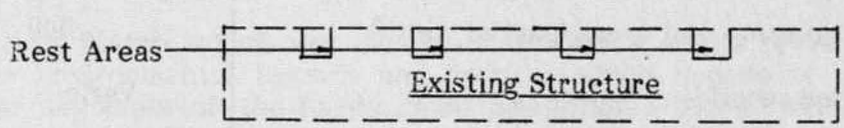
While this type of rest area represents closely spaced breaks in grade, they should not adversely effect slow moving bicycles and wheelchairs. However, riders of fast moving wheeled conveyances (bicycles, wheelchairs, skateboards, etc.) may be jolted or require extra attention be given to their balance.

The added ramp will also increase maintenance costs.

Alternative No. 3

Construct On-Ramp Rest Areas (Partial Width)

A third alternative for rest area construction is to construct rest areas within the pathway but using only part of the total width. The minimum rest area width would be 3.75 feet (1.14 m). Handrails should be constructed to provide a positive barrier to stop users from falling off the sides or end of the rest area. This technique would probably only be considered where wide structures exist. The absolute minimum ramp width for this treatment would be 8 feet with desirable minimum being about 12 feet (3.66 m) so at least 8 feet (2.44 m) is available for two way bicycle travel.



Cost

$400 each x 5 rest areas needed = $2,000 Total Cost (see Appendix H for breakdown of cost estimate).

Other Costs

The location of the rest areas may be inconvenient to some users. Secondly, the user of the rest area must detour from the direct path and then drop down the slope again after resting in order to ascend further.

Addition of these rest areas will also increase maintenance costs.

Alternative No. 4

Demolish and Rebuild

Where the structure has a grade in excess of 8.33 percent, then rest area construction will not solve the problems created by a steep grade. It may then become necessary to consider building a new structure to serve the demand. This may require demolition of the existing structure or construction of the new structure at a different location selected to better serve the travel needs of the intended users.

Cost

Varied (see Appendix H for breakdown of cost estimate).

Other Costs

If design, location and usage considerations are carefully undertaken, the new structure should be as convenient and easily maintained as the existing one, if not more so.

Summary of Alternative Costs

Alternative		Construction Cost
1	Construct off-ramp rest areas	$10,500 - $12,000
2	Overlay existing ramp to create rest areas	1,000
3	Construct on-ramp rest areas (partial width)	2,000
4	Demolish and rebuild	Varied

Recommendations

Alternative No. 4 implies tearing down the whole crossing and starting again. Before Alternative No. 4 is considered for implementation, a thorough study should be carried out to determine the warrant for the crossing.

Depending on the structure to be appended, Alternative No. 1 may not be possible because some structures would not be able to carry the additional loading.

Because they are relatively inexpensive, Alternatives No. 2 and No. 3 are recommended if they solve the problem and are possible.

TASK 5: CONCLUSIONS AND RECOMMENDATIONS

An examination of the recommended solutions shows that even where only a single major access barrier is present in a crossing structure, the cost of correcting the problem is substantial. For some of the structures, the cost of correcting the problems exceeds the estimated cost of demolishing the facility and reconstructing it to acceptable standards.

The survey of crossing structures took place exclusively during daylight hours. During these surveys, it was unusual to find the structures being used at all. There were some exceptions to this, and it is quite likely that some of the structures are more heavily used at certain times of the day, certain days of the week, and weeks of the year.

There may be a variety of reasons for the low usage found by the observers. Some of the crossing structures are in isolated places where users might feel insecure in terms of crime. Secondly, some of the crossing structures are so extensive in terms of vertical and horizontal distance to be travelled, and complex ramp layouts to be negotiated that the users must be highly motivated to wish to use them. Other structures seemed to serve very little purpose in terms of the areas in which they are located; and others are quite difficult to find even if one knows in general where they are: they are screened by trees, bushes, buildings, etc.

The high cost of constructing or reconstructing crossing structures suggests that before any changes are made to existing structures, the usage of each structure should be reevaluated.

In summary, it is concluded that both major and minor access barriers can be eliminated from existing structures in most cases. However, as discussed later, there are still several types of barrier problems for which researched solutions must be sought.

Criteria for New Crossing Structures: The Solutions Matrix

The Barriers Matrix which was developed in Task 2 and is presented in Appendix C identifies environmental hazards and barriers which impede or prevent access for particular segments of the handicapped population. The Solutions Matrix which is presented in Appendix G uses precisely the same format as the Barriers Matrix with functional disabilities listed on one axis, and environmental barriers on the other. However, this new matrix is intended to provide information covering the state of knowledge with respect to solutions for problems.

For each cell in the Barriers Matrix there is a symbol which indicates whether there is a potential problem or not. In the Solutions Matrix, for each of these potential problem cells, there is a symbol which indicates whether there is a known solution (indicated by an S), or whether further research is needed to devise or revise solutions (indicated by a O). Where no problem is indicated in the Barriers Matrix, the comparable cell in the Solutions Matrix is marked by X.

The sources for the information used in the Solutions Matrix includes previous work by the Pedestrian Research Laboratory, the studies at Syracuse University for the proposed revisions to the ANSI standards, and other accessibility studies.

Recommendations for Future Research

The Solutions Matrix shows that there are some problems for which satisfactory solutions are not yet available. Some of these problems are not new; for instance on ramps, slip resistance is of major importance, yet there is no accepted standard for the various types of walkway materials, nor for the types of slope and climatic conditions that are likely.

Some problems have accepted solutions that are questionable; stairways, to be accessible, (says the literature) should not have open risers. Yet, it is very likely that where the gap is quite small the open riser will not cause difficulty.

Some problems have been identified so recently, that only tentative solutions have been explored -- for instance, ways of assisting severely visually handicapped people to avoid hazards, and to assist them in navigating in complex environments.

All of these problems need further research. A more extensive discussion on the research questions raised by the Solutions Matrix follows.

Location and End Condition

- For some visually impaired people (and some other groups), orientation, location and direction finding is difficult for some crossing designs. Crossing approaches are not always located so that they are easy to find; some are located in parking lots and other large spaces which are difficult for the blind to navigate in; many others do not lead directly from walkways. Methods for indicating the location of crossing structures in ways that are comprehensible to the blind are needed.

- Undercrossing tunnels seem to be a barrier for some people if the tunnel is perceived as "long". These people may be fearful of antisocial activity in long tunnels, or they may suffer from claustrophobia. The question that remains is what length of tunnel is acceptable?

- Portions of over- and undercrossings are often hidden from the view of potential users, and some users are afraid of criminal activity at these locations. Studies of crossing structure design to minimize real or perceived dangers from antisocial behavior are needed.

Surface Materials

- It is well known that certain walkway surfaces will effectively prevent some handicapped users from crossing the surface -- sand, gravel, mud for example -- and other surfaces may become a barrier if the user must travel considerable distances over them -- wheelchairs over brick paving for example. However, the information has yet to be quantified so that criteria can be developed for specification purposes.

- Slippery walkway surfaces are a hazard for all pedestrians. For the elderly and handicapped, the dangers are exacerbated because of their decreased ability to regain their balance. This is particularly important for the ramping structures at approaches.

- There are not accepted standards of walkway slip resistance. The range of materials that are used for walkways have not been classified in terms of slip resistance. Criteria for slip resistance for the usual range of walkway materials set at various slopes and under various climatic conditions are needed.

Maintenance

- Most of the structures examined have had the lights vandalized. This is a serious problem for night time users and particularly for the elderly and those with low vision. None of the existing solutions seem to be vandal-proof, and few attempts were made to resolve the problems.

Stairways

- Open risers are usually listed as inaccessible particularly to those with prosthetic feet and legs because the artifical foot is apt to catch in the riser or the nosing. It is probable that certain open riser designs may not pose the problem and it is possible that some prosthesis modifications could resolve the question.

Ramps

- Current standards limit both the lengths of ramps and gradients permitted. The research on which these standards are based has been carried out using wooden ramps that are dry. It is questionable whether the same results would ensue from exterior materials and materials that are wet. None of the existing research has established maximum heights that a person can reasonably be expected to climb using ramps. Should ramps that are less steep than 1:12 have landings at more than 30' (9.1 m)? What is the maximum length/height that can be negotiated?

Handrails

- There has been no thorough examination of handrail heights for stairs and ramps, particularly heights that will be useful for children and small people. Furthermore, it is not clear whether better fall prevention devices can be developed instead of rails and balustrades.

Guardrails, Barricades, etc.

- Many of the crossing structures have walkways contained by chain link fencing. There is a question whether this fencing may not be hazardous if pedestrians, particularly those on wheels, should attempt to stop themselves by grasping this fencing.

Emergency Provisions

- While there is no data on emergencies that occur on crossing structures, there is no doubt that over- and undercrossings are physically demanding for many types of handicapped people. The question arises as to whether some types of emergency call system could or should be provided.

Lighting, Illumination

- There are questions about the nature of illumination on overcrossings. One question is whether the flashing of lights from vehicles may induce epileptic incidents. Secondly, for people with low vision and night blindness there are questions as to whether it might not be preferable to screen the overcrossing walkway from lights from vehicles in order to reduce repetitive contrast changes.

Signage/Media Cues

- Signage and information generally that can be conveyed to severely visually handicapped people using the exterior environment has been explained, but usable information systems have still to be developed. Information systems are needed that can warn of immediate hazards such as stairs, as well as providing orientation data. A limited number of detectable materials have been identified in an earlier study but the effectiveness of these and other materials has yet to be evaluated.

- The timing of traffic signals at walkways leading to crossing structures to suit the needs of the elderly and handicapped has yet to be determined. Earlier studies by the Pedestrian Research Laboratory indicated that short green cycles were perceived by these groups as being hazardous and a deterrent to using crosswalks.

Micro-Climatic Factors

- The effect of high wind gusts and wind generated by traffic on people with balance problems has yet to be established (and countermeasures if this problem is real).

Other Recommendations

- Once these research questions have been answered, then it will be possible to develop complete criteria for specifying accessible crossing structures. It is clear from the case study surveys that the recognized standards have been insufficient to ensure that accessible structures are built. It is recommended that a design guideline handbook should be prepared to overcome this problem.

- There is a need to field test the retrofit solutions developed earlier to ensure that there are no unforseen problems. Likewise, there is a need to evaluate some "best solutions" new crossing structures that apparently meet all the criteria for accessibility. Finally, it is obvious from the sample of structures surveyed, that there are a very large number of over- and undercrossings that are partially or wholly inaccessible. If these structures are to be made accessible, a survey to establish the scale of the problem will be necessary. And it is strongly recommended that the needs for building new structures, and even for retrofitting existing structures, should be examined carefully because the case studies suggest that in many cases the usage of these structures is very low.

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FEDERALLY COORDINATED PROGRAM (FCP) OF HIGHWAY RESEARCH AND DEVELOPMENT

The Offices of Research and Development (R&D) of the Federal Highway Administration (FHWA) are responsible for a broad program of staff and contract research and development and a Federal-aid program, conducted by or through the State highway transportation agencies, that includes the Highway Planning and Research (HP&R) program and the National Cooperative Highway Research Program (NCHRP) managed by the Transportation Research Board. The FCP is a carefully selected group of projects that uses research and development resources to obtain timely solutions to urgent national highway engineering problems.*

The diagonal double stripe on the cover of this report represents a highway and is color-coded to identify the FCP category that the report falls under. A red stripe is used for category 1, dark blue for category 2, light blue for category 3, brown for category 4, gray for category 5, green for categories 6 and 7, and an orange stripe identifies category 0.

FCP Category Descriptions

1. Improved Highway Design and Operation for Safety

Safety R&D addresses problems associated with the responsibilities of the FHWA under the Highway Safety Act and includes investigation of appropriate design standards, roadside hardware, signing, and physical and scientific data for the formulation of improved safety regulations.

2. Reduction of Traffic Congestion, and Improved Operational Efficiency

Traffic R&D is concerned with increasing the operational efficiency of existing highways by advancing technology, by improving designs for existing as well as new facilities, and by balancing the demand-capacity relationship through traffic management techniques such as bus and carpool preferential treatment, motorist information, and rerouting of traffic.

3. Environmental Considerations in Highway Design, Location, Construction, and Operation

Environmental R&D is directed toward identifying and evaluating highway elements that affect the quality of the human environment. The goals are reduction of adverse highway and traffic impacts, and protection and enhancement of the environment.

4. Improved Materials Utilization and Durability

Materials R&D is concerned with expanding the knowledge and technology of materials properties, using available natural materials, improving structural foundation materials, recycling highway materials, converting industrial wastes into useful highway products, developing extender or substitute materials for those in short supply, and developing more rapid and reliable testing procedures. The goals are lower highway construction costs and extended maintenance-free operation.

5. Improved Design to Reduce Costs, Extend Life Expectancy, and Insure Structural Safety

Structural R&D is concerned with furthering the latest technological advances in structural and hydraulic designs, fabrication processes, and construction techniques to provide safe, efficient highways at reasonable costs.

6. Improved Technology for Highway Construction

This category is concerned with the research, development, and implementation of highway construction technology to increase productivity, reduce energy consumption, conserve dwindling resources, and reduce costs while improving the quality and methods of construction.

7. Improved Technology for Highway Maintenance

This category addresses problems in preserving the Nation's highways and includes activities in physical maintenance, traffic services, management, and equipment. The goal is to maximize operational efficiency and safety to the traveling public while conserving resources.

0. Other New Studies

This category, not included in the seven-volume official statement of the FCP, is concerned with HP&R and NCHRP studies not specifically related to FCP projects. These studies involve R&D support of other FHWA program office research.

* The complete seven-volume official statement of the FCP is available from the National Technical Information Service, Springfield, Va. 22161. Single copies of the introductory volume are available without charge from Program Analysis (HRD-3), Offices of Research and Development, Federal Highway Administration, Washington, D.C. 20590.