



Florida Pedestrian Planning and Design Handbook



Florida Pedestrian Planning and Design Handbook

Prepared for:

Florida Department of Transportation

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Highway Safety Research Center**

April 1999

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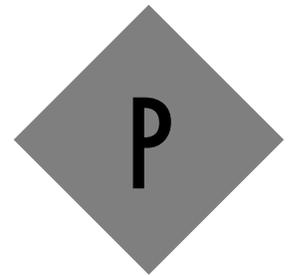
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Preface



Most of Florida was developed in the automobile age. We built entire cities for our cars, without thinking of transit, bicycling, or walking. We separated stores, schools, parks, and churches from where we live by seven-lane arterials carrying cars at high speeds. We created 100 foot and even wider intersection crossings, with up to 12 lanes on each leg. As homes, stores, and offices were built farther out, traffic speeds increased.

For decades, Florida lacked public policy to provide sidewalks, medians, and landscaped streets. With the exception of certain isolated pockets (such as historic portions of Winter Park, Coral Gables, Old Town in Key West, St. Augustine, Pensacola, and South Beach), Florida lacks well-connected walkable places. Our cities and towns are not on a people-oriented scale. It is no surprise that Floridians are deciding to drive themselves and their children to too many places. People in Florida even get into their cars to cross streets.

To counteract the effects of sprawl, we must retrofit many places for the pedestrian. It is easier to incorporate pedestrians into the original design than it is through retrofitting.

The object of this manual is to provide you — the designer, planner, safety practitioner, or community leader — with diverse tools to create public and private spaces that work for everyone. We discuss

the principles of creating safe, secure, friendly, convenient, efficient, comforting and welcoming streets, walkways, and public plazas. We have left issues and concepts broad enough to allow you to address site-specific issues. It is your task to look at each specific project or policy and to interpret how these principles apply.

We will update this manual as new knowledge becomes available. The Florida Department of Transportation Design, Operations, Maintenance, and Safety Offices are aware of the need to evaluate everything we build. We encourage you to let our current State Pedestrian Coordinator, Theo Petritsch, P.E., know of your experiences or suggestions for better design to meet the needs of all users of Florida's transportation system.

Good street design takes more than applying sound engineering principles and techniques. It is an art, one in which you need to be holistic and visionary, and receptive to the public.

Many people lost trust in decision makers who seemed insensitive to their environmental, social, and economic concerns. They said that the basic principles of town development, social and human needs were not always understood or addressed by roadway builders. They said that street and traffic problems were narrowly defined, leading to bad solutions.



Figure P-1. Everything starts with the street. The Florida Department of Transportation and Ft. Lauderdale made State Route A-1-A a commercial success. The street design was improved by widening sidewalks, dropping lanes, adding bike lanes as buffers, and landscaping.



Figure P-2. In order to retain the best people, large corporations are realizing that they need towns, neighborhoods, and shopping districts where people find security, convenience, efficiency, comfort, and a sense of welcome. These qualities are achieved by well-designed pedestrian oriented streets.

In many cases, they were right.

We now know that the best community decisions and street designs are made by broad design teams that often include street designers, business leaders, political leaders, citizen planners, neighborhood leaders, and others. It is essential to invent better process to include our best citizen input early in the conceptual process, to create vision where there is none.

As we begin the process of town and street rebuilding, there will be shaky ground. Not everyone and every town is awakening to the new possibilities of blending modern

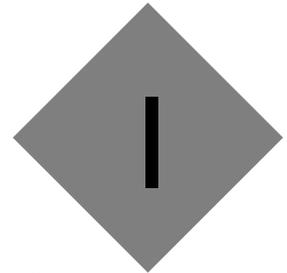
and old ways of community and street design. The design of good streets and places is often held back by those who fear change and its champions. People who seek and enjoy patterns of speed and isolation are in conflict with those who envision livable, walkable communities.

In the past, many business leaders wanted maximum access and insisted that traffic come through the center of town. Roads were widened in the very places where schools, parks, and Main Streets are located. Safety, the mobility of all users, efficiency, and the aesthetics of these streets were regarded as secondary issues.

Many business leaders are beginning to understand the need for attractive streets that can move traffic safely and efficiently, and accommodate pedestrians and bicyclists as well. Civic leaders and public officials are awakening and hearing the voices of the public again. As more communities wake up to the possibilities, a new public realm will evolve that will look very different from the one that we have today.

The sustainability of our transportation, our towns and our is tied to getting back to the basics of personal mobility, safety, security, and freedom. The quality of our lives, the future health and vitality of our children, the accessibility of those with disabilities, and our ability to deal with our urban environment are at stake. Turning our cities and towns into people-oriented places requires energy, resources, and talent. As the principal designers of place and the public realm, our challenge is huge, and our mission is clear: transform Florida into a walkable and livable state.

Walking: the World's First and Foremost Choice in Motion



Walking is the oldest and most elementary form of transportation. The *Florida Pedestrian Safety Plan* remarks (p. I-4):¹

“Walking provides free, immediate, healthful, energy-efficient motion. Evidence shows that when neighborhoods and communities are designed at a human scale to support walking trips, there are increases in community interaction and involvement. There are also reduced costs of transporting the elderly, children, the poor, and the physically challenged. A walking community also greatly increases the success of transit. These increases in walking and transit greatly reduce the congestion of roadways, and hence help maintain the mobility of all.”

Virtually everyone is a pedestrian for at least a part of every trip (Figure 1-1), and for many people walking is their primary or only form of transportation. The 1990 Nationwide Personal Transportation Survey (NPTS) estimated that 7.2 percent of all trips are solely by walking. The 1990 U.S. Census “Journey to Work” survey estimated that 4 percent of all work commutes are by walking. These mode shares could be substantially higher, because the NPTS also found that 27 percent of all trips are one mile

or less.² Also, increasing numbers of Americans walk for exercise and the associated health benefits.

Increasing numbers of Americans walk for exercise and the associated health benefits.

A 1990 Harris poll found that 59 percent of all respondents would be willing to walk outdoors or walk more often if there were safe, designated paths or walkways.² A separate case study conducted for the National Bicycling and Walking Study postulated a three to five fold increase in bicycling and walking given conducive circumstances.³ As conditions exist, people are often reluctant to walk for many reasons such as fear of crime, long walking distances, pedestrian barriers, the need to carry packages, inclement weather, lack of pedestrian facilities, and concerns about traffic safety.

Through the 1980s, 600 or more pedestrians in Florida were killed annually by motor vehicles. In the early 1990s, the annual toll fell to around 500. In Florida, the number of pedestrians killed per 100,000

population was about twice the national average in the 1980s, and is still about 1.8 times higher than the national average. Older adults, those 55 and over, account for 28 percent of Florida's population but 36 percent of Florida's pedestrian fatalities. More information about Florida's pedestrian crashes is given in Chapter 4.

These crash statistics are not surprising, given that transportation infrastructure typically accommodates automobiles at the expense of pedestrians.

Challenges to Walking

Millions of Floridians live in communities that have been designed to accommodate cars, not pedestrians. As a result, pedestrians are faced with a number of challenges and problems.

There's Nowhere to Go or It's Too Far

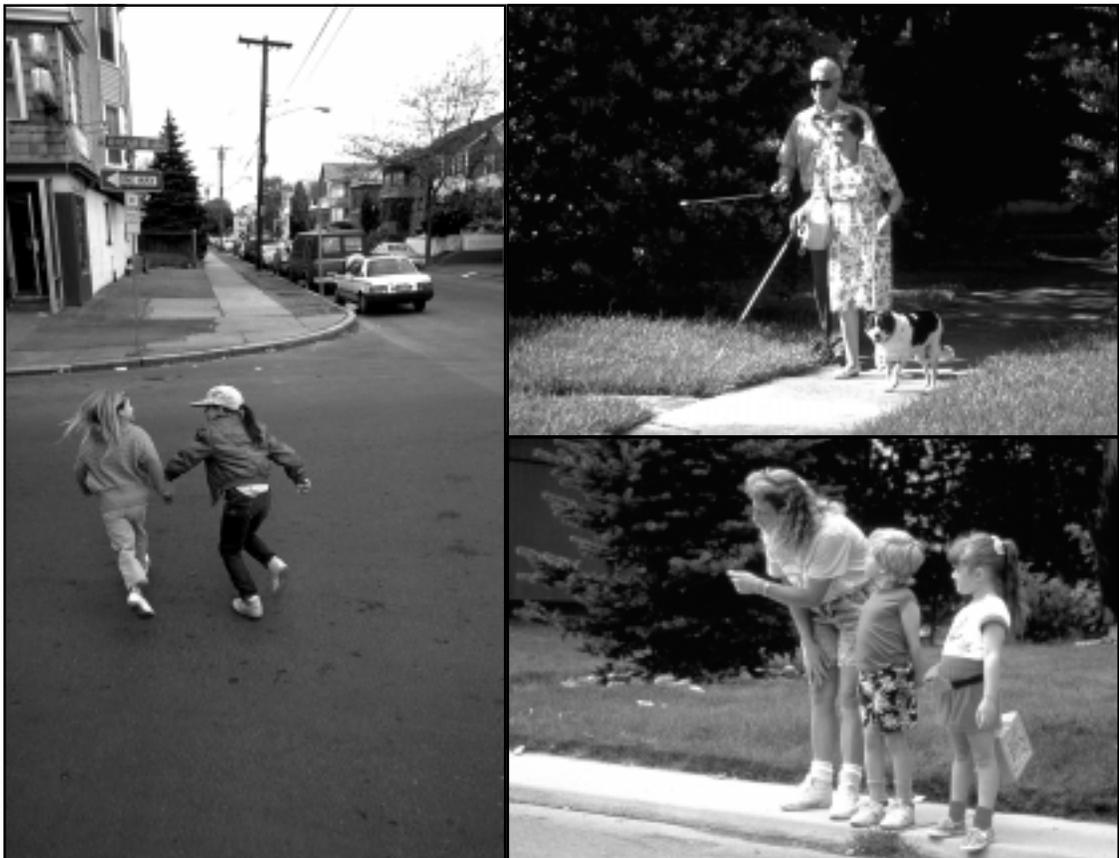
The development pattern that has prevailed for the past 50 years has tended to segregate different types of land use: housing, retail, commercial, etc. Today, many Floridians find themselves living and working in places far removed from essential services and activity centers.

This pattern of sprawl is a major challenge to the viability of walking as an alternative mode of transportation.

I Can't Get There from Here

Many physical barriers currently exist that make it difficult if not impossible to walk in the suburbs. The opportunity to walk to a destination or along a particular route is absolutely dependent on continuous access. Therefore, any gap or interruption in the route will effectively create a barrier to walking.

*Figure 1-1.
Everyone is
a pedestrian.*



Barriers include such things as the absence of any space for pedestrians to walk out of the roadway. If there are neither sidewalks nor roadway shoulders, most people will not feel comfortable walking along anything but a neighborhood street (Figure 1-2). Sidewalks in disrepair and without curbcuts at intersections will prevent some pedestrians from traveling the route. Difficulty in crossing a busy street—either at an intersection or at a “midblock” crossing—will dissuade some people from even trying to walk. Walking is also a problem once a person enters a commercial parking lot as he faces the task of getting from the car to the building and back safely.

It's Not Safe

Even when there are no absolute physical barriers to prevent people from walking, other factors may exist that scare them away. First, the fear of getting hit by a motor vehicle is a major concern to most pedestrians (Figure 1-3). The major threat to pedestrians results from excessive motor vehicle speeds and the failure of motor vehicle operators to yield or stop for pedestrians.

Second, many people believe they will be at risk to criminal acts or stray dogs if they walk in some areas. This perception may result from a lack of other pedestrians, good street lighting, and/or inadequate neighborhood policing by law enforcement agencies.

It's Not Pleasant

More than users of any other mode of transportation, pedestrians are sensitive to the nature and quality of the environment. If a route or facility is unpleasant—as a function of location, a lack of maintenance, or because it lacks various types of amenities—it is less likely to be used on a regular basis.

The task of walking in Florida has become a tedious, complicated, inefficient, and often dangerous activity in most places most of the time. This is true in suburban sprawl neighborhoods, in most downtowns, and along major commercial strips (Figure 1-4).

Those who are most dependent on walking are least prepared to deal with the lack of sidewalk systems, the lack of safe street crossings, the bidirectional left turning lanes (center scramble lanes), the vast auto-focused distances in land use and other penalties associated with walking. Groups affected most by this non-walking environment are the young, the elderly, the physically challenged and the poor. A full 37 percent of Florida's population now falls into these categories.



Figure 1-2. Along many streets, sidewalks are either discontinuous or nonexistent.

A Renewed Interest in Walking

Most people are now expressing a desire to walk again. Whether in their own neighborhoods or in a downtown, many people are getting frustrated at only being able to walk in a heated or air-conditioned mall. There is a strong movement to reclaim the streets: to get rid of crime, push out litter and filth, and rebuild green streets, flowered medians, richly detailed store fronts, quiet places to sit, and fun places to walk.

Traffic engineers are learning to work with planners, landscape architects, architects, retailers, and other urban specialists to create multifunctional streets.

Local planners and traffic engineers throughout Florida—in communities large and small—face the challenge of ensuring



Figure 1-3. The fear of getting hit by a motor vehicle is a concern to most pedestrians.

that land uses and the transportation system are sensitive to pedestrian needs. Pedestrian needs are not limited to urban areas, but are also important in suburban and rural areas. Although walking will not become the dominant mode in suburban or rural areas, the inclusion of pedestrian considerations in the planning and design process can greatly accommodate the latent demand for walking that exists in these areas.

Pedestrian Oriented Streets

Perhaps the single greatest inducement for walking is the creation of spaces that create high quality walking environments, i.e. pedestrian streets. What do these places look and feel like? The template of pedestrian oriented design is well known. Disney World's Main Street in the Magic Kingdom connotes

Figure 1-4. Major commercial strips are often inhospitable to pedestrians.



an image we all remember, whether we lived in a town with real main streets or not.

On the real Main Street, or in any pedestrian style street, buildings are set back a mere 4.6-7.6 m (15-25 feet) from the street edge. Blocks are short, crossings are narrow. Street lighting is low and warm to comfort and aid those walking at night. Meanwhile, shade, benches, friendly transit stops, drinking fountains, and perhaps even public rest rooms next to the precinct police station, create the needed comfort. In more splendid settings, flowers and fountains adorn the corners, edges or medians.

Meisner Park, in Boca Raton, Florida, is an example of a new activity center that picks up the principles of a main street. (Figure 1-5) This two-block long mixed use development was converted from an old shopping center. It was built to achieve an upscale, comfortable place for people to live, shop, or just hang around for a concert. Built with 3 story residences over the street, the park-like main street boasts an overly wide park-like median. There are true parks at the ends of several streets. Cars are invited into the space. On-street parking is offered. The shopping and residential park has been so successful that new condominium and apartment buildings are now being built in spaces that had been parking lots.

The Psychology of Space

What key psychological principles must any designer follow to attract people to a place?

Security

No one wants to walk down a street that appears cold, stark or dangerous. Too many hidden pockets, too little activity, places that are dark, isolated, or even broken up by "dead" corners or open parking lots, blank walls or block-long voids tend to dissuade people from walking there. Cars must not travel too fast nor make too much noise for the scale of the street.

Comfort

Comfort is functional. People look for basic amenities. Is the sidewalk wide enough? Is there sufficient separation from the street? Is there an edge, a transition between uses of space? Also, is there shade in summer and buildings offering protection from cold winds in the winter?

Simple amenities such as balconies or canopies to provide protection from sun or rain make a place desirable enough to protect hundreds of pedestrians at a time.

Comfort is also visual. A rich line of green trees not only offers shade, but enhances the street with needed color, vertical height, and an edge. The use of paving stones can be added to present color, texture or pattern. All streets need to have a theme—an architectural style is as essential to the street as it is to any place of attraction. Although the street theme should be uniform, there needs to be plenty of variety in individual buildings in downtown areas. Pedestrians need to have a thousand points of detail in each block.

Convenience

Streets must offer convenience. This convenience must be at a pedestrian scale. Thus, if people would like to combine 6-8 shopping destinations and a meal or a stop for coffee, all within walking distance of lodging or parking, but cannot, the economic life of the street weakens. Designers must be careful to provide not only a theme to a street, but a blend of services as well.

Efficient and Affordable

A place must be affordable. Streets that are overly expensive for the volume and categories of people that will use them cannot pay their way. Designers must be careful to build quality into every place. But quality can and should be built at a price that will be an economic success.

Welcome

People must feel welcomed by the place.



Figure 1-5. An attractive street invites low speeds in Meisner Park, Boca Raton.

The feeling of welcome is imparted by the employees of an establishment, by the people that share the street, and by the physical presence of the street itself. The inclusion of comfortable seating, quiet spaces to contemplate and look back on the walk, and helpful navigational aids, are all basic to feeling welcomed. Comfort level lets people know they can survive well in the space. Inviting places create the added feeling that they are competing for your attention, inspiring your return visit.

About the Manual

This manual provides guidelines, standards, and criteria for the planning, design, construction, operation, and maintenance of pedestrian facilities. Because pedestrian planning and design are usually not covered in any detail in university-level transportation classes, information is needed on how to plan for and build pedestrian facilities.

This manual is intended as a reference for engineers, planners, landscape architects, business leaders, politicians, citizens, and others interested in improving Florida's walking environment. It is important that people in all professions and positions understand the basic principles, procedures, and tools available to create walkable space. However, this manual is not meant to be a stand-alone document. It supplements the 1988 version of the Florida Manual of

Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways. The design of projects for the Florida State Highway System must comply with the Plans Preparation Manual. In any case, professional judgment is needed to select the optimal pedestrian facility or design feature, given an understanding of local conditions.

This manual contains 20 additional chapters.

Chapter 2 - The Pedestrian Planning Process

Provides an overview of planning considerations and outlines a planning process for pedestrians.

Chapter 3 - Human Factors and the Pedestrian

Explains human factors as they relate to pedestrian safety. Planning and design for pedestrians should take into consideration pedestrian and motorist behavior and how well pedestrians and motorists can see each other.

Chapter 4 - Characteristics of Pedestrian-Motor Vehicle Crashes in Florida Presents pedestrian-motor vehicle crash data by pedestrian characteristic and crash type. The data show that older pedestrians, nighttime crashes, and alcohol involvement are overrepresented.

Chapter 5 - Pedestrians with Disabilities Describes principles for accommodating pedestrians with disabilities. The most important considerations are curb cuts and access ramps.

Chapter 6 - Sidewalks, Walkways and Paths Provides guidelines for installing sidewalks. The design considerations are width, setback distance, grades, and pavement surfaces.

Chapter 7 - Pedestrian and Motorist Signs and Markings Discusses the use of regulatory signs, warning signs, and pavement markings. These signs and markings inform

pedestrians and motorists of legal requirements and unusual conditions that may affect safety.

Chapter 8 - Signalization

Provides guidelines and warrants for pedestrian signals. The guidelines cover signal timing and phasing, push-button signals, and audible signals.

Chapter 9 - Crosswalks, Stop Lines, Curb Ramps, and Refuge Islands

Discusses the design criteria for these facilities that greatly enhance a pedestrian's ability to cross the street.

Chapter 10 - One-way Streets

Addresses a traffic control strategy which enhances the ability of pedestrians to safely cross streets.

Chapter 11 - Intersections

Offers policy and design recommendations for making intersections more pedestrian-friendly. For example, right-turn-on-red could be prohibited at intersections with high pedestrian volume. Medians provide refuges for pedestrians crossing wide streets.

Chapter 12 - Midblock Crossings

Describes four types of midblock crossings: pedestrian refuges, bulbouts, pedestrian crossings, and signalized crossings.

Chapter 13 - Parking and Safe Access to Buildings and Schools

Recommends parking lot design that addresses pedestrian needs. Parking lots and drop-off areas should minimize conflicts between pedestrians and motor vehicles.

Chapter 14 - School Zone Practices

Describes the use of a school safety program and crossing guards to create a safe environment for school children.

Chapter 15 - Traffic Calming Strategies Discusses traffic diversion and managing traffic in place as approaches to creating safer walking conditions and more livable neighborhoods. Street closures, cul-de-sacs, and diagonal diverters divert traffic, while traffic circles, bulbouts, and speed

humps reduce vehicular speeds.

Chapter 16 - Exclusive Pedestrian Facilities

Presents planning and implementation considerations for pedestrian malls.

Chapter 17 - Work Zone Pedestrian Safety

Offers guidance on maintaining pedestrian traffic through work zones. Pedestrians must be separated from conflicts with vehicles passing around the work zone and with work site equipment.

Chapter 18 - On-street Parking

Suggests on-street parking restrictions to improve sight distance and reduce the incidence of pedestrians being struck by traffic when they cross between parked cars.

Chapter 19 - Street Lighting

Covers street lighting as a means of improving pedestrian visibility to motorists at night and allowing pedestrians to feel more secure while walking at night.

Chapter 20 - Grade-separated Crossings Considers overpasses and underpasses. These can get high numbers of pedestrians across a busy or high-speed roadway but are expensive to build.

Chapter 21 - Boulevards

Describes the characteristics of boulevards. Unlike most conventional streets, boulevards do not just move cars, they offer space for pedestrians.

Appendix

This manual was prepared by Charles V. Zegeer, Herman F. Huang, and David Harkey of the University of North Carolina's Highway Safety Research Center, Dan Burden, formerly of the Florida Department of Transportation, and consultants Michael J. Cynecki (City of Phoenix), Bill Wilkinson (Bicycle Federation of America), and Pat Greason (Safe and Secure Streets). Rachel Chessman, Carolyn Edy and Andrew Park did the

layout for this handbook.

Some of the material pertaining to various pedestrian facilities was adapted from the Institute of Transportation Engineers Committee 5A-5 report, *Design and Safety of Pedestrian Facilities: Recommended Practice*.⁴ Mr. Zegeer served as chairman of that committee, and Mr. Cynecki, Mr. Harkey and Mr. Huang were committee members. Other major resources include the *Florida Pedestrian Safety Plan*, the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), the American Association of State Highway and Transportation Officials (AASHTO), pedestrian safety research studies, and applicable Florida guidelines.^{5,6}

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Planning For Pedestrians

The National Bicycling and Walking Study, directed and published by the Federal Highway Administration (FHWA) of the United States Department of Transportation (USDOT) and released in 1994, has announced two major goals for walking in the US.¹ These are listed below along with an application of how they apply to Florida.

◆ To double the number of walking trips.

About 4% of working Floridians over 16 walked for some trips.² This would bring the goal for Florida to 8% or perhaps higher for school and other essential but not necessarily work trips. Trips made on foot will increase the capacity of the transportation system to handle travel demand by other modes.

◆ To decrease pedestrian crashes by 10%.

Just under 20% of Florida's fatal traffic crashes involve pedestrians.³ The 1994 fatality rate of 528 would be reduced to about 475 and injuries would drop from over 8,000 to about 7,200. We could set a time frame for the accomplishment of this goal, such as 1% per year.

In September 1995, the FDOT developed a *vision statement* for the Pedestrian/Bicycle Program:

We envision making all Florida destinations accessible to bicyclists and pedestrians in a bicycle/pedestrian friendly environment.

Goals specific to the fields of engineering, education, enforcement and encouragement (implementation) are identified in The Florida Pedestrian Safety Plan.⁴

- ◆ To provide a safe and pleasant walking environment in all urban locations in Florida by the year 2010.
- ◆ To determine age specific causes of pedestrian injury, and to create a comprehensive education program to teach the pedestrian and the driver highway sharing courtesy, predictability and competency.
- ◆ To improve the performance and safety of pedestrians through improved legislation and enforcement of laws.
- ◆ To fully enact the major legislative, education and enforcement recommendations of the plan by 1995, and achieve significant community and state level engineering progress by 2000.

Although progress toward these goals remains incomplete, significant progress has been realized.

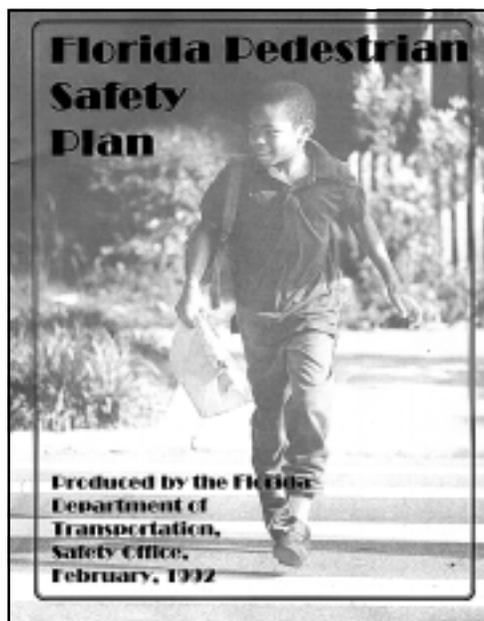
The FDOT Pedestrian/Bicycle Program

In the FDOT Central Office, the Pedestrian/ Bicycle Program, located in the Office of the State Safety Engineer, has taken the lead in planning, design and

education for pedestrianization in Florida since 1988. Each of the FDOT's eight districts has assigned a staff person(s) to be District Pedestrian/Bicycle Coordinator(s). Currently, each works on pedestrian issues on a part time basis. The District Coordinators' mission is to coordinate DOT efforts to provide safe, efficient, effective, convenient facilities and services for bicyclists and pedestrians in the district.

In-house, contract and research projects and programs contribute to the success of Florida's pedestrian agenda. A Pedestrian Safety Advisory Task Team under the auspices of FDOT assisted in the production of the Florida Pedestrian Safety Plan of 1992. A new public information campaign to alert drivers to the presence of blind pedestrians was recently completed as a partnership between FDOT and other agencies. The Traffic and Bicycle Safety Education Program at the University of Florida educates teachers and others to teach pedestrian safety to elementary school children. The Florida School Crossing Guard Training Program teaches trainers of guards to reinforce safety skills as children go to and from school. Both of these programs encourage walking to school.

*Figure 2-1
The Florida Pedestrian Safety Plan covers planning, engineering, education, enforcement, and implementation.*



Local Initiatives

Local Pedestrian/Bicycle Coordinators work within the Metropolitan Planning Organizations, Regional Planning Councils, towns, cities and/or counties. Local committees—Bicycle/Pedestrian Advisory Committees, Pathways Committees—work with government agencies and private entities to develop plans, policies, ordinances, regulations, programs, projects and capital funding priorities for provision of facilities.

Community-based pedestrian planning documents have been and are being developed by local Pedestrian/Bicycle Coordinators and other transportation planning staff. Some of these plans are being incorporated into the Local Government Comprehensive Plans, Capital Improvement Plans (CIPs), and Metropolitan Planning Organizations' (MPO) Transportation Improvement Plans (TIPs). In combination, these TIPs are expected to make up the state's Transportation Improvement Plan. (These inputs can also be expected to influence policy language, such as the Florida 2020 Transportation Plan and the state's Five-Year Work Program.)

Public Involvement

Public involvement provides opportunities for the "public" to participate in alternatives development, analysis and/or review. The "public" should consist of representatives of the various agencies of the community—city, county, neighborhood, chambers of commerce, or other merchants' associations, church groups, social services, environmental groups, school boards, neighborhood groups, groups representing ADA issues, city beautification, as well as private citizens. The alternative analysis process in open forum educates many to the constraints and potentials of a project. Well devised and prepared public involvement practices can

bring together participants who can reach consensus for the “common good” of many types of road users—a proactive rather than reactive stature.

The Pedestrian Planning Process

Data Collection and Analysis

Planning for pedestrian facilities begins with gathering data on the existing conditions and identifying problems. The worksheet at the end of this chapter may be used to identify pedestrian target groups for planning purposes. Each group has a different set of needs to be satisfied in their travel throughout their communities.

Data resources include the Florida Statistical Abstract which defines the numbers of specific age and ability groups for each county, local census tract data, MPO long-range plan estimates, and traffic crash reports from local agencies as well as the Florida Department of Highway Safety and Motor Vehicles.

Actual traffic counts which include current pedestrian trips will measure explicit numbers of trips. The collection of this data at locations identified previously will indicate whether improvements may contribute to the achievement of goals and objectives. Pedestrian trip counts will help to answer these two questions:

- ◆ In your community where should motorists most expect pedestrians to be?
- ◆ In your community where are the activity centers which attract pedestrians, or might if the environment was conducive to walking?

If we understand the travel behavior of people walking and know where they want to go, we can design environments which serve their needs and limitations. The Census provides data for analysis of current land use and travel behaviors, i.e., Journey to Work data. Public involvement processes—*focus groups, surveys*—can



Figure 2-2 The public often brings a broad perspective to the development of plans and projects for the community.

supplement census data to discuss and estimate possible future behaviors and what opportunities for change there might be (Figure 2-3).

Development of Objectives

Part of a pedestrian planning, design and construction program for a locality will be to define objectives which are quantifiable and measurable. This is important to the evaluation process. Strategies should be chosen based on their ability to meet or accomplish the objectives. Many objectives and strategies may be found in the Florida *Pedestrian Safety Plan*. Objectives may focus on target groups of pedestrians such as school children or the elderly based on crash data (Figure 2-4), or they may focus on “*countermeasures*” such as education, enforcement and engineering, or they may focus on *specific locations*, or on all of the above.

Develop Alternative Strategies

Qualified professionals—public agency staff, consultants—develop alternative scenarios and strategies. These can be based on various levels of demographic estimates and/or transportation facilities and services available for various modes. This includes anticipating new and different technologies or scarcity of resources. Preliminary routes, designs and anticipated travel behavior of user groups can be inventoried and

predicted. The selection process will focus on resources allocated to accomplish specific strategies.

Examine Alternative Strategies

Decision makers—politicians, planning commissioners, agency staff, traffic engineers, public works directors, voters—need access to preliminary strategies, plans, designs and associated costs for alternative mixes of multimodal routes and intermodal links. These alternatives would identify costs in time, money and space requirements. Thus, decisions are guided towards using resources wisely while accommodating the desires (travel demand) of residents and visitors to travel. Trade-offs and balancing actions must be taken into account as each decision to improve transportation capability is made—whether it be in education (affecting travel behavior), engineering (affecting mode characteristics) or enforcement (affecting legislation and policing). These decisions must be made taking into account broader community needs of economic benefits and livability.

Schedule Timeline

Once an alternative or package of strategies is chosen, a desirable schedule for

implementation may be established. Short and long range objectives and actions may be identified on a timeline.

Adopt Plan(s) and Design(s)

As each unique location is planned for, this needs to be or will have been incorporated into the local comprehensive or small area plan. The process will include the public—citizens, users and provider agencies—and perhaps, private land developers. Subdivision plats will include paths and sidewalks. Public transit facilities will be supplemented with accessible sidewalks, passages and plazas. Business districts, both large and small, will have pedestrian spaces equal to or greater than roadway widths.

Allocate Resources

User groups and professionals are the human resources in planning for and provision of pedestrian facilities. Bringing these people together to work through the process is paramount to the successful achievement of any stated goals and desired outcomes. The lead agency in the process should acknowledge when certain parts of the process require public input and feedback. The times when meetings are set should reflect this acknowledgment. If

Figure 2-3. Focus groups provide information on needs and opportunities in the community.



research and/or testing is necessary, people who will benefit as well as others should complement professional participation.

Transportation Equity Act for the 21st Century (TEA-21) Funding Sources for Pedestrian Projects

Each community and its agencies has access to a variety of TEA-21 funding sources with which to provide pedestrian facilities—public as well as private. They include but are not limited to the following:

National Highway System (NHS) Funds (Section 1007) may be used to construct pedestrian walkways on land adjacent to any highway on the National Highway System (other than the Interstate System).

Surface Transportation Program (STP) Funds (Section 1007) may be used for either the construction of pedestrian walkways, or nonconstruction projects (such as brochures, public service announcements and route maps) related to safe use. Ten percent of STP funds are used for “Transportation Enhancements” which include provision of facilities for pedestrians, when not part of normal roadway improvements.

Congestion Mitigation and Air Quality Improvement (CMAQ) Program Funds (Section 1008) may be used for either the construction of pedestrian walkways, or nonconstruction projects (such as brochures, public service announcements and route maps) related to safe use. These are available only in specified areas which do not meet air quality standards.

Federal Lands Highway Funds (Section 1032) may be used to construct pedestrian walkways in conjunction with roads, highways and parkways at the discretion of the department charged with the administration of such funds.

Scenic Byways Program Funds (Section 1047) may be used to construct facilities along scenic highways for the use of pedestrians.

National Recreational Trails Fund (Section 1302) monies may be used for a variety of recreational trails programs to benefit pedestrians and other nonmotorized and motorized users. Projects must be consistent with a Statewide Comprehensive Outdoor Recreation Plan required by the Land and Water Conservation Fund Act.

Section 402 Funding Pedestrian safety remains a priority area for highway safety program funding. Title II, Section 2002, of the TEA-21, addresses State and community highway safety grant program funds. The priority status of safety programs for pedestrians expedites the approval process for these safety efforts.

Federal Transit Funding Title III, Section 25 of TEA-21, continues to allow transit funds to be used for pedestrian access to transit facilities.

Major Sources of Funding at the State Level

The following are funding sources that other states have used.

Set-aside Programs Specific funds which can only be spent on pedestrian facilities. (California, Oregon, Michigan and Illinois have programs).

Department of Transportation Budget Allocations Line-item budgets for expenditure on pedestrian program activities.

Transportation Funds for Transit and Congestion Relief Programs Usually include pedestrian facilities as eligible expenditures (California).

Figure 2-4.
School children and the elderly are two pedestrian target groups.



Other State Agencies Provide funds and program support such as Detroit Commerce Main Street program, community-development grants, and marine and waterfront involvement.

Sources of Local Funds

Transportation Department Funds These are the predominant sources of local funds. The capital improvement program (CIP) budget for counties and municipalities can include funds for pedestrian planning and facilities.

Sales Tax Local sales tax designation for transportation improvements which include pedestrian walkways.

Open Space Bonds Bond issues may be solely for or may incorporate pedestrian facilities as part of trail/path development projects.

Mitigation Measures Developers may be charged project impact fees which may pay for pedestrian facilities for the current or other projects. They may also be required to construct walking facilities as a condition for enabling projects to proceed.

Restorations Requiring developers to restore rights-of-way for nonmotorized users.

Public Agency Land and Funds Donations of land and/or funds for construction for pedestrian access and use by public agencies on their land, e.g. seaports and airports.

Motor Vehicle Taxes Text to come here. Text to come here. Text to come here.

Street Utility Tax A tax on employers and households in special areas to repave existing streets which may include pedestrian features.

Parks and Recreation Department Funds Parks and Recreation Departments may be responsible for full or partial contributions to construction and/or maintenance of paths and trails.

Donations (from Public and Private Sectors) Special funding mechanisms may be created to receive public and corporate donations for county or municipal pedestrian programs. Specific transportation corridors may have combined public and private funding sources available for pedestrian project improvements.

Fund-raising Events Special fund-raising activities may be organized to provide funds for specific projects or add to general fund projects which may need enhancements for pedestrians.

Florida-Specific Funding

The vast majority of dollars for transportation projects are controlled by the Work Program of the Florida Department of Transportation—its Central Office and eight Districts. Any monies which pass through the Federal Government/USDOT and Congress are generally 80% of a specific project's funding. Transportation projects on state facilities receive 20% state dollars, while municipal projects may use 10% local funds and 10% state funds to complement Federally allocated funds.

Ongoing Evaluation

The responsibility of ongoing evaluation of policies, plans, programs and projects falls to decision makers and consumers/clients/users. Several formal processes have been established in Florida. MPOs representing many political jurisdictions and technical fields have in the past worked with relatively long-range issues. The measurement of modal splits will determine if target splits are being met. Travel demand forecasting estimates are sensitive to changes in technology and behavior. The transportation planning of MPOs will be linked with the comprehensive planning practices of land use, environmental protection/preservation and economics. Community Traffic Safety Teams attempt to meet short term problems with relatively rapid responses. Crash records, the results of enforcement campaigns and traffic engineering techniques and devices offer measures for the effectiveness of educational programs and engineering improvements.

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Human Factors and the Pedestrian

Motorists who have not built pedestrians and bicyclists into their file of things to look for do a poor job of making the detection when the person is clearly there to be seen. Driving is a very complex task. Only highly practiced drivers do an effective job of taking in and processing the right information to make quick, correct decisions. Road users work from various levels of skill, experience and impairment. About 90 percent of the information a driver processes is visual. Difficulties in information processing or perception contribute to approximately 40 percent of all traffic crashes involving human error.¹

This 40 percent failure rate should indicate to the roadway designer that we must strive to give correct, easily recognizable and task-certain cues about all elements in traffic, and pay close attention to pedestrian detection. This is especially important since most motorists are conditioned to look for things that are big and harmful to them. Too rarely are they worried about hurting someone outside of their vehicle.

Visibility and Detection

As many as 50 to 80 percent of motorists involved in pedestrian or bicycle crashes report to law enforcement officers that they “did not see them until it was too late.” Many times these motorists are telling the truth. Most often a motorist traveling in the adjacent lane (or even behind the motorist that struck the pedestrian) is able to describe the actions of the pedestrian or bicyclist. So what is happening?

As motorist speeds increase, the ability to see a pedestrian, especially at night, drops significantly.

How Long Does It Take To Perceive-React?

The Processing-Reaction Time (PRT) of a person varies greatly during the course of a day. PRT is the total time that lapses from the time when an object, such as a red traffic signal or a pedestrian, can be viewed to the time brakes are applied, or other evasive action is taken.

This time it takes to react is often listed as a range from 0.75 seconds to more than

2.5 seconds. Although there is no clear agreement on what this time is, the official time used for design standards by the American Association of State Highway and Transportation Officials (AASHTO) was derived from research done some time ago and includes 1.5 sec for perception and decision and 1.0 sec for making the response, for a total of 2.5 sec.² Taoka³ points out that the research on which the 2.5 sec figure was based has definite limitations. Specifically, subjects were alert (expecting to have to make a braking response), young (usually under 30), and driving in an uncluttered environment during daylight and in good weather.

A more recent research effort by Hooper and McGee to review current literature on the PRT topic suggests that 3.2 sec is a more reasonable figure.⁴ Even longer times are necessary if an object is not expected, such as a child darting into the street. It is generally agreed that a surprised condition involves about one-third to one-half more time. Thus, a safe figure for a surprised condition is: 3.2 + 1.6 or 4.8 sec.

Some motorists may not “see” an object like a pedestrian for a much longer period of time, or at all. It is important to understand the details of seeing. To begin with, not everyone sees the same things. Seeing is a complex, learned activity. Motorists face many challenges when they drive. Motorists who are highly competent, experienced and alert see and recognize many more critical roadway elements than those who lack experience and competence, or who are not alert. How does this happen? Research performed at the Ohio State University in the 1970s reveals that poorly trained or inexperienced drivers spend much of their time looking straight ahead, or taking in objects of low importance. Highly skilled drivers with impeccable driving records spend most of their time keeping their eyes in motion, and focusing in on objects of great importance.

Seeing is Speed Related

Research shows that the speed of the motorist and pedestrian detection are directly correlated. As motorist speeds increase, the ability to see a pedestrian, especially at night, drops significantly.

The Process of Seeing

In order to “see” something, the human mind goes through five psychological steps (selection, detection, recognition, location, and prediction). The motorist goes through all five steps before any motor skills are applied to activate muscles which in turn perform braking, steering or other correcting.

(1) Selection. In this process the eye is moving constantly across the roadway and the near roadway visual field to find those objects of greatest importance. An oncoming car, or a car approaching rapidly from the side is likely to be detected in a hurry.

(2) Detection. During this phase something of importance is detected and marked for further study. It may be an object, such as a pedestrian that is not usually a threat or an item considered important. Because of the pedestrian’s movement, the brain seeks more information.

(3) Recognition. The unique gait of the pedestrian, the shape, and the continued forward motion now allows the perceiver to identify or recognize that this truly is a person, an object of potentially great importance.

(4) Location. Thus far, however, especially at night, the motorist does not know how far out the pedestrian is located. Does this call for action, or not? Finally it is decided that the person is at a specific distance, and that this distance is growing critical.

(5) Prediction. The motorist now predicts if the pedestrian will continue forward. If the pedestrian is looking toward the motorist, some drivers would not yet react, but if the person is looking away, or chatting with someone else while moving forward,

they are likely to account for that action and begin reaching for the brakes.

If the motorist lacks experience, this last step may be overlooked, and the process of seeing begins again with the person looking for another object of importance. Finally, impact.

Night Vision

Can a motorist see a pedestrian at night in sufficient time to stop? People lack the nocturnal vision of many other animals. All humans traveling at more than walking speed at night are exceeding their natural abilities. Bicyclists can manage in some locations with powerful lights. Motorists, due to their higher speeds, need even more powerful lights. At yet higher speeds, motorists need either high beams or roadway illumination. Unfortunately, high beams cannot be used on suburban roads, and many cities fail to pay for the installation or maintenance of adequate highway lighting. Thus, deficiencies in pedestrian and bicyclist detection result.

Retroreflective Materials

Some, but not all, of these defects are made up through traffic engineering. Engineers are highly sensitive to the need to

use retroreflective signs, pavement markings, poles, cones and other objects to guide the night motorist down the road, or through a work zone. Since most materials reflect very little light at night, special materials have been developed allowing higher travel speeds. Indeed, on the modern highway it would be almost inconceivable to drive at speeds above 40 km/h (25 mph) if these products were not widely used.

Retroreflective materials are typically made up of thousands or even tens of thousands of small prisms or glass beads that bounce back light to its source. Cars, motorcycles and most bicycles have some of these materials. Unfortunately, pedestrians rarely have such materials, although they are readily available. So, again the pedestrian and often the bicyclist are hard to detect, especially at high motor vehicle speeds.

Eye Diseases and the Effects of Age

Children have one-third less peripheral vision than adults. Children lack experience, and so they cannot predict events and select important items in traffic safely. Some very young children cannot tell the difference between a parked car and one that is moving toward them.⁵ Seniors (65 and above) likewise have reduced peripheral vision.



Figure 3-1. On higher speed urban roads, low-level tungsten lights on high-angle cobra mounts provide even lighting to the entire roadway.

All older adults lose vision in a number of ways. Some effects are felt at the age of 40, many by age 55, and even more by age 65. This physiological degradation is pre-programmed, and is one of the guarantees in life. It includes the inability to see contrast easily and reduced night vision (cut to one-third, one sixth or even one-twelfth of normal night vision). The older person's eyes take much longer to focus from near to far. The older person is troubled by night glare to the point of having extreme discomfort. These effects are part of the normal aging process and cannot be reversed.

In addition there are a number of eye diseases that reduce the ability to see. Glaucoma, rapid onset glaucoma, cataracts, monocular blindness, retinal degeneration, diabetic retinopathy, macular degeneration, and a detached retina are among the most common diseases that reduce vision. Although many of these diseases are treatable, many people drive for years thinking they can see fine, not knowing how much of a risk they are to others.

Color and Fluorescence

Colors at the middle of the spectral (wavelength) field are easiest to detect. This includes orange and yellow. Yellow has been selected for warning signs. In recent decades engineers have learned to create dyes and pigments that emit more light than occurs in nature. These fluorescent materials transform invisible wavelengths and add them to those already detected. Examples include lime-green signs and the more traditional fluorescent orange vest and traffic cones used by highway workers. As long as there is even some solar light (such as dawn, dusk and fog or rain conditions), fluorescent materials appear to blaze. But once totally dark—night conditions—fluorescence does not work at all. That is why retroreflective materials must be sewn into all fluorescent clothing or garments to offer detection both night and day.

Motorist Behavior

The social and psychological aspects of driving and walking have generally been ignored. Both activities are very social in nature. Most drivers are influenced by the speed of others around them. Driving alone, some drivers will drive slower, and some will drive faster than when they are in the presence of others. Some motorists may feel that bicyclists or pedestrians are an impediment to their travel. Their attitude affects their ability to react correctly when it becomes essential. Invasion of one's personal space, communication, distraction by a passenger, imitation of other drivers, and false expectations of what the pedestrian or a driver will do can be misleading.

Motorists tend to give various levels of respect to pedestrians based on the motorist's travel speed, the acceptance of a gap when turning right or left, competing visual needs and interests, their ability to deal with complex happenings, traffic volume, and the presence and speed of other vehicles, especially those alongside or behind them.

Stopping Behavior

Even though the law requires the motorist not to proceed at any time that a pedestrian is in the roadway about to cross their path, many motorists tend not to yield to pedestrians. Although this stopping/proceeding behavior is regional, there is always a tendency for motorists to be more or less courteous based on a number of factors. Based on informal observations in a number of cities, the following can be implied about motorist behavior.

Motorists are likely to stop for a pedestrian when:

- ◆ The motorist's speed is at 32 km/h (20 mph) or less
- ◆ The motorist does not sense the impending danger of a trailing motorist

- ◆ The motorist is not anxious to be somewhere
- ◆ The pedestrian is a uniformed police officer
- ◆ The pedestrian is a child, an older adult, a woman, or has an apparent disability
- ◆ The pedestrian makes clear that he/she is about to cross by looking at the motorist
- ◆ The pedestrian points (extends an arm) indicating he/she is about to cross
- ◆ The pedestrian actually enters the street

Motorists are not likely to stop when:

- ◆ The motorist speed exceeds 56 km/h (35 mph)
- ◆ A downstream traffic signal is likely to change to red
- ◆ The pedestrian is not a uniformed police officer

Motorists rarely stop when:

- ◆ Speeds are greater than 72 km/h (45 mph)
- ◆ A police cruiser is not in sight
- ◆ The motorist fears personal attack from individuals in the area

Unfortunately, this failure to slow or stop may occur even when the pedestrian is crossing in a crosswalk, and where continued motion of the motorist places the pedestrian in imminent danger.

Traffic Engineering Practices

The correct placement of signs, pavement markings and other devices at and on the approach to midblock crossings is important. This is especially true at higher speeds. Clear, crisp, well placed messages and the location and marking of a crosswalk that helps alert a motorist to a potential pedestrian collision should be a top priority of all traffic engineers.

Primacy

The placement of the right signs and markings in just the right places is essential to reduce the 40 percent of occurrence of cognitive errors in information processing. If the mind is alerted or primed to expect something, it is more likely to see the object correctly and efficiently. Even a rare event in a given place is more likely to be detected. Signs must be placed so that the driver sees them when it is most essential. Useless signs should be avoided for the same reason.

Spreading

Where all of the needed information cannot be placed on one sign or on a number of signs at one location, spread it out over space so as to reduce the information load on a driver. One reason for putting a midblock crossing in a visually quiet location is that the signing can have more effect. However, putting the crossing upstream of where pedestrians are actually desiring to cross may distract the motorist from focusing on where the critical activity is naturally occurring.

Coding

Where possible, organize pieces of information into larger units. Color and shape coding of traffic signs accomplish this by representing specific information about the message based on the color of the sign background and the shape of the sign panel.

Redundancy

Redundancy is the practice of saying the same thing in more than one way. The STOP sign in North America has a unique shape, color, and message, each of which convey the message to stop. The stop bar/line accentuates this message, and by having primed the driver at a critical location with an advance warning about the upcoming stop, the motorist is more likely to be alerted and ready to respond.

By seeing more than one message about a potential object or task, a person is more

likely to see and react to the object. To overcome the effects of aging on short-term memory, and to doubly, triply or quadruply alert motorist of an important event that may occur at high speeds (65 km/h (40 mph) and above), and where complex movements are taking place, it is important to repeat essential messages. Thus an advance warning sign, warning sign, pavement word or symbol marking and an overhead sign with a flashing beacon may be required in some locations. So as to not lose the effect of signing, designers should thoroughly test and determine at what level they are getting a favorable response.

Driver Expectancy

Driver expectancy is the readiness of the driver to respond to events, situations, or the presentation of information. It is primarily a function of the driver's experience. An experienced driver and parent traveling down a neighborhood street is far more likely to react quickly to a child darting into the roadway than is a young inexperienced driver.

Violation of Expectancy

If a driver rounds a corner and sees a

newly installed traffic signal for the first time or sees a wheelchair coming at him in the lane he is in, the first impulse or reaction is to ignore the visual message. Engineers have learned to correct for this tendency by going to a flashing signal for the first month, and putting up signs alerting a person to the new signal system.

Pedestrian Behavior

Observations of pedestrians in New York City show that motorists and pedestrians failed to yield the right of way with about equal frequency with right-turning maneuvers. On cars' left-turning maneuvers, the drivers failed to yield to the pedestrian 62% of the time, compared with a 38% failure rate for pedestrians.⁶ A high failure rate by left-turning drivers is especially disconcerting, since these occur at lethal speeds. Older pedestrians are especially at risk when this error is made.

To reduce the likelihood of error, the roadway designer must consider that there is a natural tendency for motorists to fixate on objects more to their right. In a study by Shinar, McDowell and Rockwell, it was



Figure 3-2. Diagonal spans (above) are not encouraged, because motorists are looking into the sky far from the opposing traffic and the pedestrian. Instead, left emphasis enhancement signals are encouraged (right), because they allow motorists to observe the signal, oncoming traffic, and the pedestrian at the same time.

learned that eye fixations were 3.6 degrees to the right on right curves, but almost straight ahead on left curves.⁷ The left turning driver is focused largely on selecting a safe gap in opposing traffic. If the only traffic signals that are available are overhead, such as on a mast arm, diagonal span or box span, attention to this visual cue often comes second in priority. Note that such placement of signals is well out of the normal field of vision. Pole mounted signals placed in the left corner are recommended as an enhancement. This feature allows the motorist to seek a gap and look at the signal (next to the pedestrian) all in one easy motion.

The low number of pedestrians that walk in suburban areas may be another reason why they are not always included in the motorist search patterns. As land use practices and other incentives lead to increased walking, there is a strong probability that motorist inclination to search for pedestrians will increase.

How Long Is A Pedestrian Willing To Wait?

As a general rule, pedestrians are anxious to get back underway within 30 seconds. If waiting periods are longer, high school, college and middle-aged adults, in particular, tend to look for a gap that they can use. In other cases, anticipating a long wait, the same pedestrians tend to cross in other non-signalized locations. Although it is not always practical to reward pedestrians with this short a wait time, every effort should be made to keep the wait to the minimum. This short wait can often be achieved in pedestrian-oriented downtown locations.

For the designer, it is important to recognize the pedestrian's impact upon street and highway operations, and the influence of physical and behavioral characteristics of pedestrians on the degree of this impact. In that context, the highway designer needs to have an appreciation of some general characteristics of the pedestrian such as body area, walking rates, and capacities for pedestrian-related

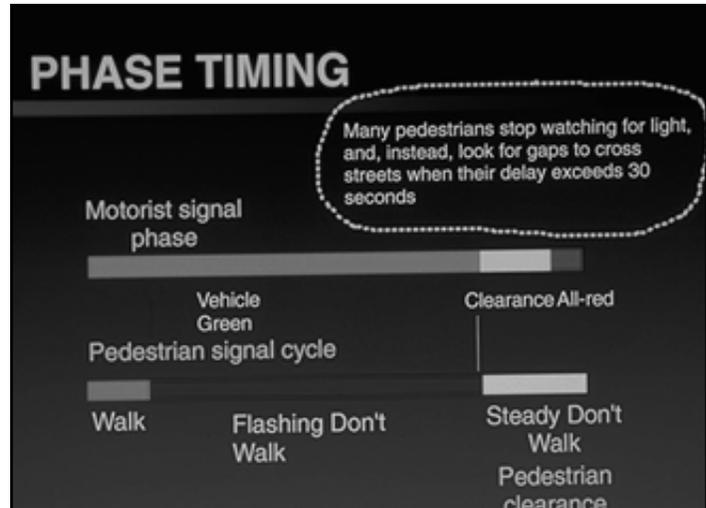


Figure 3-3. When practical, signal cycles should be timed so that pedestrians do not have to wait longer than 30 seconds.

facilities. Besides knowing about average pedestrians, the designer also needs to know something about pedestrians with physical, visual, or mental disabilities.

Body Area

The physical dimensions of pedestrians influence the capacity and operation of pedestrian facilities. Information on the dimensions of the human body (from an aerial view, an ellipse of 600 mm x 450 mm (24" x 18")) can be found in the 1990 AASHTO Green Book⁸ and is based on work by John Fruin.⁹ There is widespread agreement on these dimensions, but it must be noted that they do not take into consideration the increased body ellipse needs of elderly with canes or walkers, or adults with shopping carts or baby carriages. While the need to design for this element of the pedestrian constituency may be small, the designer should still be aware of these diverse user groups. Whenever possible, pedestrians will maintain some separation from each other, so sidewalks should be designed wide enough for faster pedestrians to overtake slower ones.

Walking Rates

Walking rates are generally 0.8 to 1.8 m (2.5 to 6.0 feet) per second with an average of 1.2 m (4.0 feet) per second in accordance



Figure 3-4. Signal timing should be set for the special populations that use a particular crossing.

with the 1988 MUTCD.¹⁰ Some sources state that, in areas where there are many older people, a walking rate of 0.9 m (3.0 feet) per second should be considered. However, this limited amount of information does not give a full appreciation of walking rate characteristics. Some studies have shown an even wider range in walking rates, approximately 0.8 to 2.4 m (2.5 to 8.0 feet) per second.¹¹

A current Federal Highway Administration study dealing with older pedestrian characteristics for use in highway design should yield some useful information about this subject so that a definitive standard can be reached.¹² Pedestrians with ambulatory difficulties are especially sensitive to stairs, curbs, or other horizontal obstructions that are in their paths. Recent research shows that they are also sensitive to the type and condition of the walking surface. Kulakowski et al., found that walkers with certain physical disabilities require higher levels of walking-surface friction than the non-impaired walker.¹³ In other words, it is important to provide surfaces that are not slick.

Pedestrian Capacities

Pedestrians are all ages and abilities. Each of the following groups of pedestrians has highly distinct walking characteristics and abilities:

Children	0-4
Children	5-9
Children	10-15
Teens	16-18
Adults	19-64
Seniors	65-75
Seniors	75+

Visually impaired

Mobility impaired

Mentally impaired

Emotionally impaired

Skateboarders, roller skaters, in-line skaters, wheelchair assisted, motorized wheelchair assisted, scooters, others

By considering the physical and physiological limitations of each user group, we are better able to plan, design, and program to more fully accommodate the customer. Too often, designers only consider the above average customer, since traditional highway design has considered its user the 85th percentile driver. This excludes attention to the unique qualities and performance of children, many seniors, and those with disabilities. Many designers must now develop insights and sensitivities previously lacking in literature and their background. The section below explores common characteristics of both limits and abilities of each group.

1. Young children

At a young age, children have unique abilities and needs. Since children this age vary greatly in ability, it is important for parents to supervise and make decisions on when their child is ready for a new

independent activity. These limits and abilities include:

- ◆ Impulsive, unpredictable
- ◆ Limited peripheral vision, sound source not located easily
- ◆ Limited training, lack of experience
- ◆ Poor gap/speed assessment
- ◆ Think grown-ups will look out for them
- ◆ Close calls are fun
- ◆ Short, hard to see
- ◆ Want to run, desire to limit crossing time
- ◆ Like to copy behavior of older people

2. Preteens: Needs and abilities

By middle school years, children have many of their physical abilities, but still lack experience and training. Now there is a greater desire to take risk.

- ◆ Lack experience
- ◆ Walk and bicycle more and at different times (higher exposure)
- ◆ Ride more frequently under risky conditions (high traffic)
- ◆ Lack positive role models
- ◆ Walk across more risky roadways (collectors and above)
- ◆ Willing to take chances

3. High school-age: Needs and abilities

By high school and college age, exposure changes, and new risks are assumed. Many walk and bicycle under low light conditions.

- ◆ Very active, can go long distances, new places
- ◆ Feel invincible
- ◆ Still lack of experience and training
- ◆ Capable of traveling at higher speeds
- ◆ Will overestimate their abilities on hills, curves, etc.

- ◆ Attempt to use bicycles, in-line skates based on practices carried over from youth
- ◆ Willing to experiment with alcohol, drugs

4. Novice adults

Adults who have not walked and bicycled regularly as children, and who have not received training are ill-prepared to take on the challenges of an unfriendly urban environment.

- ◆ 95% of adults are novice bicyclists
- ◆ Many are unskilled in urban walking
- ◆ Drinking can influence their abilities
- ◆ Many assume higher skills and abilities than they actually have
- ◆ Most carry over sloppy habits from childhood
- ◆ Many new immigrants, especially from Asia, are unprepared for urban auto traffic

5. Proficient adults

Can be any age. Are highly competent in traffic, capable of perceiving and dealing with risk in most circumstances. Some use bicycles for commuting and utilitarian trips, while others use bicycles primarily for recreation.

Fig. 3-5. School crossing guards help children to cross streets safely.



*Human Factors
and the Pedestrian*

Figure 3-6. Fifty-five percent of older males have hearing problems and are subject to right turning conflicts.



- ◆ Comprise only 1-4% of bicycling population in most communities
- ◆ Tend to be very vocal and interested in improving conditions
- ◆ Some are interested in serving as instructors, task force leaders

6. Senior adults

Senior adults, ages 60 and up, begin a gradual decline in physical and physiological performance, with a rapid decline after age 75. Many are incapable of surviving serious injuries. These changes affect their performance. Seniors:

- ◆ Walk more in older years, especially for exercise/independence
- ◆ Many have reduced income and therefore no car
- ◆ All experience some reduction in vision, agility, balance, speed, strength
- ◆ Some have further problems with hearing, extreme visual problems, concentration
- ◆ Some have a tendency to focus on only one object at a time
- ◆ All have greatly reduced abilities under low light/night conditions

- ◆ Many overestimate their abilities

7. Disabled

For those of us fortunate to live to an older age, 85 percent of us will have a permanent disability. Disabilities are common through all ages, and the permanently disabled constitute at least 15 percent of our population. Those with permanent physical disabilities, often kept away from society in the past, are now walking and bicycling on a regular basis. Many others have temporary conditions, including pregnancy, and broken or sprained limbs that may restrict their mobility.

- ◆ Visually impaired, hearing impaired, mobility impaired, mental/emotional impairment, other
- ◆ Many older adults have reduced abilities
- ◆ Many were previously institutionalized, and are not trained to walk the streets
- ◆ Those dependent on alcohol or drugs may be hard to recognize

A more complete discussion of disabled pedestrians is in Chapter 5.

8. Ethnic/cultural diversity/tourism

America is rapidly becoming a nation with no clear majority population. All groups need access and mobility in order to fully

participate in society. Transportation officials must pay close attention to communication, the creation of ethnic villages, and subcultural needs and practices. By the year 2000, it is predicted that our nation will attract millions of annual tourists from Third World nations. Most of these people will depend heavily on walking and transit to get around.

- ◆ Some newly arriving groups lack urban experience
- ◆ Many are used to different motorist behavior

9. Transportation disadvantaged

Too often transportation professionals live, work and play with people just like them. Many assume that everyone has a car, and therefore access and mobility to society. In contrast with this belief, 30-40 percent of the population in most states do not have their own car, often because they cannot afford to purchase or operate a car. These men, women and children are highly dependent on walking, transit and bicycling for their basic freedom, access and mobility.

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Characteristics of Pedestrian-Motor Vehicle Crashes in Florida

A total of 5,307 pedestrians were reported killed in motor vehicle crashes in the United States in 1997.¹ These deaths accounted for 12.6 percent of the 41,967 persons killed in motor vehicle crashes. An estimated 77,000 pedestrians received nonfatal injuries in motor vehicle collisions. These accounted for 2.3 percent of all 3,399,000 persons injured.

In Florida, a total of 535 pedestrians were killed in motor vehicle crashes in 1997. Figure 4-1 shows that the number of fatalities has generally declined since 1980, with the biggest drops from 1989 through 1991.² Given our state's high population growth, the fatality rates have fallen even more dramatically, to 3.69 fatalities per 100,000 residents in 1993 (Figure 4-2).^{1,2} However, in 1995, the number of fatalities rose to 564, and the fatality rate increased to 3.99 per 100,000 residents.² As of 1997, Florida had the third highest fatality rate among all 50 states, with a rate that was 1.82 times that of the nation.

Although a drop in pedestrian fatalities has occurred in recent years, a serious pedestrian safety problem continues to exist

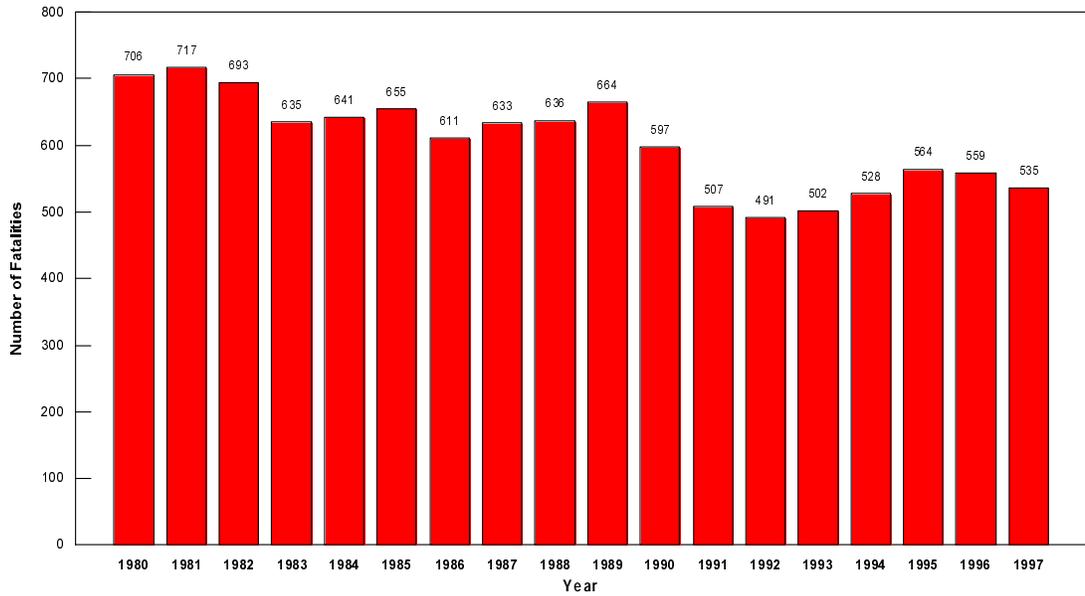
in the U.S. as a whole and Florida in particular. This chapter presents crash data compiled by the Florida Department of Transportation. The data pertain to pedestrian actions and crash types, age distribution, light condition, and alcohol and drug use. Data from other studies are also presented.

Florida's fatality rate is 1.8 times that of the nation, third highest among all 50 states.

Pedestrian Actions and Crash Types

From 1993 through 1997, our state recorded 2,688 traffic-related pedestrian fatalities. Forty-eight percent (1,291) of these incidents occurred while pedestrians were crossing roads between intersections (Figure 4-3). Another 13.3 percent (358) involved pedestrians crossing roads at intersections. Other common pedestrian actions were walking with traffic (7.9 percent) and playing or standing in the roadway (6.5 percent).²

Figure 4-1. Pedestrians killed in Florida, 1980-1997.



Several studies conducted for the U.S. Department of Transportation in the 1970s used field observations, personal interviews, and information from accident reports to identify specific accident types. The most frequently occurring accident types in urban areas were dartouts (first half) (23 percent), intersection dash (12

percent), dartouts (second half) (9 percent), and midblock dash (7 percent).^{3,4} Combining first- and second-half dartouts and midblock dash reveals that 39 percent of urban pedestrian accidents were midblock. Twenty-two percent were at intersections and vehicle merge locations (intersection dash, vehicle turn-merge

Figure 4-2. Pedestrian fatality rates in Florida and the United States, 1980-1995.

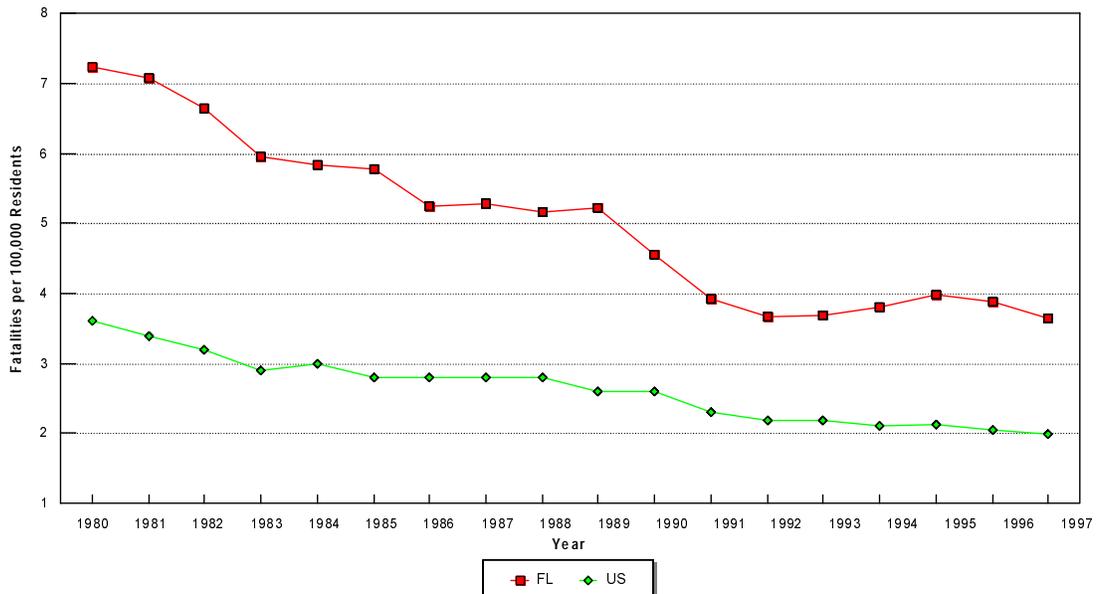


Figure 4-3. Actions of pedestrians killed in Florida, 1988-1992.

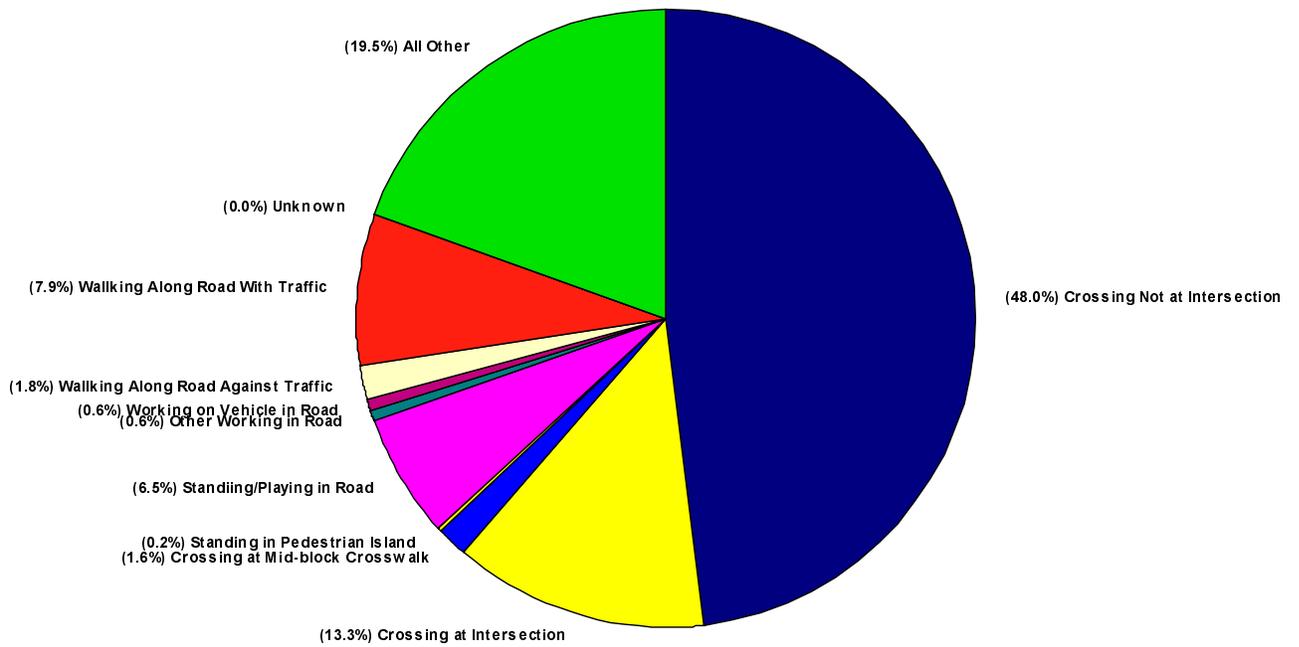


Figure 4-4 Pedestrian crash types.

Accident Type: ICE CREAM VENDING TRUCK

The pedestrian is struck going to or from an ice cream vending vehicle. This accident occurs almost exclusively in residential areas. Most occur as the pedestrian is leaving the vending vehicle.

Accident Type: INTERSECTION DASH

Similar to the dart out, this type of accident occurs in or near a marked or unmarked crosswalk. A person runs across the intersection, is seen too late by the driver, and is struck.

Accident Type: BACKING-UP

A pedestrian is struck after failing to see a vehicle backing up, or not being seen by the driver of the backing vehicle.

Accident Type: BUS STOP

A bus has stopped to discharge passengers. A person leaves the bus, begins to cross the road in front of the bus, and is struck by an overtaking vehicle.



Figure 4-5. Intersection dash accidents are the most common accident type for 5- to 9-year-old children, particularly males.

with attention conflict, turning vehicle, and trapped). Some of the major pedestrian crash types are illustrated in Figure 4-4.

In a six-state study by William Hunter, et al., 5,000 pedestrian-motor vehicle crashes that occurred in 1991 were classified into 15 crash type subgroups.⁵ These crashes happened in Florida and five other states.

Figure 4-6 depicts Florida’s 832 crashes by subgroup.

The most common subgroups were other midblock (13.8 percent), not in the road (12.7 percent), walking along roadway (10.3 percent), other intersection (10.2 percent), and backing vehicle (10.1 percent).

Figure 4-6. Major pedestrian crash type subgroups in Florida, 1991.

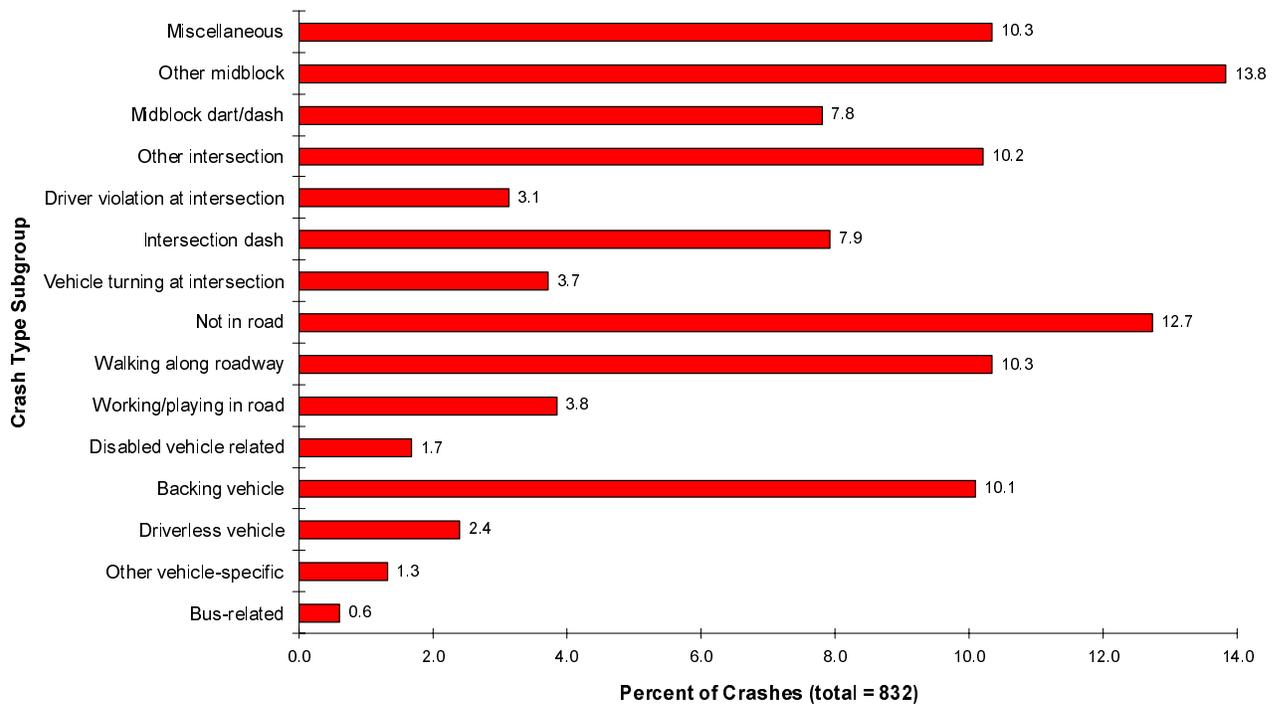


Figure 4-7. Florida pedestrian fatalities and injuries by age, 1988-1992.

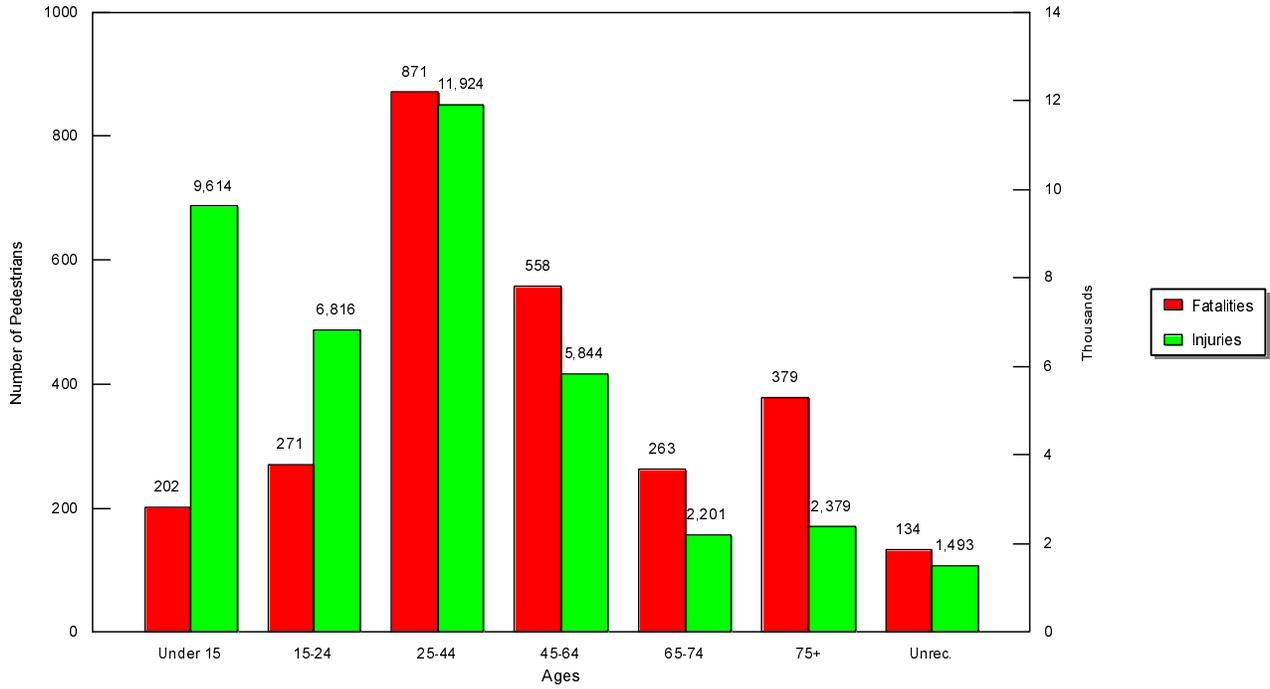
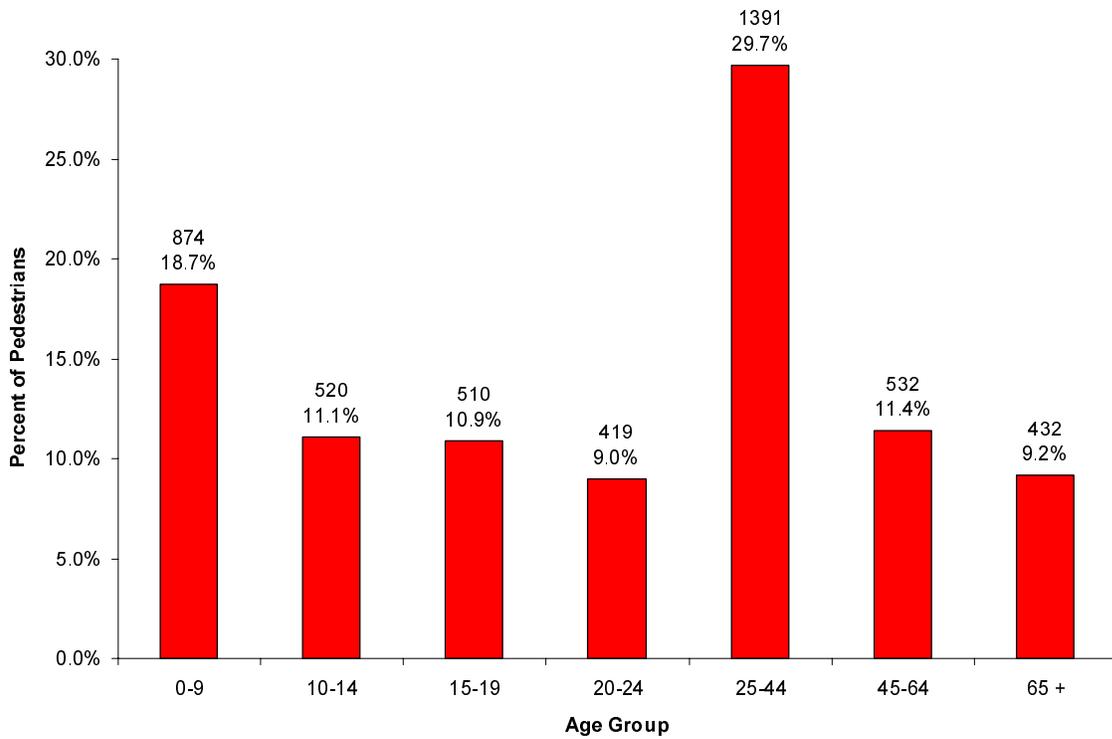


Figure 4-8. Age of pedestrians involved in crashes, six-state study, 1991 data.



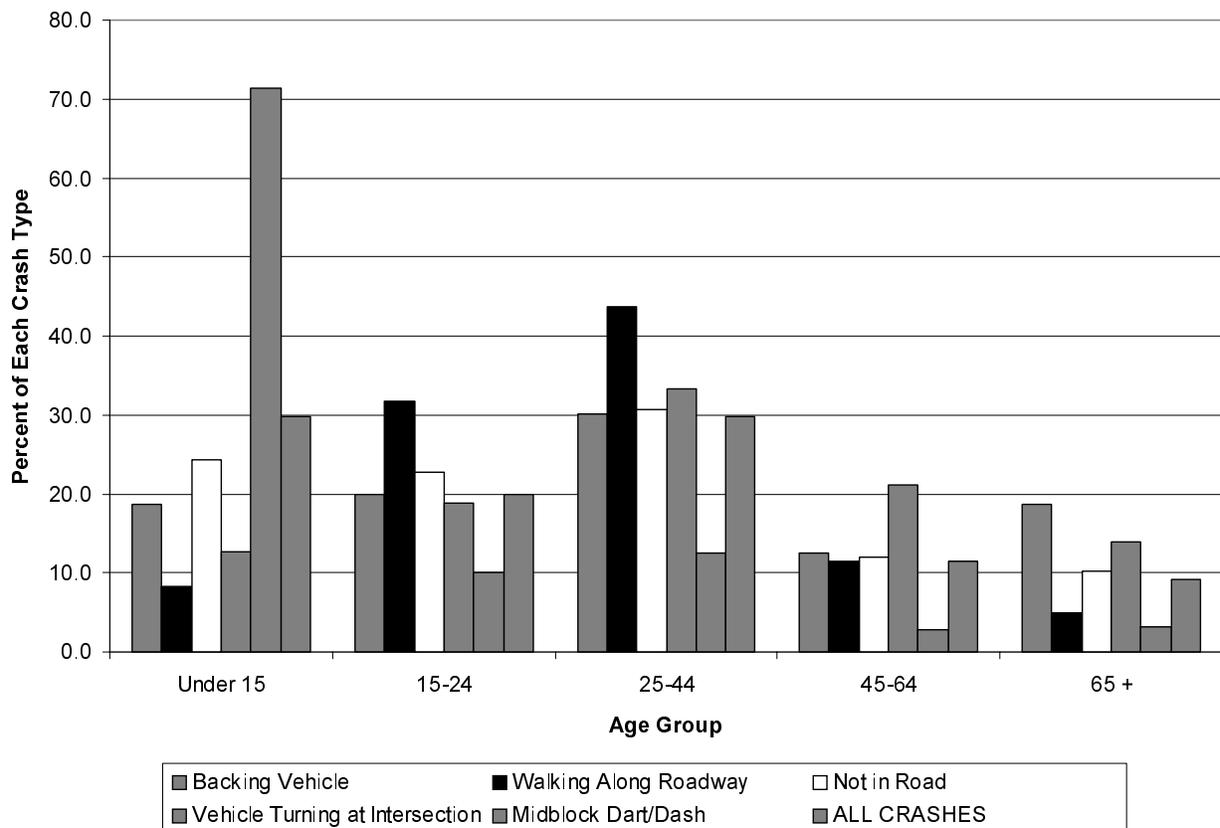
Fatalities and Injuries by Age

Adults 55 and over comprise about 28 percent of Florida’s population but accounted for 36 percent of pedestrian fatalities between 1993 and 1997 (Figure 4-7).² The over-representation of older adults may be the results of lessened mobility, deteriorating eyesight and hearing, and a lower ability to recover from injuries once struck by a vehicle. In contrast, pedestrians under age 18 were the most likely to be injured, possibly the result of greater exposure and less experience in dealing with traffic.

Similarly, the six-state study found that younger pedestrians were most commonly

involved in accidents (18.7 percent of all pedestrians involved in accidents were less than 10 years of age) (Figure 4-8).⁵ Only 9.2 percent of the pedestrians were 65 years or older. These older pedestrians accounted for a disproportionately high percentage of backing vehicle (18.6 percent), other intersection (14.7 percent), and vehicle turning at intersection 13.9 percent) accidents (Figure 4-9). Older pedestrians were under represented among intersection dash (2.6 percent), midblock dart/dash (3.2 percent), and walking along roadway (4.9 percent).

Figure 4-9. Pedestrian crash types by age, six-state study, 1991 data.



Light Condition

Two-thirds of Florida's pedestrian fatalities between 1993 and 1997 took place at night and another four percent happened at dawn or dusk (Figure 4-10).² Pedestrians often wear clothing that is hard for motorists to see at night, and thus are vulnerable to getting hit by vehicles. This figure agrees with nationwide Fatal Accident Reporting System (FARS) data, which indicate that 67 percent of pedestrian fatalities occurred at night, dawn, or dusk. By age group, young children and older citizens suffered fewer nighttime fatalities, because these age groups are probably least likely to be outside after dark. (Figure 4-11)⁵

Among 4,784 pedestrian crashes in the six-state study, only 39 percent occurred at night, dawn, or dusk.⁵ This finding may reflect higher levels of walking during

daylight hours, and thus, greater daytime exposure. The Florida and FARS data reveal that nighttime accidents are more likely to be fatal. It is likely that nighttime drivers are driving too fast, often under the influence of drugs or alcohol and do not see pedestrians soon enough to slow down and avoid a collision.

Light condition for the more common crash type subgroups is shown in Figure 4-12.⁷ Nearly two-thirds of walking along roadway accidents occurred at night, dawn, or dusk, compared to 39.4 percent of all pedestrian accidents. In fact, 41.6 percent of walking along roadway accidents took place under dark conditions without street lights. This is precisely when pedestrians are the least visible to motorists. One-third or fewer of the other accidents shown occurred in darkness, dawn, or dusk.

Figure 4-10. Florida pedestrian fatalities by light condition, 1993-1997.

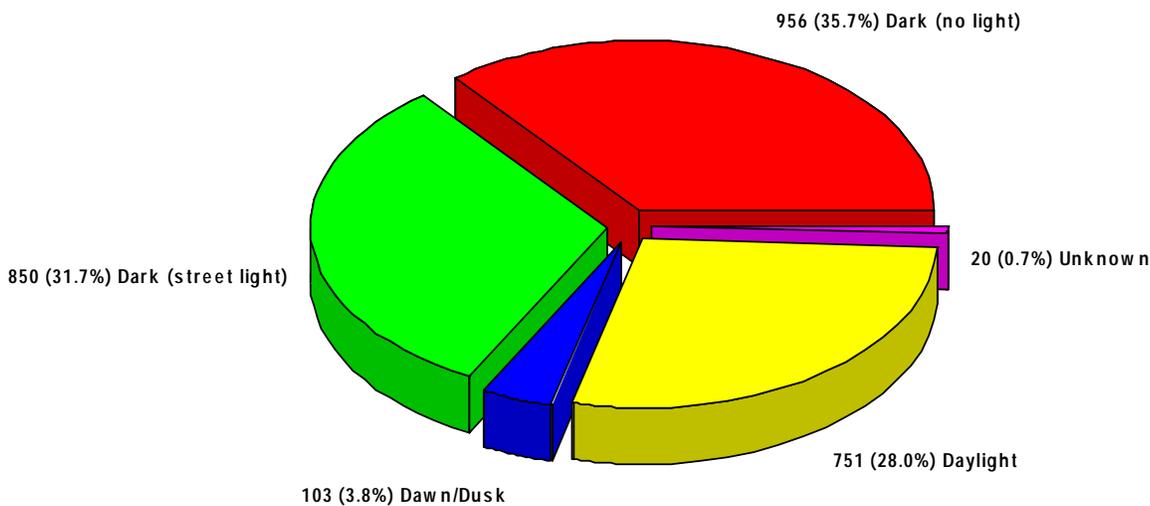


Figure 4-11. Pedestrian fatalities by light condition and age, six-state study, 1991 data.

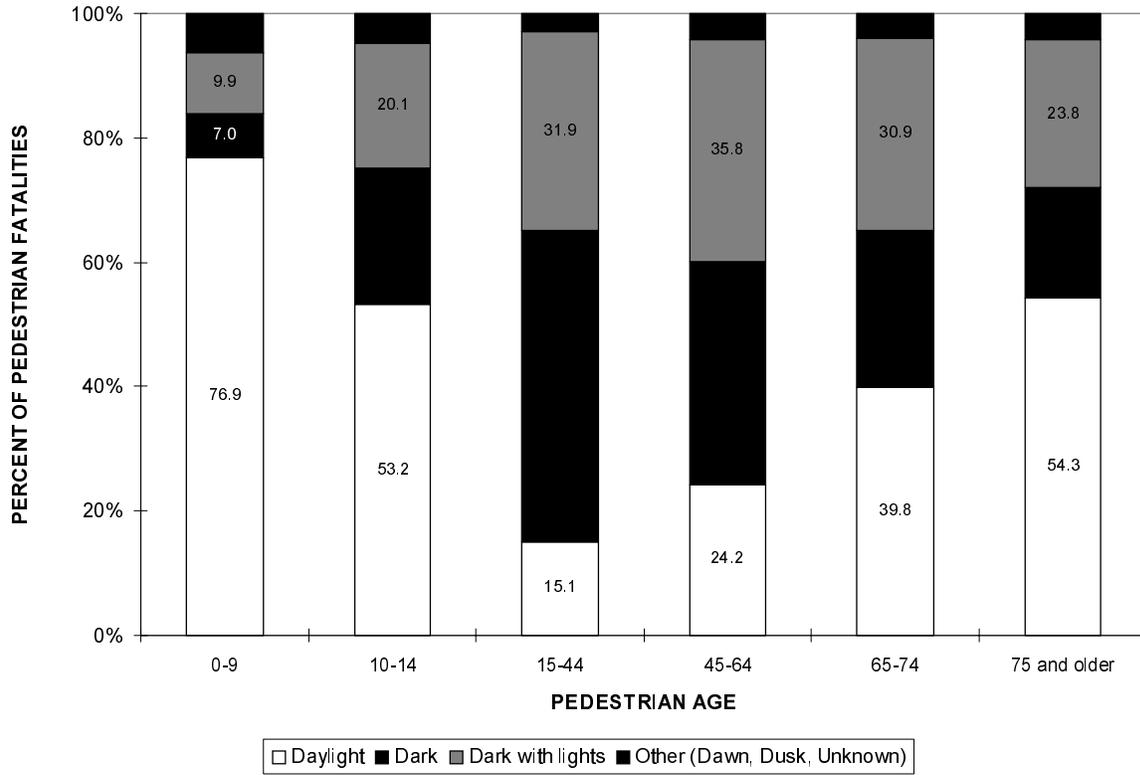
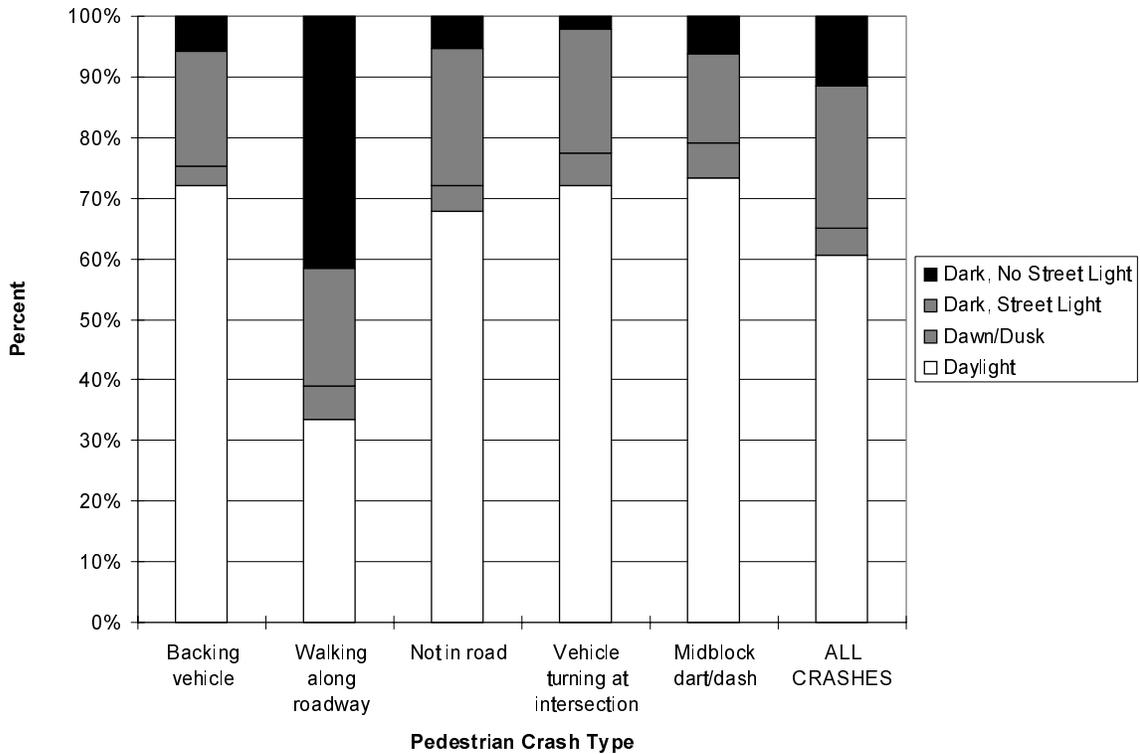


Figure 4-12. Pedestrian crashes by light condition, six-state study, 1991 data.



Crashes

Figure 4-13. Florida pedestrian fatalities by impairment, 1993-1997.

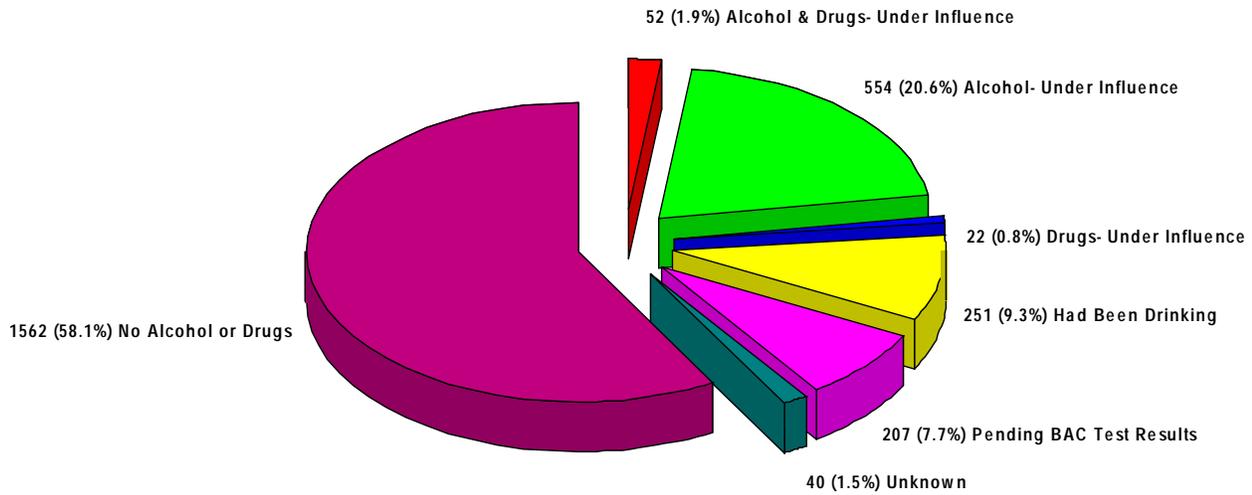
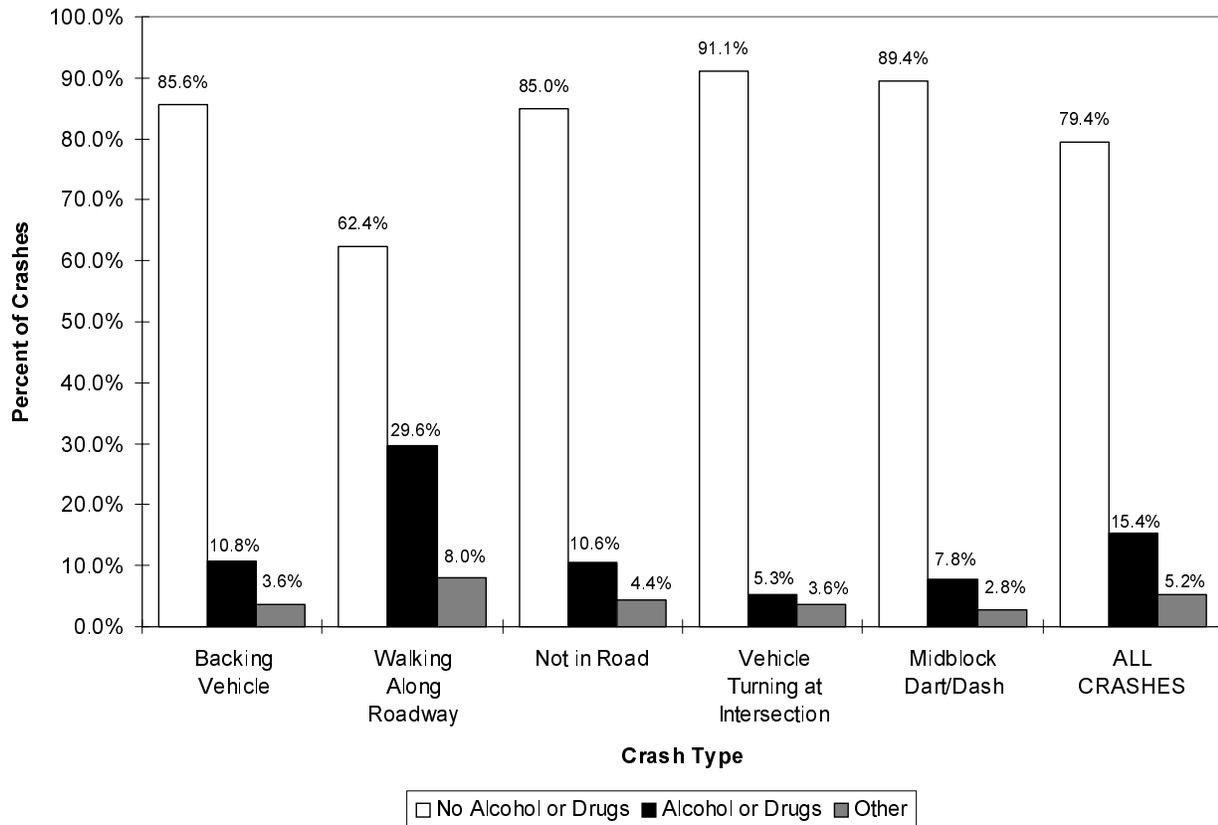


Figure 4-14. Pedestrian crash types by impairment, six-state study, 1991 data.



Alcohol and Drug Use Among Pedestrians

As many as 40 percent of pedestrians killed in Florida were impaired by alcohol or drugs (Figure 4-13).² This number includes 22 percent who were under the influence of alcohol and another 9 percent who had been drinking. Of all pedestrians killed in the U.S. between 1980 and 1989, 22.1 percent had been drinking. The highest rates of alcohol use were in the 25 through 44 age group (34.9 percent) and the 15 through 24 age group (30.9 percent). Overall, 20.5 percent of pedestrian crashes in North Carolina involved drinking.⁶

In the six-state study, 15.4 percent of pedestrians had been drinking or using drugs.⁵ Compared with other common crash types, alcohol or drug use was the most common among walking along roadway crashes (29.6 percent) (Figure 4-14).⁵ The dangers of walking along the roadway are magnified by alcohol or drug impairment. Drunken pedestrians may exhibit behavior unpredictable to motorists, may be less attentive to their surroundings, and may be unable to react to potential conflicts with motor vehicles (Figure 4-15).

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Figure 4-15. Pedestrians who drink have the judgment skills of a child and the mobility skills of a senior.



Pedestrians with Disabilities

5

There are 43 million persons in the United States with disabilities. Virtually all are pedestrians at one time or another. People with disabilities hold jobs, attend school, shop and enjoy recreation facilities. Anyone can experience a temporary or permanent disability at any time, due to age, illness, or injury. In fact, 85 percent of Americans living to their full life expectancy will suffer a permanent disability. Design deficiencies frequently can be overcome by an agile, able-bodied person. However, when age or functional disabilities reduce a person's mobility, sight, or hearing, a good design is very important.

For traffic engineering purposes, a disability can be classified in one or more of three functional categories: mobility impairments, sensory deficits, or cognitive impairments. A person with a **mobility impairment** is limited in his/her method or ability to move about because of a physical disability or circumstance. This includes people who use wheelchairs and those with braces, crutches, canes and walkers. It also includes persons with balance or stamina problems. Pregnant women are in this category as well.

While **sensory deficits** are most often associated with blindness or deafness, partial hearing or vision loss is much more common. Other persons have lost sensation

in some part of their body. Color blindness, especially of red and green, is also a sensory deficit.

85 percent of Americans living to their full life expectancy will suffer a permanent disability.

Cognitive impairments refer to a diminished ability to process information and make decisions. This includes persons who are mentally retarded or who have a dyslexic type of learning disability. In the United States, those who are unable to read or understand the English language are also in this category.

Based on tests conducted by the Veterans Administration, the level of energy expended by a wheelchair user is about 30 percent higher than that needed by a pedestrian walking the same distance. Moreover, a person on crutches or with artificial legs uses 70 percent more energy to go the same distance. If a person using a wheelchair travels a full city block and finds no curb cut, doubles back and travels that same distance in the street, it is the equivalent of an ambulatory person going four extra blocks. This illustrates the importance of removing physical barriers from our street network.

The Americans with Disabilities Act (ADA)

The Americans with Disabilities Act was signed into law on July 26, 1990. This civil rights law assures that a disabled person will have full access to all public facilities throughout the U.S. It is important to be not only in compliance with the letter of the law but also with the spirit of the law. A prioritized plan for improvements should be in place with resources allocated to those locations where there is the greatest need. A primary concern for public agencies is providing access to public transit and to public buildings and facilities. In most cases this will involve removing barriers to wheelchair access along sidewalks, installing accessible wheelchair ramps, and improving access to bus stops, as well as other features to accommodate pedestrians with various disabilities.

Dimensions and rules in this chapter are based on current standards set by the Architectural and Transportation Barriers Compliance Board, the Uniform Federal Accessibility Standards (UFAS), and the American National Standards Institute (ANSI) codes at the time of writing of this document. These rules may be updated from

time to time, and local codes which are more strict should supersede these codes.

Sidewalks

While wheelchairs require 0.9 m (3 ft) minimum clear width for continuous passage, sidewalks should have a minimum clear usable width of at least 1.5 m (5 ft). They should be paved with a smooth, durable material. Sidewalks should be built and maintained in urban areas along all major arterial streets, in commercial areas where the public is invited and at all transit stops and public areas. It is desirable to have paved sidewalks on both sides of all streets in urban and suburban areas to provide mobility for disabled (as well as non-disabled) pedestrians. A planting strip, which serves as a buffer between on-street vehicles and pedestrians on the sidewalk, can be especially beneficial to visually impaired pedestrians and to wheelchair users. Sidewalks should be kept in good condition, free from debris, cracks and rough surfaces.

To the extent practicable, sidewalks should have the minimum cross slope necessary for proper drainage with a maximum of 25 mm (1 in) of fall for every 1.2 m (4 ft) of width (2 percent). A person

*Figure 5-1.
Pedestrian facilities
must be designed to
accommodate the
needs of the
physically disabled.*





Figure 5-2. Curb cuts are the single most important design consideration for persons in wheelchairs.

using crutches or a wheelchair has to exert significantly more effort to maintain a straight course on a sloped surface than on a level surface.

There should be enough sidewalk cross slope to allow for adequate drainage. The maximum cross slope should be no more than 2 percent (1:50) to comply with ADA requirements. Driveway slopes should not encroach into the sidewalk, and a 1.8 m (6 ft) setback will generally prevent this encroachment.

Where the sidewalk is located adjacent to the street, it should be rerouted sufficiently away from the street (to the back of the right-of-way or on an easement if necessary) out of the driveway slope.

Ramps are defined as locations where the grade exceeds 5 percent along an accessible path. Longitudinal grades on sidewalks should be limited to 5 percent, but may be a maximum of 1:12 (8.3 percent) if necessary. Long, steep grades should have level areas at intermittent distances, since traversing a steep slope with crutches, artificial limbs or in a wheelchair is difficult and level areas are needed for the pedestrian to stop and rest. In

areas where it is impossible to avoid steep grades, an alternative route (such as an elevator in a nearby building) should be provided. However, the ADA does not require accommodations in all locations where natural terrain prevents treatments.

Where grades exceed five percent, special textures and handrails may be required. Handrails are used by persons in wheelchairs to help pull themselves up and are used by other persons for support. Specifications for ADA approved handrails can be found in the Americans With Disabilities Act Handbook. Informational signs, indicating alternative routes or facilities, can be placed at the base of the grade or in a guidebook for the area. Arrangements may be made with the local transit authorities to transport persons with disabilities at reduced (or no) fares where steep grades or other obstacles prohibit or severely impede access.

Street Furniture

Street furniture, such as benches and bus shelters, should be out of the normal travel path to the extent possible. For greater conspicuity, high contrast colors, such as

red, yellow and black are preferable. The following guidelines should be considered in the positioning of street furniture:

- ◆ Street furniture should not hang lower than 2.0 m (6.7 ft) over a walking area.
- ◆ No object mounted on a wall or post, or free standing should have a clear open area under it higher than 0.7 m (2.3 ft) off the ground.
- ◆ No object higher than 0.7 m (2.3 ft) attached to a wall should protrude from that wall more than 100 mm (4 in).
- ◆ No protruding object should reduce the clear width of a sidewalk or walkway path to less than 0.9 m (3 ft).

Another common problem for wheelchair users is the placement of street furniture next to on-street parking which can make exiting a car or lift-equipped vehicle difficult. One remedy is to relocate the street furniture towards the end of the parking space instead of the center, or at the back of the sidewalk furthest from the curb. At least 1.5 m (5 ft) of clear space width along the sidewalk is needed to allow for exiting a vehicle. Other objects, such as street light poles, may be more difficult to move, so consideration may be given to relocating the handicapped parking space or reserving extra handicapped parking spaces.

Some individuals may have difficulty operating pedestrian push buttons. In some instances there may be a need to install a larger push button or to change the placement of the push button. Pedestrian push buttons should always be easily accessible to individuals in wheelchairs, and should be no more than 1.05 m (42 in) above the sidewalk. The force required to activate the push button should be no greater than 2.2 kg (5 lbs).

Pedestrian push buttons should be located next to the sidewalk landing, the top of the ramp, and adjacent to the appropriate crosswalk ramp. If there are two push buttons at a corner (one for each crosswalk)



Figure 5-3. A pavement grinding project left an exaggerated lip at this curb cut.

the push buttons should be located on separate poles and adjacent to their respective ramps.

Parking

A parking space width of at least 4.0 m (13 ft) is needed to operate a lift equipped van. In off street parking lots, the minimum parking width for a handicapped space should be 3.7 m (12 ft) wide, with an access aisle of 1.5 m (5 ft). Two adjacent handicapped parking spaces may share a common access aisle. In parking structures, some handicapped spaces should have a 3.7 m (12 ft) clearance for use by lift equipped vans with raised roofs. Providing an accessible route to and from all parking spaces is essential.

Handicapped parking spaces in parking lots should also be as level as possible to allow for greater stability for persons in a wheelchair when loading and unloading a vehicle.

Curb Cuts and Wheelchair Ramps

The single most important design consideration for persons in wheelchairs is to provide curb cuts (Figure 5-2). New and rebuilt streets with sidewalks should always have curb cuts at all crosswalks. It is desirable to provide two curb cuts per corner. These also benefit others with mobility limitations, elderly pedestrians and persons pushing strollers, carts etc. A roll curb is a barrier and will not allow for wheelchair access. Curb cuts should be at least 1.0 m (3 ft 4 in) wide at the base with flared sides that do not exceed a slope of 2.33 percent and ramps that do not exceed 8.33 percent.

The ramps should be flared smooth into the street surface. Ramps should be checked periodically to make sure large gaps do not develop between the gutter and street surface. There may be a need to remove accumulations of asphalt at the edge of the curb radius.

Single ramps located in the center of a corner are less desirable than a separate ramp for each crosswalk to accommodate disabled pedestrians and should not be built

for new construction or reconstruction of sidewalks or roads. Separate ramps provide greater information to visually impaired pedestrians in street crossings especially if the ramp is designed to be parallel to the crosswalk. Crosswalk markings should be located so that a pedestrian in a wheelchair should not have to leave the crosswalk to enter or exit the street. In some cases a wider ramp may be used to accommodate pedestrians in wheelchairs.



Figure 5-4. This island (above and left) does not have a cut-through. Note that the older woman is having difficulty whereas the other pedestrians (left) are already crossing.

Ramps or cut through islands should be provided for marked or unmarked crosswalks at median (or frontage road) islands (see Figure 5-4). Cut-throughs should be designed to provide proper drainage and avoid ponding.

Drainage is important. Standing water can obscure a drop-off or pothole at the base of a ramp and makes the crossing messy. Storm drain inlets should be clear of the crosswalk. If this is not possible, the openings in the grate should be no larger than 13 mm (0.5 in) in width.

Bus Stops

All transit vehicles will eventually be able to accommodate wheelchairs. There are three major types of wheelchair accessible buses that may be used by a local transit authority:

- ◆ *Front Door Wheelchair Lift* - This type of lift will not operate well with a heightened crown, high curb or gutter depression. It is better to pave the bus stops so that a stopped bus will be approximately level. The sidewalk should be less than 200 to 250 mm (8 to 10 in) above the street surface. Newer buses are designed to accommodate a 200 to 280 mm (8 to 11 in) high curb.
- ◆ *Center Door Bus* - Center door lift designs require the door of the bus to be positioned within 300 mm (12 in) of the curb. This usually requires a longer bus stop and more stringent parking enforcement near the bus stop than for buses with front door lifts.
- ◆ *Low Floor Bus* - This bus is built so that the entryway is 280 to 330 mm (11 to 13 in) high, and there are areas in the bus that can be accessed without going up any steps. The physical design requirements of the bus stop is virtually identical to the first two designs, however, a 280 mm (11 in) curb height works best.

Not only should the sidewalk network be accessible with curb ramps, but the bus stop must be accessible from the sidewalk. This may require removing obstacles such as bushes and street furniture between the sidewalk and bus waiting area and paving an accessway to the bus stop.

Resources

The following Federal agencies are responsible for providing information about the Americans with Disabilities Act. The agencies and organizations are sources for obtaining information about the law's requirements and informal guidance for complying with the ADA. They are not sources for obtaining legal advice or legal opinions about your agency's rights or responsibilities under the ADA.

Architectural and Transportation Barriers
Compliance Board
1331 F Street, NW Suite 1000
Washington, DC 10004-1111
1-800-872-2253 (voice and TDD)

Equal Employment Opportunity
Commission
1801 L Street, NW
Washington, DC 20507
Questions and Documents: 1-800-669-3362
(voice)
1-800-800-3302 (TDD)

Federal Communications Commission For
ADA documents and general information:
202-632-7260 (voice)
202-632-6999 (TDD)

President's Committee on Employment of
People with Disabilities Information Line:
ADA Work : 800-232-9675 (voice and TDD)

U.S. Department of Justice Civil Rights
Division Public Access Section
P.O. Box 66738
Washington, DC 20035-6738
202-514-0301 (voice)
202-514-0383 (TDD)

U.S. Department of Transportation Federal
Transit Administration
400 7th Street, SW
Washington, DC 20590
202-366-1656 (voice)
202-366-2979 (TDD)

Office of the General Counsel
202-366-9306 (voice)
202-755-7687 (TDD)

Sidewalks, Walkways, and Paths

Areas that are designed to allow pedestrians to move efficiently and safely from one location to another can typically be classified as one of the following:

- ◆ **Sidewalk**—This is a paved area (typically concrete) which normally runs parallel to vehicular traffic and is separated from the road surface by at least a curb and gutter. Sidewalks are common in urban areas, may be used in some suburban locations such as residential areas, and are not often present in rural areas, primarily due to the high installation cost and low anticipated use.
- ◆ **Walkway**—This is an area for general pedestrian use (other than a sidewalk or path) such as courtyards, plazas, and pedestrian malls.
- ◆ **Path**—This is a temporary or permanent area that is normally dirt or gravel, although some paths are asphalt. A path typically indicates the common route taken by pedestrians between two locations and often indicates the need to provide a sidewalk or at a minimum, a paved surface.

This chapter primarily focuses on the design criteria for sidewalks. However, many of the same criteria apply to pedestrian paths. Walkways are part of exclusive pedestrian facilities (Chapter 16).

Properly planned, designed, and constructed sidewalks are essential...

Properly planned, designed, and constructed sidewalks are essential for increasing pedestrian mobility, accessibility, and safety, especially for persons with disabilities, the elderly, and children (Figure 6-1). Sidewalks increase pedestrian safety by separating pedestrians from vehicle traffic. One recent FHWA study cited the presence of sidewalks in residential areas as the one physical factor in the roadway environment having the greatest effect on pedestrian safety.¹

Figure 6-1.
Properly built
sidewalks are
essential for
increasing
pedestrian
comfort,
mobility,
accessibility,
and safety.



Placement

The inclusion of sidewalks is often determined by the engineer or planner on a site-by-site or project-by-project basis, without specific criteria for determining where sidewalks should be used. The most specific guidance provided by the American Association of State Highway and Transportation Officials (AASHTO) is for urban collectors and local streets as follows:

*“Sidewalks used for pedestrian access to schools, parks, shopping areas, and transit stops and placed along all streets in commercial areas should be provided on both sides of the street. In residential areas, sidewalks are desirable on both sides of the streets but need to be provided on at least one side of all local streets.”*²

It is the policy of the Florida DOT that all new urban roadway projects will include sidewalks if pedestrian traffic can be expected. There are some other general principles to consider in the placement of sidewalks:^{1,3}

- ◆ All roadways where pedestrian travel is expected should have a walking area that is out of the vehicle travel lanes. While a separate sidewalk or path is preferred, a paved roadway shoulder, particularly in rural areas, may serve the need. However, this provides the lowest level of service for pedestrians and does not serve children, older adults, and people with disabilities.
- ◆ Efforts should be made to provide direct connections between residences and activity areas such as shopping centers and transit stops. The most direct, and thus preferred, routes can usually be determined during the planning stages of a development. Incorporating these direct routes into the developments through easements or other means is preferred by residents and most cost effective when done at the planning stages.

- ◆ Developers should be required to incorporate sidewalks into every residential, commercial, and industrial project. Where undeveloped areas exist between already developed areas, local jurisdictions should fill in the gaps by connecting the developments with properly designed sidewalks.
- ◆ Schools should be required to incorporate sidewalks into their sites, and the sidewalks should be wider than adjacent areas to accommodate the high numbers of children during peak arrival and dismissal times.
- ◆ Whenever possible, sidewalks should be continued with their full width on bridges. Sidewalks on bridges should be placed to eliminate the possibility of pedestrians falling into the roadway, or over the bridge itself. Sidewalks should be placed on both sides of all bridges. Under extreme conditions sidewalks can be used on one side only, but should only be done when safe crossings can be provided on both ends of the bridge.

One additional factor that must be considered when determining sidewalk placement is the Americans with Disabilities Act (ADA). The ADA specifically states that: “At least one accessible route *within the boundary of the site* shall be provided from public transportation stops, accessible parking, accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve.”⁴

If any part of this accessible route is part of a public sidewalk or other public pedestrian facility, efforts must be made to comply with requirements of the ADA. Many of these requirements are addressed in the design elements that follow.

Design Elements

Width

The width required for a sidewalk will depend on where it is installed and its anticipated level of use. When determining sidewalk width, it is important to remember two things: 1) a pedestrian requires a specific amount of lateral and longitudinal space for walking, and 2) the determined width is the “effective width,” exclusive of any obstructions. The minimum width for a sidewalk shall be 1.5 m (5.0 feet), or 1.8 m (6.0 feet) when placed at the back of the curb.

The “effective width” of a sidewalk can simply be defined as the total width minus the width for shy distances from buildings, the street, and other objects, and minus the width for objects placed on the sidewalk such as light poles, parking meters, newspaper stands, trash cans, mail boxes, and other street furniture. Recommended effective widths based on type of area, type of roadway, and number of dwelling units are shown in Figure 6-2.⁵ A planting strip wider than 0.6 m (2 ft) is often needed to accommodate traffic signs and utilities and provide enough space to maintain grass and other landscaping. Wider landscaping strips are usually easier to maintain than very narrow strips. Florida DOT recommends a minimum 1.8 m (6 ft) planter strip to place the sidewalk far enough back so that the driveway slope does not encroach into the sidewalk.

Whenever the sidewalks are protected by a wide utility strip, the sight distance should be carefully checked. Vegetation, fences, or buildings on private property can obstruct the view of a driver at the stop line. Whenever this situation occurs, the sidewalk should be brought closer to the street in the vicinity of the intersection. This permits the stop bar to be moved closer to the street. The exact amount of the shift is dependent on available right of way and the sight obstruction.

Type of Area (land use, roadway functional classification, or number of dwelling units)	Recommended Minimum Effective Width
Central Business District (CBD) Manual,	Wide enough to meet the level of service based on methods found in the 1985 Highway Capacity with a minimum width of 2.4 m (8 ft.).
Commercial and Industrial - outside the CBD	1.5 m (5 ft.) wide with a 0.6-m (2-ft.) planting strip or 2.1 m (7 ft.) without a planting strip
Residential-Arterials and collectors outside the CBD	1.5m (5 ft) wide with a 0.6-m (2-ft.) planting strip
Residential - local streets, multi-family and single family	(1 to 4 dwelling units/acre) 1.5m (5 ft.) wide with a 0.6-m (2-ft.) planting strip

Figure 6-2. Recommended minimum effective sidewalk widths based on area type, roadway type, and number of dwelling units per acre.⁵

In areas with insufficient right-of-way width, the following alternatives are offered in order of preference:

1. Construct roads with narrower travel lanes.
2. Use a 0.6 m (two-foot) utility strip with sign posts against the sidewalk or with signs behind the sidewalk.
3. Use a reduced sidewalk width (no less than 1.5 m (five feet)) that provides a lower level of service to the pedestrian.
4. Place sidewalk against curb. Some consideration should be given to installing guardrails between travel lanes and sidewalks for higher speed roads, particularly in school zones. If sidewalks are placed against the curbs, they must be widened to a 1.8 m (six-foot) minimum.

Pedestrian Buffers and Setback Distances

A buffer between pedestrian and motor vehicle traffic can offer many advantages to the comfort and safety of the pedestrian. A buffer can be in the form of a landscape strip, a parking lane, an on-street bike lane or a pedestrian fence or jersey barrier between the sidewalk and motor-vehicle lane.

On-street parking is generally not recommended along high speed arterials for obvious reasons, but it is generally needed along lower speed streets in residential, commercial and business districts and in the CBD. While parked cars can provide an effective safety barrier and separation between moving vehicles and pedestrians, care must be taken to reduce any visual screening of pedestrians crossing midblock and at intersections.

Bike lanes provide a helpful buffer area between motorized traffic and pedestrians. Pedestrian fencing can provide a barrier to help prevent pedestrians from darting into the street or from crossing at unsafe or less desirable locations. However, fencing may create a maintenance problem if placed close to the street, and may also create a visibility problem at driveways and intersections. Alternatively, landscaping may be used to direct pedestrians toward desired crossing locations.

The distance of the sidewalk from the roadway is defined as the setback distance and is an important design element. Sidewalks built close to the travel lane, particularly where vehicle speeds are high and where there is a high number of trucks,

discourage pedestrian travel due to perceived safety risks, increased noise levels, and splashing during wet weather. Though sometimes not feasible, sidewalks should be built as far from the road surface as physically possible, ideally near but not at the right-of-way line. Setbacks of 1.5 m (5 ft) or greater are recommended for purposes of:⁶

- ◆ Providing a margin of safety between the pedestrian and passing vehicles.
- ◆ Minimizing vehicle/pedestrian conflicts.
- ◆ Reducing potential splashing of pedestrians by passing vehicles.
- ◆ Providing space for utilities, parking meters, traffic control devices, landscaping, street furniture, and snow storage.
- ◆ Preventing driveway slopes from encroaching into the sidewalk, which may present a problem for the elderly or persons in wheelchairs or on crutches.

However, when sidewalks are placed at the back of a swale, they must be brought closer to the parallel roadway at intersections. On bridges for high speed

roadways, it may be desirable to build a jersey barrier between the sidewalk and the curb lane. This will compensate for the lack of setback and avoid the high cost of extra bridge width while providing a high level of security and safety for pedestrians.

Where setbacks or other forms of pedestrian buffers can not be provided, it is recommended that wider sidewalks be constructed. In addition, there should be a 0.3 to 1 m (1 to 3 ft) space between the sidewalk and the right-of-way line. This will reduce the chance of the landscaping infringing onto private property or the sidewalk, and help with sight distances.

Pavement Surfaces

Sidewalks are typically constructed of concrete. However, other materials may be used to create a smooth walking surface, including asphalt and pavers of various materials. Care should be taken to ensure that the material selected does not become overly slippery when it gets wet and that required maintenance is minimal. On pathways, inexpensive materials such as well compacted limestone screenings or wood chips can be used to create a



Figure 6-4. A wide setback distance increases pedestrian comfort.



Figure 6-3. Sidewalks should be properly maintained, free from obstructions and potential problems for pedestrians.

functional facility. The use of materials other than concrete can often produce aesthetically pleasing environments that are well received by local residents. However, care must be taken to maintain these materials at a level that will be usable by people in wheelchairs.

Maintenance

Once installed, sidewalks need to be maintained to avoid creating obstructions and potential problems for pedestrians. A program of inspection and cleaning should be established by the local maintenance, traffic engineering, or public works department. Assistance in reporting problems may be requested from other

government personnel such as police or letter carriers who are commonly on the sidewalks. Local ordinances should be passed requiring adjacent property owners to be responsible for minor maintenance of sidewalks along their property; requirements may include debris removal, and clearing of overgrown trees and bushes.

Care should also be taken to make sure private landscaping, such as fences or decorative walls, does not create vision obstructions, and thus sight distance problems, at driveways, alleys or intersections. While the public agencies are not the caretakers of private property, they should develop a system to notify individuals who create vision obstructions which require corrective action. This system can greatly enhance the pedestrian environment.

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Motorist & Pedestrian Signs & Markings



Signs and markings are governed by the Manual on Uniform Traffic Control Devices (MUTCD), which provides specifications on the design and placement of traffic control devices installed within the public right-of-way.¹ The MUTCD encourages a conservative use of signs. Signs should only be installed when they fulfill a need based on an engineering study or engineering judgement. In general, signs are often ineffective in modifying driver behavior, and overuse breeds disrespect and diminishes their effectiveness.

Unnecessary signs and posts represent a hazard to errant motorists and may cause an obstruction to pedestrians and bicyclists. Unnecessary signs also represent an ongoing maintenance cost and are a source of visual blight. Sign placement and location criteria are provided in the MUTCD.

Regulatory Signs

Regulatory signs are used to inform motorists or pedestrians of a legal requirement and should only be used when the legal requirement is not otherwise

apparent. They are generally rectangular in shape, usually consisting of a black legend on a white background and must be reflectorized or illuminated. The most common types of regulatory signs related to pedestrians are shown in Figure 7-1. Signs used on roadways are to have the dimensions shown, whereas signs used on trails are generally smaller. Many motorist signs, including “Stop” and “Yield” signs, turn restrictions, parking restrictions and speed limits also have a direct or indirect impact on pedestrians.

The MUTCD encourages a conservative use of signs.

The Institute of Transportation Engineers has taken the position that no overall significant safety detriments occur with right-turn-on-red, while allowing it results in significant benefits in reduced energy consumption, positive environmental impacts, and reduced operational delays.²

However, Right Turn on Red is known to increase pedestrian/motorist conflicts. Typically the motorist is searching to the

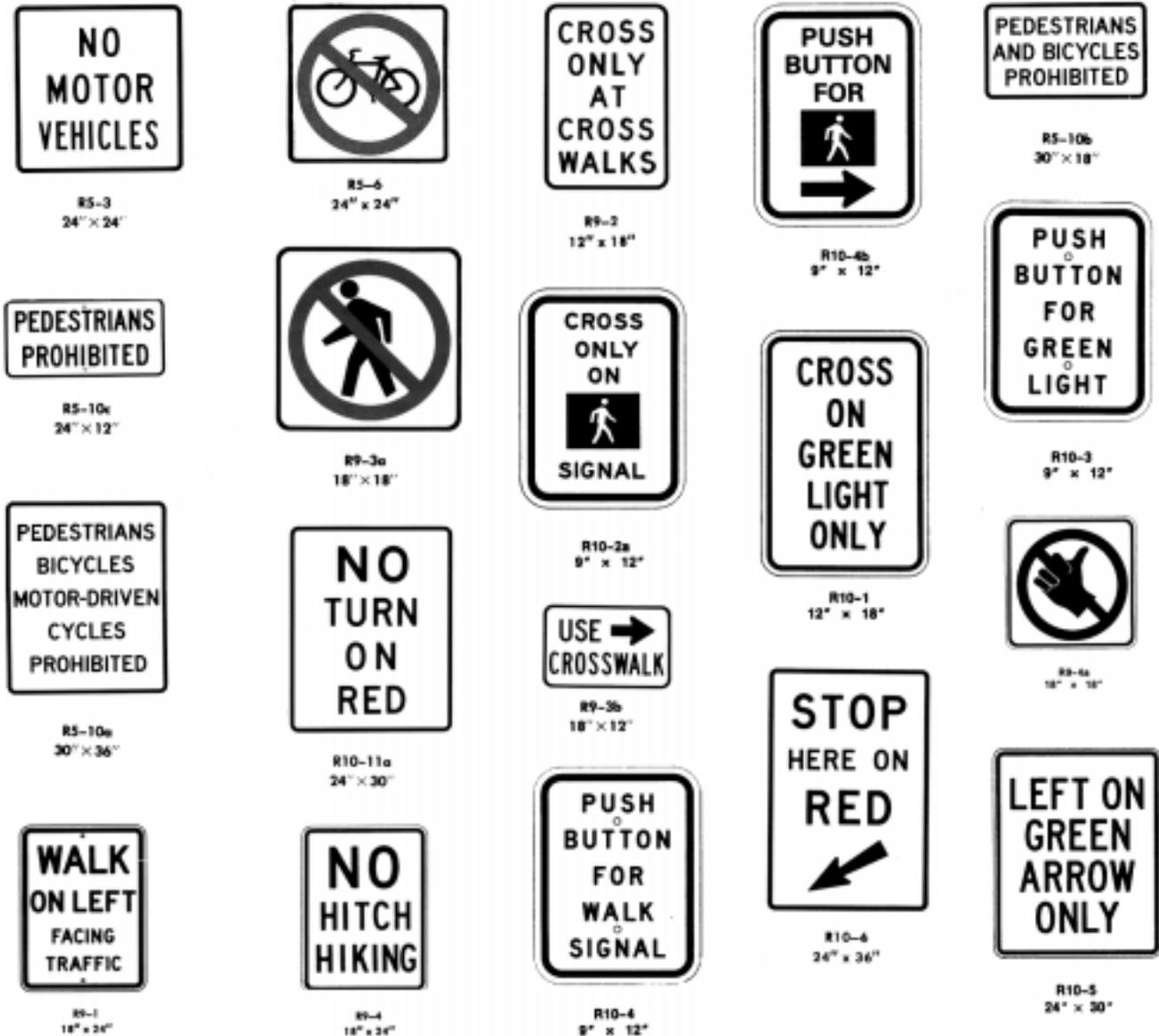


Figure 7-1. Typical regulatory signs relating to pedestrians.¹

left while the pedestrian is being directed by another traffic control device (a pedestrian WALK signal) to proceed. The pedestrian falsely assumes that the motorist will comply with the law and yield to them.

The "No Turn On Red" (R10-11a) sign may be used in some instances to facilitate pedestrian movements. The MUTCD lists six conditions when no-turn-on-red may be considered, three of which are directly related to pedestrians or signal timing for pedestrians. Considerable controversy has

arisen regarding pedestrian safety implications and right-turn-on-red operations, ranging from one study which indicated a significant increase in pedestrian accidents with right-turn-on-red³ to other studies which concluded that right-turn-on-red does not pose a pedestrian safety problem under most circumstances.^{4,5}

Consideration should also be given to pedestrian conflicts associated with right-turn-on-green (where the pedestrian has a WALK indication and the motorist has a

green ball indication) if right-turn-on-red is prohibited. Often, motorist compliance to “No Turn On Red” signs is low, particularly when the signs are poorly located and low pedestrian and cross-street traffic exists.

The use of “No Turn On Red” signs at a traffic signal should be evaluated on a case-by-case basis, and less restrictive alternatives should be considered in lieu of “No Turn On Red” signs. Recommendations relating to pedestrians include:

- ◆ Part-time restrictions should be discouraged; however, they are preferable to full-time prohibitions when the need only occurs for a short period of time. Although not in the MUTCD, the use of the “No Turn On Red When Pedestrians Are Present” sign may be an appropriate alternative.
- ◆ Universal prohibitions of right-turn-on-red are discouraged at school crossings. Restrictions should be made on a case-by-case basis and be sensitive to special problems of pedestrian conflicts, such as the unpredictable behavior of children and problems of the elderly and persons with disabilities. Pedestrian volumes should not be the only criteria for prohibiting turns on red.

Other regulatory signs relating to pedestrians include:

- ◆ Pedestrian prohibited signs (R5-10c, R9-3a, R5-10b) to prohibit pedestrian entry at freeway ramps.
- ◆ Pedestrian crossing signs (R9-2, R9-3a, R9-3b) are used to restrict crossings at less safe locations and divert them to optimal crossing locations. Various alternatives include the “Use Crosswalk” (with supplemental arrow) sign which may be used at signalized intersection legs with high conflicting turning movements or at midblock locations directing pedestrians to use an adjacent crosswalk. The signs have the most applicability if placed in front of schools or other major pedestrian generators.

- ◆ Extreme caution is urged in use of the R9... series. If there are high left turning volumes on a Tee-intersection, directing the pedestrian away from the unopposed turns is a smart safety measure. Signs should not be used to direct pedestrians away from a specific leg of an intersection crossing if they subject the pedestrian to increased levels of conflict and substantial increases in crossing time. Trading off increased motoring efficiency of the intersection to sacrifice the safety and mobility of the pedestrian is not a fair trade.

- ◆ Traffic signal signs (R10-1 to R10-4) include the pedestrian push button signs or other signs at signals directing pedestrians to cross only on the green light or walking man (WALK) signal. Pedestrian push button signs should be used at all pedestrian actuated signals. It is essential to provide guidance to indicate which street the button is for (either with arrows or street names). The signs should be located adjacent to the push button and be visible to approaching pedestrians.

Florida’s roadway design standards call for two separate poles, one for each pedestrian activator button. The poles are placed at the top of each of two curb cuts. Although this potentially doubles the cost of the actuators and pedestrians must push both buttons, the increased cycle efficiency can be a significant capacity benefit.

Other educational signs may be used for pedestrians at traffic signals to define the meaning of the walking man/hand symbol (or WALK, flashing DONT WALK and DONT WALK) signal indications. The decision to use these educational signs (or stickers placed directly on the signal pole) should be based strictly on engineering judgement. Their use may be more helpful near schools and in areas with a concentration

Figure 7-2. Typical warning signs relating to pedestrians.¹



of elderly pedestrians. This information may also be effectively converted into brochures for distribution and ongoing education purposes.

Warning Signs

Warning signs are used to inform motorists and pedestrians of unusual or unexpected conditions and when used, should be located to provide adequate response times. Warning signs are generally diamond-shaped with black letters or symbols on a yellow background and must be reflectorized or illuminated. Special lime-green fluorescent signs are being tested in the U.S. for special emphasis pedestrian crossings. Typical warning signs relating to pedestrians are shown in Figure 7-2.

The sign used to warn motorists of possible pedestrian conflicts is the Advance

Pedestrian Crossing sign (W11-2). This sign should be installed in advance of midblock crosswalks or other crossing locations where drivers may not expect pedestrians to cross. Typically this sign is placed 250 feet in advance of the crossing. This significantly minimizes their use at most urban intersections since pedestrians are an expected occurrence. This sign may also be selectively used in advance of high volume pedestrian crossing locations to add emphasis to the crosswalk. The advance pedestrian crossing sign provides more advance warning to motorists than crosswalk markings, and on some occasions may be used when crosswalk markings do not exist.

Where there are multiple crossing locations which cannot be concentrated to a single location, a supplemental distance plate may be used (NEXT XXX FEET). The advance pedestrian crossing signs should not be comounted with another warning sign

(except for a supplemental distance sign or an advisory speed sign) to avoid information overload. Care should be taken in sign placement in relation to other signs to avoid sign clutter and allow an adequate motorist response. The MUTCD specifies a 0.75 m by 0.75 m (30 in by 30 in) sign size. However, it may be helpful to use larger 0.90 m by 0.90 m (36 in by 36 in) signs on high speed or wider arterial streets.

The *Pedestrian Crossing* sign (W11A-2) is similar to the *Advance Pedestrian Crossing* sign, but has the crosswalk lines shown on it. This sign is intended for use at the crosswalk. Because of its placement and the motorist's inability to distinguish and comprehend the subtle difference between the two signs (W11-2 versus W11A-2), its usefulness is limited. If used, it should be preceded by the advance crossing warning sign and should be located immediately adjacent to the crossing point. To help alleviate motorist confusion, a black and yellow diagonally downward pointing arrow sign may be used to supplement the pedestrian crossing sign (W11A-2). Stop signs need to be placed before crosswalks so that motorists will be more likely to stop

before they encroach upon the sidewalk.

The Playground sign (W15-1) may be used in advance of a designated children's play area to warn motorists of a potential high concentration of young children. This sign should generally not be needed on local or residential streets where children are expected. Furthermore, play areas should not be located adjacent to high speed major or arterial streets, or if so, should be fenced off to prevent children from running into the street.

"Caution - Children at Play" or "Slow Children" signs are not valid MUTCD signs and *should not* be used since they may encourage children to play in the street and may encourage parents to be less watchful of their children.⁶ These signs provide no guidance to motorists in terms of a safe speed, and the sign has no legal basis for determining what a motorist should do. Furthermore, motorists should expect children to be "at play" in all residential areas, and the lack of signing on some streets may indicate otherwise. The use of this nonstandard sign may imply that the local agency approves of streets as



Figure 7-3. Pedestrian crossing signs along the edge of the roadway may be supplemented by signs in the median, overhead signs, and high-visibility crosswalk markings.

playgrounds, which may result in extra vulnerability to tort liability.

School Warning signs include the advance school crossing signs (S1-1), the school crossing sign (S2-1), “School Bus Ahead” (S3-1) and others. Additional information can be found in Chapter 14 of this document. School related traffic controls are discussed in detail in Part VII (Traffic Controls for School Areas) of the MUTCD.

The MUTCD allows for the development of other specialty warning signs based on engineering judgment for unique conditions. These signs can be designed to alert unfamiliar motorists or pedestrians of unexpected conditions and should follow the general criteria for the design of warning signs. Their use should be minimized to retain their effectiveness and minimize sign clutter.

Pavement Markings

Pavement word and symbol markings such as “SCHOOL XING” or “PED XING” may also be used as motorist warning devices. These may be helpful on high speed arterial or major streets with unusual geometrics (such as vertical or horizontal curves) in advance of a pedestrian crossing area. Markings should be white and placed to provide adequate motorist response. Their use should be kept to a minimum to retain effectiveness. Consideration should be given to the agency’s ability to maintain these markings. If used, the word or symbol markings shall be white and should generally be used in each approach lane (except for the SCHOOL message). Pavement word markings need not be used on both approaches to a crosswalk if conditions differ between the approaches.

All pavement word and symbol messages require periodic maintenance, and replacement after resurfacing. If used, it is advisable to maintain an inventory of pavement stencils to assist in periodic monitoring and maintenance.

Pavement Messages for Pedestrians

Florida has recently tested special signs and pavement markings that alert the pedestrian to search “left-right-left” before entering the street. Markings were used selectively at signalized intersections. The educational/instructional information substantially increased the number of pedestrians who look for traffic before entering the roadway.

Voice Messages for Pedestrians

Florida also recently tested voice messages giving the pedestrian a friendly reminder to search “left-right-left” before crossing the roadway. This message was well received, and substantially increased the number of pedestrians who searched for traffic before entering the roadway. A side benefit to this technique was that it told blind pedestrians which street they were about to cross.

References

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4. Safety and Delay Impacts of Right-Turn-on-Red, AASHTO Task Force on Right-Turn-on-Red, American Association of State Highway and Transportation Officials, Washington, DC, 1979.

5. McGee, H.W., "Accident Experience With Right-Turn-on-Red," Transportation Research Record 644, Transportation Research Board, Washington, DC, 1976.
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Signalization



Signal Warrants

Traffic signals are intended to assign the right-of-way for vehicular and pedestrian traffic. When installed appropriately, traffic signals can provide many benefits, such as creating gaps in heavy motor vehicle traffic for pedestrians to cross safely at intersections or midblock. Unwarranted or improperly used traffic signals can cause excessive delay for pedestrians and/or motor vehicles, signal disobedience, and an increase in certain crash types. Even where warranted, traffic signal installations commonly result in an increase of rear-end and total crashes, but generally with a corresponding reduction in more severe right-angle crashes. The *Manual on Uniform Traffic Control Devices (MUTCD)* provides 11 separate warrants (Table 8-1) for installing new traffic signals.¹ Note that warrant numbers 3 and 4 relate directly to pedestrians, and warrant number 6 (and in some instances warrant 8) also makes some reference to pedestrians. In reality, only a small percentage of new traffic signals have been installed based primarily on pedestrian considerations. In most cases traffic signals are installed based on vehicular traffic considerations. However, revisions to the minimum pedestrian volume warrant (warrant 3) are expected to provide easier justification of traffic signals based on the needs of pedestrians.^{1,2}

The revised minimum pedestrian volume warrant states that a traffic signal may be warranted when the pedestrian volume crossing the major street at an intersection or midblock location during an average day is:

- ◆ 100 or more for each of any four (4) hours; or
- ◆ 190 or more during any one (1) hour.

Past experience shows that traffic signals are often among the highest pedestrian accident locations.

These volume requirements can be reduced by as much as 50 percent when the predominant crossing speed is below 1.1 m per second (3.5 feet per second) as would be the case if there is a high percentage of elderly or disabled pedestrians. In conjunction with these volumes, there shall be less than 60 gaps per hour in the traffic stream of adequate length for pedestrians to cross during the same period.

Simply meeting a warrant does not necessarily justify installation of a traffic signal. Strong consideration must be given to signal spacing, signal synchronization, and sight distances. Where practical, it is more

Warrant Title

- 1 *Minimum vehicular volume*
 - 2 *Interruption of continuous traffic*
 - 3 *Minimum pedestrian volume*
 - 4 *School crossings*
 - 5 *Progressive movement*
 - 6 *Accident experience*
 - 7 *Systems*
 - 8 *Combination of warrants*
 - 9 *Four-hour volumes*
 - 10 *Peak-hour delay*
 - 11 *Peak-hour volume*
-

Table 8-1. Warrants for installing new traffic signals.

desirable to signalize intersections instead of midblock crossing locations where drivers may be less likely to expect pedestrian crossings.

Warrant 6 (Accident Experience) may be used to justify a traffic signal if 5 or more “correctable” collisions occur in the previous 12 months, and at least 80 percent of the Minimum Volume warrant (warrant 1), the Interruption of Continuous Traffic warrant (warrant 2), or the Minimum Pedestrian Volume warrant (warrant 3) is met. Pedestrian collisions should be considered when using the Accident Experience warrant if the pedestrian is in the process of crossing the street in a reasonable manner. However, past experience shows that traffic signals are often among the highest pedestrian accident locations. Traffic signals cannot be expected to reduce or eliminate pedestrian collisions unless the signal is designed, operated and maintained properly and if pedestrians and motorists use reasonable care when crossing and when driving.

Pedestrian Signals

Pedestrian signals may be needed at highly complex or multiphase traffic signals where pedestrians regularly cross and where confusion may exist. Pedestrian signals may also be needed for crossings of wide streets where the vehicle signal indication does not provide ample signal change (clearance) information to pedestrians (Figure 8-2).

Pedestrian signal indications consist of the symbolic man/hand signal display or the WALK/DONT WALK signal display in conjunction with traffic signals. The steady hand symbol (or DONT WALK) indicates that the pedestrian should not be in the street. The flashing hand symbol (or flashing DONT WALK) is a clearance interval that means the pedestrian should not start crossing, but should have enough time to complete their crossing if they are already in the street (i.e., don’t start). The walking man symbol (or WALK) indicates that pedestrians may cross the street in the direction of the signal after searching to determine that it is safe. Pedestrian signal displays are illustrated in Figure 8-1. The WALK/DONT WALK signals are currently suitable alternatives to the (walking man/hand) symbolic displays. However, the next version of the MUTCD plans to phase out the use of the word message at new signal installations. It is recommended that agencies now program a “soft replacement” from WALK/DONT WALK messages in favor of the international walking man and hand symbols.

It has been well documented that many pedestrians do not understand the meaning of the pedestrian signal indications, particularly the flashing hand (or flashing DONT WALK). These problems highlight the need for more effective education of pedestrians to better understand the meaning of pedestrian signals. Education should include distribution of educational pamphlets or programs through schools, libraries, and community centers as well as signage such as the R10-4B “Push Button

For Walk” (or Pedestrian Symbol) sign (Figure 8-3). Although not incorporated into the MUTCD, an additional pedestrian education sign that may be used is shown in Figure 8-4 and is similar to ones used in cities throughout the U.S.

Besides a lack of understanding, some pedestrians violate signals due to impatience. Motorists put pedestrians at risk



Figure 8-1. Pedestrian signal displays.

when they run red lights and when making right and left turns while failing to yield the right-of-way to pedestrians lawfully in the crosswalk. Police enforcement is often the best solution to these problems.

Warrants for Pedestrian Signal Indications

Pedestrian signal indications should ideally be installed at all traffic signals, even if pedestrian crossings are rare. Also, crosswalks should be installed at all signalized intersections (and signalized midblock locations) to guide pedestrians to cross at the preferred crossing location. According to the MUTCD, pedestrian signal indications are normally required under the following circumstances:¹

- ◆ When the traffic signal is installed based on meeting the Minimum Pedestrian Volume or School Crossing Warrant.
- ◆ When an exclusive pedestrian crossing interval is provided (i.e. all conflicting vehicular traffic is stopped for pedestrians).
- ◆ When the vehicle signals are not visible to pedestrians (such as at one-way streets or “T”-intersections) or when the vehicle signals are not in a position to adequately serve pedestrians.
- ◆ Signalized intersections at established school crossing locations.
- ◆ Crossings of wide streets where the vehicle signal does not provide an adequate pedestrian clearance interval.
- ◆ When multiphase timing (as with split phasing or left turn arrows) is used and extra guidance is needed for pedestrians.
- ◆ When pedestrian push buttons are used.
- ◆ When optically programmed signal heads or tunnel visors are used and the traffic signal is not visible to the pedestrian.

Location of Pedestrian Signal Indications

The pedestrian signal heads must be positioned in alignment with the crosswalk so they can be seen by pedestrians while they are waiting on the curb at the other side of the street, and while crossing the street. The base of the signal housing is required to be between 2.1 m (7 ft) and 3.1 m (10 ft) high so that it will not normally require pedestrians to duck or be blocked by a car.

On wide streets, it may be advisable to install pedestrian signals in the medians, particularly where there are high numbers of elderly or visually impaired pedestrians. At tee-intersections, the pedestrian crossing should be located so the left-turning vehicles do not cross the pedestrian crossing.

Visors should be used for the pedestrian signal indication so that the signal is not readily visible outside of the crosswalk. This should hopefully encourage more pedestrians to cross in the crosswalk.

After the pedestrian signal is installed, each crosswalk should be inspected to make sure that traffic signs, trees, utility poles and other obstacles do not block the view of the signal indication. Periodic maintenance of landscaping may be needed to make sure the signal indications remain unobstructed.



Figure 8-2. Crosswalks, traffic signals, and pedestrian signals give pedestrians the opportunity to cross streets predictably and effectively.



Figure 8-3. Example of an instructional sign for pedestrians to activate the signal.

Pedestrian Signal Timing

For traffic signals at wide intersections, pedestrian crossing times are often the overriding factor used in determining green splits and cycle lengths. This also often leads to using minimum WALK and clearance (flashing DONT WALK) intervals.

The MUTCD requires at least a 4 to 7 second walking man (WALK) interval. At times this may present a dilemma to pedestrians who see a flashing hand (or flashing DONT WALK display) before they are more than one or two lanes across the street. While pedestrians almost always continue to cross rather than return to their starting point, it is desirable to provide a longer WALK interval where possible. When the vehicular green time is longer than that required for a 4 to 7 second WALK interval plus the pedestrian clearance interval, the WALK time should be extended to the maximum possible.

Recent research conducted for FHWA by Knoblauch indicates that senior adults often need 1.5 seconds just to get into the street. Curb ramps and audible signals may enable them to get into the street sooner. Seniors often allow younger pedestrians to go first, thereby entering the street last, after the WALK phase has ended. A slower walking speed should be used for calculating the clearance interval at locations with high numbers of elderly pedestrians. In the absence of a specific study, a walking speed of 0.9 to 1.2 m per second (3 to 4 ft per second) is recommended.

The clearance interval should be used on the full curb to curb walking distance (i.e., all the way across the roadway). This distance is measured from the center of the crosswalk. It is important to know that previous MUTCD language only required the engineer to get the pedestrian to the middle of the last lane. That language was found to be unsafe, and has been dropped. This requires upgrading of many existing intersection signal cycles.

Extra crossing time may be needed at signals with school crossing guards or with high pedestrian volumes to clear the queue of pedestrians waiting to cross. These locations should be evaluated on a case by case basis. Walking distances at some wide intersections may be excessive even for very mobile pedestrians. However, Florida DOT does not recommend pedestrian signal timing that only allows enough time to cross to a median. Signals should be timed to allow the pedestrian to cross the entire street on one crossing interval.

To help combat this dilemma we emphasize again the need for a design team approach. The traffic operations of an intersection must influence preliminary design and geometrics. Overly wide intersections may look good on paper, but they remain unsafe for motorists and pedestrians who must muscle their cars or their bodies in order to get through them quickly.

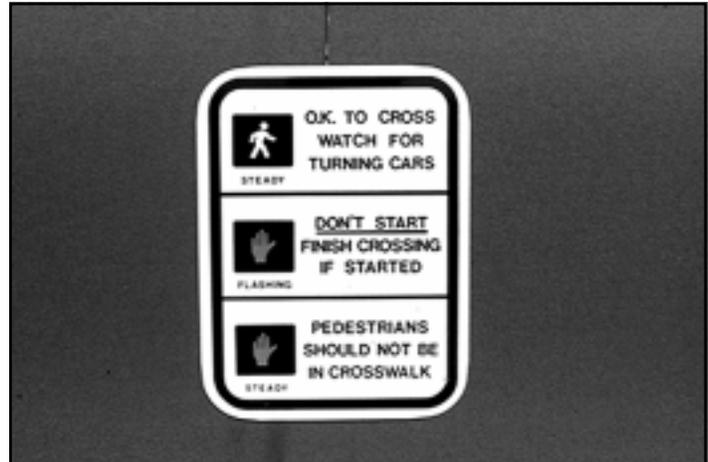


Figure 8-4. Example of an educational sign for pedestrian signal displays.

Case Study of Intersection Compression

In one fully designed intersection that was 55 m (180 ft) wide, trained engineers were able to apply channelized right turn slip lanes on all 4 quadrants, reduce lane widths to 3.4 m (11 ft) and take other measures that brought the pedestrian crossing width down to a more manageable 28 m (92 ft). This savings of 27 m (88 ft) on all four legs brought the signal cycle down 62 seconds, and greatly improved the efficiency and performance of the intersection for all roadway users.

Designers are also reminded never to trade pedestrian mobility and safety for maximum motorized capacity. To abandon the pedestrian on any leg of a four-cross intersection in order to achieve a higher level of efficiency is not condoned. By closing a leg to pedestrians the individual must now cross through the three remaining legs, encounter up to triple the conflict, and have substantial delays in trip time. The overriding principle in the design of a balanced transportation system is always to provide equal care and treatment for all users.

Left and Right Turn Phasing

Thirty-seven percent of all pedestrian accidents at signalized intersections involve left- or right-turning vehicles. One national study found that the left turn vehicle-pedestrian accident rate was twice that

involving right-turning vehicles.³ Potential solutions to pedestrian collisions involving right- or left-turning vehicles in some situations include:

- ◆ Design compact intersections with small turning radii which force slower turning speeds. This technique should not be used if it would result in capacity failure in locations with large left-turning truck volume. Instead, slip lanes may be required.
- ◆ Prohibit right-turn-on red (Figure 8-6). However, consideration should be given to the potential increase in right-turn-on green conflicts.
- ◆ Where channelized right-turn slip lanes are used to accommodate high right-turn volumes or truck traffic, place the crosswalk as far upstream as possible to make pedestrians more visible to the right-turning driver. The right-turn slip lane should be designed with 50 to 60 degree intersect angles which will limit vehicle speeds to 15 to 20 mph so as to make crossings safer for pedestrians. Motorists entering a crosswalk area at speeds in the 15-20 mph range almost universally yield to a pedestrian who is communicating an attempt to cross. Motorists entering a slip lane at 25-30

mph are less likely to stop. Motorists entering at higher rates of speed rarely stop for a pedestrian. Slip lanes should further be designed with the tail facing toward the approaching motorist (see Figure 11-4).

- ◆ Use a separate left-turn phase for motorists (left turn arrow), where pedestrians can not cross during the left-turn interval.
- ◆ Far left signal heads may be used for left-turning vehicles.

Left Turn Prohibitions

Many downtowns and urban cores like “K” Street and others in Washington, D.C., High Street through downtown Columbus, Ohio and U.S. Route 101 through San Francisco, California, have corridor-long prohibition of left turns. This adds to the system efficiency on the main route, and reduces conflicts with pedestrians. It also is a benefit to older drivers who are at high risk attempting to make left turns. Motorists reach their destination through a series of much safer right turns.

Be selective in this type of treatment. This is an aggressive approach that should be considered as part of a larger traffic management strategy for the district. The prohibition of a turn movement may shift the problem to another location and have a very negative effect on capacity and delay. However, heavy pedestrian volumes may justify left-turn prohibitions.

Pedestrian Signal in a Coordinated Signal System

The accommodation of pedestrians in a coordinated signal system may significantly influence the effectiveness of the signal system. It is not unusual to have signalized intersections where the pedestrian timing needs exceed those for its companion vehicular movement.

The length of the walking man (WALK) and flashing hand (DONT WALK) clearance intervals can have a major impact on the cycle



Figure 8-5. Pedestrian push button and signal heads are placed in channelized islands to guide pedestrians over a shorter crossing distance.

length in a coordinated signal system. This may result in longer cycle lengths, which will result in longer waits for pedestrians and vehicles on minor street approaches to traffic signals.

One solution is to design the system timing to operate without the pedestrian timing unless pedestrian actuation is detected. Then when a pedestrian push button is activated, the local intersection is disconnected from the system for one cycle to service the pedestrian movement. While this may work for areas with low pedestrian volumes, frequent pedestrian activations will severely disrupt the efficiency of the system. If high numbers of pedestrian crossings exist, it is best to accommodate the pedestrian on every cycle and eliminate the need for pedestrian actuation.

Signals in coordination should have the flashing “DONT WALK” end on the yellow. The first part of the through green should be “WALK”. As a minimum, the “WALK” interval should be:

$$3 + (n-1) 2 \text{ seconds,}$$

where 3 seconds = pedestrian perception/reaction time,

n = number of rows in the 85th percentile group, and

2 = additional seconds for each additional row of pedestrians.

Pedestrian Signal Phasing

Five signal phasing alternatives exist to accommodate pedestrian crossings at signalized intersections.

1. Standard (concurrent) timing - a walking man (or WALK) indication is displayed concurrently with the green light for motorists on the parallel street. Left or right turning motorists must yield to pedestrians in the crosswalk.
2. Early release of pedestrians - the signal displays red for the parallel vehicle movement, particularly the right turn, while the walking man (or WALK)



Figure 8-6. Right-turn-on-red restrictions can improve pedestrian safety when used properly. The top sign creates confusion and should not be used. The bottom sign conveys a much clearer message.

signals are displayed. The vehicular traffic then gets a green signal indication. This can be used at some intersections to reduce left-turning and right-turning crashes with pedestrians.

3. Late release of pedestrians - vehicles on the parallel street get a green signal indication before pedestrians get the walking man (or WALK) indication.

4. Exclusive pedestrian phasing - All vehicular traffic is stopped while

pedestrians are allowed to cross in any crosswalk.

5. Scramble pedestrian phasing - All vehicular traffic is stopped while pedestrians are allowed to cross in any crosswalk or diagonally across the intersection (sometimes called Barnes dance).

In actual practice, the concurrent signal timing is appropriate in most applications. Early or late release of pedestrians may be appropriate where there is a very high volume of right or left turning traffic. Under rare circumstances where there are very high pedestrian volumes (more than 1,200 pedestrians per day) and vehicle flow and signal synchronization is less of a concern, the exclusive pedestrian phase or scramble phasing may be used, which increases pedestrian safety, although it increases delay to pedestrians and motorists. While early release and late release timing may be used at locations with high vehicle turning movements, it is often preferred to also prohibit right turn on red and use protected left-turn phasing with these timing options.

Studies of various pedestrian signal phasing reveal that overall delay is lowest when using the concurrent signal timing. Exclusive or scramble pedestrian intervals may be safer for pedestrians where there are very high pedestrian crossing volumes (over 1,200 pedestrians per day), but results in the highest overall delay for motorists and pedestrians. If scramble timing is used, the clearance interval must be based on the longest crossing which is usually one of the diagonal crossings.

Pedestrian Push-Button

At locations with actuated traffic signals and signals where pedestrian activity is infrequent and pedestrian phasing is not warranted on a full-time basis, the use of pedestrian-actuated signals (i.e. push-buttons) is appropriate. When push buttons are used, there should always be a pedestrian signal head. Using pedestrian

buttons to activate a green traffic signal is inconsistent and can be confusing.

Designers are cautioned to not use actuated push buttons on crossings where there is always adequate time to phase a pedestrian. Pedestrians should not be required to push buttons when it is not essential for adding time. Many pedestrians do not push buttons. It is the engineer's job to give them a WALK signal whenever possible. Otherwise they give up on these information systems, and fail to use them, even when they have a specific purpose.

Where to Locate Push Buttons

Pedestrian push-buttons should be mounted at the top of and as close as possible to each of the two ADA ramps. This indicates the ideal standing location, provides a uniformity that allows the pedestrian always to push the correct button and simplifies the finding the button by a blind person. If there is only one ramp (due to an earlier design), two poles are still needed, positioned to indicate to the pedestrian the street to be crossed. In all placements, the pedestrian push-button must be easily accessible to a pedestrian in a wheelchair. Push-button devices are most often needed on intersection medians and refuge islands.

Where Not to Locate Buttons

Pedestrian push-buttons and pedestrian signal heads are not placed on each side of the intersection when channelized islands are used. All instrumentation is placed in the channelized islands. The pedestrian crosses to the island, activates the button and uses the WALK and signal phase to cross the shorter distance. This technique adds to the efficiency of the pedestrian crossing, often subtracting 12-15 m (40-50 ft) (10-12 seconds) from the crossing time (see Figure 8-5).

Improving the Effectiveness of Push-Buttons

Signs such as "Push Button for Walk Signal" are needed with the actuation devices to explain their meaning and use.

When two actuation devices are placed close together for crossings in different directions (e.g. at intersections), it is important to indicate which crosswalk signal is controlled by each push-button (e.g., “Push Button To Cross Central Ave.” or the standard arrow symbol indicating which street to cross).

The following are recommendations to improve the effectiveness of pedestrian push-buttons:

- ◆ Inspect and maintain the push-button on a schedule similar to that of vehicular traffic signals so that it is always operating properly.
- ◆ Assure pedestrians that the push-button is responsive to pedestrians by displaying the WALK signal within a reasonable amount of time after the button is pushed (i.e., preferably within 30-60 seconds).
- ◆ It is best to use push-buttons that are large and concave and do not require a substantial amount of force to activate. This will make it easier to use by young children, elderly and handicapped pedestrians.

Considerations for Persons with Disabilities

Pedestrians with disabilities may include those with a lack of mobility, stamina, visual impairments, hearing impairments and others.

Accommodation of blind and visually impaired pedestrians at traffic signals presents a unique challenge to the traffic engineer. Many visually impaired pedestrians are taught to use audible cues from the traffic to determine when it is appropriate to cross. When this is not possible, there is often a request to install audible pedestrian signals. Audible pedestrian signals may be appropriate near a school for the blind or community centers where large numbers of visually impaired pedestrians cross.

It has been found that audible pedestrian signals do more than assist blind

pedestrians. All pedestrians waiting to cross benefit by a prompting sound. The Australian audible signal has been found to be so helpful to everyone that it is used in most urban locations. The device uses a low, slow clicking (as loud as a pen being clicked) to guide visually impaired to the top of the ramp. When the signal has changed the clicking rate increases. This clicking guides the blind pedestrian to the ramp on the opposite corner. This audible cue alerts all pedestrians that it is time to search and begin their crossing.

There are no warrants for audible pedestrian signals and no standardization in the audible message which may lead to confusion for pedestrians. Until warrants and improved guidelines are developed, the use of audible pedestrian signals is left to the judgment of the local traffic engineer based on site specific conditions and the characteristics of the pedestrian population that routinely uses the intersection. The Florida Department of Transportation hopes to test and release standards by 1997.

Also of value to people with disabilities are handicapped ramps and proper ramp surface treatment, such as tactile warning surfaces. Chapter 5 covers ramps in more detail.

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Crosswalks, Stop Lines, Curb Ramps, and Refuge Islands

Crossing a street at an intersection or designated midblock crosswalk generally requires a pedestrian to proceed from a sidewalk, down a curb ramp, through the crosswalk, up the curb ramp, and onto the sidewalk. If the street is excessively wide or if traffic volumes are extremely heavy, a refuge island may be encountered in the middle of the street. This chapter discusses the design criteria for these three elements associated with crossing the street.

Crosswalks

A crosswalk is defined as the portion of roadway designated for pedestrians to use in crossing the street (Figure 9-1). Crosswalks may be marked or unmarked. At intersections, there is no legal difference between a marked or unmarked crosswalk. If no markings are present, the width of the sidewalk or path extended across the street defines a legal crosswalk. Where markings are present, the legal crosswalk is defined by such markings. While markings are not needed to designate a crosswalk at intersections, they are needed to designate a midblock crosswalk.

In the 1950's and 1960's, crosswalk markings were thought of as a public service under the assumption that marked crosswalks were generally safer than unmarked crosswalks, and the more the better. Studies conducted since that time have produced mixed results with respect to the safety benefits of marked crosswalks.^{1,2,3,4,5}

This chapter discusses the design criteria for these three elements associated with crossing the street.

Two efforts indicated that marked crosswalks were successful in encouraging more pedestrians to cross within the markings, but that pedestrian safety may be reduced at unsignalized intersections where marked crosswalks are used.^{1,2} One of the conclusions for these results was that pedestrians may "feel safer" within a marked crosswalk and expect motorists to act more cautiously. In reality, crosswalk markings are not as visible to motorists as they are to pedestrians, and the pavement markings cannot stop an inattentive or impaired driver. Another research effort showed marked crosswalks to be as safe or safer than



Figure 9-1. Properly designed crosswalks, curb ramps, and refuge islands can greatly enhance a pedestrian's ability to cross a street.

unmarked crosswalks for all conditions studied.³

In practice, marked crosswalks are typically assumed to be most beneficial at signalized intersections, particularly in urban areas and where pedestrian signals (i.e., walking man/hand signals) are present. The use of marked crosswalks is discouraged at some types of midblock locations and at unsignalized intersections of high-speed roads. In particular, midblock crosswalks may be inappropriate on moderate- and high-speed roads (e.g., with speed limits of 40 mph and above) and where sight distance is limited.

Placement

Crosswalks should be placed in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).⁴ A summary of the MUTCD provisions for crosswalk markings is provided in Table 9-1. Other criteria, based on various levels of pedestrian and vehicle volumes, have also been developed to assist in determining when and where crosswalk markings may be beneficial.⁵ As shown in Figure 9-2, if the combination of pedestrian and vehicle volumes is great enough to produce an intersecting value to the right of the appropriate curve, then a crosswalk may prove to be beneficial on that particular leg of the intersection. Note that the chart takes

into account the type of pedestrian, number of lanes, presence or absence of a refuge area, and also assumes that the basic criteria (shown in the top right-hand corner) have been met.

The most essential tool for use in determining crosswalk placement is engineering judgement. No set of guidelines can cover every situation or guarantee improved safety. Agencies should strive for uniformity to give motorists and pedestrians a consistent, predictable traffic environment. Overuse should be avoided to maximize the effectiveness of those crosswalks that are marked. Marked crosswalks are generally recommended at the following locations:⁶

- ◆ Signalized intersections. In general practice, signalized intersections in urban areas should have marked crosswalks on all four legs.
- ◆ Locations where a marked crosswalk can concentrate or channelize multiple pedestrian crossings to a single location.
- ◆ Locations where there is a need to delineate the optimal crossing location, due to confusing geometrics or traffic operations.
- ◆ Approved school crossings or at crossings on recommended safe routes to school.
- ◆ Other locations with high numbers of pedestrian crossings (more than 25 pedestrians per hour) and/or pedestrian/vehicle conflicts.
- ◆ To reach channelized islands when the volume of pedestrians times the number of vehicles exceeds 800 per hour. Do not use crosswalks at lower levels of conflict.

Where it is considered desirable to install midblock crosswalks, advance pedestrian warning signs should be used to warn motorists of pedestrian crossing activity (*see chapter 7 for more information on signs and markings*). Markings may be difficult to see during adverse weather conditions. Other actions that should also be considered when

installing a midblock crosswalk include positioning it near a street light (or installing additional lighting) and installing a pedestrian refuge island for the crosswalk.

Other factors that should be considered in the design and installation of crosswalks include:

- ◆ Adequate sight distance for the motorist and pedestrian should exist. (If it takes 11 seconds to enter and exit the crossing then an 11 second stopping sight distance is needed). This includes examination of on-street parking, street furniture (e.g. mailboxes, utility poles, newspaper stands) and landscaping. In some instances, curb bulbouts may be an excellent way to bring the pedestrian forward of parked cars and street furniture.

Marked crosswalks should not be located immediately downstream from bus stops, traffic signals or other marked crosswalks.

- ◆ An examination of street lighting should be conducted. It is highly advantageous to locate a marked crosswalk at a streetlight, particularly if nighttime crossings are common.

Here is additional guidance for midblock crossings:

A minimum enhancement that benefits pedestrians is a raised median island. This allows pedestrians who cross midblock to focus on one direction of traffic at a time, thus simplifying the crossing task. Medians may be essential on multilane roadways. More information about medians can be found in Chapter 12.

Crosswalks may be placed up to every five hundred feet when pedestrian volumes warrant. The use of marked midblock crosswalks at appropriate central business district locations channelizes pedestrian crossings, and helps motorists focus their attention on those areas where they should be the most alert.

Table 9-1. Recommended guidelines for crosswalk design and placement.⁴

Condition Level ¹	Requirement Description
Shall	Have 150 mm (6-in) minimum width markings of solid white lines.
Should	Have 1.8-m (6-ft) minimum [3 m (10 ft) desirable] crosswalk width
	Be used where substantial pedestrian/vehicle conflicts exist.
	Be used at appropriate points of pedestrian concentration or where pedestrians could not otherwise recognize the proper place to cross (e.g., loading islands, midblock pedestrian crossings.)
	Not be used indiscriminately.
	Be installed based on an engineering study if located other than at a STOP sign or traffic signal.
May	Have advance warning signs installed at midblock crossings where pedestrians are not expected, and allow for restriction of parking for adequate visibility.
	Be marked with white diagonal or longitudinal lines (parallel to vehicle traffic) for added visibility.
	Omit the transverse crosswalk lines when the extra diagonal or longitudinal markings are added. Use unique markings for diagonal crossings at signals when an appropriate exclusive pedestrian phase is used.

Refuge islands can be added when median islands are not practical. Crosswalk markings are appropriate when refuge islands are used. More information about refuge islands can be found later in this chapter.

Midblock crossings can be signaled when warranted. On multilane highways, pedestrians face the threat of one motorist stopping while a motorist in the adjoining lane continues forward. To reduce the likelihood of a pedestrian being hit by the second motorist, the stop bar should be placed back 36-50 feet from the crosswalk.

Design of Crosswalks

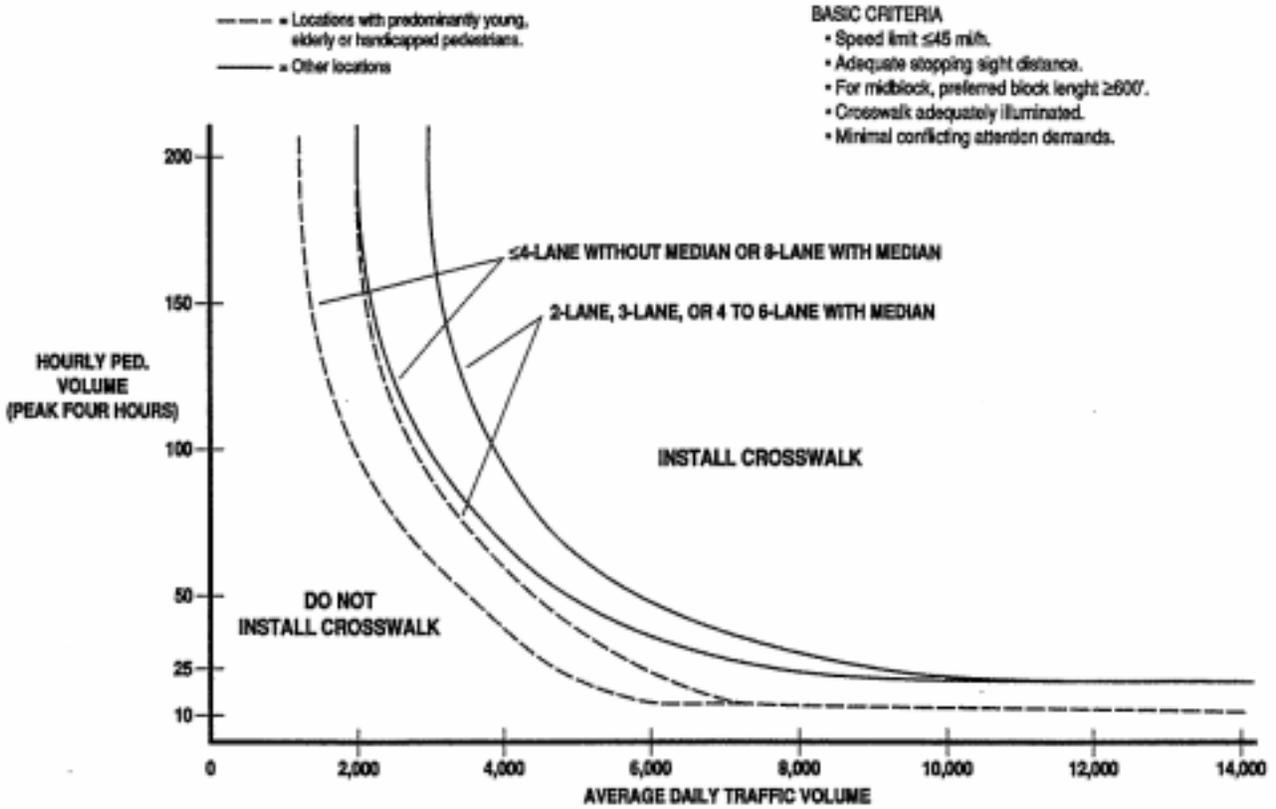
There are operational concerns with narrow crosswalks. Also, there are high costs associated with their installation. For these reasons, it is recommended that wider

crosswalks with wider pavement markings be installed than is required by the MUTCD. It is suggested that a 3 m (10 ft) wide crosswalk be installed, while wider crosswalks may be used where higher pedestrian volumes exist or where it is desirable to increase the conspicuity of the crosswalk. Similarly, crosswalk lines of 250 to 300 mm (10 to 12 in) in width are recommended, with wider lines or advanced stop lines used when greater emphasis is considered helpful.

Crosswalks at Skewed Intersections

Crosswalks need to be kept close to the turning traffic so that pedestrians stay within the driver’s line of sight. The MUTCD recommends keeping the crosswalk lines within 0.6 m (2 feet) of the lateral lines of

Figure 9-2. Guidelines for crosswalk installation at uncontrolled intersections and midblock crossings.⁵



1. If using only the peak hour, threshold must be increased by 1.5
2. For streets with median, use one-way (directional) ADT volume.

Other notes: Minimum striping is 6" parallel lines. Consider bolder markings and/or supplementary advance markings or signing at uncontrolled locations where speed limits exceed 35 mi/h.

the highway. If this cannot be achieved it is essential to stay as close as practicable.

On skewed or highly skewed roadways there is a trade-off between making a 90 degree crossing of a roadway, or matching the junction of the roads (Figure 9-3). This skew also adds another 3.1-9.2 m (10-30 feet) to the crossing width. By dropping back to a 90 degree crossing, the crosswalk may end up 3.1 m (10 ft) or even 9.2 m (30 feet) from the intersection. This creates one of two problems. Either the motorist tends to move closer to the intersection, thus blocking the intersection, or he/she picks up high speed that endangers the pedestrian on the right turn leg of the intersection. Therefore, it is FDOT policy that crosswalks follow the skew and stay close to the turning traffic.

Crosswalk Placement on Hills and Curves

Avoid placing crosswalks on hills where vertical stopping sight distances are restricted. Motorists need at least 4 seconds to detect, react and slow down for a pedestrian in a crosswalk. At locations where crosswalks are needed, placement at the top of a hill is much better than just below the crest.

Likewise, avoid placing crosswalks on curves where horizontal stopping sight distances are restricted. Placement where the motorist has been slowed by a curve and is now able to view the pedestrian fully is desirable. There will be locations where crosswalks are needed along a corridor with curves. Often a refuge or median island will help slow the motorist, and provide a low conflict crossing for pedestrians.

If inadequate vertical or horizontal stopping sight distances exist, the use of traffic calming measures (such as the refuge or median island mentioned above) to reduce motorist speed, or special signing, beacons, even signalization is desirable. Begin the median island before the curve.

Crosswalk Markings

Three different designs, as shown in



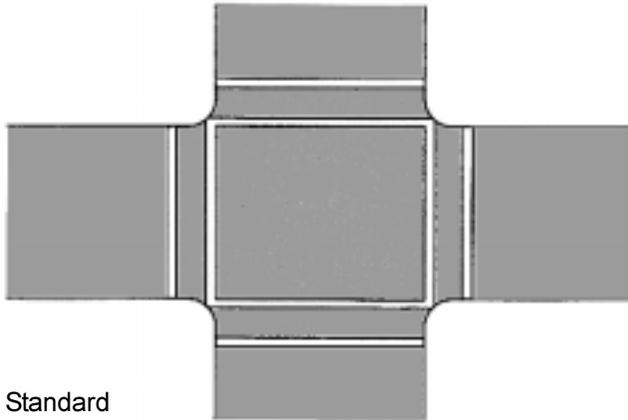
Figure 9-3. A crosswalk at a skewed intersection — there is a trade-off between making a 90-degree turn and staying close to the turning traffic.

Figure 9-4, are typically used to designate crosswalks. The standard crosswalk consists of two parallel white lines (scenario a). However, diagonal or zebra (scenario b), or longitudinal or ladder (scenario c) lines may be used for increased emphasis. Special markings (Figure 9-5, bottom) should be used where a high volume of wheelchairs or roller bladers (trail crossings) can be anticipated. This open design permits those with thin wheelchair casters and wheels or rollers to cross a high visibility marking without ground interference.

High Visibility Crosswalk Markings

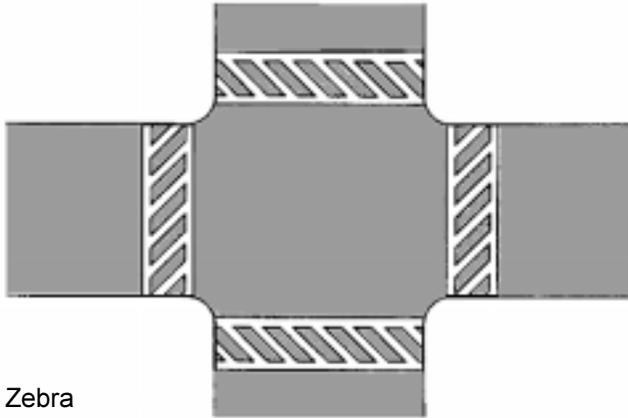
The advantage of type (b) is higher visibility and reduced maintenance. Properly placed, the wheels of crossing motorists can fall between the open spacing, thus allowing the markings to remain visible much longer than with other markings. Another benefit of (b) and (c) as high visibility markings is that bicyclists traveling perpendicular to the crosswalk can pass between the markings. Wide markings can be slippery to bicycle wheels when wet. Care should be taken in maintaining type (b) and type (c) markings, since successive overcoats of paint or thermoplastic creates a buildup that can slow or hamper wheelchairs and roller bladers. The high visibility markings shown in Figure 9-5 (bottom) are not found in the MUTCD. Their use can be justified by

a — Standard crosswalk marking.



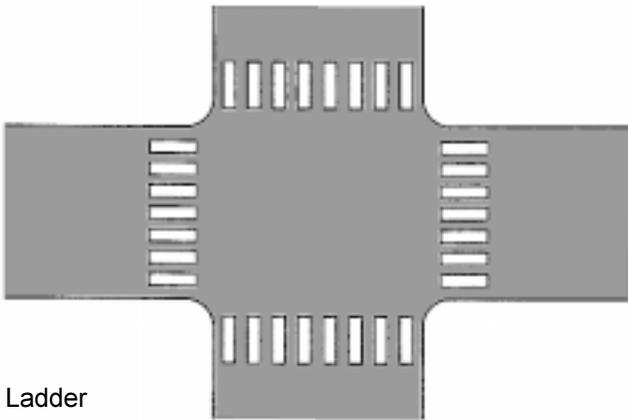
Standard

b — Crosswalk marking with diagonal lines for added visibility.



Zebra

c — Crosswalk marking with longitudinal lines for added visibility.



Ladder

having demonstrated improved maintenance and operational characteristics which are a benefit for wheelchairs and rollerbladers.

There is debate among some engineers whether high-visibility crosswalks should be reserved for places where added emphasis is needed, such as at midblock crossings, schools or high volume pedestrian crossings (Figure 9-5). In contrast to this philosophy is the desire to use these markings in all locations, in order to reinforce a simple, clear, consistent visual message to motorists that this more readily detected crosswalk marking is a place to expect pedestrians.

Paver Stone Crosswalks

Some downtowns have made a significant investment in the use of color rich paver stones to delineate the intersection and crosswalks. These include Washington, DC; Portland, Oregon; Ft. Lauderdale (A-1-A), Florida; Daytona Beach, Florida; and Orlando, Florida. Pavers can be used to create useful patterns. For instance, on the highly successful boulevard style “K” street in Washington, DC, designers created different colors to indicate when a pedestrian is in a conflict versus a nonconflict (refuge-protected) zone.

If paver stones are used, they must be designed to eliminate the movement of the stones or bricks. A solid granite or concrete parallel strip must be used along with a solid re-bar reinforced concrete pad for the full length and width of the crossing. If these levels of care are not followed, the paver stones will float and create depressions and gaps that trap narrow heels and dislodge bicyclists.

Raised Crosswalks

At airports, on traffic calmed neighborhood streets, and some collector roads, where speeds are maintained at or below 40 km/h (25 mph), it is possible to raise the entire crosswalk area 150 mm (6 inches). An approach and departure change in grade of 1:12 is used, and the minimum 3 m (10 foot) or greater width crosswalk is

Figure 9-4. Typical crosswalk markings.⁴

used. When traffic calming is used in these types of locations it is always desirable to have the traffic calming feature at the specific location where pedestrians cross. In this way the motorist's gaze is directed at the crossing rather than at an upstream or downstream location.

One especially effective raised crosswalk is found at the Daytona Beach, Florida airport. The raised crossing has imbedded yellow lights and prisms on the approach taper. Although expensive, this high use pedestrian zone treatment leads to a nearly 100 percent yielding behavior by motorists.

RPMs and Marked Buttons

Crosswalks marked with buttons or reflective raised markers (RPMs) are not recommended. Any rumble effect given to motorists at this point is provided too late for use as advance warning, and the pedestrians who walk along the lines (especially older adults and blind pedestrians) may trip on the RPMs. RPMs are also detrimental to wheelchairs and bicyclists. RPMs may be used upstream (not in bike lanes) from a crosswalk in conjunction with advance pedestrian warning signs in an attempt to enhance motorist awareness of the upcoming crosswalk. These devices should not be used in bike lanes or where bicycling traffic can be anticipated.

Maintenance

Marked crosswalks should be kept in good condition and should be removed when no longer needed. Shorter service life, longer dry times and the need for more extensive barricading make painted crosswalks less desirable than longer life plastic materials and ultimately more expensive to maintain. However, plastic pavement markings are more difficult to remove, often requiring special equipment.

It is desirable to maintain an inventory of crosswalk locations for periodic maintenance and monitoring purposes. Once installed, the crosswalk should be monitored for continued

applicability and usefulness. When no longer useful, crosswalk removal may be coordinated with a street resurfacing project.

Stop Lines

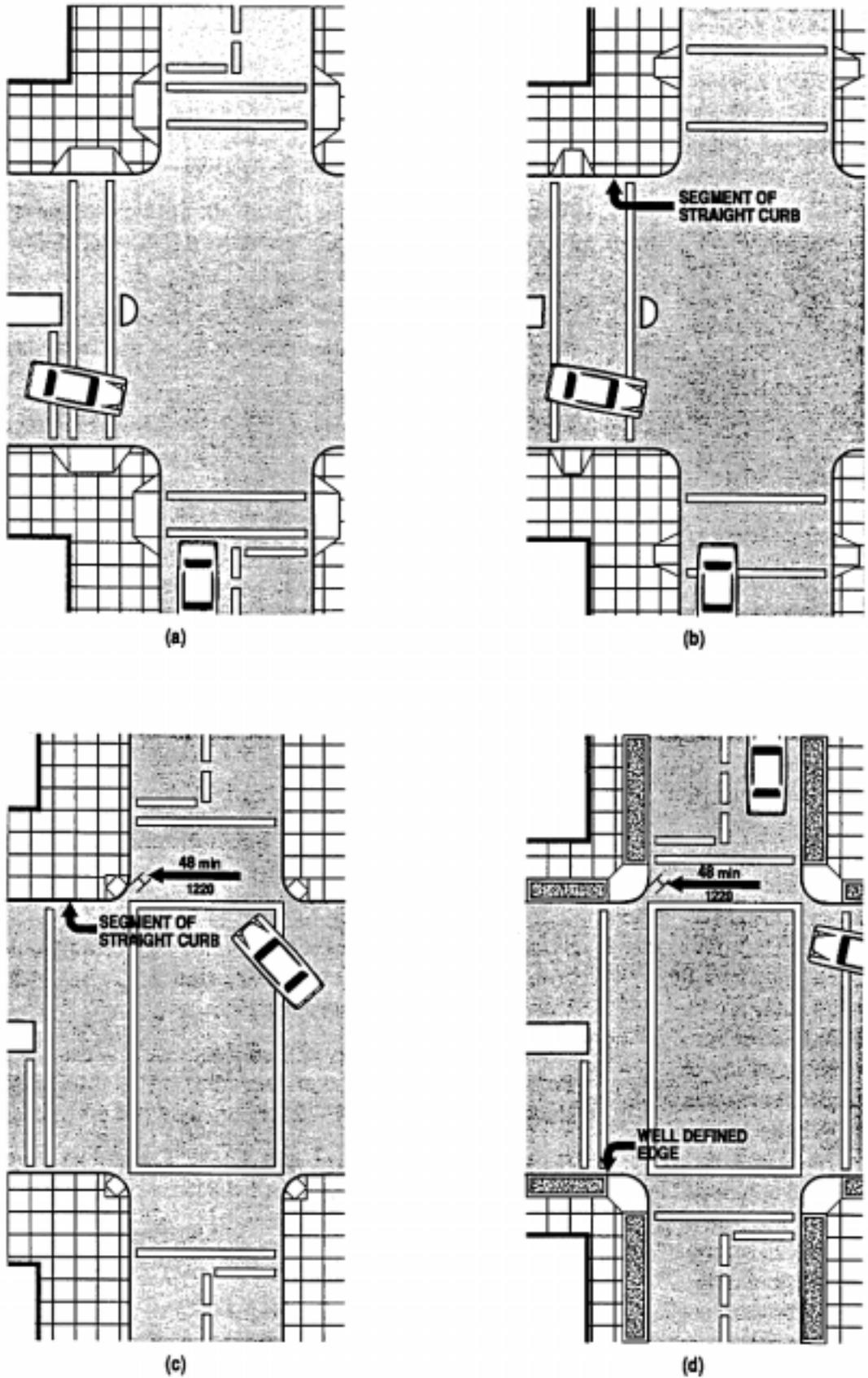
Effective traffic operations are needed to prevent motorists from stopping in crosswalks. Stop lines may be used as a guide to indicate the optimal stopping location for motorists, and may be used in advance of marked crosswalks to help encourage motorists to stop further back from the crosswalk. They are intended to be used at locations where motorists are required to stop, and may be used on approaches to traffic signals, stop signs (with or without marked crosswalks), or uncontrolled marked crosswalks.



Figure 9-5. High-visibility markings such as longitudinal lines may be used in crosswalks for increased emphasis.

Crosswalks, Stop Lines, Curb Ramps, and Islands

Figure 9-6. Crosswalk placement in accordance with various ramp designs. (A) and (b) are the preferred treatments in Florida. (C) and (d) should be used only if there are right-of-way constraints or if significant retrofitting of drainage facilities would be required.



Curb Ramps at Marked Crosswalks

When used on the approach to a marked crosswalk, stop lines should normally be placed about 1.2 m (4 ft) in advance of the nearest crosswalk marking. This distance may need to be extended back in those locations where high end semitrailers (long haul designs) are frequent, since their high nose prevents their drivers from seeing young children or those in wheelchairs.

Staggered Stop Lines

While stop lines are generally installed parallel to the crosswalk line, they may be installed at an angle, or staggered (offset) in each lane, which offers the benefit of allowing motorists in all lanes of a multilane approach to have a better view of pedestrians.

Midblock, Multilane Stop Lines

When a midblock crossing is used on a multilane highway, the stop line is best placed 12.2 m (40 feet) back from the nearest point in the crosswalk (see figure 9-7). By doing so, a stopped vehicle does not block the pedestrian or next lane motorist from seeing one another. This stop-line location greatly reduces the “multiple threat” type of pedestrian/vehicle conflict (see figure 4-4). Generally motorists will comply with this marking. If not, an enhancement sign “Stop Here When Pedestrian Is Crossing” with a downward arrow greatly increases compliance.

Agencies that do not deem stop lines cost effective must consider the trade offs:

- ◆ having motorists (especially high nose trucks) create sight distance problems for themselves and others
- ◆ the impact to pedestrians when crosswalks are blocked
- ◆ when older or disabled pedestrians are forced to wait a full cycle, or
- ◆ when younger pedestrians are forced to cross in the inner intersection, behind the offending vehicle or other unsafe positions.

Signal Loop Detector Placement

Signal loop detectors should not be placed in front of the stop line. There is a tendency in traffic engineering to move loop detectors forward when there is a high level of motorists creeping forward into the crosswalk area. If there is a high level of noncompliance with the stop line, consider increasing the stop line visibility (wider), and adding a regulatory sign (“Motorists Must Stop Here,” with downward arrow, or “\$75 Fine for Blocking Crosswalk”).



Figure 9-7. The failure to use stop lines encourages many motorists to stop too close to the intersection, forcing pedestrians into the parallel roadway. A midblock stop line queues motorists back 40 feet, reducing the chance for a multiple threat crash.

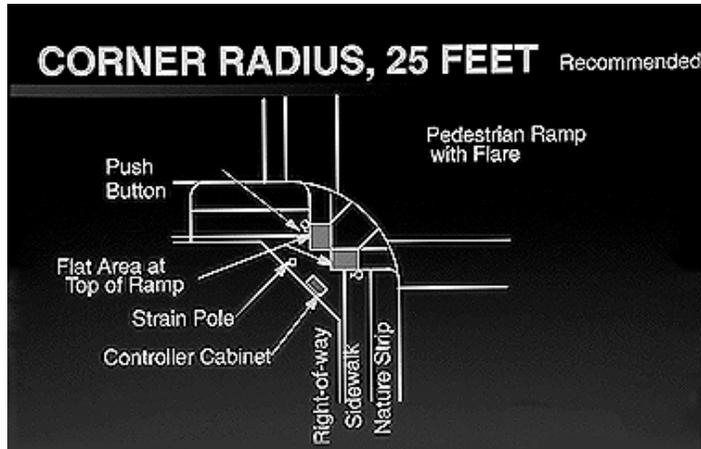


Figure 9-8. Side treatments for curb ramps.

Curb Ramps

Properly designed curb ramps allow for a safe and efficient transition from the elevated sidewalk surface to the street surface or vice versa. It is important that these ramps be designed and installed to meet the needs of those persons for whom they were intended, i.e., those who have difficulty negotiating a curb.

Placement

In accordance with the Americans with Disabilities Act, curb ramps shall be provided wherever an accessible route crosses a curb. The ramps shall be wholly contained within the crosswalk, as shown in Figure 9-6. Diagonal ramps are not recommended; instead, one ramp should be used for each crossing direction. Other considerations for the placement of curb ramps are as follows:^{7,8}

- ◆ Curb ramps should not be placed so that pedestrians have to cross storm water grates or inlets, manhole covers, other access lids, or ponding water. The Florida DOT uses a standard calling for curb inset inlet grates on each side of the corner connected to a diagonal pipe that feeds into one stormwater drain.
- ◆ Curb ramps that service adjoining crosswalks should be separated as much as possible.

- ◆ Curb ramps should be located within the crosswalk. Wider than minimum curb ramps are encouraged to permit the maximum number of people to enter and leave a sidewalk at one time. Full crosswalk width ramps are encouraged. Curb ramps should be located to prevent their obstruction by parked vehicles.
- ◆ Curb ramps in bulbouts achieve several added benefits including higher visibility of the pedestrian while waiting to cross, improved geometrics, improved sight distances in general, and reduced crossing distance.

Design

The slope of a curb ramp (measured as shown in Figure 9-8) shall not exceed 1:12 in compliance with ADA. If the curb ramp is located where pedestrians would normally walk across the ramp, or where it is not protected by handrails or guardrail, then flared sides should be used as shown in Figure 9-8. The flared sides should have a maximum slope of 1:12. If the curb ramp is located where pedestrians would not normally cross it, then returned curbs, like the one shown in Figure 9-8, may be used. The minimum width of a curb ramp, exclusive of the flared sides, shall be 1 m (40 inches). As mentioned earlier, widths greater than the minimum are always desirable. Where large volumes of pedestrians are expected, a minimum width curb ramp will result in pedestrian delays and capacity problems.

Designs for new wheelchair ramps should include a flat landing area at the top of the ramp for the entire width of the ramp and 1.2 m (4 ft) long, to give wheelchair users a good surface to maneuver and change directions. The surface of a curb ramp should be stable, firm, and slip-resistant. The texture of the ramp should be coarse enough so that it is not slippery when wet, yet smooth enough not to cause problems for wheelchair users. The ADA's requirements for tactile curb surfaces are

currently being reviewed. One possible treatment is shown in Figure 9-9.

Designs must pay close attention to the lip between the bottom of the ramp and the pavement. Wheelchairs have difficulty handling more than a 6.3 mm (1/4 inch) transition lip (elevation change) (see Figure 5-3). Access through medians and channelized islands is best handled by not ramping up and down, but by maintaining a cut through the entire area. To drain the island a slight (2%) slope can be used.

Although minimum widths must be observed, wider sections are encouraged. When practicable, the ramp should encompass the entire width of the crosswalk. This practice is essential for multiuse trail crossings.

Maintenance

A program of routine maintenance should be developed to inspect and clean curb ramps, and to repair any damage noted during the inspections. This should be done at the same time that marked crosswalks are inspected.

Refuge Islands and Medians

Pedestrian refuge islands are defined as the areas within an intersection or between lanes of traffic where pedestrians may safely wait until vehicular traffic clears, allowing them to cross a street. Refuge islands, like the one shown in Figure 9-10, are commonly found along wide, multilane streets where pedestrians may not be able to safely cross without adversely affecting motor vehicle traffic flow. These islands provide a resting area for pedestrians, particularly those who are disabled, elderly, or otherwise unable to completely cross an intersection within the available gap or provided signal time.

Refuge islands also provide pedestrians the advantage of allowing them to search for vehicles in only one direction as they cross from the curb to the island or from the island to the curb. The delay for pedestrians can also be reduced significantly. One study found that pedestrians crossing an



Figure 9-9. A tactile curb ramp.

undivided, multilane street may experience delays 10 times longer than the delay incurred crossing a street with a median.⁹ This is because pedestrians need a much larger gap to feel safe crossing the undivided street.

Placement

Pedestrian refuge islands may be installed at intersections or midblock locations deemed appropriate through engineering studies. As a general policy, FDOT prefers to use medians to limit access and improve efficiency, safety, and aesthetics for all roadway users. This recommendation applies to roads with speeds of 65 km/h (40 mph) and higher, but can be done on all roadways with sufficient right-of-way.

Refuge islands should be considered during the design of complex intersections or streets rather than after construction has been completed. They must be visible at all times with the stopping sight distance as the minimum distance requirement. Refuge islands should be designed to minimize the potential hazard to motorists and pedestrians alike.

Refuge islands and medians can be beneficial under certain conditions but may involve some trade offs and can cause increased problems if not designed and installed properly. The typical conditions where refuge islands can provide the greatest benefit, and thus are recommended, include:⁶

- ◆ Complex or irregularly shaped intersections where islands could provide a pedestrian with the opportunity to rest and become oriented to the flow of oncoming traffic.
- ◆ Wide, two-way streets (four lanes or more) with high traffic volumes, high travel speeds, and large pedestrian volumes;
- ◆ Wide streets where the elderly, people with disabilities, and children cross regularly;
- ◆ Wide, two-way intersections with high traffic volume and significant numbers of crossing pedestrians; and
- ◆ Low volume side street traffic demands with insufficient green time to cross.

Five and seven lane streets, with a center two-way left-turn lane, are not “pedestrian friendly.” In addition to the sheer width of the roadway, the two-way left-turn lane exposes pedestrians to traffic from both directions. Motorists are looking for gaps in oncoming traffic and may not be watching out for pedestrians.

It is more desirable to construct a four- or six-lane street with a raised median that includes left turn slots at intersections. This will provide a better continuous pedestrian refuge island and allow for a landscaping buffer between traffic flows for improved aesthetics. Florida DOT design standards



Figure 9-10. Refuge islands allow pedestrians to cross one direction of traffic, rest if necessary, and then cross the other direction of traffic.

now prohibit the building of five- and seven-lane highways. Refuge islands should be of sufficient width for safe pedestrian storage. Typically, a refuge should have a minimum width of 2.4 m (8.0 feet), although even a width of 0.9 m (3.0 feet) is better than none at all. It is also helpful to avoid small discontinuous islands which motorists may not see, making it likely for vehicles to drive into the island.

In areas where refuge islands are designed and maintained properly, the advantages to pedestrians are many, including:⁶

- ◆ Providing pedestrians with a resting place when crossing wide roads or intersections;
- ◆ Providing a pedestrian storage area;
- ◆ Increasing the capacity of the intersection with a near-side island that provides a better location for the stop bar;
- ◆ Loading and unloading transit riders (although curbside locations provide a better alternative); and
- ◆ Providing location for traffic control and utility pole installations (but not in the crosswalk area).

Design

Pedestrian refuge islands should be designed in accordance with the AASHTO policy and the MUTCD requirements.^{4,11} Design considerations should include:

- ◆ Raised curbs with cut-through ramps at pavement level or curb ramps should be provided for wheelchair users. Cut-through ramps should be graded to drain quickly and should also have special provisions to assist the visually impaired in identifying the refuge island. Islands with ramps should have a level area at least 1.2 m (4 ft) long at the same level as the top of the raised median to provide a level area for wheelchair users.
- ◆ The smallest curbed island that should be considered is 4.6 square meters (50

square feet) for urban areas and 7.0 square meters (75 square feet) for rural areas with 9.3 square meters (100 square feet) a desirable minimum for both areas. Triangular islands should not be less than 3.7 m (12 feet), and preferably 4.6 m (15 feet) on a side after the ends of the radii. Elongated or divisional islands should not be less than 1.2 m (4 feet) wide and 6.1 to 7.6 m (20 to 25 feet) long.

- ◆ An approach nose, offset from the edge of the traffic lane, should be constructed and appropriately treated to provide motorists with sufficient warning of the island's presence. This can be achieved through illumination, reflectorization, marking, signage, and/or size.
- ◆ Pedestrian push buttons and signage adjacent to crosswalks on the pedestrian refuge should be provided at all signalized crossings.
- ◆ Guidestrips for the blind should be considered, particularly if they are provided on other nearby facilities.
- ◆ No obstruction to visibility by such features as foliage, barriers, or benches.
- ◆ Barriers may be necessary to keep pedestrians from stepping into traffic at improper locations.

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One-way Streets



10

One-way streets can be beneficial to pedestrians when properly designed and placed. However, when designed to increase traffic speeds they can make a formerly quiet, pleasant place hostile and uninviting. In that case, the speed of traffic through a town not only poses increased risk to the public, but it also increases noise and creates other discomfort.

Advantages of One-way Streets

Crossing one-way streets is generally much safer for pedestrians than crossing two-way streets. A study of nearly 1300 intersections in 15 cities across the United States revealed lower levels of pedestrian collisions occurred at intersections of two one-way streets than at intersections of two-way streets.¹ One-way streets reduce the complexity for pedestrians who are crossing a street allowing them to concentrate on only one direction of traffic. In addition, drivers can devote more of their attention to pedestrians since all vehicles are traveling in the same direction.

One-way streets are most applicable in Central Business Districts or densely developed central city areas where pedestrian traffic is generally higher. One-way streets operate most efficiently in pairs that are no more than 0.4 km (0.25 mile)

apart. If the one-way street pair is further than 0.4 km (0.25 mile) apart, the operational efficiency is usually lost. Motorists wishing to travel a short distance in the opposite direction of the one-way street must travel a considerably longer distance out of their way. The ideal spacing for a one-way pair is typically one block apart.

Based on past experience, properly-placed one-way streets will generally reduce pedestrian crashes 10 to 15 percent.

Advantages of one-way streets include the following:

- ◆ Safer for pedestrians and motorists. Not only will pedestrian accidents be reduced, but total accidents will generally be 10 to 50 percent lower based on past experience.²
- ◆ Improved traffic capacity. One-way streets are much more efficient for through traffic and may increase the capacity of a street as much as 50 percent.³
- ◆ Reduced conflict points for turning vehicles on the one-way street. Since there is no opposing traffic, left turning traffic should be able to concentrate more on pedestrians. This means that left-turns should be as simple as right-



Figure 10-1. One-way streets offer a number of advantages for pedestrians.

turns. Studies indicate that vehicles turning left on one-way streets tend to hit pedestrians much more frequently than right-turn vehicles. This may be due to roof support pillars obstructing the view of the parallel crosswalk on the left side of the vehicle.³

- ◆ Signal timing is much simpler and signal progression much easier to obtain on a one-way street. One-way streets can better accommodate closely spaced and poorly spaced traffic signals in the CBD area.
- ◆ May allow retention of parking on narrow streets where it is generally not possible to do so with two-way operation.

On one-way streets where signal cycle lengths are kept short (60 seconds or less), the pedestrian receives significant opportunities to cross either at signalized or unsignalized crossings. However, one-way streets with 3 or more lanes may increase speeds and conflicts and it becomes hard to keep cycle lengths short. The removal of a lane can provide substantial improvements to crossing times, and give main street designers more room to provide adequate sidewalk and buffer widths.

The recent conversion of Lake and Lucerne, a pair of three-lane, one-way streets in Lake Worth, Florida to two lanes has reduced crossing widths, allowed a second lane of on-street parking to be placed, increased sidewalk widths, allowed space

for bulbouts and outdoor cafes, and allowed the placement of additional landscaping. The effects of these changes on traffic is a reduced travel speed through the downtown (reduced from 56 to 40 km/h (35 to 25 mph). Capacity of the roadway has remained constant. The level of service before the treatment was “C,” and is still “C.”

Disadvantages of One-way Streets

One-way streets are detrimental to the pedestrian and urban design if they speed motor vehicle traffic in the area. The designer must ask the question, “Will this treatment merely let people drive into and out of the downtown faster, or is there some other significant benefit to all roadway users?”

The use of one-way streets can have substantial negative effects on a downtown main street or shopping district. Small towns in Florida like Brooksville, Havana, Plant City and Lake Worth chose to place one-way streets to channel more traffic into and through their downtowns in recent decades. These towns are now trying to determine how to reduce the speed of these vehicles to compatible levels. In some cases taking a lane away (Lake Worth), narrowing lanes, adding parking buffers, bulbouts on corners, reducing the progression rate of traffic signals, or eliminating progression altogether, is being considered. Traffic calming is discussed in Chapter 15.

These and other disadvantages of one-way streets are listed below.

- ◆ Motorists are likely to drive faster than they would on two-way streets and thus present a greater hazard to pedestrians.
- ◆ Crossovers at each end of the one-way pair are expensive to build.
- ◆ Traffic circulation in a one-way street system is less direct. This extra travel distance will likely increase the amount of fuel used and travel time (and thus, stress) for those motorists.



Figure 10-2. One-way streets that contain wide travel lanes can result in higher than desired vehicle speeds, which can cause problems for pedestrians.

- ◆ Signal progression for those streets crossing the closely-spaced one-way pair is difficult, if not impossible to achieve in both directions.
- ◆ May adversely affect transit operations if transit vehicles are forced to use two streets instead of one. This may also adversely affect walking distances for transit patrons.
- ◆ Emergency vehicles may need to take a more circuitous route.
- ◆ One-way streets require much more signing than a two-way street.

Converting to a one-way street system should be thoroughly planned and take into account the changes in pavement marking, signing, positioning of parking meters, curb parking restrictions, and traffic signal design and signal detectors. One-way signing is needed at alleys and driveways where not previously needed. Planning for one-way street conversion should include the following parties:

- ◆ The local business community,
- ◆ Area neighborhoods and other affected property owners, as well as the local transit agency,
- ◆ Other investors,
- ◆ Sanitation, police, and fire departments,
- ◆ Representatives from the affected school

district, and

- ◆ Others that may be affected by the change.

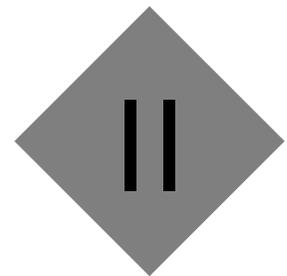
The conversion to one-way streets should be preceded with a comprehensive public information campaign that should include informational signs prominently posted along the streets that are to be converted, providing a projected conversion date.

The community needs to understand the full impact of converting to or from one-way streets. The decision should not be left up to the current slate of politicians. The recent Lake Worth decision was made following an intense seven-day planning charrette that involved over 200 people.

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Intersections



Many roadway intersections in Florida do not adequately accommodate pedestrian crossings. This chapter is adapted from pages II-7 through II-11 of the *Florida Pedestrian Safety Plan* and chapter 1 of the *ITE's Design and Safety of Pedestrian Facilities: Recommended Practice*. It offers many policy, design, and technical recommendations for facilitating pedestrian crossings at intersections.

Discussion

Intersections, particularly signalized intersections, are the most dangerous part of the road network for pedestrians (Figure 11-1). Most pedestrian fatalities in Florida occur at intersections. There are 32 possible vehicle- pedestrian conflicts at the four-way intersection of two roads. Many occur at high speeds.

Another type of intersection that can adversely affect pedestrian safety is the intersection between expressway ramps and local streets. Such sites often involve high-speed vehicles coming off the ramps and passing through the intersection or attempting to merge with the surface street. Exiting motorists may place their attention primarily on other traffic and not on pedestrians. Moderate to high volumes of pedestrians and exiting traffic can further

increase the hazard. Pedestrian safety can be severely threatened at such sites, unless appropriate safety enhancements are made.¹

The level of hazard at many of these intersections can be lessened through the use of appropriate traffic-control devices (e.g., warning signs) to reduce vehicle speeds and alert motorists and pedestrians. In some instances, pedestrian barriers, modified signal timing (e.g., longer vehicle clearance intervals), or even grade separation (e.g., pedestrian overpasses) in extreme situations may be needed to reduce a serious pedestrian safety problem.²

Pedestrian safety can be severely threatened at intersections.

It is preferable that intersection areas (conflict zones) be as small as possible to reduce the:

- ◆ pedestrian crossing distances
- ◆ pedestrian/bicyclist to vehicle exposure
- ◆ vehicle to vehicle exposure

These practices make the vehicle paths clearer and reduce the relative speed between opposing movements. Channelization with medians, and right turn slip lanes with channelization islands can also reduce the

Figure 11-1.
Traffic engineers face their greatest dilemma at the intersection.



conflict zone and provide safe refuges for pedestrians. Prohibited turns which are dangerous to pedestrians can be blocked. (See *AASHTO*, pp. 828-830.)³

Right-turn-on-red (RTOR) has the potential to increase pedestrian accidents. The person most at risk is the pedestrian crossing from the right to the left in front of a driver. The driver focuses his attention to the left and can start to turn before noticing the pedestrian on his right. Sixty-seven percent of RTOR/pedestrian accidents involve this movement. (See *figure 61 in Bowman et al.*)⁴

Modern roundabouts can be an effective treatment for reducing pedestrian/vehicle conflicts and vehicle speeds in residential neighborhood streets. In crossing the modern roundabout, the pedestrian only needs to cope with one direction of vehicle movement.

Recommendations

Policy Recommendations

1. A prohibition of Right-Turn-On-Red should be considered at those intersections where pedestrian volumes are significant and field studies suggest this treatment.

2. Install two pedestrian curb ramps per corner as near as possible to the pedestrian push button, to aid the handicapped, sight impaired, persons with strollers, etc. in crossing at crosswalks. A single ramp design is not desirable as it will direct pedestrians into through traffic.

3. Medians are recommended whenever the crossing distance exceeds 18 m (60 feet) to provide a refuge for slow or late crossing pedestrians. Push buttons should be installed in the median and handicap ramps or a full cut should be provided through the median. Refuge islands should preferably be at least 1.8 m (6 feet) and in no case less than 1.2 m (4 feet) wide to keep island users, particularly those in wheelchairs propelled by attendants, from projecting into the traffic lanes. (See *Bowman, et al., p. 124.*)⁴ Pedestrian signals should be timed to allow adequate time for pedestrians to cross the full width of the street. This is because placing push buttons in the median may encourage the use of quicker walking speeds for design. This means the pedestrian would have to wait an entire cycle, sometimes as much as 4 minutes, to finish crossing the street. In this case, the pedestrian may choose to cross against a red light.



Figure 11-2. Medians are recommended whenever the crossing distance exceeds 60 feet to provide a refuge for pedestrians.

Otherwise he is left, although on a refuge, in a vulnerable location. Refuge islands are covered in Chapter 9 of this document.

4. Where warranted, install pedestrian buttons in accordance with *DOT Standard Index #17784* in a standardized manner at all signalized crosswalks and in medians. Pushbuttons should be installed on separate poles according to illustration. This enables use by handicapped and sight impaired users and reduces the confusion normally associated with these devices for the general population.

5. Pedestrian signal heads should be installed at all urban signalized intersections. Install pedestrian signals on the poles that support the push buttons so they relate to the signal display. If the distance between the pedestrian signals across the road is greater than 18.3 m (60 feet), another pedestrian signal should be installed in the median if possible. This will enable elder and sight impaired pedestrians

to see the signalheads. All signal heads should be brought up to current standard shown in MUTCD Figure 4-3 (page 4D3).⁵ These standards specify the use of white and Portland orange colors only, since elder pedestrians may have difficulty distinguishing color differences on the nonstandard signal heads. Symbols should be used instead of words as the illustration depicts.

6. Where possible, move existing and install new drainage structures out of the curb radius to prevent pedestrians from design-induced tripping. Where possible, install drop inlets on the upstream side of corners to prevent large volumes of water flowing around corners. Also ensure that the road and gutter take water away from the pedestrian crossing.

7. When diagonal spans supporting traffic signalheads would prevent pedestrians from seeing the current vehicle phases, convert existing span wire installations and install new traffic signal installations using pole/mast arm mounted signals or box spans.

8. Parking should be prohibited within 18.3 m (60 feet) of the approach to, and 9.2 m (30 feet) on the departure from, a signalized intersection. Vehicles parked close to an intersection block a driver's view of pedestrians. (See *Zegeer and Zegeer, Pedestrians and Traffic Control Measures, pp. 19, 21 and 60.*)²

9. When advantageous, provide full corner and half corner sidewalk flares (bulbouts) on streets with parking. This rarely reduces vehicle capacity, yet provides the pedestrian with a shorter crossing distance and increased visibility and height. This treatment is generally not recommended on new arterials. For more detail, see Chapter 15 of this document.

10. When approaching drivers' view of pedestrians is restricted, clean up the corner by using joint-use poles to support traffic signals, street names, lighting, and signs. Relocate or remove all other items or trim



Figure 11-3. Signals frequently used by elderly or physically impaired pedestrians should be retimed to provide a crossing time commensurate with their ability.

trees or shrubs.

11. When there is inadequate pedestrian walk and clearance time, retime existing and new signals to ensure adequate crossing time for pedestrians. Signals frequently used by elder or physically impaired persons should be retimed to provide a crossing time commensurate with their ability (Figure 11-3).

12. The design of a new intersection or the replacement of an existing intersection may make it necessary to move some of the



Figure 11-4. This intersection could be improved in many ways. Note that pedestrians leaving the lower right corner must walk a distance of over 20 feet just to get to the first lane to be crossed—a channelized slip lane would reduce this distance.

above ground utilities located at the intersection. For example, fire hydrants or utility poles may have to be relocated. When these relocations occur, consideration of the pedestrian circulation paths in and around the intersection is critical. While attention to pedestrians may not be the most important consideration here, they cannot be totally ignored.

Design or Technical Recommendations

Many signalized intersections are unfriendly to pedestrians because of the speed and complexity of vehicle movements and the number of lanes added for capacity. The AASHTO Green Book describes various types of basic and enhanced intersection designs, with limited discussion on how different design treatments can be used to accommodate pedestrians.³ Devices such as flared curbs (bulbouts), curb ramps, channelization islands, pedestrian refuge islands, and medians have been used to shorten crossing distances, increase pedestrian and vehicle visibility, simplify the crossing task, control vehicle paths, and control vehicle speeds. Intersections should be designed to be as compact as possible as per AASHTO standards.

Although these pedestrian-sensitive treatments are conceptually simple, they do require a significant amount of planning and engineering design, as well as consideration of their operational effects and maintenance requirements. This is especially true at locations where these types of treatments are used as retrofit solutions rather than new construction (see Chapter 15).

Use of pedestrian-related geometric features at an intersection could have an effect on the vehicular capacity of the intersection. The principal effect on capacity will be caused by narrowing lanes and reducing curb radii. While narrowed lanes have a direct computational effect on intersection capacity, the effects of reduced curb radii are much harder to quantify.⁶

Other factors that may affect intersection

capacity include the increased number of pedestrian crossings caused by an improved pedestrian environment and the relocation of bus stops caused by the reconfiguration of the intersection. Pedestrians and vehicles must be given equal status when analyzing the options at an intersection, and thus, some loss in motor vehicle capacity may be necessary to accommodate pedestrians.

To reduce the risk of roadway crossings, to the maximum extent practicable, future planning and project development should consider the following:

- ◆ Use one-way streets or divided roadways with refuges so that pedestrians will have to watch traffic from only one direction.
- ◆ Use paired one-way streets properly designed with slip lanes and medians to reduce number of lanes to be crossed.
- ◆ Construct T-intersections which have fewer conflict points for pedestrians.

The AASHTO Green Book recommends the intersection of roadways at 90 degree angles.³ This design standard represents the best option for both pedestrian and vehicular traffic. Sight lines are optimal, conflict space is limited, and crossing distances (and hence exposure time) are reduced.

- ◆ Restrict left turns in downtown or commercial zones. At signalized intersections, use protective phase left turns whenever practicable.
- ◆ Consider modern roundabouts at intersections as they effectively reduce vehicle speed and pedestrian/vehicle conflicts. (Figure 11-5).
- ◆ Consider roundabouts at intersections that are not part of a coordinated sign system as roundabouts increase capacity and decrease crashes, especially for pedestrians.

When roundabouts are used, marked pedestrian crossings should be placed

one full car length back from the yield line. A channel cut should be placed in the splitter island to assist pedestrians in their crossing.

- ◆ Use right-turn slip lanes under yield control instead of double or triple-turn lanes under signal control.

Factors affecting the danger to pedestrians by right-turning vehicles include the number of turning lanes, turning volume, turn radius and distance from start of turn to crossing pedestrian.

Turning radii should be no larger than necessary. When radii are too large, and sidewalks are placed at the back of the curb, the crossing distance and exposure time for pedestrians increase. There is a tendency to use suburban design corner radii in urban areas. As a general rule, corner radii should be no more than 6.1-7.6 m (20-25 feet) for central business districts and residential neighborhoods, and 9.2 m (30 feet) for side streets entering major roadways. Using three centered, compound radii and channelization where truck volumes are high helps to keep radii reasonably small.

A balance must be struck between small radii and the turning paths of large vehicles. Too small a radius can cause large vehicles to mount the curb and eventually break it up or hit pedestrians who are standing close to the corner. Radii of 9.2 m (30 ft) or more are



Figure 11-5. Modern roundabouts can reduce vehicle speed and pedestrian/vehicle conflicts.

only recommended when large trucks or buses turn frequently. In these situations, right turn slip lanes should be considered, as they will provide a better operating environment for the large vehicle and the pedestrian (Figure 11-6). By comparison, double right turn lanes are very dangerous for pedestrians as the driver in the second lane has his vision of pedestrians blocked by the vehicle in the right-most lane.

When intersections are overly wide for pedestrian crossings, channelized right turn lanes can be beneficial. The angle of 55-60 degrees shown in Figure 11-7 maximizes motorists' tendency to yield to pedestrians, keeps speeds at a prudent level, maximizes viewing angles, and maximizes the turning capacity of motorists.

Since T-intersections create fewer pedestrian-motor vehicle conflict points compared to a four-way intersection (9 vs. 32), their use enhances highway efficiency, reduces conflicts, and improves the safety of both motorists and pedestrians in the area. T-intersections should be considered in future roadway reconstruction projects. T-intersections are also recommended in residential neighborhoods and near schools.

Angle ("Y") intersections invite high

motorist turning speeds and result in wide pedestrian crossings. During reconstruction and when safety conditions warrant improvement, these intersections can be tightened into 90 degree corners. Often the captured land can be turned into a nicely landscaped area that enhances the aesthetics of the street and walking experience.

Five- or six-legged intersections present multiple conflict points for pedestrians and bicyclists as motor vehicles arrive from several directions. Such intersections can often be redesigned as four-way intersections. One or more legs can be reconfigured to create a minor intersection at a different point along the main roadway. Alternatively, traffic can be restricted on one or more streets to reduce the number of vehicle movements in the intersection. A roundabout can be installed so that pedestrians walk around the roundabout and cross one street at a time, as a series of T-intersections.

A commonly overlooked element of the design or redesign of an intersection, from a pedestrian perspective, is the provision and maintenance of adequate intersection sight distance. Maintenance of adequate sight distance for drivers is important in

Figure 11-6. Right-turn slip lanes, where the right-turning traffic must yield before entering the roadway, are a safer alternative for pedestrians than double right-turn lanes.



preventing both vehicle-vehicle and vehicle-pedestrian conflicts. However, provision of adequate sight distance for pedestrians through the design process is equally important in avoiding vehicle-pedestrian conflicts.

Often an intersection design includes the use of pedestrian design features such as bollards, landscaping, benches, or bus shelters. Although these items clearly enhance aesthetics and the overall quality of the pedestrian experience, they can also limit the available sight distance for vehicles approaching or departing from the intersection, as well as for pedestrians waiting to cross at the intersection. This is most acute at stop-controlled intersections. Frequently, these items appear after the intersection has been constructed or reconstructed. Therefore, not only is it important to consider sight distance during the initial design phase, but also during the operational life of the intersection when other features are added.

Although horizontal sight distance is the more frequent problem, vertical sight distance cannot be ignored either. However, for pedestrians, the problem with vertical sight distance at intersections comes from high seat position operators (e.g., truck drivers) who have their line of sight to the pedestrian standing on the curb blocked by trees, signs, or other low-hanging obstructions. As with the ground level obstructions, the careful designer should check to see that adequate sight lines are provided.

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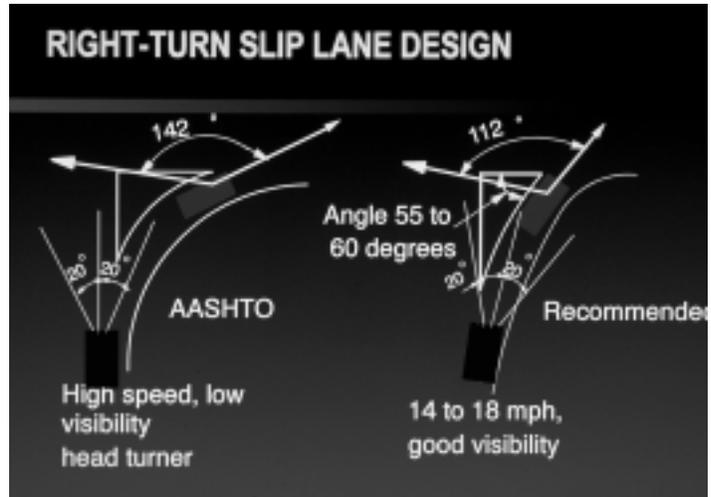


Figure 11-7. AASHTO's standards for right-turn slip lanes (left) encourage high motor vehicle speeds and provide low visibility. By comparison, FDOT's recommended standards encourage low motor vehicle speeds and provide good visibility.

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Midblock Crossings

For most of this century — since pedestrians and motorists began competing for space — safety campaigns have directed pedestrians to walk to intersections to cross roadways, where the number of conflicts is the highest. This is helpful advice, especially in downtown locations where signalization is frequent, where cycle lengths are short, where blocks are long, and where intersections are small and compact. But with the advent of the modern suburb, blocks are much longer, signalization is even less frequent, some intersections are very wide, and vehicle speeds are much higher than downtown. Under these conditions, crossing at intersections becomes less practical and often more dangerous.

Today's designer is challenged to find workable crossing points to aid pedestrians across high-speed roadways. When convenient and manageable crossing points are not identified, most pedestrians cross at random, unpredictable locations. In making random crossings they create confusion and they add risk to themselves and drivers.

This chapter addresses two ways to facilitate non-intersection crossings, medians and midblock crossings. By placing medians along multilane roadways, the designer helps channel pedestrians to the best locations: where gaps are more

frequent, where lighting is improved, and where motorists have the best chance to search, detect, recognize, and respond to the presence of pedestrians. Where there are medians, the pedestrian still may cross at random locations, but due to the increased frequency of acceptable gaps and greatly reduced conflicts, the pedestrian is inclined to find a longer gap, then walk and not rush across the roadway.

Midblock crossings are an essential design tool. All designers must learn the best placement, geometrics, and operations of midblock crossings.

Midblock crossings are an essential design tool.

Medians and Refuge Islands — Powerful Safety Tools

A median or refuge island is a raised longitudinal space separating the two main directions of traffic movement. Median islands by definition run one or many blocks. Refuge islands are much shorter than medians, and are a length of 31-76 m (100-250 ft). Medians and refuge islands can be designed to block side street or driveway crossings of the main road and block left

turning movements. Because medians reduce turning movements, they have the ability to increase the flow rate (capacity) and safety of a roadway.

Medians are now an essential tool to minimize the friction of turning and slowing vehicles. Medians maximize the safety of the motorist and pedestrian. Medians have been extensively studied by the Georgia and Florida Departments of Transportation. Based on more than 1,000 centerline miles (1,600 km) of conversion from two way left turn lanes (TWLTL's) to raised medians, motorist crashes were reduced dramatically. It has also been shown through FDOT research that pedestrians are at high risk while standing in TWLTL's.

Midblock crossings can be kept simple and are easily located on low volume, low speed roadways, such as short 40-48 km/h (25-30 mph) collectors through neighborhoods. When collectors are longer and handle more traffic and higher speeds, medians or refuge islands are helpful, and sometimes essential. On multilane minor and major arterials, refuge islands or raised medians are essential. However, when used, crosswalks must be placed with great care in these locations, especially once travel speeds exceed 64 km/h (40 mph).

Advantages of Medians

Medians separate conflicts in time and place. The pedestrian faced with one or more lanes of traffic in each direction must determine a safe gap in 2, 4 or even 6 lanes at a time. This is a complex task requiring accurate decisions. Young and older pedestrians have reduced gap acceptance skills compared to pedestrians in other age groups. Pedestrians typically have poor gap assessment skills at night. Many may predict that a car is 61 m (200 ft) off when in fact it is only 31 m (100 ft), far too close to attempt a crossing.

Medians Allow More Frequent Gaps

Medians not only separate conflicts, they also create the potential for acceptable gaps.

On a standard-width four lane plus TWLTL roadway of 20 m (64 ft) (five twelve foot lanes plus two 24 inch gutter pans), it takes an average pedestrian travelling 1.2 m (4 ft) per second nearly 16 seconds to cross. Finding a safe 16 second gap in 4 moving lanes of traffic may be difficult or impossible (Figure 12-1). In any event, this may require a wait of 3-5 minutes. Faced with a substantial time delay, many pedestrians select a less adequate gap, running across the roadway, or standing in the TWLTL hoping for a further gap. If a raised median is placed in the center, the pedestrian now crosses 7.9 m (26 ft). This requires two 8 second gaps (Figure 12-2). These shorter gaps come frequently. Based on traffic volume and platooning effects from downstream signalization, the pedestrian may be able to find an acceptable gap in a minute or less.

Medians are Cheaper to Build

The reduced construction cost of a median vs. a TWLTL comes as a surprise to many designers. Grass medians allow natural percolation of water, and thus reduce drainage and water treatment costs. Medians do not require either a base or asphalt. Curbing is essential in urban sections, but is cheaper than other associated construction costs. Medians average a 5-10% reduction in materials and labor costs compared to a TWLTL.

Medians are Cheaper to Maintain

While there is only a slight savings in cost to build a raised median versus a TWLTL, there is substantial savings in maintenance. A study for Florida DOT by Chris Warren of Lake City Maintenance compared 6.44 km (4.0 miles) of median versus TWLTL maintenance costs and found medians save an average of 40% of maintenance costs based on a 20 year roadway life.¹ More frequent resurfacing, such as every 7-9 years would show a much greater savings. This too surprises many designers. During the full life of the roadway asphalt, a raised median saves costs

Figure 12-1. Midblock crossing without median—the person must look in both directions.

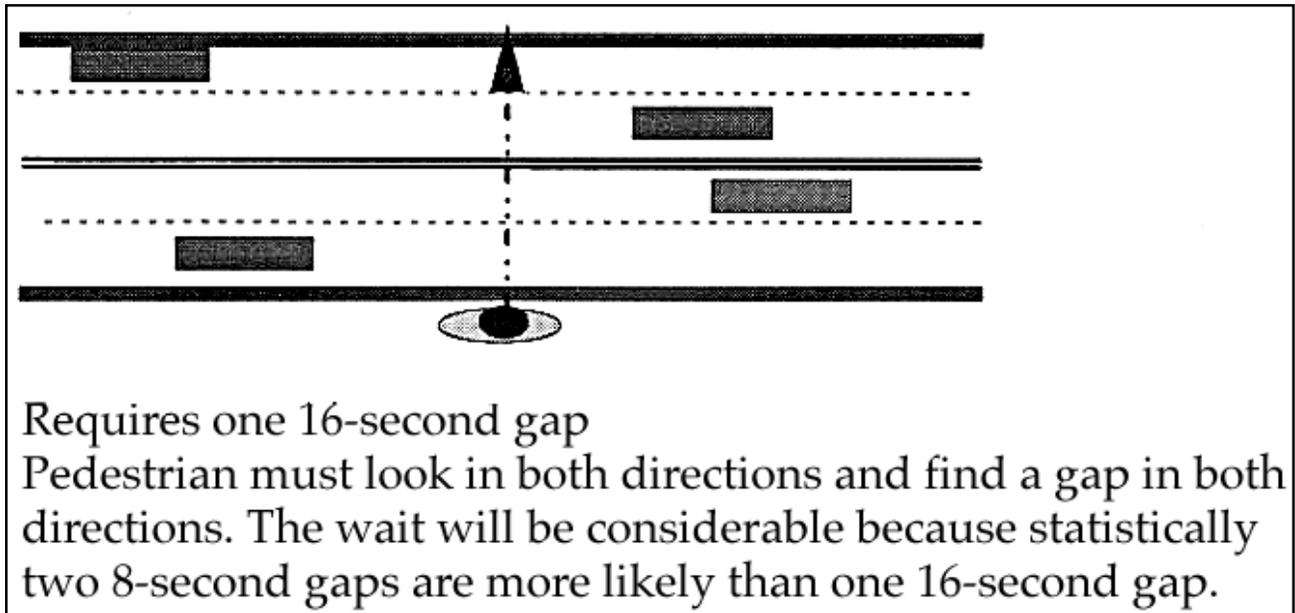
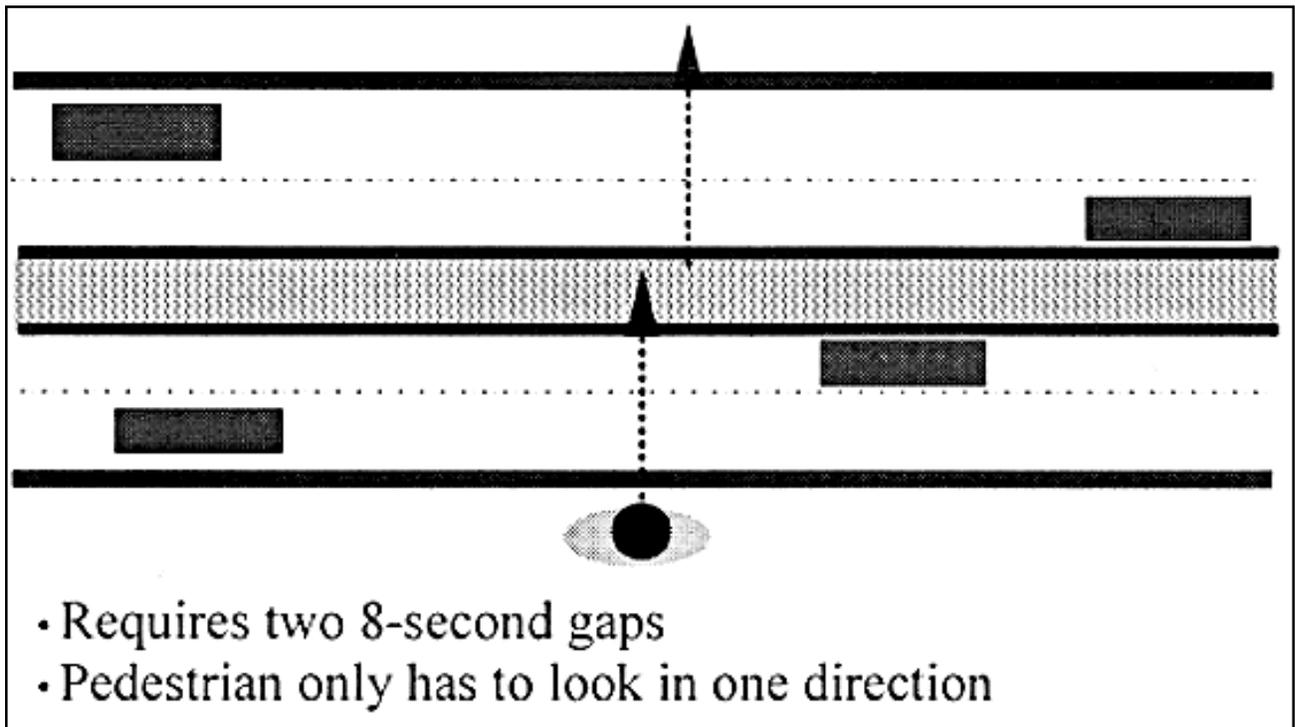


Figure 12-2. Midblock crossing with median — the pedestrian needs to look in only one direction at a time.



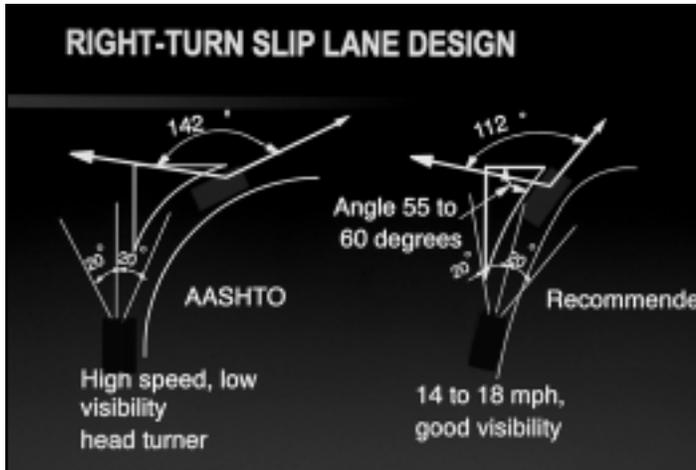


Figure 12-3. AASHTO's standards for right-turn slip lanes (left) encourage high motor vehicle speeds and provide low visibility. By comparison, FDOT's recommended standards encourage low motor vehicle speeds and provide good visibility.

associated with sweeping of accumulated debris, repainting of lines, replacement of raised pavement markers, and the resurfacing of the lane. The raised median requires infrequent cutting of grass, and occasional litter cleanup. If the median is dedicated by agreement or permit to the community for landscaping, then the costs to the state highway department drop to near zero. (See the FDOT Landscape Guide.)

Design Considerations

Ideally, a median should be at least 2.4 m (8.0 ft) wide to allow the pedestrian to wait comfortably in the center 1.2 m (4 ft) from moving traffic. If this cannot be achieved, a width of 1.8 m, 1.2 m, or even 0.6 m (6, 4 or even 2 ft) is better than nothing. To find needed width, especially in a downtown or other commercial environment, consider narrowing travel lanes to an appropriate width. In most locations this reduction in travel lanes can only be made to 3.4 m (11 ft), but in many other locations, where speeds are in the 32-48 km/h (20-30 mph) range the reduction to 3.1 m (10 ft) or even 2.7 m (9 ft) is possible, and may be desirable.

Medians typically have an open flat cut, and do not ramp up and down due to the

short width. If the island is sufficiently large, then ADA approved ramps (1:12 grade) should be used. It is best to provide a slight grade (2% or less) to permit water and silt to drain from the area.

Channelized Islands

When right-turning car or truck volumes are high, the designer often dedicates a special turning lane to this need. A special raised channelized island can benefit the motorist, adds to the capacity of the roadway, and benefits the pedestrian.

Although there is some controversy about the benefits to pedestrians, a properly designed slip lane clearly improves pedestrian crossings. It does so by separating conflicts in time and space. The pedestrian fully clears the right turning threat by picking a gap and going to the island. In most cases, it is safer to let the pedestrian pick a gap than it is to have him count on a right-turning motorist to stop at a red light. If there is another island on the far side of the leg, the pedestrian now only has the left-turning motorist and through motorist to contend with, and both are partially controlled by signalization.

To be useful to the pedestrian, the channelized island must be large enough to store the number of pedestrians that would normally be there during peak periods. This could be as little as 7.0 square meters (75 square feet), which is the minimum space permitted by AASHTO for a raised island. More typically, the channelized island would have 9.3 to 27.9 square meters (100 to 300 square feet).

The island must be designed to slow the motorist on approach, and to set up a proper viewing angle for gap selection at the intersection. This angle has been found to be 55-60 degrees. When properly designed at this angle, the tail of the channelized island (slip lane) will face the approaching motorist (see Figure 12-3).

Midblock Crossings by Roadway Classification

Midblock crossings are located and placed according to a number of factors including roadway width, traffic volume, traffic speed and type, desire lines for pedestrian movement, and adjacent land use. Guidance for median placement on various types of roadways appears below.

Local Roads

Due to their low traffic speed and volume, local roadways rarely have median treatments. Some exceptions may apply, especially around schools, hospitals, where traffic calming is desired and in other unique locations.

Collector Roads

Two-lane collector roads occasionally have medians or refuge islands. Rockville, Maryland, uses refuge islands to channel pedestrians to preferred crossing locations. Used in a series, these refuge islands have a strong visual presence, and act as significant devices to slow motorist travel through the corridor. A 16 km/h (10 mph) speed

reduction (from 64 km/h to 48 km/h [40 mph to 30 mph]) has been achieved. Pedestrians crossing at these midblock refuge islands with marked crosswalks (who also make their intent to cross known) achieve a nearly 100% favorable response from motorists.

When collector roads are widened to 4 lanes (not recommended), raised medians may be essential. A boulevard style street with tree canopies is recommended. This canopy effect helps reduce travel speeds.

Multilane Arterial Highways with Four Lanes

Suburban crossings of four-lane roadways are greatly improved when medians and midblock crossings are used (see Figure 12-4.) On lower volume roadways it is best to not use signalization.

Signalization may be helpful or even essential under the following conditions:

- ◆ On higher volume roadways,
- ◆ Where gaps are infrequent,
- ◆ In a school zone,
- ◆ Where elderly or disabled pedestrians cross,



Figure 12-4. A raised median provides pedestrians a place to wait safely and to cross one direction of traffic at a time.

Midblock Crossings

Figure 12-5. At times it may be necessary to block midblock access to pedestrians, such as on this busy section of U.S. Route 1 through Miami. These shrubs below the palm trees are dense enough to divert pedestrians to adjacent intersections.



- ◆ Where speeds are high, or
- ◆ When a number of other factors are present.

Daytona Shores, Florida, requested and had the Florida Department of Transportation install a half dozen refuge islands along the popular coastal U.S. Route 1. Pedestrian crossings before the installation were entirely random. These installed refuge island crossings were left unsignalized. During the first month there was very little movement of pedestrians to the island. However, starting in the second and subsequent months pedestrians began and continued to make their crossings at the islands, especially when traffic volumes were high and gaps were few. Most pedestrians learned that by using the refuge islands they did not have to run to make it across the street.

Multilane Arterial Highways with Six or More Lanes

Designers attempting to achieve high capacity with the creation of six-lane high speed urban roadways create nearly absolute barriers to pedestrians and bicyclists.

Crossing times of 15, 20, or more seconds may be very risky or impossible. When these conditions are reached, medians, signalization or grade separated crossings may be needed. With three or more lanes, merging is occurring, lane changing increases, and there is a greater tendency for motorists to speed and slow. This creates highly complex conditions for the pedestrian to predict.

At intersections where vehicle speeds are high, signalization may be the only practical means of helping pedestrians to cross unless it is part of a signal coordination scheme. At high speeds, and with infrequent signal calls, high numbers of rear end crashes can be anticipated. It is best not to allow urban area roadways to achieve high corridor speeds. This is especially true in areas where land use supports higher densities. The higher the speed the greater the engineering challenge to cross pedestrians safely.

If a pedestrian crossing is needed, the designer must increase the devices used to alert the motorist to the potential stopped condition. The standard pedestrian crossing and advanced crossing symbol with .9 by .9

m (36 x 36 inch signs) is an absolute minimum for speeds of 64 km/h (40 mph) or greater. Pavement word symbols can be used as further enhancement. An enhanced crosswalk marking such as a zebra or ladder style crossing should be considered. Large overhead signs, flashing beacons, bulbouts, and even flashing overhead signs have been successfully used in some locations.

Midblock Crossing Design

The design of midblock crossings makes use of similar warrants to standard intersections. Stopping sight distances, effects of grade, cross slope, need for lighting, and other factors all apply. The design considerations for medians are covered earlier in this chapter. However, there are a number of added handbook that must be followed.

Connect Desire Lines

All other factors considered, pedestrians and bicyclists have a strong desire to continue their intended path of travel. Look for natural patterns. A parking lot on one side connecting a large office complex on another virtually paints the desired crossing

location. Use of a high angle video time lapse camera to map pedestrian crossings quickly paints this location, if it is not already well known.

Vertical Height — Curbing and Landscaping

Curbing should be a non-mountable design. The planting of low shrubs and high canopy trees is highly desirable. A 2.4 m (8 ft) median is wide enough to allow the planting of non-frangible trees 1.2 m (4 ft) on either side. Make certain that landscaping allows adequate stopping sight distances, and allows the standing pedestrian to be easily detected from all approaches. Motorists often react favorably to the presence of a well landscaped area, often reducing their driving speed. Thus the use of trees, shrubs and colorful native plants and other landscaping is a positive feature.

Lighting

Motorists need to see pedestrians standing waiting to cross and those that are crossing. Either direct or backlit lighting is effective. Some overhead signs, such as in Portland, Oregon and Seattle, Washington, use overhead lights that identify the pedestrian crossing and also shine down on the actual crosswalk.



Figure 12-6. At this midblock crossing in Venice, Florida, the motorist and pedestrian can see one another.

Grade Separated Crossings Midblock or intersection grade separated crossings are effective in a few isolated locations. However, due to their cost and their potential for low use, engineering studies should be conducted by experienced designers. If given a choice, on most roadways, pedestrians generally prefer to cross at grade. Chapter 20 of this document covers grade-separated crossings.

Midblock Signals

The placement of midblock signals is called for in some locations. The warrants provided in the *Manual On Uniform Traffic Control Devices* (MUTCD) should be followed. But even more caution needs to be provided for signalized midblock locations. Pedestrians feel frustrated if a signal is holding them back from crossing when there is an ample gap. Many will choose to cross away from the crossing, while others will dutifully push the activator button, not get an immediate response, and cross when there is a sufficient gap. A few seconds later, the approaching motorists must stop at a red signal for no reason which can encourage motorist disrespect for the signal in the future.

Thus, the best signal setup for a midblock crossing is a hot (nearly immediate) response. As soon as the pedestrian call actuator button is pushed, the clearance interval should be activated. This minimal wait time is a strong inducement for pedestrians to walk out of their way to use the crossing. Hot responses can often be used if the nearby signals are not on progression, or if there are no other signals in the area. Even if the nearby signals are on progression, a hot response may be permitted in off-peak hours. Midblock signals should be part of a coordinated system to reduce the likelihood of rear-end crashes and double-cycled, i.e., pedestrian cycles per one vehicle cycle at intersections to reduce pedestrian delay.²

If a midblock signal system is used it is important to place a pedestrian push button in the median. There will be times when some pedestrians start too late, or when older pedestrians lack time, even at 0.9 m (3.0 ft) per second to cross. In these rare events the pedestrian needs to reactivate the signals.

The Placement and Design of Driveways

The frequency, design and placement of driveways have more impact on pedestrians than has been assumed. If the driveway crossing is overly wide, if driveways are frequent, or if the entry and exit speeds are high, the pedestrian faces substantial discomfort and risk. Every driveway creates potential conflicts. Reducing the number of driveways reduces the number of conflict points. As a general policy, suburban roadway driveways should not be permitted within 34 m (110 feet) on the approach to a signalized intersection, nor within 70 m (230 feet) on the departure side. This principle also applies to side streets. If there is a dedicated right turn lane, driveways should be outside of this lane as well. The ADA requires a 36 inch flat space on top of all driveways. Where sidewalks are built at the back of curb, this may require that a bulbed out section be added to the top of each driveway.

Driveway entry and departure radii are calculated by a combination of factors including the width of the receiving driveway, the design vehicle and desired turning speed. Motorists should have very low turning speeds across most driveways. A highly restrictive radius of 3.1 m (10 feet) may be necessary where pedestrian volumes are high and where the motorist is out of the main stream of traffic, or on lower class roads. There will be many rural section driveways where a 7.6 m (25 foot) radius applies.

At least four levels of driveway openings may be considered. Residential entries minimize pedestrian impact by using a 3.7 m (12 foot) driveway. For small commercial driveways, a 7.3 m (24 foot) opening is often the minimum needed. For large retailers and gas stations where large WB-15 trucks enter, it is necessary to apply a 9.2 m (30 foot) width. For malls and other large volume driveways, limit the opening that a pedestrian must cross to 11.0 m (36 feet). If more lanes are needed, use a median to separate directionality and break the pedestrian crossing distance back to 11.0 m (36 feet) or less.

Left turns into driveways can be dangerous to pedestrians. An important tool in access management on many multilane highways is a right-in, right-out driveway. This design requires a raised channelized island. To provide for the pedestrian, use a full cut allowing the pedestrian to cross and store in this space, separating conflicts in time and space.

Urban driveways are infrequent, especially where pedestrian-oriented design is used. However, in some downtown locations, parking garages, open parking lots, and other exceptions exist. In these cases, openings should be narrow and highly restricted for low-speed entry (8-13 km/h (5-8 mph) maximum). It is preferable to have garage driveway openings on side streets where these crossing conflicts affect fewer pedestrians. It is also best to have most parking on the perimeter of a downtown. In this way, traffic into the center of town is minimized, and priority is given to the pedestrian. Once again the strategies of using right-in right-out only driveways may be a “best” design.

Parking and Safe Access to Buildings and Schools

Standards are needed for separating pedestrians and vehicles to all common destinations. These include schools, public and commercial buildings, commerce in or near neighborhoods, tourist or entertainment districts, and other locations. This chapter is adapted from pages II-11 through II-16 of the *Florida Pedestrian Safety Plan*. It recommends policies, practices, and specific treatments to address pedestrian needs in parking lots, drop-off areas, tourist areas, and entertainment districts.

Discussion

Florida commerce is aided greatly by achieving a friendly environment for walking in tourist and entertainment districts. Every effort must be made to give the highest possible priority to walking, anticipating that tourists will prefer to park their cars and travel on foot to the many commercial eateries and attractions (Figure 13-1). Likewise, efforts should be taken to discourage vehicle use.

As with pedestrian access from off-site, parking lot design should address pedestrian needs equally with vehicular needs. Proper

facility design can, to some extent, control pedestrian movement and reduce conflict areas (Figure 13-2).

Pedestrians should be provided separate facilities and encouraged to use them. Directness is often a major influence in a pedestrian's choice of route. Therefore, separated walkways should provide as straight a route from a parked vehicle to the destination as does the roadway.

Not enough consideration has been given to providing for pedestrian needs in parking lots.

Not enough consideration has been given to providing for pedestrian needs in parking lots. Although the convenience of car drivers may be the site developer's primary concern, numerous conflicts are created for the guest/customer through the layout of parking and interior circulation.

In most cases, pedestrians must trek through lengthy parking lots. Many lots create such an unwalkable atmosphere that many drivers illegally park at front entrances or drive up and down aisles to get



Figure 13-1. Pedestrians need safe and attractive entrances with walkways that do not conflict with vehicle traffic.

to the nearest available space. Lots traditionally fail to take into consideration the vast expanse of inhospitable space created for those walking in from the street. Numerous landscaping obstacles are created, blocking reasonable access by pedestrians and creating sight restrictions. Many lots encourage high speeds and allow for two-way traffic circulation in unwarranted areas. In other lots, the spaces are arranged in a “herring bone” design, which inconveniences pedestrians (Figure 13-3).

Figure 13-2. Pedestrian oriented designs such as this one minimize pedestrian conflicts with autos, creating a safe area to shop and relax.



Site Planning

Whenever practical, buildings should be sited near the roadway. The creation of unwalkable stretches of commercial parking lot strip development greatly increases the numbers of citizens finding trips outside of the car to be inconvenient and unsafe. Placing motor vehicle parking behind or alongside a building can reduce pedestrian/motor vehicle conflicts, and encourage walking. Unfortunately, many communities have zoning requirements that will not allow this type of development. If these zoning requirements cannot be changed, then separate pedestrian facilities should be constructed from off site to the building's entrance. Pedestrians should not be forced to share road pavement with vehicles, except in crosswalks.

Site developers should always consider the walking task. Meandering walks may look good but are not an efficient way of getting people from one place to another. Points of origin and destination need to be established and a direct walkway built between them. If a walkway does not provide the most convenient route, it will not be used often (Figure 13-4).

Planning also should consider future adjacent development and should provide for pedestrian traffic. Developers should set aside funds for future walkway construction as it may not be possible to predict accurately the route pedestrians will take between sites. When the adjacent site is completed, allow adequate time for paths to develop, then construct walks. See chapter 4 in TRB Report 294A for more details in this regard.¹

Recommendations

Parking Lots and Drop-Off Zones for School and Community Areas

1. To eliminate conflicts, provide traffic circulation that fully separates drop-off traffic from pedestrians. Traffic circulation should also minimize conflicts with pedestrians. Whenever practical, traffic circulation should provide a traffic-free pedestrian approach in the most common pedestrian arrival directions.

2. Far side bus stops have proven to reduce multiple-threat pedestrian crashes. However, near side bus stops are sometimes needed when a transit route turns, at crossings of some one-way streets, where it will prevent pedestrians from crossing a busy street, or when there is not a good far-side stopping location. Some transit agencies use a combination of near side and far-side stops at major intersections when there is heavy transfer traffic between two routes. However, a near side bus stop should be avoided in advance of an unsignalized marked crosswalk.

Midblock bus stops are sometimes located on long blocks when there is a midblock pedestrian generator such as a church, shopping center, or stadium. These types of bus stops may require a longer bus stop if the operator has to maneuver between parked vehicles.

All bus stops must be accessible to pedestrians in wheelchairs, and should be marked by a sign at or near where the door



Figure 13-3. This “herring bone” parking lot design is impractical for pedestrians to navigate.

of the bus is expected to stop. Bus stop signs, benches, or shelters and other street furniture should not obstruct access along the sidewalk or block access to the bus, and should be located far enough from the curb so they will not be hit by overhanging mirrors.

3. Control parking lot interior circulation, and provide sidewalk median access to parking.

4. Reduce pedestrian/automobile conflict points in all parking lot traffic circulation (Figure 13-5).

5. Reduce or eliminate driveway access on pedestrian emphasis streets, or minimize driveways by using a shared-use driveway (Figure 13-6).

6. Prohibit unsignalized left turns from roads into and out of all driveways at public schools, public buildings and large commercial buildings.

7. Plan parking garages with side or rear street entrances.

8. Provide separate access to garages for pedestrians.

9. Where pedestrian volumes are high, use raised pedestrian crossings, and illuminate the crossings.



Figure 13-4. If a walkway does not provide the most direct route, it will not be used often.



Figure 13-5. This effective treatment allows pedestrians safe, convenient access to this building from the sidewalk even while traversing a parking lot.

10. To the maximum extent practical, create one-way traffic flow to minimize pedestrian conflicts with vehicles.

11. Including the following treatments can promote the use of separated facilities:

- ◆ Walkway coverings (to protect walkers from the elements)
- ◆ Additional lighting of walkways (to increase individuals' sense of security)
- ◆ Landscaping which does not impede pedestrian mobility or create sight restrictions (may also provide shade and protection from the elements)
- ◆ Shopping cart storage locations
- ◆ Raised walkways (eliminates "puddle jumping" during wet weather)
- ◆ Drainage system design (channeling rain water into the roadway discourages the roadway's use by pedestrians during wet weather)

12. The desirable walkway width is 1.5 m (5 ft) of usable walking space. When walkways are constructed between rows of parking stalls, the facility should be at least 3.4 m (11.2 ft) in width to allow 0.8 m (2.6 ft) of automobile overhang with 1.5 m (5 ft) of walking space.

13. Bulbouts should be provided at all pedestrian/vehicle facility intersections to shorten the distance a walker must cross (Figure 13-7).

14. Crosswalks should be well marked to alert motorists and pedestrians (Figure 13-8). Heavily used crosswalks should be raised to slow vehicular traffic.

15. All facilities must be handicap accessible, not only to provide for the needs of handicapped people, but to allow shopping carts to be pushed easily on the walkways.

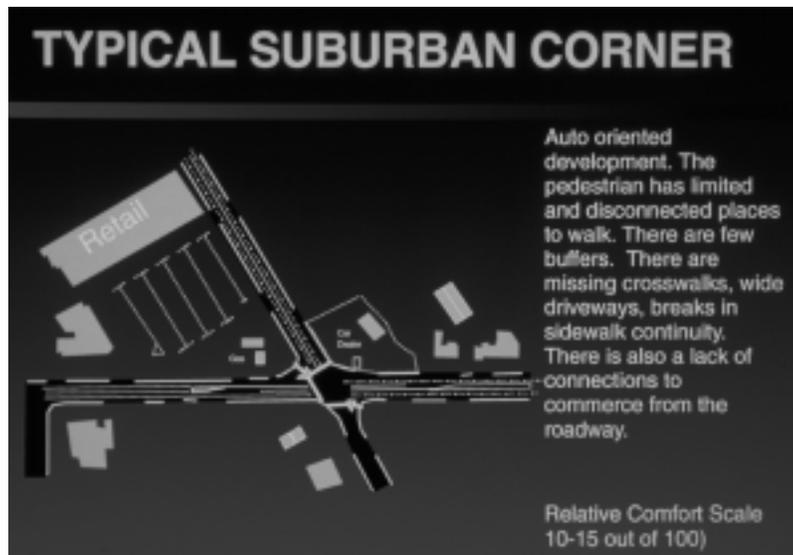
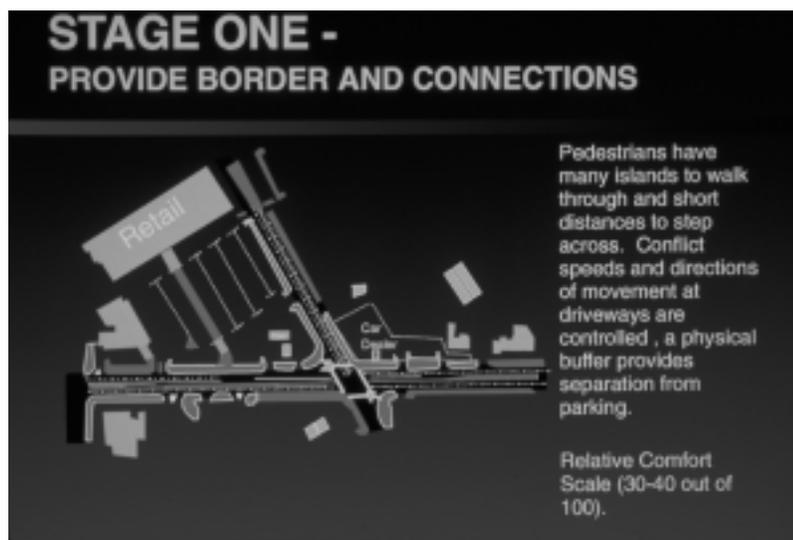


Figure 13-6. Unrestricted driveway access creates eight potential conflict points at every driveway (left). A raised median and consolidating driveways reduce conflict points (below left).



Simplify and Calm Motor Vehicle Movement to Promote Pedestrian Safety in Parking Lots

Motor vehicle facilities also should be designed to promote pedestrian safety. Traffic calming methods should be used throughout a lot's design. Vehicular circulation planning should:

- ◆ Encourage the use of perimeter roads by vehicles. All perimeter roads should promote pedestrian traffic from off-site by providing conspicuous crosswalks in convenient locations.
- ◆ Place roads away from buildings because
- of the high concentration of pedestrian traffic. (Emergency vehicles must have access to the area adjacent to a building).
- ◆ Arrange parking aisles to work in pairs (one-way streets shaped to form a "U"), when near buildings, or other destinations.
- ◆ Create one-way parking aisles to allow for simpler crossing by pedestrians. One-way use of aisles may need to be encouraged with signage or other means.
- ◆ Place parking spaces at an angle. Angled parking provides a greater chance for motorists and pedestrians to see each other.



Figure 13-7. Bulbouts (or corner flares) shorten pedestrian crossings distances and slow traffic speeds.

In High Concentration Tourist Zones

Tourist or entertainment zones should be as free of motor vehicle traffic as practical. Planning and design incentives should favor a walking environment over a driving environment. Traffic should circulate around, not through, popular tourist or entertainment zones.

1. Consider auto-free zones. Otherwise, minimize commercial business vehicle access, use one-way pairs, and use strategies to prevent motorist “cruising.” Keep vehicle speeds to the absolute minimum. Provide sufficient garages to encourage parking and walking.

2. Fully illuminate all roadways and intersections. Provide frontal approach illumination of pedestrians at all crosswalks.

3. Provide illuminated overhead signs on all midblock crossings. Use traffic signal heads where warranted. Also provide minimum width crossings by using bulbouts and other strategies at all midblock crossings.

4. Provide appropriate width sidewalks. Eliminate driving lanes to favor pedestrian circulation and movements.

5. Allow for increased walking activity, standing, bus waiting zones and window shopping. Recess street furniture to create

obstacle free pedestrian zones.

6. Provide maps and information signing. Maximize the use of international symbols. Provide sidewalk imbedded maps or waist level maps. Provide color/symbol coded walking trails (Figure 13-9).

7. Provide traffic calming strategies such as side street closures for parking and pocket parks. Set the maximum speed to 40 km/h (25 mph) and highly enforce it. Provide special crossings such as raised crossings, zebra crossings, Barnes Dance, or bulbouts.

8. Eliminate or greatly reduce vehicle turning movements. If auto-free zones are not practical during work days, consider designing auto-free zones for evening and special event times.

9. Reduce turning speeds to 24 km/h (15 mph) or lower through design of intersections and driveways.

10. Eliminate left turns where practicable.

11. Evaluate Right-Turn-On-Red (RTOR).

In Entertainment Districts

Many people walking or driving in entertainment districts at night are under the influence of alcohol. These motorists and pedestrians commonly exhibit unpredictable behavior and may be unable to react in time to avoid collisions. As many as 47 percent of pedestrians killed in Florida were impaired by alcohol or drugs (Figure 4-13). To increase pedestrian safety:

1. Eliminate far-side parking for all taverns.

2. Encourage zoning that creates entertainment districts accessible by side streets. Consider auto free zones where “bar hopping” is frequent. Where taverns are permitted on both sides of a main roadway, consider reducing traffic speeds to 32 km/h (20 mph), and illuminate streets fully. Provide pedestrian refuges.



Figure 13-8. Enhanced pedestrian crossings assist the designer where pedestrian traffic and movements are dominant or preferred.

References

1. Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas. TRB Report 294A, Transportation Research Board, Washington, DC.

Figure 13-9. Informational signs and maps help tourists immensely in some situations.



School Access and School Zone Practices

Traffic control in school areas is a highly sensitive subject. If all the demands of parents and others were met, there would be many more police, adult crossing guards, traffic signals, flashers, signs, and crosswalks. However, past experience has shown that school crossing controls requested by parents, teachers and others are often unnecessary, costly, and tend to lessen the respect for traffic controls that are warranted. Safe and efficient traffic control can best be obtained through uniform application of realistic policies, practices and standards developed through engineering studies.

Pedestrian safety depends in large part on public education and an understanding of accepted methods for efficient traffic control. Nonuniform procedures and devices cause confusion among pedestrians and vehicle operators, and can contribute to crashes. In order to achieve uniformity of traffic control near schools, comparable traffic situations must be treated in the same manner. Each traffic control device and control method must fulfill a specific function related to specific traffic conditions. Pedestrians under the age of 15 experience a collision involvement rate twice that of all pedestrians. The youngest

students of five to eight years in age are particularly overinvolved in pedestrian accidents. They cannot be treated as short adults. Young children are not able to judge the speed of approaching vehicles, nor the adequacy of gaps in traffic, and their peripheral vision is not well developed. Young children are also often inattentive and careless in crossing streets. Despite this, the trip a child walks to and from school, in general, is a safer one in relation to other pedestrian activities of children.

Pedestrians under the age of 15 experience a risk of pedestrian collisions twice that of all pedestrians.

School Safety Program

School area traffic safety requires a partnership between traffic engineers, school officials, parents and students. The lack of commitment by any one of the partners will seriously diminish the safety program.

A school area traffic safety program consists of two parts: The physical facilities



Figure 14-1. Properly designed facilities in school zones are necessary to create a safe environment for children.

and the operation plan. Sidewalks and walkways separate school children from the flow of vehicular traffic, and along with fencing, driveway and school location, are a key part of the physical facilities for walking school children. The operation plan consists of the traffic control devices and the supervisory/control elements for the school walking trip.

The selection of the appropriate school zone traffic control is dependent upon the traffic characteristics, school location, the number of students crossing, and the ages of the students. In general, the most effective school zone traffic control includes well-trained adult crossing guards. On-site school

safety near bus loading areas, driveways, and parent loading zones often require adult supervision, generally by teachers or teacher aides.

School Location and On-Site Safety

Site selection and school layout are some of the most important factors in obtaining safe traffic conditions near schools. Donated land or land presently owned by the school district may not always be the best site for a school. Sites should be of sufficient size to accommodate the school buildings, playgrounds and athletic areas, bicycle and motor vehicle parking areas, bus loading areas and parent pickup zones.

The school site must be readily accessible from the street network to avoid traffic congestion that may put pedestrians at risk. In addition, schools must be accessible to students in wheelchairs. It may also be advisable to provide separate bikeways and sidewalks at schools or wider sidewalks to accommodate the many users adjacent to schools.

School sites should have separate parking areas for teachers, students and visitors. Bus loading areas should always be separated from all other vehicle traffic. Driveways should be located to minimize crossings by students, and students should never be required to cross parking areas.

Elementary schools and middle schools should be located inside residential neighborhoods, close to the students that the school is serving. The need to cross major streets on foot should be minimized. Elementary schools should not be located on high speed major streets. It may be best for school districts to change school boundaries or institute busing rather than exposing young children to crossings of wide arterial streets with high volumes or high speed traffic.

Sites for high schools are generally larger, require substantially more on-site parking areas, and are generally located on collector streets or major arterials. Driveway and school crossing locations should be coordinated with local traffic engineers to optimize existing traffic control and provide optimal spacing for future traffic signals.

Parking shall be restricted at driveways and in advance of all school crossing areas. Such parking restrictions protect school children by maximizing their visibility to motorists.

Fencing or other pedestrian barriers should be used to control student crossings and direct students to optimal crossing locations that can be better supervised. Crossing and student loading areas adjacent to the school should be reviewed for street lighting, particularly where student activity occurs during the hours of darkness. Street lighting also helps reduce the incidence of vandalism at the school site.

School Operating Plan

Each school should establish a program which includes a safe walking trip to school, utilizing existing traffic controls to the extent practical, and work with local officials to identify areas requiring improvements in accordance with the ITE Recommended Practice School Trip Safety Program Handbook.¹ In addition, a supervision and control plan should be adopted by each school.

The six steps in developing a school program based upon the “School Trip Safety Program Handbook” are:²

1. Set up the school trip safety process.
2. Identify deficiencies in routes.
3. Develop route maps for safe routes to school.
4. Select route improvements and control measures.

5. Implement route improvements.
6. Evaluate routines periodically.

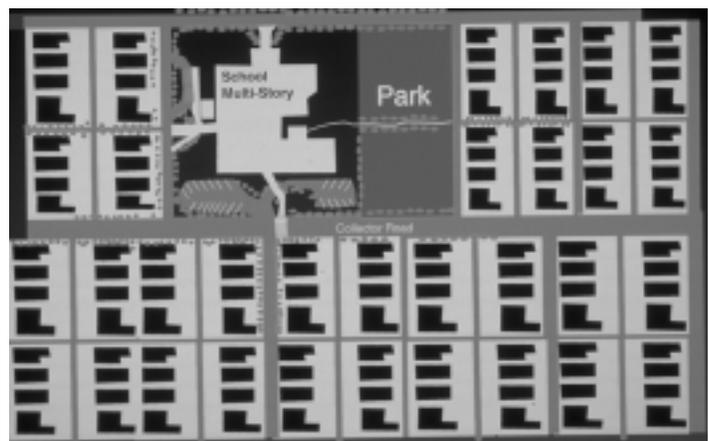
Traffic Controls in School Zones

Sidewalks and walkways should exist along all designated safe school routes. Crosswalk markings are helpful in designating and directing students along the safe school route. Traffic signals are sometimes needed to create adequate gaps in vehicular traffic at school crossings to allow children time to cross major streets safely. Speed tables with crossing markings on top can be placed at school crossings. Speed tables function much like speed humps (see Chapter 15) in that they slow down motorists. Signs should be placed ahead of the speed tables to alert drivers of their presence and that students may be crossing.

Factors such as sight distance, accident history, vehicle speeds, street width, age of students and other location and traffic characteristics should be considered in selecting the specific type of traffic control appropriate at each school crossing location.

According to the school crossing warrant, traffic signals are generally warranted at established school crossing locations when the number of gaps in the traffic stream during school crossing periods is less than the number of minutes

Figure 14-2. Example of school site layout.



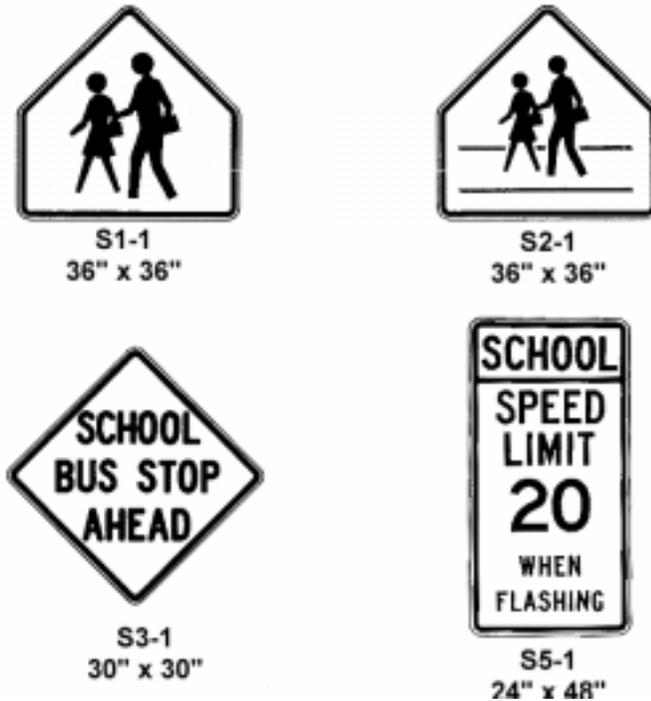


Figure 14-3. Warning signs used to alert motorists to schools and school crossings.

in that same period.³ Traffic signals should not be installed if there are only small numbers of students crossing; instead, an alternate crossing location or mode of transport should be considered. If installed under the School Crossing warrant, traffic signals should be coordinated with adjacent signals, and operate in an actuated mode to minimize traffic disruption. The signals should be equipped with pedestrian signal indications and pedestrian push buttons, and the designated crosswalks should be marked. School traffic signals may require adult crossing guards, particularly for younger students.

School Advance warning signs (S1-1) should be installed in advance of all school buildings and at major school crossings. The School Crossing sign (S2-1) is not well understood by motorists and is of limited value. When used, the S2-1 School Crossing sign shall be placed at the school crosswalk, and must be preceded by the S1-1 School Advance warning sign. The SCHOOL BUS STOP AHEAD sign (S3-1) is intended for use when a school bus that has stopped to

pick up or discharge riders is not visible for 150 m (500 feet) in advance because of limited sight distance. Reduced speed limits may be established in school zones. One type of school speed limit sign consists of a top panel with the legend SCHOOL, a speed limit sign, and a bottom panel with a legend such as WHEN CHILDREN ARE PRESENT. Alternatively, flashing beacons can be used in conjunction with the SCHOOL SPEED LIMIT XXX WHEN FLASHING sign (S5-1) to advise motorists to slow down in school zones when school children are expected. These signs are shown in Figure 14-3.

All decisions on the use of traffic control devices near schools should be coordinated with the school principal or district transportation director. The school principal should be contacted to coordinate any traffic control changes or construction activities near the school, even if not directly related to the school.

School Crossing Guards

Supervision of crossing school children should be carried out by adult crossing guards and may be supplemented by members of the school safety patrol (Figure 14-4). Control of vehicular traffic can only be exercised by police officers.

Adult guards should be considered when special problems exist which make it necessary to assist school children in crossing safely. The primary functions of crossing guards are:

- ◆ To instruct, direct and control students crossing the streets and highways at or near schools.
- ◆ To assist teachers and parents in the instruction of school children in safe crossing practices.

Crossing guards are appropriate for high school students under certain circumstances exist. However, many high school students resent being controlled by a crossing guard.

Most older students have driver's licenses and may be more likely to drive than to walk to school. Such student drivers may create a hazard for pedestrians.

Adult crossing guards should operate under the jurisdiction of the local school district, police department, or traffic engineering department. Crossing guards should normally be trained employees (instead of unpaid volunteers) for reliability and insurance purposes. The decision on where to place adult crossing guards should be made jointly by the school principal or transportation director and local traffic engineer.

In the absence of other handbook, the following criteria may be used to select appropriate locations for crossing guards:

- ◆ Uncontrolled marked crosswalks, where there is not a controlled crossing location within 180 m (600 ft), and
 - ◆ Urban Areas - 40 or more students cross a street where there are more than 350 vehicles per hour during each of two hour crossing periods, or Rural Areas - 30 or more students cross a street where there are more than 300 vehicles per hour during each of two hour crossing periods.
- ◆ When speed limit exceeds 60 km/h (40 mph), the rural criteria should be used.
 - ◆ Stop sign controlled intersections of collector or arterial streets where there are more than 500 vehicles per hour during any period when children are going to or from school, and there are high numbers of students crossing.
 - ◆ Traffic signals where there are high numbers of students crossing and high turning volumes or wide streets.

Above all else, engineering judgment should dictate when and where adult crossing guards are needed based on an engineering study.

It is recommended that crossing guards wear an easily recognized uniform. They are required to wear a fluorescent and reflective safety vest, use a stop paddle, and/or wear fluorescent gloves and use a whistle. In most parts of the U.S., school guards seldom wear uniforms identical to the police, and often a safety guard cap and reflective, bright orange vest worn over civilian clothes is all that is used as the uniform. Crossing guards should be provided with bright yellow or orange raincoats for use during wet weather conditions.



Figure 14-4. Crossing guards should not simply hold up a sign and let the children run across the street. Scenes such as this one prove the need for a crossing guard training program.

Crossing Guard Training

Florida has developed a standardized training course for crossing guards throughout the state to comply with section 234.302, Florida Statutes. The Statute requires all counties with 75,000 or more population to train and certify school crossing guards in accordance with handbook developed by the Florida Department of Transportation. The goal is for all school crossings to be conducted in the same manner and to eliminate confusion to motorists as well as students.

Two types of courses are available, trainers and guards. The 12-hour trainer's course covers the following:

- ◆ the Florida School Crossing Guard Training Guidelines;
- ◆ Florida/National Pedestrian/Bicycle Crash Statistics;
- ◆ crash causation;
- ◆ visibility and conspicuity;
- ◆ traffic control devices including the "WALK", flashing "DON'T WALK", and steady "DON'T WALK";
- ◆ purpose, goals and responsibilities of the school crossing guard;
- ◆ limitations of children in traffic;
- ◆ public image;
- ◆ uniforms;
- ◆ legal/risk management aspects of the job; and
- ◆ most importantly, the standardized procedures for conducting a school crossing

The standardized procedures address proper positioning of guards, alert signals to motorists and pedestrians, and proper entrance/exit into streets and highways. The procedure also includes reminding the children to look left-right-left and over their shoulder before entering the roadway even

when the guard says it is clear.

Once state certified as a trainer, the certified trainer will conduct school crossing guard training classes consisting of four hours of classroom training, two hours of in-the-field training, and two hours on-site observation at the guard's post. The guard will then be state certified. All guards must be retrained annually.

There is no fee for the course and training manual. However, there is a supplemental audiovisual kit containing a 15-minute training video, and a set of 80 slides.⁴ available for \$25. Kits can be obtained at the training sessions or by writing to the Florida Department of Transportation School Crossing Guard Program.

Crossing guards should also be provided with an identification card, a list of responsibilities, and a list of phone numbers in the event of an emergency or if other concerns arise with students or traffic conditions at their crossing.

School Safety Patrol

School safety patrols offer a way of extending traffic safety education beyond the classroom. Careful instruction and supervision of patrol members are essential if the patrol is to be efficient and helpful to other students.

If used, the school safety patrol should be organized and administered by each school, with the school principal responsible for determining the overall school safety patrol policy. Administrative responsibility for actual operation of the patrol may be delegated to an individual teacher. The school safety patrol members should be selected from the upper grade levels, preferably not below the fifth grade. Qualities such as leadership and reliability should be considered in selection, and patrol service should be voluntary and open to all who qualify. Patrol members should have written approval of parents or guardians.

References

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2. Manual on Uniform Traffic Control Devices for Streets and Highways, Report No. FHWA-SA-89-006, Federal Highway Administration, Washington, DC, 1988.
3. Florida School Crossing Guard Program: Training Manual, Florida DOT, State Safety Office, 605 Suwannee Street, MS 82, Tallahassee, FL, 32399-0450, September 1993.
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Traffic Calming Strategies

15

Introduction

Local residential access streets are designed to carry low traffic volumes (less than 2,000 vehicles/day) at low speeds. As traffic volumes and speeds increase on a particular residential street, there is a significant decrease in the actual and perceived quality of life for the residents who live on that street because of safety, noise, and pollution. It has been found that volumes exceeding 2,000 vehicles/day are considered a problem by local residents.

Local efforts to improve the pedestrian environment on neighborhood streets should try to reduce the number of possible conflicts (and the potential for injury when the conflicts involve speeding traffic) between cars and other users (e.g., pedestrians and children on bikes). Neighborhood traffic control measures serve this purpose by reducing the speeds and/or volumes of motor vehicle traffic. An agency may find it necessary to rate the relative need of each location when allocating funds for popular traffic control measures. In cases where public funding is not available, neighborhoods may be willing to pay the cost of installing these measures themselves, as long as the proposed location is reasonable and otherwise fits the program criteria.

What Is Traffic Calming?

Traffic calming involves strategic physical changes to streets to reduce vehicle speeds and to decrease the cars' dominance. Traffic control devices are designed and located to keep through traffic on arterial roads. They do so by making the travel time on the residential streets and downtowns greater than the travel time on the adjacent arterial roads. Traffic calming also seeks to control the behavior of the remaining drivers. Many traffic calming devices can be retrofitted: speed humps, chicanes (devices that cause a driver to move left/right as they travel along the street), speed tables, and modern roundabouts. More extreme examples are street closures or restricted access.

Traffic control devices are designed and located to keep through traffic on arterial roads.

During the initial street design, other traffic calming treatments can be built into the street: narrower streets, street pavers instead of asphalt, and different street designs. Many traffic calming schemes have the following common aims:

Traffic Calming Strategies

Figure 15-1. These medians and bulbouts calm traffic on this revitalized main street.



- ◆ Improve safety for people, especially children, by controlling conflict points, reducing vehicle speeds and vehicle volumes.
- ◆ Improve the physical environment by lowering vehicle generated noise, pollution, and disruption.
- ◆ Create a green and inviting streetscape.
- ◆ Increase security by bringing back a higher number of pedestrians.

Most residents request traffic calming for a single street or block. However, traffic calming applied to one street usually affects a much larger area, either by restricting access to that area or by diverting traffic to nearby streets. It is best to treat an entire neighborhood with traffic calming strategies, and get the entire neighborhood involved in the decision-making process on the strategies to select. Other agencies, such as police, fire, sanitation and transit departments, need to be involved if access is affected, as well as the local school district if a diverter or street closure will affect school bus service.

In Europe and Australia, traffic calming techniques began in 1970. Their effectiveness has been proven and many now appear to be part of the original street

design rather than an afterthought. To reach this position, there was a strong desire to change the balance, to experiment, to learn from others, and to do the “right thing” for all people.

Traffic calming has not been extensively used in most part of the U.S. In Florida and other states, traffic calming offers promise as a means of managing motor vehicles. Traffic calming techniques need to be implemented and evaluated, and perhaps modified, to work in American settings.

Often, preliminary investigations will reveal if the problem is better treated by other programs. If there is poor sight distance at an intersection, clear the sight lines. A large number of crashes at a single intersection can be due to a wide range of items which would require a safety study.

Alternatively, residents unhappy with the streetscape identify trees and shrubs as part of a traffic calming scheme. Instead of landscaping, building a park so children do not have to play on the “unsafe” street may be more appropriate. Poor land zoning that creates traffic problems or truck traffic may be better treated by rezoning or by working with the company managers to reroute their trucks.

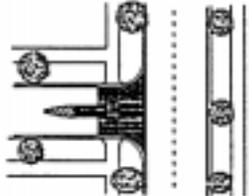
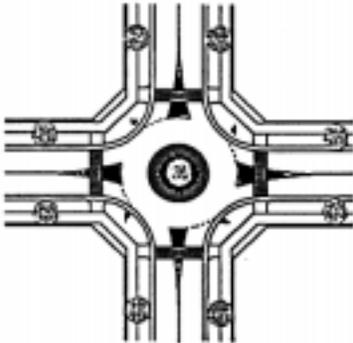
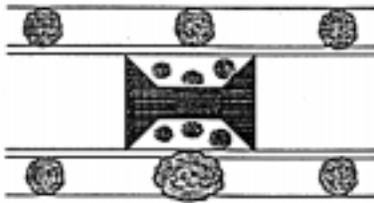
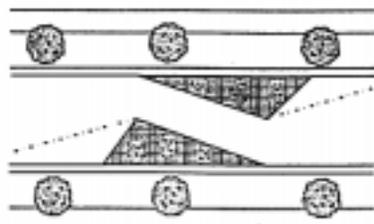
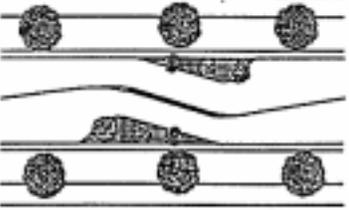
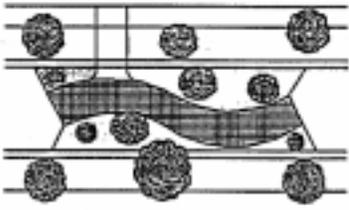
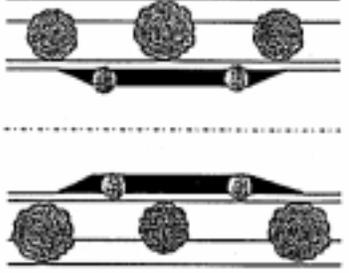
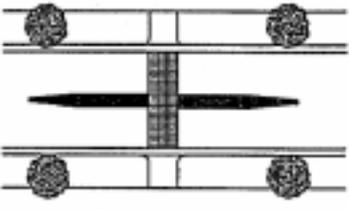
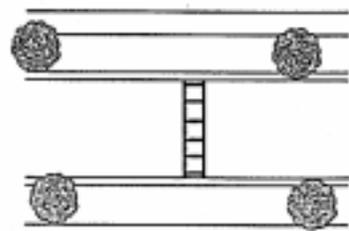
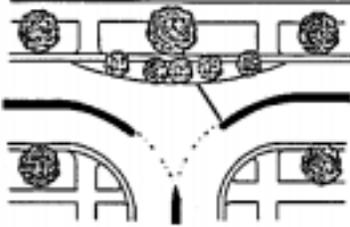
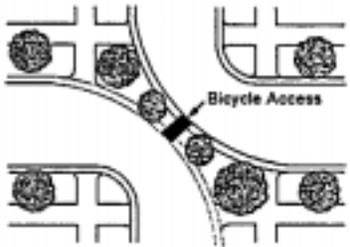
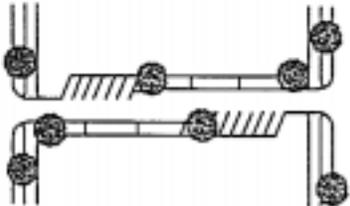
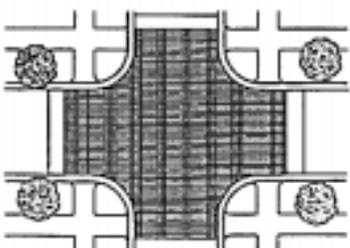
DEVICE	ADVANTAGES	DISADVANTAGES
 <p>1. Gateway treatments</p>	<p>Positive indication of a change in environment from arterial road to a residential street.</p> <p>Reduces entry speeds.</p> <p>Reduces pedestrian crossing distance.</p> <p>On very wide streets provides space for landscaping in the median.</p>	<p>Low speed of turning vehicles may restrict arterial road flow.</p>
 <p>2. Roundabouts</p>	<p>Reduces crashes by 50 to 90 percent when compared to two-way, four-way stop signs and traffic signals by reducing the number of conflict points at intersections.</p> <p>Reduces vehicle speeds .</p> <p>Provides space for landscaping.</p> <p>Cheaper to maintain than traffic signals.</p> <p>Effective at multi-leg intersections.</p> <p>Provides equal access to intersections for all drivers.</p> <p>Provides a good environment for cyclists.</p>	<p>May be restrictive for larger vehicles if designed to too low a speed. Providing a mountable apron this limitation can be minimized.</p> <p>May require additional lighting.</p> <p>If left turns by large vehicles are to be accommodated then right-of-way may have to be purchased.</p>
 <p>3. Single-lane slow point</p>	<p>Reduces vehicle speed.</p> <p>More effective when used in a series.</p> <p>Imposes minimal inconvenience to local traffic.</p> <p>Pedestrians have a reduced crossing distance and so have a safer crossing.</p> <p>Provides space for landscaping.</p> <p>Provides a visual obstruction.</p>	<p>Landscaping needs to be controlled to ensure visibility is reduced.</p> <p>Contrary to driver expectation of unobstructed flow.</p> <p>Can be hazardous for drivers and cyclists if not designed and maintained properly.</p> <p>Confrontation between opposing drivers arriving simultaneously could create problems.</p>
 <p>4. Single-lane angled slow point</p>	<p>As for (3).</p>	<p>As for (3).</p>

Figure 15-2. Traffic calming—advantages and disadvantages.

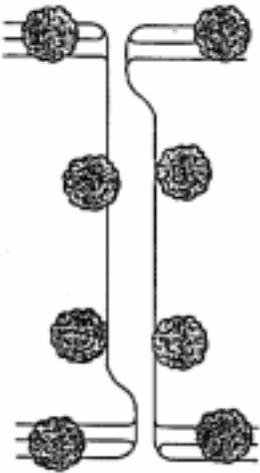
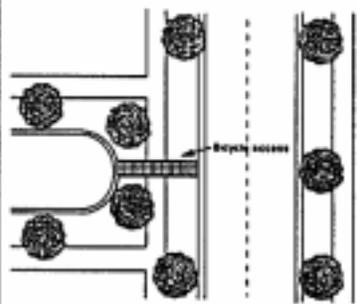
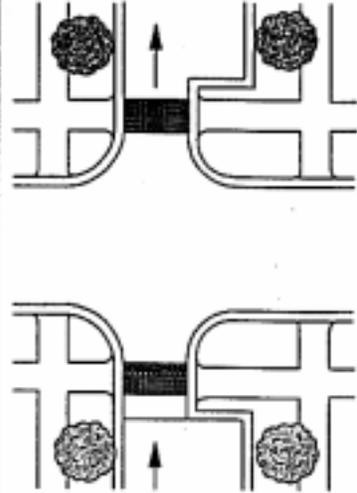
Traffic Calming Strategies

DEVICE	ADVANTAGES	DISADVANTAGES
 <p>5. Two-lane angled slow point</p>	<p>As for (3), except that pedestrian safety is less than (3).</p>	<p>As for (3).</p> <p>It is less effective in controlling speeds because drivers can create a straighter through movement by driving over centerline.</p>
 <p>6. Driveway link</p>	<p>As for (3).</p> <p>Provides a greater visual obstruction.</p> <p>Provides a large area for landscaping.</p> <p>Length of device is limited by cost.</p> <p>A very effective method of changing the initial impression of the street. If done right drivers will not be able to see through. Appears as a road closure yet allows through movements.</p>	<p>Increases the area of landscaping to be maintained by residents.</p> <p>Cost is greater than many other devices. Therefore better to be installed in conjunction with street reconstruction.</p>
 <p>7. Two-lane slow point</p>	<p>Causes only minor inconvenience to drivers.</p> <p>Regulates parking and serves to protect parked vehicles as the bulb-outs can be installed in no-parking areas to stop illegal parking.</p> <p>Reduces pedestrian crossing areas.</p> <p>Provides space for landscaping.</p>	<p>Not very effective in slowing vehicles or diverting through traffic.</p> <p>Only partially effective as a visual obstruction.</p>
 <p>8. Mid-block median</p>	<p>Provides a refuge for pedestrians and cyclists.</p> <p>Can improve the streetscape if landscaped.</p>	<p>Will only create a limited reduction in vehicle speeds.</p>
 <p>9. Speed bump</p>	<p>Reduces vehicle speeds in the vicinity of the bump. Better if used in a series at 300 to 500 feet spacing.</p>	<p>Creates noise particularly if there are loose items in vehicles or trailers.</p> <p>If not well designed drivers will put two wheels in the gutter to reduce impact.</p> <p>A harsh cheap solution. There are more effective and nicer treatments.</p>

Traffic calming — advantages and disadvantages.

DEVICE	ADVANTAGES	DISADVANTAGES
 <p>10. Modified intersection</p>	<p>Reduces vehicle speeds.</p> <p>Reduces through traffic along the top of the Tee.</p> <p>Necessary to enforce changes in priority from one street to another.</p>	<p>Can be hazardous for vehicles and cause confusion regarding priority if incorrectly or inadequately designed.</p>
 <p>11. Diagonal road closure</p>	<p>Eliminates through traffic.</p> <p>Provides area for landscaping.</p> <p>Reduces conflicts.</p> <p>Increases pedestrian safety.</p> <p>Can include a bicycle pathway connection.</p>	<p>Will inconvenience residents in gaining access to their properties.</p> <p>May inhibit access by emergency vehicles unless the street names are changed.</p> <p>Will move through traffic to other streets if not back to the arterial.</p>
 <p>12. Shared zone</p>	<p>Provides a low speed shared environment that is safe for all users.</p> <p>Improves amenity without restricting access.</p> <p>Provides flexibility for on-street parking.</p>	<p>High cost unless part of original design.</p>
 <p>13. Intersection hump</p>	<p>Slows vehicles in the most critical area and so helps to make conflict avoidance easier.</p> <p>Highlights intersection.</p>	<p>Increases difficulty of making a turn.</p>

Traffic calming — advantages and disadvantages.

DEVICE	ADVANTAGES	DISADVANTAGES
 <p>14. Modified street design</p>	<p>Reduces vehicle speeds without reducing access.</p> <p>Enhances amenity.</p> <p>Provides a large area for landscaping.</p> <p>Reduces the visual sight line.</p>	<p>High cost of retrofitting. Better as part of street reconstruction or initial construction.</p>
 <p>15. Street closure</p>	<p>Eliminates through traffic.</p> <p>Reduces the speed of the remaining vehicles.</p> <p>Improves safety for all other street users.</p>	<p>Reduces emergency vehicle access unless street is renamed.</p> <p>Reduces access to properties for residents.</p>
 <p>16. Partial street closure</p>	<p>Reduces through traffic in one direction and partially in the other.</p> <p>Allows two-way traffic in the remainder of the street.</p>	<p>Reduces access for residents.</p> <p>Emergency vehicles only partially affected as they have to drive around partial closure with some care.</p>

Traffic calming — advantages and disadvantages.

Two basic approaches can be used to facilitate pedestrian movement, safety, and general livability in neighborhoods: 1) installing physical controls requiring vehicular diversion; and 2) managing traffic in place. The primary difference between the approaches is the extent to which conflicts between vehicles and pedestrians are separated.

Figure 15-2, which was prepared by Michael Wallwork of the Genesis Group in Jacksonville, lists the advantages and disadvantages of 16 traffic calming devices.¹ This chapter presents handbook for several, such as roundabouts, diagonal road closures or diverters, and modified street designs like chicanes.

Controls Involving Traffic Diversion

Neighborhood traffic control measures involving traffic diversion are geometric (physical) features that force or prohibit a specific action such as a turn or a through movement. Geometric features have the advantages of being largely self-enforcing and of creating a visual impression that a street is not intended for through traffic. Their disadvantages relative to other devices are their high cost, their negative impact on emergency and service vehicles, the loss of convenient access to some parts of a neighborhood, and a resulting increase in traffic on nearby streets. They are also static and must be appropriate at all hours of the day and night.

Street Closures

Street closures may be appropriate where large volumes of through traffic or turning vehicles create unsafe conditions in a residential area. They are generally installed with curbs forming street-ends or diagonals across intersections that eliminate through vehicular traffic. Bollards allow free access to pedestrians and bicyclists. They eliminate motor vehicle traffic, but can be removed for entry by emergency vehicles. Landscaping is often included with these

measures to serve as a visual cue to motorists, and as a visual enhancement for the neighborhood. Street closures may adversely affect access by emergency vehicles. They may turn out to be unpopular with residents where access is made more difficult. Thus, prior consultation with residents is necessary at early stages of planning and design to minimize opposition.

In a partial street closure, access to or from one end of a street is prohibited by a physical barrier and a no-entry sign. The street remains two-way but access from the closed end is permitted only for bicyclists and pedestrians.

Driveway links are narrowed roadway segments with textured or colored paving and ribbon curbs or landscaping to mark the edges. While not a true street closure, driveway links reduce through traffic because drivers cannot see through them and therefore perceive them as street closures. These cost more than many devices, though, and the landscaping must be maintained.

Cul-de-sacs

An intersection cul-de-sac is a complete closure of a street at an intersection, leaving the block open to local traffic at one end, but physically barring the other. Thus, a cul-de-sac represents the most extreme technique for deterring traffic short of barring all traffic from the street in question. A turnaround must be constructed at the closed end of the street of sufficient size to allow sanitation trucks and emergency vehicles to turn around. A cul-de-sac can be designed to allow emergency vehicles to pass through, by use of mountable curbs or removable barriers. These designs will generally allow other vehicles to pass through and constant enforcement may be required to prevent those other vehicles from passing through.

Since a cul-de-sac is completely effective at its task of preventing through traffic, the choice of where and whether or not to use it depends largely on other aspects of traffic movement. For example, a cul-de-sac is less desirable in the vicinity of fire, police, or

ambulance stations where emergency vehicle movements are frequent. It is also less desirable in areas where multi-alarm fires are more likely. The provision of other services that require large vehicles, such as school bus routing and sanitation pickup, needs to be considered when designing cul-de-sacs. A cul-de-sac is desirable adjacent to schools and parks, where the vacated street can be converted into additional play space.

Cul-de-sacs are extremely effective at limiting traffic volumes. They normally reduce traffic to that generated by the land uses that are adjacent to the street. Although a cul-de-sac is not a speed attenuating device, it may serve the purpose since the street comes to a dead end. However, cul-de-sacs will generally require additional right-of-way dedication on local streets and must be large enough to accommodate a sanitation truck or fire truck that needs to turn around. Cul-de-sacs limit access for residents as well as nonresidents and if overused, can have the effect of confining people in their neighborhoods.

A cul-de-sac placed within one block, rather than at one end, performs the same function as an intersection cul-de-sac.

Midblock cul-de-sacs are typically used when two different traffic-generating land-use types are adjacent to each other. An example of this is when a commercial area is backed by a residential area. The cul-de-sac is placed at the transition so that the commercial area is afforded the access, yet its traffic does not intrude into the residential area.

Diagonal Diverters

A diagonal diverter is a barrier placed diagonally across an intersection to convert the intersection into two unconnected streets, each making a sharp turn. The primary purpose of a diagonal diverter is the same as that of forced-turn channelization to break up the routes, making travel through a neighborhood more difficult, while not actually preventing it.

Studies of systems of diverters have shown that traffic on streets with diverters can be reduced from 20 to 70 percent depending on the system of devices in the area. In these studies, traffic on adjacent streets with no diverters increased by as much as 20 percent. These devices have little to no effect on speeding, other than in

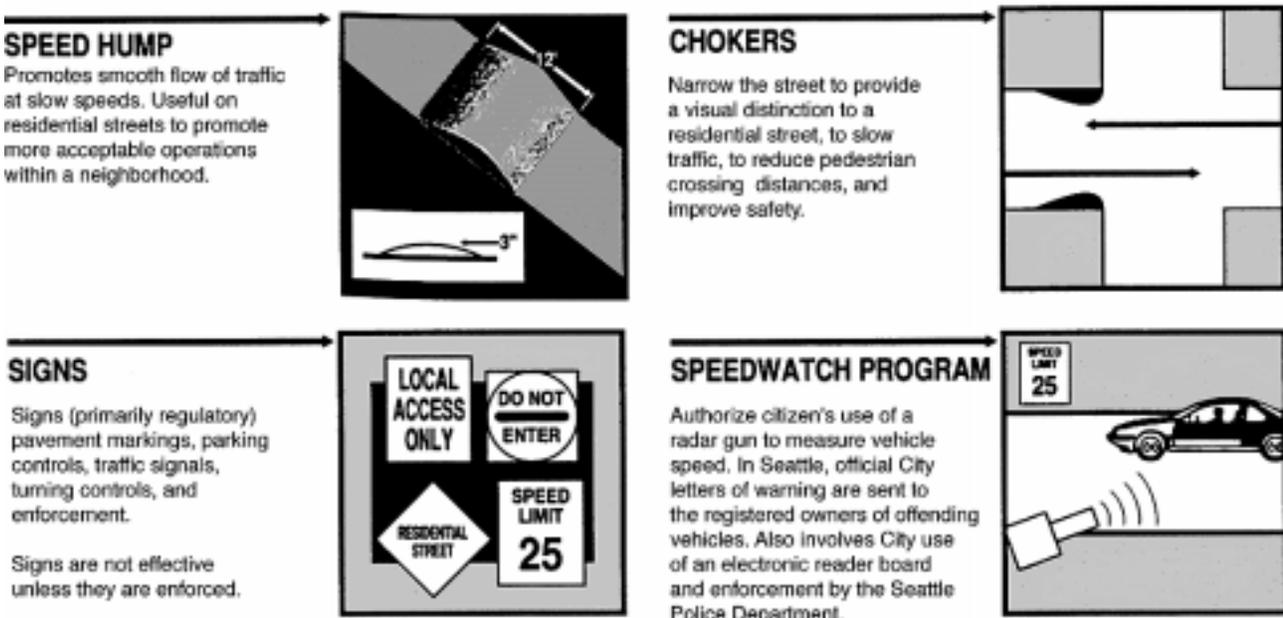


Figure 15-3 Traffic control measures used to manage traffic in place.

the immediate area of the diverter, and a minimal effect on traffic safety.

Diverter and cul-de-sacs should only be used in cases where a reasonable arterial or access street alternative is available and easily accessed. Otherwise, vehicular traffic will simply reroute to other residential streets and likely result in similar problems on those streets. Diverted traffic should be directed to the nearby arterial street, and signage should be used with diverters to discourage motorists from entering the neighborhood.

Public participation in determining use and location of diverters is essential to successfully address traffic concerns of a neighborhood. Residents should have a voice in the design and operation of the streets on which they live. Community, neighborhood, and political forces also need to be in favor of these controls before proceeding.

Careful thought needs to be given to circulation patterns resulting from diverters/closures. A trial installation is strongly recommended by use of barricades, barrels or guardrails. A trial period on the order of six to eighteen months gives ample time to collect data showing new traffic patterns and to evaluate community support again. In the event of permanent installation, small park features can be included in the diverter/closure area to further enhance pedestrian and neighborhood surroundings.

Managing Traffic in Place

When the nature of the street system, community sentiment, or the local political climate do not favor street closures or diverters, there are numerous effective measures to manage traffic in place and still provide improved pedestrian surroundings. Each of the measures to manage traffic in place can be used in areas where there is a desire to slow down traffic and reduce collisions or collision potential. While reducing speeds and collisions, these

measures normally have small effects on traffic volumes. Cost may be an important factor in finally deciding which measures to use; however, some can be installed inexpensively, using temporary installation schemes. Several of these measures are shown in Figure 15-4, and all of these measures have positive results for pedestrian use and activities on neighborhood streets.

Speed Limit Signs and Speed Zones

Speed limit signs are regulatory devices that are intended to inform the motorist of the speed limit of the roadway. Speed limit signs usually have no effect on traffic volumes and little if any effect on traffic speed, since drivers usually drive at what they perceive to be safe and reasonable under existing conditions. Studies in Europe have also shown that the use of speed limit signs without any physical barriers to traffic generally resulted in no change in driver speeds. Other traffic calming facilities generally must be installed in conjunction with reduced speed limit signing to obtain lower speeds.

Mini-Circles

Mini-circles are raised circular islands in the center of an intersection, which creates a one-way, circular flow of traffic within the intersection area. Mini-circles separate points of conflict and often slow speeds of vehicular traffic.² Mini-circles differ from roundabouts in that mini-circles are smaller (usually no more than 3.1 m (10 ft) in diameter) and are used in residential neighborhoods. They can easily be placed in existing intersections as part of a traffic calming scheme. The mini-circles narrow the available travel path, thereby forcing motorists to slow down. Roundabouts are larger and are used at the intersection of arterial roads. The roadway follows a circular path around the roundabout but the travel path is not narrowed. Mini-circles of an intermediate size, such as 3.1 m (10 ft) in diameter, have been used mainly as speed control devices within the intersection of two local streets, such as the one shown in

Figure 15-4. A secondary objective is to reduce traffic volumes by using them as a part of a group of mini-circles or other devices that slow or bar a driver's path. The following three handbook regarding mini-circles have been developed:

- ◆ If the objective is to reduce traffic speeds along a section of a residential street, two or more mini-circles at adjacent intersections should be used. A single mini-circle will slow traffic in the immediate vicinity of the intersection, but its impacts on traffic speed will generally be confined to within approximately 120 m (400 ft) of the mini-circle.
- ◆ A mini-circle should not be installed in an intersection with a high volume of left-turn movements. Many motorists will make left turns to the left of the mini-circle. This creates conflicts with traffic approaching from the left.
- ◆ Mini-circles should be designed with mountable curbing on the perimeter to accommodate unusually large service vehicles.

Chicanes

These are alternately placed curb extensions, parking bays, or other barriers into the street that force motorists to slow down and drive around them. The curb extensions narrow the road to one lane, with two-way operation. Chicanes are effective at reducing speeds and collisions. Installations result in loss of on-street parking, so if parking demand is high, this measure may not be appropriate. In such situations, parking controls should be used, as discussed below. Designers should be aware that the reduced roadway width can endanger bicyclists when motorists try to overtake bicyclists while passing through the chicane or when motorists view the chicane as an obstacle course.

Chokers or Bulbouts

A choker (also known as a bulbout curb bulb, nub, neckdown or gateway) is a narrowing of a street, either at an intersection or midblock, in order to reduce the width of the traveled way (see Figure 15-3). While the term usually is applied to a design which widens a sidewalk at the point of crossing, it also includes the use of islands which force traffic toward the curb while reducing the roadway width. Streets

Figure 15-4. A traffic mini-circle used at the intersection of residential streets.





Figure 15-5. A choker (curb bulb) used on a one-way residential street.

narrowed at the crosswalk reduce the distance over which pedestrians are exposed to vehicular traffic. Bulbs provide safe areas for people to walk or play, or may provide added area for landscape or gateway features, thereby improving the appearance of the neighborhood. An example of a choker on a one-way residential street is shown in Figure 15-5.

Studies to date have shown that bulbouts reduce traffic volume only when they either reduce the number of lanes of travel or add friction to a considerable length of street. Curb bulbs also appear to have a significant effect on speed and can improve the safety of an intersection by providing pedestrians and drivers with an improved view of one another.

Speed Watch and Enforcement Programs

Neighborhood residents often feel uneasy when they perceive that motorists are traveling too fast on their streets. This uneasiness can keep residents from enjoying their own surroundings as pedestrians.

Speed watch programs normally include: the use of radar to check speeds of passing motorists, the recording of license plate numbers of speeding motorists, and

notification of those speeding motorists as to the residential nature of the street on which they were caught speeding. Enforcement presence or follow-up is often effective. Many of the motorists speeding on residential streets live in the neighborhood themselves, so this is really a neighborhood awareness program, where neighbors participate in a process to help return their streets to a safer, more comfortable state. Speed watch programs are less successful when speeding motorists live outside the neighborhood and are “cutting through.”

Pedestrian Secure Streets (INSERTB)

FDOT has found that seniors and children make only half of their potential walking trips due to their fear of being victims of crime. The most significant way to increase walking levels is to get more people walking. If an environment appears harsh or unfriendly, few people walk, and the lack of pedestrians keeps others away.

Once a place appears safer and more friendly for walking, people will return to the streets. Street designers need to work as a team to create well-lit streets, to provide open landscaping, and to eliminate hiding places. The use of low shrubs to define street and sidewalk edges, to keep sitting

Figure 15-6. Speed humps are intended to reduce traffic speeds to 32 to 40 km (20 to 25 miles) per hour.



places open and inviting, and to undertrim trees for maximum viewing are important. Walls and fences should not be built around parks and other public lands.

There has been a tendency in recent years to gate streets in some neighborhoods to “keep crime out.” Traffic engineers are cautioned that such action may create more problems than it solves, by moving not only crime but also traffic to an adjacent neighborhood, and thus, may not be the best global solution. The solutions offered through traffic calming and other techniques appear to be more pedestrian friendly and should be explored more fully. Chapter 15 is devoted to traffic calming.

Speed Humps

Also known as road humps, undulations, or “sleeping policemen,” speed humps have undergone extensive demonstration and evaluation in Europe, Australia, and the United States. The purpose of speed humps is to promote the smooth flow of traffic at slow speeds around 32 to 40 km/h (20 to 25 mph). They are not meant to reduce vehicle speeds to 8 to 16 km/h (5 to 10 mph), as are speed bumps.

The speed hump is an elongated hump with a circular-arc cross-section rising to a maximum height of 75 mm (3 inches) above

the normal pavement surface and having a chord distance of 3.7 m (12 ft) in the direction of vehicular travel (see Figure 15-6). Speed humps have proven to be more effective, quieter, and safer than conventional speed bumps, and speed bumps are not recommended for street use.

Humps can be effective in reducing traffic speeds to reasonable levels on local residential streets. Substantial reductions in the speeds of the fastest cars can be expected along with an 85th percentile speed of about 40 km/h (25 mph). Typical average speeds on hump-equipped streets are under 32 km/h (20 mph). Although humps can be traversed safely at high speeds, most drivers will generally drive slower.

Although quieter than speed bumps, the primary disadvantage to speed humps remains noise to the adjacent homeowners. Some residents find speed humps (or the warning signs) unsightly and there are complaints of motorists driving with two wheels along the gutter (and sometimes onto the sidewalk) to avoid the hump. Residents along the street must be aware of the advantages and disadvantages of speed humps, and those living directly in front of the proposed hump location should provide written approval of the hump installation.

The ITE Technical Council Committee 5B-15 has stated that the individual municipal traffic engineer should be responsible for determining the safety of the design and the criteria used for installation of speed humps, including signs and/or markings. For guidance in the design and installation of speed humps, refer to the Handbook for the Design and Application of Speed Humps - A Proposed Recommended Practice.³ Representatives from the municipality should evaluate speed humps once they have been installed by collecting speed, volume, and accident data to determine their continuing effectiveness.

Stop and Yield Signs

The purpose of a two-way stop sign is to assign the right-of-way at an intersection. Two-way stop signs are suitable for use at minor street approaches to arterials and collector streets, and when there is poor sight distance. Stop signs do not reduce speeding on local streets, except for approximately 60 m (200 ft) prior to the intersection, and are expressly prohibited for this purpose by the MUTCD. Stop signs, however, do stop vehicles at intersections, where pedestrians typically cross the street. Two-way stop signs have little to no effect on reducing traffic volumes and the results on traffic safety are mixed.

Four-way stop signs are rare outside of the U.S. and Canada. They are usually intended for intersections where traffic volumes or other conditions do not warrant traffic signals (see Table 8-1) or as a stopgap measure when a signal is urgently needed, but is not yet constructed. Four-way stops are frequently requested as a speed control device, yet studies have shown that when stop signs are overused, only five to twenty percent of the motorists come to a complete stop, forty to sixty percent come to a rolling stop (below 8 km/h (5 mph)), and twenty to forty percent pass through the stop sign at speeds higher than 8 km/h (5 mph). Studies have also shown that violation rates are higher at stop signs that are placed as speed control devices.

Yield signs are used to assign right-of-way between two intersecting streets without requiring traffic on the other street to come to a complete stop. In the United States, this sign is used where sight distances at the intersection of two non-arterial streets permit traffic on the controlled street to approach safely at 25 km/h (15 mph) or higher. In many countries, the sign is the standard for assigning the right of way of vehicles on an arterial street. Yield signs offer little benefit to pedestrians, since motorists generally yield only to other motor vehicles, and pedestrians must choose gaps in traffic to cross.

Other Signage

Signs such as CHILDREN AT PLAY, RESIDENTIAL STREET, and LOCAL ACCESS ONLY, are not standard and not generally recommended or effective for use in neighborhoods. These signs by themselves have little, if any, effect in reducing vehicle speeds or volumes. A number of more helpful measures for managing traffic in place involve warning or regulatory signs such as DO NOT ENTER, NOT A THRU STREET, DEAD END, or turn restrictions. The MUTCD and engineering judgement will serve as a guide on what to use and when. As with diverters or street closures, residents should have input into any traffic signs that will restrict their access.

The Planning Process

To be successful, a traffic calming program needs a structured planning process, community participation, and consultation with all relevant authorities. The project is undertaken in response to the needs of residents of a street, area, or the community. Residents are the main initiator of traffic calming schemes, although elected representatives or city staff can also initiate schemes.

The planning process for a traffic calming scheme is complex and includes

significant resident participation. In the past, skipping or skimming over parts of this process has caused schemes to fail. It is more than simply providing a technical solution to a specific traffic problem. It is an interaction between land use, transportation, resident/community needs, and preferences. Traffic calming is not, and should not be seen as, traffic management solely for the safe and efficient movement of vehicles. It is a community project where the residents and other affected people must be active participants so they become owners of the project and increase its acceptance.

Three key groups should be included in the public participation process: the residents of the neighborhood, local traffic engineering and public works officials, and local elected officials. The residents of the area should have a voice in the design, function, and operation of the streets where they live, because they ultimately are the ones subjected to undesirable traffic conditions, and they must live with any restriction resulting from a traffic management program. The public works professionals of the community, including city planners, traffic engineers, transit officials, sanitation officials, police, firefighters, and emergency medical services, have a responsibility to identify these problems and to assist the residents in formulating alternative solutions. School officials must also be involved if a potential solution will affect their bus routing or limit teacher/parent access to their school.

The elected officials ultimately will make the decisions regarding the implementation of any proposed traffic management program. For this reason, they should be involved from the onset and should be made aware of the existing problems, alternative solutions, and the final implementation plan.

1. Identify Problems and Issues: Collect and analyze crash data, traffic volumes, streetscape, residential, neighborhood, and community problems.

2. Establish Objectives: Specify and get agreement on the scheme's aim with the residents. This step is essential in evaluating and comparing alternative schemes and their relative success.

3. Alternate Plans: Develop a set of alternate schemes meeting the above aims.

4. Plan Selection: Evaluate the impact of each plan, including achievement of the aims, and undesirable or unavoidable impacts. After consultation with the residents, refine the final plan, design individual traffic control measures, and develop a staged construction plan.

5. Implementation: Undertake any additional "before" studies, tell the community of the work program, and of traffic detours. Often people do not appreciate what a particular device is really like on-the-road. A useful technique is to install cheap, temporary treatments so the residents can try them before proceeding with the final construction.

6. Review: Never assume the scheme achieves the desired effect. Drivers can be very innovative and may find unexpected alternate routes. Conduct after studies to measure their effectiveness, impacts, and resident/community reaction. Change the scheme if necessary.

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Exclusive Pedestrian Facilities

Various alternatives have been implemented to restrict motor vehicles from the pedestrian environment, including residential yards, play streets, pedestrian malls, and transit malls. While pedestrian malls and other auto-free areas are usually developed as part of an urban renewal or downtown revitalization effort, they have the effect of improving pedestrian safety and facilitating pedestrian movement.

Pedestrian malls are streets which have been closed to all vehicular traffic and are reserved for the exclusive use of pedestrians, with few exceptions. Delivery and refuse collection access may be permitted during specified times of the day, and emergency service access must be permitted at all times.

Transit malls are streets where pedestrians share the space with transit buses or light rail vehicles (and sometimes bicycles, delivery and refuse collection vehicles, and taxis), but other vehicles are not allowed, except for emergency and maintenance vehicles. Transit vehicles operate on a narrow right-of-way within the mall space. Pedestrian malls can be developed in each of the following manners:

- a. Modified Street - One block of a conventional street is closed to vehicular traffic for the exclusive use of pedestrians.
- b. Plaza or Interrupted Mall - Several blocks of a retail street are exclusively designated for pedestrian use, with cross streets left open to vehicular traffic.
- c. Continuous or Exclusive Mall - A multiblock area, which may include more than one street, is exclusively designated for pedestrians, with the exception of emergency, maintenance, and delivery vehicles. The area extends the full length of the shopping area, through intersecting streets, without interruption.
- d. Displaced Sidewalk Grid - A pedestrian walkway is developed away from the regular sidewalk grid through alleys and laneways, arcades, and/or lobbies within buildings.

For urban street malls to be successful, they must provide a viable and attractive alternative to regional shopping malls.

Planning Considerations

For urban street malls to be successful, they must provide a viable and attractive alternative to regional shopping malls. This can be difficult when it is considered that street malls must necessarily be planned and

designed around existing roadway configurations, traffic patterns, parking, retail mix and other constraints. Street widths can be too wide, walking distances too long, and retail development poorly located to encourage the patterns and volume of pedestrian activity needed to support a successful urban mall. In order to succeed, the street mall must, therefore, capitalize on its primary advantage as an outdoor activity space by promoting parades, street fairs, bicycle and track races, antique car rallies, marching band competitions, concerts, and other similar public events to encourage pedestrian activity and establish an area identity.

The primary objectives of the pedestrian mall should be to reestablish or fortify an urban area's economic viability while simultaneously creating a social setting capable of responding to a variety of needs. The success or failure of an urban pedestrian mall is dependent upon many factors, some of which are directly controlled during the planning process. The following considerations identify elements of planning essential to the effective realization of pedestrian malls.

Relationship of Mall to Central Area Development

Pedestrian malls succeed or fail according to their degree of accessibility either by public transit or by private automobile. The success of a pedestrian zone is directly related to its ability to create a range of activities to suit a variety of users. For example, Albany's government mall in New York State has suffered a loss of vitality because it is only able to attract patrons during lunch break hours and is practically deserted at other times. A more balanced use of the area's resources over extended periods of time, a high level of urban vitality, and an increased feeling of safety can be achieved by attracting a full spectrum of users through mixed use zoning.

Cooperation and Support

Progress in implementing the planned improvements can be much more rapid when commercial and public interests coincide. Many proposals meet opposition from shop owners who believe that their business will suffer if vehicular access is restricted along their premises. In reality, they often get more business after the parking (often used by employees, not the customers) is removed. Shopkeepers are often resistant to the mall concept until they are made aware of the potential benefits. It is important to obtain the cooperation of commercial interests at the initial planning stages in order to ensure viability of the proposals.

Eliciting public support during the course of the pedestrian mall development is important in guaranteeing the success of the mall. The creation of a pedestrian mall affects a wide range of user groups whose participation is vital. These groups should be consulted and involved during the early planning stages of project implementation.

Existing Vehicle Traffic Patterns

Some cities have radically altered circulation patterns in order to decrease traffic congestion and redistribute vehicular traffic flow in the area of the pedestrian mall. This can be accomplished by developing one-way streets, restricting turning movements, limiting access to certain categories of vehicles, redesigning intersections, and retiming traffic signals.

Public Transit Services

Most cities with successful pedestrian malls have introduced policies that encourage the use of public transport. The success of these policies has varied depending on the extent of traffic congestion and the efficiency of the public transportation system. As always, public transit should be inexpensive, fast, comfortable, safe and enjoyable to ride. Other tactics that can be successful are reserved lanes for public vehicles, low

fares, convenient pickup and drop-off locations within the mall, and better security. Those pedestrian malls that are built as transit ways can provide increased mobility to pedestrians by dropping them at major department stores or activity centers within the mall itself.

Parking Supply

Effective parking policies have a significant impact on both the regulation of parking density and the attractiveness of parking spaces to mall users. Some cities use different strategies to meet the demands of employees seeking day-long parking and visitors looking for short-term parking. Some cities offer park-and-ride systems to allow downtown or mall employees to park their cars at the periphery of the city limit and ride to work via rapid transit or special buses. On-street parking meters and multilevel parking facilities at the edge of the pedestrian mall areas can provide short-term parking needs; time can be charged in incremental rates to promote a quick turnover.

Delivery of Goods

The opposition of many merchants to the idea of a pedestrian mall results from the problem of delivering merchandise to stores and making it possible for customers on foot to handle the purchases easily. One of the most common strategies has been to allow structural changes in the street pattern to make possible store deliveries from courtyards and alleys as well as using time restrictions on the use of pedestrian mall space by commercial trucks. Some downtown merchants have introduced free pushcarts in order to meet customer demand for assistance in delivering their goods to either the central transportation terminal or to where their car is parked. Establishments that sell bulk goods, such as grocery stores, should be relocated to the periphery of the mall where ready access to parked vehicles is available.



Figure 16-1. Pedestrian malls provide for pedestrian safety and mobility.

Essential Services

Essential services such as emergency fire, police, medical, refuse removal, taxis, vehicle pickup and drop-off, truck delivery and pickup, and mall cleaning must also be considered. Provisions must be made to allow emergency service vehicles quick access within the pedestrian mall. Additional amenities within the pedestrian mall such as canopies and covered ways will need to be sufficiently high in order to enable emergency vehicles to pass underneath. There are also certain types of businesses that require such access for other vehicle types. For example, a hotel located on the street to be made into a pedestrian mall will need to provide continuous access to taxis for its viability. Similarly, security vehicles will need to reach banks and



Figure 16-2. Crosswalks should be provided for pedestrians to cross streets in interrupted malls.

businesses located within the pedestrian mall during nighttime hours.

Accessibility Needs

Care must be taken that the paving system used does not impede the safe and easy movement of wheelchairs. Planters, benches and other amenities should be placed in a straight line to satisfy the expectancy of the visually impaired.

Design Considerations

Quality of design and durability of construction materials have proven to be essential elements in the success of pedestrian malls. The ideal pedestrian mall

is designed in a relatively narrow street right-of-way, with concentrated shopping and commercial land uses within the normally accepted walking distance limit of 0.4 km (0.25 mi), and larger traffic generators (“anchors”) located at opposite ends of the mall to encourage walking along the mall. Excessively wide streets dilute pedestrian activity, making a mall appear dull and uninteresting, and also reduce exposure to retail edges due to the increased sight distances.

To be successful, the pedestrian mall must be interesting, safe, convenient and appealing to the shopper. Some successful street malls are located in areas such as historical districts where there is an established pattern of tourist and visitor activity. When this pattern exists, it can be enhanced by designing storefronts and street furniture to keep with the local “theme.” Otherwise, it is necessary to develop design and marketing strategies which will encourage downtown activities and use of the mall. The primary advantage of a street mall is the ability to conduct large-scale outdoor events. Event spaces for setting up concerts, grandstands, and other activities should be considered in the mall design. Access to electrical outlets should also be considered.

Street furniture, paving treatments, lighting, and landscaping are important design considerations. Street furniture elements should be of modular design incorporating several components in a single unit. Other amenities such as benches arranged in groups in small rest areas, local street maps and points of interest displays, programs of future events, transit stop enclosures, and transit system information displays will improve the convenience and attractiveness of the mall.

Pavers are a popular surface treatment in malls, but the pavers must be placed on a substantial subbase to avoid settlement or “frost-heaving” and dislodgment, which can result in tripping. Since emergency vehicles require access to all parts of the pedestrian



Figure 16-3. Pedestrian malls enhance the aesthetics of the downtown area.

mall, the paved areas need to be designed to take the weight of service and emergency vehicles and allow them to move around easily. Pedestrian oriented lighting, with control of overhead illumination so as not to overpower shop window lighting, is preferred to restore a more intimate and natural scale to the converted street. Landscaping should be carefully chosen, not only for appearance, but for maintenance and growing characteristics. Plants or trees that interrupt sight lines and potentially provide concealment can reduce perceived security and discourage pedestrian activity at night.

Crosswalks should be provided for pedestrians in transit malls, interrupted malls, and plazas where pedestrian-vehicle conflicts are present. Such conflicts may be minimized through: 1) one-way cross streets, and 2) signals and warnings to the motorists, such as signs or contrasting pavements at the mall crossings. The mall should be designed to keep transit vehicles

and other service vehicles to a slow (pedestrian) speed, and there should be ample visibility between pedestrians and other vehicles in the mall.

Implementation Considerations

Feasibility studies which determine the levels of political, business, and general public support are essential. Included in these evaluations should be potential effects on traffic, area economics, and the social environment. Temporary pedestrian malls or street closures can be set up as part of a feasibility study to determine a more permanent need.

Successful implementation requires a great deal of cooperation and organization. A primary leadership group and working committees must coordinate and administer the process. Public and private interest should be developed through the media, informational meetings, pamphlets and

displays. Management, financial and scheduling plans should be developed and followed. In addition, periodic review sessions should be held to: 1) consider and develop alternative concepts, and 2) ensure that all concerned parties have adequate opportunity to contribute as they see fit.

Several advantages exist from the design and implementation of pedestrian malls, including:

- ◆ A reduction in pedestrian delays and/or pedestrian congestion.
- ◆ Enhancement of the aesthetic and social environment of the downtown area.
- ◆ Greater pedestrian accessibility to retail merchants.
- ◆ An increase in the use of public transportation.
- ◆ A decrease in noise and air pollution on affected streets.
- ◆ A potential increase in revenues, sales, and land values.
- ◆ Increase in the efficiency and time savings of mass transit in transit malls.

Along with the advantages of pedestrian malls, there also exist several disadvantages, including:

- ◆ A potentially high cost of installation, maintenance and operation.
- ◆ Rerouting of vehicle traffic to other streets.
- ◆ Potential reduction in retail activity and an increase in noise and air pollution on nearby streets.
- ◆ Disruption of utility and emergency services.
- ◆ Disruption of bus routes and delivery of goods.
- ◆ Placement problems with street furniture for visually handicapped pedestrians.
- ◆ Potential parking problems for visitors

and employees. Potential security and policing problems if poorly lit and designed with numerous “hidden” spaces.

- ◆ Potential maintenance problems.
- ◆ Conflicts between pedestrians and transit vehicles in transit malls.
- ◆ Pedestrian-vehicle conflicts at cross streets in a plaza or interrupted mall.

Conflicts between pedestrians and vehicles at midblock locations where displaced sidewalk grids are used.

Summary

In summary, the conversion of streets to full pedestrian malls is an ideal way to provide for safe and free-flow movement of pedestrians in a desired area, such as for retail shopping. Although the conversion of streets to pedestrian malls is usually the result of efforts to revitalize downtown areas, improved pedestrian safety can be a beneficial result of such malls.

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Work Zone Pedestrian Safety

17

Proper planning for pedestrians through and along construction areas is as important as planning for vehicle traffic, especially in urban and suburban areas. Pedestrian considerations, including access to bus stops and crosswalks, must be an integral part of each construction project. There are three considerations for pedestrian safety in highway and street work zones:

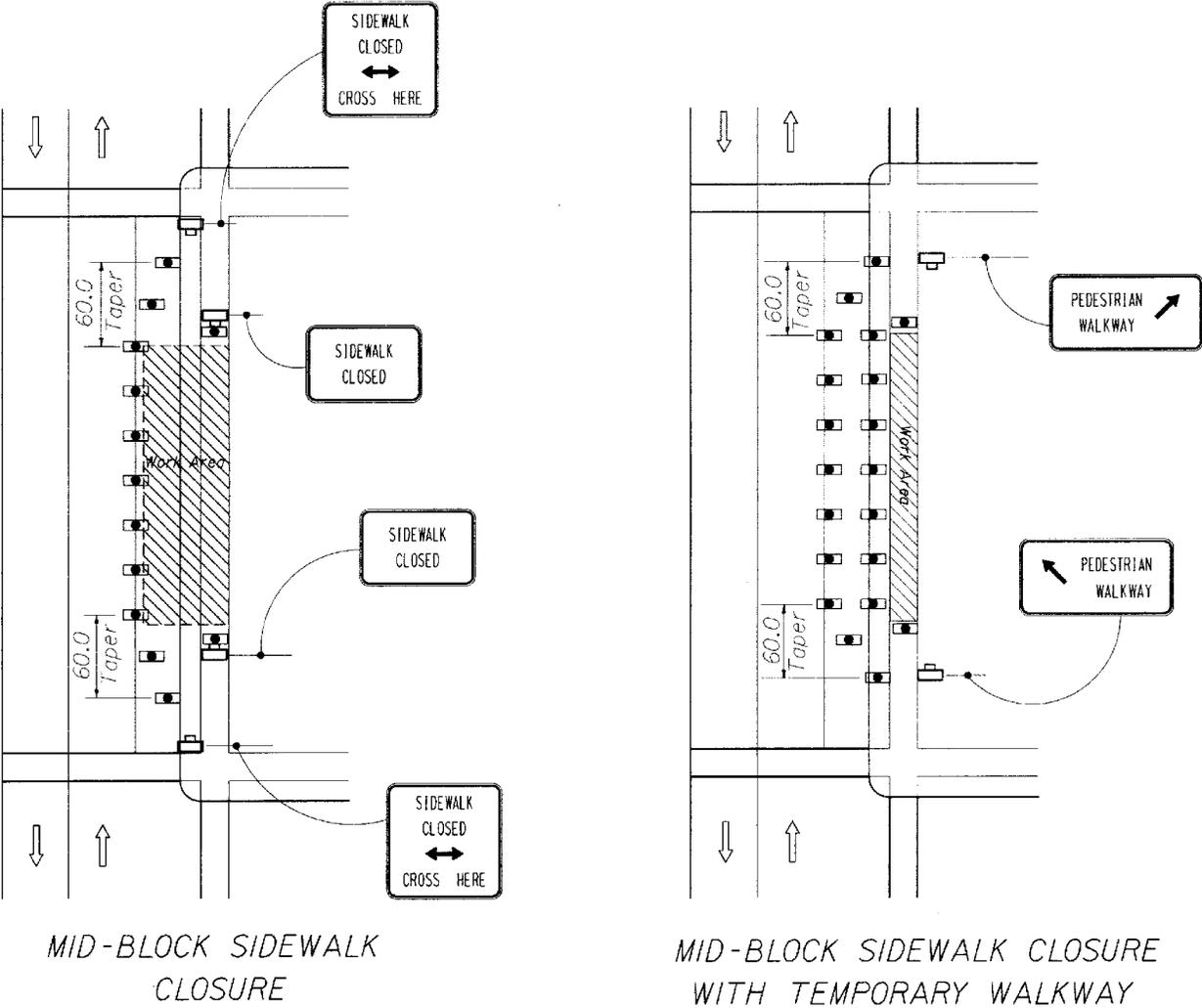
- ◆ Pedestrians must be separated from conflicts with work site vehicles, equipment and operations.
- ◆ Pedestrians must be separated from conflicts with mainline traffic moving through or around the work site.
- ◆ Pedestrians must be provided with a safe, accessible and convenient travel path that duplicates as nearly as possible the most desirable characteristics of sidewalks or footpaths.

When construction requires closing existing crosswalks and walkways, contractors and other work crews must provide temporary walkways and direct pedestrians to the safest, most convenient route possible. Walkways must be clearly identified and wheelchair accessible, protected from motor vehicle traffic and free from pedestrian hazards such as holes, debris, dust and mud.

When a parking lane exists next to a work site that closes a sidewalk, the parking lane may be used for the pedestrian detour route. Consideration may also be given to closing a moving lane on a multilane street to provide a continuous pedestrian path. When there is no available parking or curb lane, pedestrians must be diverted from a direct encounter with the work site by using advance signing as approved in the *Manual on Uniform Traffic Control Devices*.¹

Good engineering judgment in each work zone situation should readily determine the extent of pedestrian needs.

If required, safe crossings must be provided to the opposite sides of the street. Signing for these crossings should be placed at intersections so that pedestrians are not confronted with midblock work sites that will induce them to attempt skirting the work zone or making a midblock crossing. Pedestrians will infrequently retrace their steps to a prior intersection for a safe crossing. Therefore, ample advance notification is needed. Two approaches to accommodate pedestrians in a midblock work zone are shown in Figure 17-1.²



MID-BLOCK SIDEWALK CLOSURE

MID-BLOCK SIDEWALK CLOSURE WITH TEMPORARY WALKWAY

Figure 17-1. Two approaches to accommodate pedestrians in a midblock workzone.²

For temporary work zones of short duration, and under low speed conditions, it is acceptable to use traffic barricades and traffic signs to separate pedestrian traffic from work zone and vehicle traffic, if approved by the local engineer. Barrier walls are recommended.

At fixed work sites of significant duration, especially in urban areas with high

pedestrian volumes, pedestrian fences or other protective barriers may be needed to prevent pedestrian access into a construction site. This is particularly important near school areas. When used, pedestrian fences should be 2.4 m (8 feet) high to discourage people from climbing the fences.

For construction or demolition of buildings adjacent to sidewalks, a covered walkway may be needed to protect foot traffic from falling debris. These covered walkways should be sturdily constructed and adequately lit for nighttime use. External lighting and diagonal white and orange stripes on the exterior of the pedestrian walkway may be needed when placed next to traffic.

Covered walkways and pedestrian fences and other barriers must be designed to provide ample sight distance at intersections and crosswalks. Solid construction fences must be angled at corners or be replaced with chain link fencing to provide adequate visibility.

When pedestrians are judged especially vulnerable to impact by errant vehicles along moderate to high speed streets, foot traffic should be separated and protected by longitudinal barrier systems. Where a positive barrier is clearly needed, it must be of sufficient strength to avoid intrusion by an impacting vehicle into the pedestrian space. Short intermittent segments of longitudinal systems should be avoided. Upstream ends of the system must be flared or protected with impact attenuators properly fastened to the longitudinal barrier. For work zones adjacent to high speed traffic, wooden railings, chain link fencing with horizontal pipe railing and other similar systems are not acceptable.

Construction work zones should be inspected daily and monitored continuously for vehicle and pedestrian needs. Security guards or flagmen may be needed to monitor work sites and help control pedestrian traffic. Where construction vehicles and equipment need to cross pedestrian paths, flagmen, police officers or traffic signals should be used during crossing times.

Good engineering judgment in each work zone situation should readily determine the extent of pedestrian needs. Particular attention should be paid to nearby

pedestrian generators, particularly schools, parks and community centers. Officials should be contacted at these facilities to alert them of upcoming traffic control changes and accommodate special pedestrian needs, particularly for long-term and major construction activities. Use temporary crossing guards for construction in or near school zones.

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On-Street Parking

18

On-street parking has an important relationship to vehicle and pedestrian safety, the capacity and level of congestion on a street, the economic vitality of adjacent businesses and providing a service to nearby residences. It can create an effective buffer separating pedestrians on the sidewalk from motor vehicle traffic on the adjacent roadway. The presence of on-street parking reduces motorists' speed, further enhancing pedestrian safety and comfort. On the other hand, the presence of on-street parking results in less visibility between the motorist and pedestrians, especially for children.

The pedestrian dartout, often involving children, is one of the most common types of midblock pedestrian collisions in residential areas. Intersection and midblock bulbouts can reduce these problems. Since a large proportion of pedestrian collisions occur midblock, the restriction of on-street parking in areas with high levels of pedestrians may improve pedestrian safety. However, this is often not practical. Parking restrictions near intersections also play an important role in pedestrian safety. Florida state law states that "No person shall:

1. Stop, stand or park a vehicle:
 - a. on a sidewalk;
 - b. within an intersection;
 - c. on a crosswalk;

2. Stand or park a vehicle, whether occupied or not, except momentarily to pick up or discharge a passenger or passengers:
 - a. within 20 ft (6.1 m) of a crosswalk at an intersection;
 - b. within 30 ft (9.1 m) upon the approach to any flashing signal, STOP sign, YIELD sign, or traffic-control signal located at the side of a roadway."

The presence of on-street parking results in less visibility between the motorists and pedestrians.

The Manual on Uniform Traffic Control Devices (MUTCD) also recommends prohibiting parking within 30.5 m (100 ft) on the approach to a signalized midblock crosswalk, and 6.1 m (20 ft) beyond the crosswalk. Many local jurisdictions provide other ordinances to further manage on-street parking. On-street parking is generally not an issue in rural areas due to the sparse or undeveloped land use and the low numbers of pedestrians. Parking in urban and suburban areas may pose a problem to pedestrians and should be reviewed and managed to create an optimal balance between serving the adjacent land uses and serving pedestrians and other traffic needs.

Figure 18-1. On-street parking in commercial areas provides convenient parking and minimizes the negative impacts of off-street parking.



Urban Area Characteristics

The urban area where curb parking is typically present is in the central business district (CBD), the central city and in the suburbs. Each has unique characteristics related to the parking on various types of streets in each area.

Central Business District

The CBD normally has slower moving vehicles (typically 40 to 48 km/h (25 to 30 mph)), closely spaced traffic signals, marked crosswalks at most intersections, and a high demand for on-street parking and high parking turnover. Parking spaces are often governed by parking meters and, on occasion, the spaces may be marked on the pavement to better organize parked vehicles and to prevent vehicles from encroaching intersections and marked crosswalks. Red curb markings along with NO PARKING signs are often used to prevent cars from parking too close to intersections.

Loading zones and bus stops are often an issue in CBD areas due to the high

competition for limited curb space. Placing these zones adjacent to intersections often facilitates buses (or trucks using the loading zone) by providing a maneuvering area and minimizing the space needed for the zone. Bus stops should be placed downstream from a traffic signal or intersection (when practical) to encourage pedestrians to cross *behind* the bus. Downstream locations for commercial loading zones at intersections are also more practical since it will provide greater intersection visibility. However, this is sometimes difficult to accommodate since the business requesting the loading zone generally wants it adjacent to their building where they can directly view the truck being unloaded and for convenience.

Central City

The highest density of housing, and thus demand for on-street parking, occurs in the central city. Many of these areas were built before multiple vehicle households were common, and many of these homes do not have driveways or adequate off-street parking areas. People come home from work to find parking at a premium, which may

force them to park a significant distance from their homes. During winter months this may occur during hours of darkness with reduced pedestrian visibility.

Corner parking restrictions are often needed and should be enforced. Supplemental parking restriction signs, such as NO PARKING WITHIN 30 FEET (or NO PARKING WITHIN 50 FEET) may be needed below STOP signs to obtain better motorist compliance or assist in enforcement. NO PARKING HERE TO CORNER (OR CORNER TO HERE) signs often provide the most straightforward information to motorists at intersections.

Individual intersections should be field checked to determine which parking restrictions are needed to provide adequate visibility for pedestrians and motorists. Crash history is often an important tool to determine if additional parking removal is needed at an intersection. Worn, faded, defaced or damaged parking restriction signs should be replaced to command respect from the public. Although the MUTCD does not require these signs to be reflectorized, they should be reflectorized to improve motorist compliance at night and to be more visible (and less of a potential obstacle) to traffic at night.

Figure 18-2. Pedestrian sight distance and parking restriction for a parallel-parked vehicle, pedestrian standing at the curb.

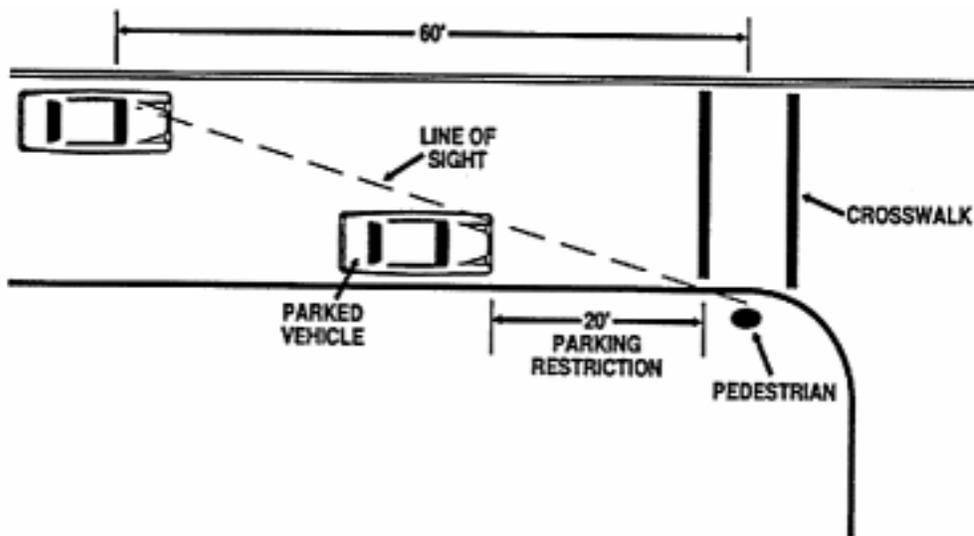
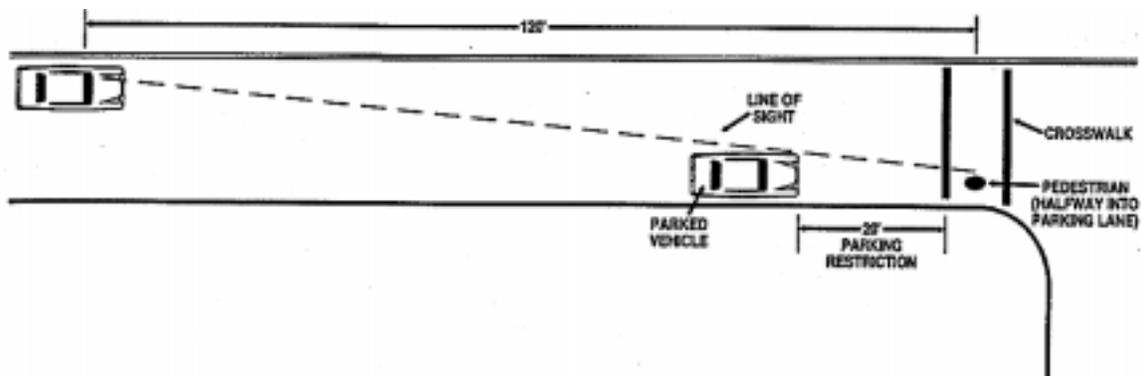


Figure 18-3. Pedestrian sight distance and parking restrictions — for a parallel-parked vehicle, pedestrian standing halfway into the parking lane.



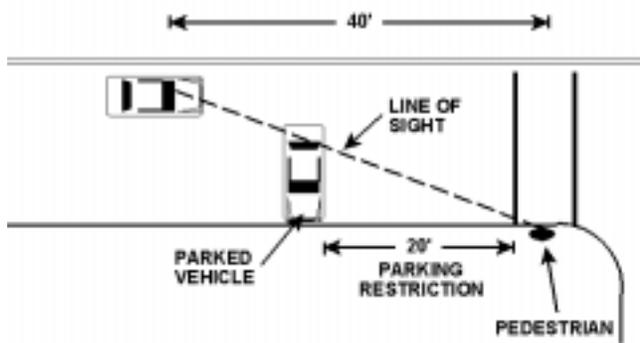


Figure 18-4. Pedestrian sight distance and parking restrictions—angle parking at 90 degrees.

Suburbs

Parking is generally restricted on the higher speed major arterials in suburban areas. However, parking is usually very common on lower speed collector streets and local streets. Housing is usually less dense and pedestrian volumes are lower than in CBD or central city areas, and parking restriction signs are usually not needed. In suburban areas, schools and parks warrant special attention.

School areas are areas with high numbers of young children, often with high levels of pickup and drop-off traffic during school crossing times. Most newer schools are designed with adequate on-site parking for teachers, parents and bus loading activities. This may not be the case at older schools, particularly during days of inclement weather. On-street parking around schools generally should be avoided. If on-street parent drop-off areas or bus loading area are needed, consideration should be given to providing loading bays. Parking should be restricted near crosswalks and driveways. Adult crossing guards should be stationed at busy crossing locations adjacent to elementary and middle schools to help monitor student activity and parent parking.

Removal of curb parking or designating on-street pickup zones along schools should

be coordinated with school officials. Enforcement of parking violations may be needed if parent notification through the school and adult crossing guard/teacher monitors fails to correct the problem.

Overflow parking problems may also occur near high schools and community colleges resulting in complaints from nearby residents. This overflow student parking is generally more of a nuisance and social problem, and usually does not pose a safety problem unless students park too close to driveways or intersections. In some cases residents should be allowed to request parking restrictions during the school day in front of their homes (i.e., NO PARKING 7 AM - 3 PM SCHOOL DAYS ONLY). These restrictions apply to *all* motorists, including the residents. Another potential option is a resident permit parking program, which requires the local jurisdiction to pass a special ordinance and establish guidelines for the program.

Community or regional parks are generally located along collector or local streets and may attract large numbers of vehicles on weekends or for special events. These facilities should be designed with adequate off-street parking. However, there may be times where on-street parking demand exists. A similar problem occurs along *recreational fields* such as soccer fields or baseball diamonds during practice sessions or league play. In many instances these athletic fields are adjacent to schools with adequate off-street parking, but these parking areas may be less convenient than adjacent on-street parking. On occasion consideration may be given to prohibiting curb parking to improve pedestrian safety. Not only do the parked cars obstruct the view of children who may run into the street, but every space between cars represents a potential crossing location. It is best to fence the areas along parks and athletic fields to channelize pedestrian crossings and help minimize midblock dartouts. Parking restrictions can be limited to pedestrian crossing areas and near

driveways. These areas should also be evaluated for lighting if nighttime pedestrian activity is present.

There are some instances where on-street parking is preferable or necessary due to a lack of alternate parking areas. Prohibiting parking on the side of the street closest to the park or athletic field may require everyone to cross the street to their parked vehicles. Prohibiting parking on the far side of the street and allowing parking adjacent to the park or athletic field may be a better option if practical. In some cases curb parking restrictions may cause overflow parking into nearby neighborhoods.

Roadway Type

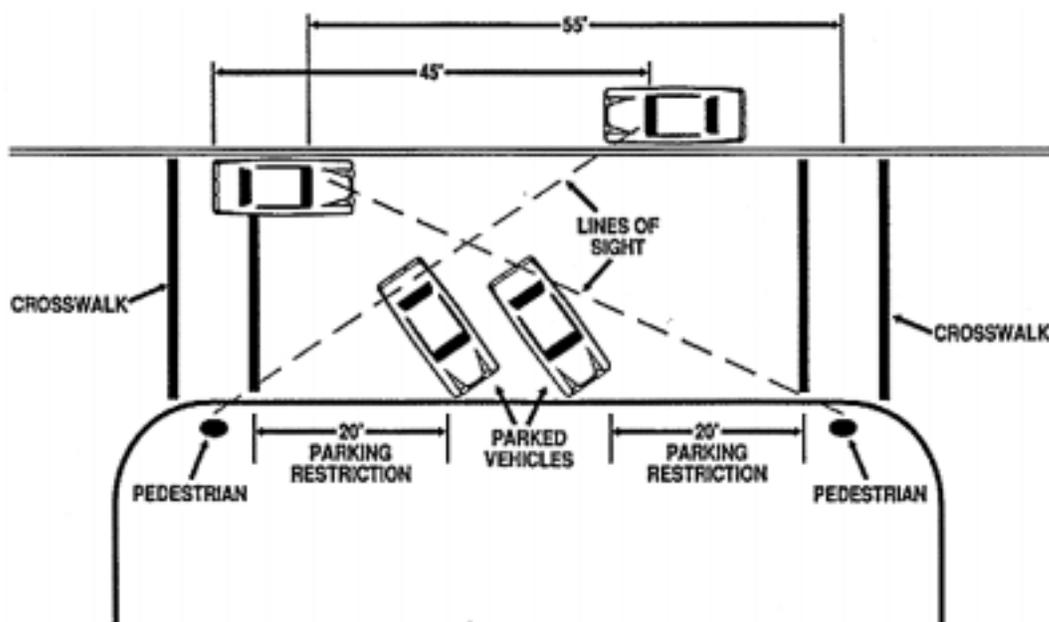
Not only is the location within the urban area a determining factor in the type of on-street parking restrictions, but the type of roadway (major arterial vs. collector street) must also be considered.

Major Arterials are wider and have higher traffic levels and higher speeds.

Pedestrians are generally accommodated at marked (or unmarked) crosswalks and at traffic signals. Parking is generally prohibited outside the CBD. The primary considerations generally relate to overall traffic safety and traffic capacity. The removal of parking lanes often allows for added through lanes or a two-way-left-turn lane. Improved pedestrian conditions may be the by-product of these actions. If parking exists along higher speed arterials, more parking restrictions should exist. For streets with speed limits of 55 to 70 km/h (35 to 45 mph), it is recommended to restrict parking within 15.3 m (50 ft) on the approach to the crosswalk. Streets with speed limits greater than 70 km/h (45 mph) should have parking restricted within 30.5 m (100 ft) of the crosswalk.

The width, traffic levels, traffic speed and function of the collector street are different from a major arterial street. Collector streets tend to have more on-street parking and neighborhood shopping centers or residential land uses. Under most

Figure 18-5. Pedestrian sight distance and parking restrictions — angle parking at less than 90 degrees.



circumstances curb parking is safely accommodated on collector streets. In some cases neighborhood shopping centers where adequate off-street parking is not available may pose a problem to pedestrians. Consideration for visibility at driveways, intersections and pedestrian crossings may conflict with the merchant's desire to provide as much convenient curb parking as possible. Signing or curb marking may be used to limit parking at pedestrian crossing areas. A review of curb parking may also be needed in dense residential areas with insufficient off-street parking. In both cases parking should not be removed until after consulting with and notifying the adjacent property owners or residents.

Sight Distance and Parking Restrictions

The primary purpose of restricting parking at intersections is to improve sight distance. In the past, this has been done mainly for the motorist and has resulted as a side benefit for pedestrians. The basic requirement for sight distance also applies to pedestrian crossing areas, and is based on safe stopping distances.² However, pedestrians have different operating characteristics and different capabilities than motor vehicles. For example, a pedestrian moves slower than a motor vehicle, and can stop faster or start faster than a motor vehicle. An adult pedestrian can see over or through a parked car. Pedestrians can safely position themselves at the edge of a parking lane to see around parked cars without exposing themselves to traffic. On the other hand, children may not have the maturity of a motorist and may be less apt to stop and look for traffic before crossing. Small children and pedestrians in wheelchairs usually can not see over or through a parked vehicle and are less likely to be seen by approaching motorists.

Figure 18-2 shows the condition of a pedestrian standing at a curb with the typical restriction of parking prohibited

within 6.1 m (20 ft) of the crosswalk. With parallel parked vehicle, a pedestrian can see 18.3 m (60 ft) without looking through or over the vehicle. If the pedestrian steps halfway into the parking lane, about 1 m (3 ft) into the street, the visibility increases to 36.6 m (120 ft) as shown in Figure 18-3. If the pedestrian moves to the edge of the parking lane, the sight distance is limited only by the individual's visual capacity.

Angle parking at 90 degrees to the curb has a much more dramatic effect on visibility at intersections as shown in Figure 18-4. If 90 degree parking exists within 6.1 m (20 ft) of a crossing, the pedestrian on the curb can only see 12.2 m (40 ft) beyond the parked car, and must walk 3.7 m to 4.9 m (12 to 16 ft) into the street to adequately see approaching traffic. To obtain the same visibility as parallel parking conditions at intersections, 90 degree angle parking should be prohibited within (9.2 m) 30 ft of the intersection. Angle parking at less than 90 degrees, for example 60 degrees, increases available sight distance for pedestrians looking to the left, but reduces it for the pedestrian looking to the right (Figure 18-5).

Fortunately angle parking is only practical in low speed CBD areas and is not practical on higher speed streets for safety purposes due to the awkward backing maneuver needed to leave the parking space. Angle parking should also not be allowed along the shoulders of high speed major arterials where the motorist has to back into the street. On occasion, signs such as PARALLEL PARKING ONLY may be needed to change undesirable parking patterns along the shoulders of major arterials.

Parking removal may be a double edged sword. While it may improve sight distance and increase the capacity of a roadway, parking removal will generally encourage higher travel speeds and longer effective crossing distances, which are not desirable for pedestrians.

Accident studies may be needed to determine if parking removal is needed. At times special measures may be needed to compensate the loss of parking to adjacent homeowners and businesses. If problems only occur during certain times of the day, part-time parking restrictions should be considered.

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19

Street Lighting For Pedestrians

Street lighting is a very helpful tool for pedestrian safety, security, comfort and the economic vitality of a urban area (Figure 19-1). Ample lighting not only allows pedestrians to be better seen by motorists at night, it allows pedestrians to see better and feel more secure during nighttime hours. Street lighting allows pedestrians to read street name signs or to identify any obstacles in or near the sidewalk or path at night. Providing high levels of lighting is critical for revitalizing downtown urban areas and is needed to encourage pedestrian shopping and attendance at events and other recreational activities at night. In these areas, it is best to consider separate pedestrian level lighting, directly over the sidewalk area. In some cases, this lighting may be designed directly into nearby buildings and structures.

In general, lighting may be warranted at locations where the local governmental agency concurs that lighting will contribute substantially to the efficiency, safety and comfort of vehicle and pedestrian traffic.¹ It

is not practical to develop specific lighting warrants to satisfy all roadway conditions.

Often the decision to provide lighting or a specific level of lighting is linked to funding levels and other concerns. In rural

Pedestrians prefer lighting that makes nighttime conditions appear closer to daytime conditions.

areas and some neighborhoods on the fringe of suburban areas, residents may desire to have no street lighting to preserve a “rural” feel to the area. While there is no requirement to have street lights, this desire must be tempered with the concern to provide for pedestrian and other traffic needs.

It is a desirable practice to provide street lights at all public street intersections where there is an available power source. For major arterial streets in urban and suburban areas, continuous street lighting should be installed. Information on the spacing of street lights can be found in the Plans Preparation Manual. However, light spacing may be increased to take advantage of existing power poles rather than have an

Figure 19-1. Street lights improve pedestrian operations and security.



extra series of roadside obstacles (utility poles). For arterials with raised medians or wide streets of five or more lanes, double-sided lighting is preferable to single-sided light. It is best to install street lights on both sides of the street, rather than double headed lights in the median, to provide more light where pedestrian traffic exists.

For collector streets, continuous lighting should be installed if funds are available and there is a justification because of neighborhood security, traffic volume, or nighttime crashes which show that continuous lighting may be helpful. If justified, one-sided lighting is usually adequate.

For local streets, midblock lighting should be installed bordering parks, schools, large community centers, churches and housing projects where an engineering study demonstrates a need. Midblock lights may be installed on any residential street if funding is available. The spacing of the lights is directly related to the available funding level for lighting. A typical minimum spacing of 76 m (250 ft) is recommended, but the spacing may be closer if funds are available. Due to a concern for residents living near a proposed

street light, a petition should be submitted showing approval for the light by the adjacent residents. Shielding or lower-height lighting can be used to minimize light shining into nearby residences.

As a practical matter, street lights should be installed with all new development. Developers should be required to pay for installation of the street lights and fixtures subject to the specification and approval of the local jurisdiction. Lighting plans should be reviewed with other utilities to take advantage of existing power poles, and against landscaping plans to avoid future conflicts with trees. Street lights should be installed concurrently with all other off-site improvements.

Street light poles, like other power poles, should be installed behind the sidewalk, or at least 1.8 m (6 ft) behind the curb. If an existing utility line is not located adjacent to the street or pedestrian walkway, a separate set of street light poles may be needed.

Lighting for Other Pedestrian Facilities

Lighting should also be considered for

other pedestrian facilities where nighttime activity is expected. Pedestrian level lighting is recommended for pedestrian paths and walkways on separate rights-of-way or easements. The primary concern is for reduced likelihood of crime and improved pedestrian comfort and security. Lighting should also be considered for pedestrian underpasses and overpasses. Twenty-four hour lighting may be needed in pedestrian or mixed-use tunnels. Daytime lighting is generally not needed when the length to height ratio of a tunnel is less than or equal to 10:1.¹ When the length to height ratio exceeds 10:1, it is necessary to analyze the specific geometry, traffic conditions, and level of pedestrian activity to determine if lighting is needed. For short underpasses, favorable positioning of the lights adjacent to the underpass can often provide an adequate level of nighttime illumination without the need for light fixtures on the structure.

Vandal resistant fixtures are recommended where the light fixtures are at a lower level, or where they are more prone to vandalism. An inspection program should be established to review the lighting at periodic intervals.

Crosswalks should be located to the extent practical to take advantage of existing street lights where pedestrian activity is expected at night. In any case, nighttime inspections should be utilized to review conditions and determine if additional lighting is helpful, and where it would be most beneficial. This can also be used to evaluate nighttime pedestrian activity and light available from other sources. In some cases tree trimming may improve the effective illumination of the pedestrian crossing or sidewalk area.

While continuous lighting to provide a consistent and uniform level of light is highly desirable, it is also desirable to consider additional lighting at select pedestrian crossing locations where nighttime activity is frequent. This may be

accomplished by providing an additional street light, or by providing a brighter light. A review of nighttime pedestrian accidents or activity may be used to identify locations where additional lighting may be helpful.

Pedestrians prefer lighting that makes nighttime conditions appear closer to daytime conditions. Of the primary types of lighting available for pedestrian facilities (low pressure sodium, high pressure sodium, and mercury vapor), mercury vapor lighting provides the least color distortion. However, high pressure sodium is more energy efficient and is an acceptable alternative. While low pressure sodium street lights provide a higher output of light at a lower cost, pedestrians (and drivers) generally feel less comfortable with the yellow light produced. In most cases the high pressure sodium street lights offer the most overall advantages when lighting the street area.

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Grade-Separated Crossings

Grade-separated crossings are facilities that provide for pedestrians and motor vehicles to cross at different levels. Such facilities can greatly reduce pedestrian-vehicle conflicts and potential accidents. Not only have grade-separated structures been found to substantially improve pedestrian safety, they can also reduce vehicle delay, increase highway capacity, and reduce vehicle crashes when appropriately located and designed.^{1,2} However, grade-separated crossings are expensive and they work only in limited settings.

Types of Facilities

Several types of grade-separated crossings have been used, including:

Overpasses:

1. Pedestrian Overpasses/Bridges - These are passageways for pedestrians constructed over a roadway in which stairs or ramps generally lead up to the overpass. In some cases, however, the road is depressed and the bridge is at ground level.

Grade-separated crossing can greatly reduce pedestrian-vehicle conflicts and potential accidents.

2. Elevated Walkways - These refer to sidewalks or walkways above ground level that often run parallel to the flow of motor vehicles. Such facilities may be freestanding or connected to adjacent buildings.
3. Skywalks/Skyways - These typically refer to enclosed walkways built one or more levels above ground level that connect buildings at midblock. These crossings allow for walking between buildings without being exposed to inclement weather and are especially beneficial to elderly and physically



Figure 20-1. Grade-separated crossings improve pedestrian safety.

disadvantaged pedestrians with lesser mobility.

Underpasses:

4. Pedestrian Tunnels/Underpasses - These generally involve stairs or ramps that lead down to a below-ground passageway. In some cases, however, the underpass is at ground level and the road is elevated.
5. Below-Grade Pedestrian Networks - These consist of extensive underground walkways that carry pedestrians parallel and perpendicular to the flow of motor vehicles traveling above them. These networks are sometimes used in conjunction with subway systems.

Planning Considerations

Locations that are prime candidates for grade-separated crossings are in areas where the pedestrian attractors such as shopping centers, large schools, recreational facilities, parking garages, or other activity centers are separated from the pedestrian generators by high-volume and/or high-speed arterial streets. Grade-separated facilities are

sometimes found in suburban and rural areas to connect residential areas with shopping centers or schools that are separated by freeways or high-speed arterial highways. In downtown areas, urban renewal projects provide an opportunity for adding grade-separated crossings.^{2,3,4,5}

The effectiveness of grade-separated crossings depends on their perceived ease of accessibility by pedestrians, because an overpass or underpass will not necessarily be used simply because it improves safety. Instead, pedestrians tend to weigh the perceived safety of using the facility against the extra effort and time required.² Studies have also shown that grade-separated crossings should ideally be on the normal path of pedestrian movements. However, fences, medians, railings, or other barriers may also be needed to prevent pedestrians from crossing at-grade.^{2,7} Otherwise, pedestrians tend to cross at locations they believe to be more direct.

Overpasses vs. Underpasses

The decision of whether to use an overpass or underpass involves the consideration of the relative advantages and disadvantages of each. Overpasses, more

commonly used than underpasses, require more vertical separation to provide clearance for large trucks. Underpasses need to be only 3.1 m (10 feet) (less than half the height of an overpass) and require shorter stairs or ramps and less right-of-way than overpasses. Two disadvantages of underpasses are their possible greater expense and costs related to relocation of utility lines, and possible drainage problems. Also, potential security problems often discourage pedestrians from using underpasses, particularly at night. The presence of activity centers at or near a grade-separated crossing helps to reduce crime and allows users to feel more secure. Overpasses should be enclosed to prevent the dropping of rocks or other debris onto vehicles passing below.^{2,7}

Warrants for Overpasses and Underpasses

Because of the high costs associated with grade-separated facilities, they should be incorporated into the early stages of planning new developments which are intended to generate substantial volumes of pedestrians. General guidelines and criteria for installing overpasses and tunnels are as follows:

Overpasses:

1. Work best if a very high volume of both motorized traffic and pedestrian activity exists. An overpass placed where there is an almost total lack of gaps, such as on a well-used freeway or nearly saturated multilane highway, may meet this warrant. When pedestrian activity is low, crime problems increase. Any perception of crime eliminates those few remaining pedestrians who desire to use the facility.
2. Are needed across roads with high speeds and many lanes with limited gaps. In this high risk crossing condition, there may be more gaps, but the conditions are so risky that many pedestrians will use the overpass. Such overpasses may be warranted near schools or other activity centers such as sporting or entertainment

complexes.

3. Can connect two activity centers. Sites with the above roadway conditions, or a school where the highway separates athletic fields or a second campus from the main campus, are warranted locations. When these conditions exist, it is best to begin the crossing from the second floor of one building and cross to a terraced earth wall on the opposite side. Pedestrians have a strong dislike for long stairs and ramps.
4. Work best with wide bridges. Bridges 3.1 m (10 feet) or more in width are best. They should be open and well lit and should minimize the need to use stairs or ramps to get across the bridge.
5. Require activity centers. When possible, have commercial kiosks or other activity centers at or near an overpass to curtail crime and unwanted activity.
6. Can be used with trails. On long, straight trail approaches, virtually all users will make use of an overpass. However, pedestrians approaching an overpass horizontally along the roadway are not inclined to go out of their way to reach the structure. Some use will be achieved by installing stairs and ramps. An even better action is to terrace the approach and allow a natural climb to the bridge structure.
7. Need to meet ADA standards.

Tunnels:

1. Are well lit. Consider using a median in the road and placing a large skylight in the center of the tunnel for natural light. Use overhead luminaries above this skylight to further light the tunnel at night.
2. Have vandal-resistant walls. Pedestrians do not like graffiti and other acts of vandalism. The best tunnels use artwork, glazing, or other methods to reduce vandalism.

3. Split the grade. Individuals about to enter a tunnel want to see the horizon at the far side. This effect is achieved by raising the roadway at least halfway, and thus depressing the tunnel only half of the elevation change.
4. Require robust activity. Commercial kiosks, entertainment complexes, and other activity centers are even more essential for successful tunnels, especially for major tunnels where undesirable elements might otherwise congregate.
5. Need to meet ADA standards.
6. Have good drainage - make drainage grates pedestrian-friendly.
7. Have video monitors. These need to be monitored, otherwise pedestrians will get a false sense of security.

While these criteria above are somewhat general, they do provide important factors for designers, planners, and developers to consider in determining where pedestrian facilities should be constructed. More specific warrants were developed by Axler in 1984 for grade-separated pedestrian crossings:⁸

1. The hourly pedestrian volume should be more than 300 in the four highest continuous hour periods if the vehicle speed is more than 65 km/h (40 mph) and the proposed sites are in urban areas and not over or under a freeway. Otherwise, the pedestrian volume should be more than 100 pedestrians in the four highest continuous hour periods.
2. Vehicle volume should be more than 10,000 in the same four-hour period used for the pedestrian volume warrant or have an ADT greater than 35,000 if vehicle speed is over 65 km/h (40 mph) and the proposed site(s) are in urban areas. If these two conditions are not met, the vehicle volume should be more than 7,500 in the four hours or have an ADT greater than 25,000.
3. The proposed site should be at least 183

m (600 ft) from the nearest alternative “safe” crossing. A “safe” crossing is defined as a location where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross. Another “safe” crossing is an existing overpass or underpass near the proposed facility.

4. A physical barrier is desirable to prohibit at-grade crossing of the roadway as part of the overpass or underpass design plan.
5. Artificial lighting should be provided to reduce potential crime against users of the underpasses or overpasses. It may be appropriate to light underpasses 24 hours a day and overpasses at nighttime.
6. Topography of the proposed site should be such as to minimize changes in elevation for users of overpasses and underpasses and to help ensure that construction costs are not excessive. Elevation change is a factor that affects the convenience of users.
7. A specific need may exist for a grade-separated crossing based on the existing or proposed land use(s) adjoining the proposed development site that generates pedestrian trips. This land use should have a direct access to the grade-separated facility.
8. Funding for construction of the pedestrian overpass or underpass must be available prior to a commitment to construct it.

Note that these criteria provide specific volumes of pedestrians and motor vehicles and vehicle speeds for which a pedestrian overpass or underpass is justified. However, while these specific values may be considered appropriate in certain instances, many economic and other factors also should be considered before making a final decision about installing high-cost grade-separated facilities for pedestrians.

Formal procedures have been established for assigning benefits and costs associated with adding overpasses and underpasses.

Benefits are weighed based on their	<p>perceived importance to the local community. Lists are given in Tables 20-1 and 20-2 of benefit variables and cost items associated with such facilities. Benefits can include not only improved safety to pedestrians, but also reduced travel time, maintenance of the continuity of a neighborhood, and many others. Facility costs include design and construction costs, site preparation, finishing touches (e.g., lighting, landscaping), and operation and maintenance costs. Further details on quantification of benefits and costs for grade-separated pedestrian crossings are given in NCHRP Report No. 189 (<i>Quantifying the Benefits of Separating Pedestrians and Vehicles, 1978</i>) and NCHRP Report No. 240 (<i>A Manual to Determine Benefits of Separating Pedestrians and Vehicles, 1981</i>)^{9,10,11}</p>
Other Transportation	
Safety	
Environment/ Community	<p>Pedestrian Transportation</p>
	<ol style="list-style-type: none"> 1. Travel time 2. Ease of Walking 3. Convenience 4. Special Provision for Various Groups
Residential/ Community	<ol style="list-style-type: none"> 5. Motor Vehicle Travel Costs 6. Use of Automobiles 7. Impact on Existing Transportation Systems 8. Adaptability to Future Transportation Development Plans
Commercial/ Industrial Districts	<ol style="list-style-type: none"> 9. Societal Cost of Accidents 10. Accident Threat Concern 11. Crime 12. Emergency Access/Medical & Fire Protection
Urban Planning	<ol style="list-style-type: none"> 13. Pedestrian-oriented Environment 14. Effects of Air Pollution 15. Noise Impacts 16. Health Effects of Walking

Table 20-1. Pedestrian facility evaluation variables.²

- | | |
|---|--------------|
| 17. Residential Dislocation | |
| 18. Community Pride and Cohesion | |
| 19. Community Activities | |
| 20. Aesthetic Impact, Compatibility with | Neighborhood |
| 21. Gross Retail Sales | |
| 22. Displacement, Replacement, or Renovation Encouraged by Facility | Required or |
| 23. Ease of Deliveries & Employee Commuting | |
| 24. Attractiveness of Area to Business | |
| 25. Adaptability to Future Urban Development Plans | |
| 26. Net Change on Tax Receipts and Other Revenue | |
| 27. Public Participation in the Planning Process | |
| 1. Design and architect costs | |
| 2. Financing costs and legal fees | |
| 3. Site preparation | |
| ◆ Real estate acquisition | |
| ◆ Demolition | |
| ◆ Drainage | |
| ◆ Grading | |
| ◆ Utilities relocation | |
| ◆ Foundations | |
| ◆ Required permits | |
| 4. Construction | |
| ◆ Height, width and length of facility | |
| ◆ Length of span (if any) | |
| ◆ Method of support | |
| ◆ Enclosures (if any) | |
| ◆ Materials | |
| ◆ Walkway paving, curbs | |
| 5. Finishing touches | |
| ◆ Lighting | |

- ◆ Street furniture
 - ◆ Amenities
 - ◆ Landscaping
6. Operation and maintenance
- ◆ Cleaning
 - ◆ Gardening
 - ◆ Maintenance and repairs
 - ◆ Lighting
 - ◆ Security
 - ◆ Taxes
 - ◆ Insurance

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Table 20-2. Major cost components of pedestrian facilities.²

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Boulevards

Suburban strip style streets emphasize speed and volume for motor vehicles, and de-emphasize human activity. Better forms for streets and highways are needed. Boulevards still allow volume, but reduce urban area speed. The modern boulevard was perfected in Paris, then used heavily throughout Europe and North America. Examples abound in most older U.S. cities, with the park movement in the late 1800's and the city beautiful movement in the early 1900's.

Getting back to the basics of good urban form, boulevards are now being reconsidered in many cities throughout America. They are friendlier for pedestrians, they elicit successful transit, make for successful commercial districts, and often are accepted by nearby residents as an approved form of roadway widening.

Best known boulevards include New Orleans classic St. Charles sporting a central median allowing the oldest continuous operating trolley in America; Monument Avenue gracing some of the finest homes in Richmond, Virginia; Fairmount Boulevard in Cleveland, Ohio; K Street in Washington, D.C.; and Dolores Street in San Francisco. One of the freshest new boulevards is the 1990's remake of Pennsylvania Avenue in Washington, D.C. This bustling eight-lane roadway has generous 9.2 - 18.3 m (30-60 foot) wide sidewalks with ample plantings of trees, and daytime parking in one of the

Boulevards are being reclaimed in diverse downtowns such as Baltimore, Boston, Cleveland, and Denver.

lanes to buffer the vehicle movements from adjacent pedestrians. Other new boulevards are being reclaimed in diverse downtowns such as Baltimore, Maryland; Boston, Massachusetts; Cleveland and Columbus, Ohio; Denver, Colorado; and Portland, Oregon.

This chapter is intended as an introduction to what boulevards are and how they are used. The design considerations of boulevards are too complex to be covered in a single chapter.

Figure 21-1. K Street in Washington, D.C., is an example of a successful boulevard.



What is a Boulevard?

The Classic Boulevard is inviting as a new form for moving vast volumes of traffic, yet creating an exciting partnership for successful people oriented commerce and neighborly places to live and play alongside. This form is characterized by a central roadway of at least four lanes, for generally through and non-local traffic. On both sides of the central roadway, tree-lined medians separate it from access lanes and sidewalks.

An example of this classic design is “K” Street in downtown Washington, D.C. (Figure 21-1). With four lanes in the center, two twelve foot side medians, then nineteen feet for a combined parking and access lane on either side and 6.1 m (20 feet) for each sidewalk, the cross section finishes out at 46 m (150 feet), building to building. The success of the access street in this classic boulevard model is that it strips away many of the turning movements. The medians allow superior transit operations, while the pedestrians move freely from the sidewalk space to the medians for temporary storage while awaiting a bus.

Why Are Boulevards Better than the Alternative?

Boulevards will not work everywhere, but where they do work there are many benefits. From the perspective of the pedestrian there is much to gain from a boulevard. Boulevards often create pleasant environments with shade, reduced corridor traffic speeds, low turning speeds, parking buffers to the street and ample width sidewalks. Often boulevards result in more successful adjacent neighborhood and commercial land use. There is often room for parks, plazas and cafes. The increased activity of a boulevard leads to reduced crime. For the motorist there is a significant reduction in stress. Boulevard style streets give the perception to motorists that their travel times and distances are 20-40% shorter than reality.

Esplanade — Chico, California

Chico is a small college and agricultural town in California’s Central Valley. This street was not originally a boulevard. It was

reconfigured in the 1950's. Residents of Chico have voted the Esplanade the best street in the city. The Esplanade is the major north/south traffic street and business street serving State Highway 99. The boulevard has four lanes occupying 8.2 m (27 feet) on each side of a 3.1 m (10 foot) center median. A twenty-eight foot and a ten-foot median are found on the two sides, followed by a 6.2 m (20 foot) parking and access lane. Sidewalks are found at the back of the parking lanes. The boulevard is 15 blocks long, and is graced by bungalow style homes. The tree plantings are large Sycamore and London Planes spaced 9.2 - 10.7 m (30-35 feet). Signal timing is set at 45 km/h (28 mph) in the center, with a new signal every two blocks. Traffic in the center moves at 50 km/h (31 mph), while 34 km/h (21 mph) is characteristic on the access roads. Virtually all traffic (875 average VPH per direction) moves in the center. Only a dozen cars an hour were found moving along the side streets. Bicycles use the access roads.

Comparisons Between Boulevards

A. Jacobs found that the low operating speeds of boulevard streets allow motorists and pedestrians to intermingle safely and efficiently. There are far fewer conflicts than the high numbers of users would suggest. Although the streets are capable of carrying very high volumes of pedestrians and vehicles, the physical space remains very pleasant. Boulevard streets were compared to similar volume roadways in the same part of town. In all cases the boulevard streets were at least as safe as the comparison road. The areas are often quieter than other styles of streets, nicely shaded, and there is plenty of human activity and purposeful lingering.

What Designs Are Most Safe?

Boulevards that emphasize low travel speeds, especially on access lanes, produce the best results. Motorists are mindful of



Figure 21-2. Neighborhood boulevard streets produce low-speed travel. Proper placement and undercutting of trees keep sight lines open.

traffic signals and stop signs. And generally pedestrians are watchful of cars and they pay attention to signals. Motorists are more considerate of pedestrians, partly because they see more of them and they are traveling at speeds where courtesy is easy (Figure 21-2).

Wide traffic lanes and long blocks are associated with higher speeds and more midblock crossings by pedestrians. Pedestrians are frustrated by long walks to intersections, and on the higher speed roads their injury rates and injury severity go up.

Intersections

Classic boulevard intersections can be highly complex. Sketches showing the potential crossing conflicts defy logic and common sense. Potential crash conflicts are staggering. Yet in application, especially when the physical features of design are well crafted, the intersection has a harmony and quality producing limited and low impact crashes. Based on volume, pedestrian movements are very safe. As an example of the very complex movements and the very low vehicle crash rate, France's Avenue Marceau has four streets intersecting at one point. Accident data at this intersection reveals that none of the intersections have more than ten crashes a year, which was the

Figure 21-3. This boulevard has an attractively-landscaped median. The sidewalk offers pedestrians a scenic, tree-lined place to walk.



threshold for entry into the report that was provided.

Removing complexity from rather straightforward intersections may not always make them safer. Mangrove Avenue in Chico runs parallel to the Esplanade, has significantly fewer intersections, and carries about the same amount of traffic. Major intersections have lights timed to eliminate left-turn conflicts. And yet, Mangrove has a similar crash rate to the Esplanade. The simplification of the intersections of boulevard streets, such as in Washington D.C., does not improve safety, but possibly erodes safety. A. Jacobs points out that one-way boulevards, which greatly simplify complex intersections, have a higher crash rate than those that are more complex.

Access Lanes

On urban streets, where abutting uses have direct access to the street, with the constant need for pickup and drop-off, and with deliveries to shops, the disturbance to through traffic caused by single- and double-parking, and by cars pulling in and out of

parking, is much greater on normal streets than on boulevards, where it is unobtrusively carried out on the access lanes. Access roads should be kept relatively narrow and slow. If desired, bike lanes can be added to access lanes, along with parking, to narrow wide existing lanes to those that are safer. It is best if blocks are short, and for signal phasing to favor lower speed (40-48 km/h) (25-30 mph) center travel lane speeds.

Boulevards Work Best When the Pedestrian Is an Equal

Note that all successful boulevards have ample space for the pedestrian. Those that tend to fail for both motorists and pedestrians leave the pedestrian as a secondary consideration. Along a classic boulevard, pedestrians require:

- ◆ Narrow access roads
- ◆ A buffer (parking, nature strip or bike lanes)
- ◆ Ample lines of shade trees
- ◆ Short blocks

- ◆ Good street lighting

and ideas, boulevards have lasting value.

Desired features include:

Outdoor parks

- ◆ Cafes, kiosks, phone booths
- ◆ Benches, walls and other good sitting places
- ◆ An abundance of stores at ground level
- ◆ Interesting, nicely landscaped traditional style homes

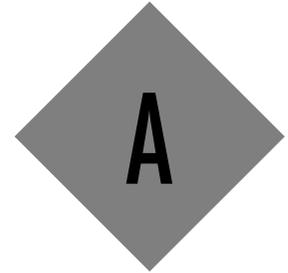
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Conclusion

Boulevards bring additional needed form, function, tools and challenge to a community's public space. They are more complex and diverse in their operations than conventional streets and street patterns. Boulevards are highly flexible, and they can be used where there is low or high density, in residential as well as commercial parts of town. A successful boulevard can often be built within existing rights-of-way.

Boulevards offer space for motorists, transit and pedestrians. Boulevards meet the needs of a total public, from young children, to those with physical limitations, to those in their retirement years. Boulevards are born out of the history of great cities. They offer efficiency and quality. Boulevards have the ability to carry people and goods with safety, convenience and charm in their center, on their edges, and even underneath.

Well designed boulevards compete on an equal basis with conventional roadways in safety and capacity. They do not operate at high speeds, nor should they be designed to. Instead they offer to the commuter, the through driver, and the local resident, a sense of place, a tranquility, a fullness and wholesomeness all too rare under conventional highway design. Because of their value in bringing back commercial street activity, diversity, chance discovery, social interaction, and the exchange of knowledge



Transportation Center. Funded in part by FHWA.

F. Kent interview, *Project For Public Spaces* research on public spaces.

W. Kulash interview by Dan Burden, and *Washington Post* article, September 1995.

Appendix Traffic Laws and Definitions for Pedestrians

Traffic laws are written and enforced to create uniform and predictable movements between vehicles, and in vehicles and pedestrians and other moving traffic. Although laws may vary slightly from state to state, there is striking similarity between

the language of most states. The uniformity of this language is achieved by having each state legislature address specific laws as set forth in the Uniform Vehicle Code (UVC). The language in this section is taken from the UVC.

Design/Law Link

A general observation regarding motorist behavior is that most motorists fail to respect the safety and needs of pedestrians. Many pedestrians correspondingly ignore traffic law, forcing many motorists to take evasive actions.

The behavior between the two groups can be and is strongly influenced by design. For example, a motorist approaching a crosswalk at low speed (below 32 km/h (20 mph)) is likely to stop for a pedestrian wishing to cross. Motorists traveling at speeds of 48 km/h (30 mph) or greater are likely to continue, even though the pedestrian may be clearly intending to cross.

By paying closer attention to designs that elicit the best behavior of both groups, the designer may be able to create crossings that do not require signalization or other highly evasive design strategies.

Jaywalking

This commonly used word does not appear in traffic law. Generally, however, a person is breaking the law and is considered to be *jaywalking* when he or she is doing any of the following:

- ◆ Crossing against a red light
- ◆ Crossing not fully in a crosswalk or crosswalk area
- ◆ Crossing midblock between two adjacent signalized intersections
- ◆ Crossing diagonally
- ◆ Causing a vehicle to have to brake suddenly, creating an unsafe condition
- ◆ Crossing at grade when in the immediate presence of an overpass or tunnel, and when a vehicle has to correct for the actions of the pedestrian.

Common Motorist Violations

- ◆ Speeding
- ◆ Failure to stop or yield to a traffic control
- ◆ Failure to stop or yield to a pedestrian in a crosswalk
- ◆ Illegal right turn on red
- ◆ Parking in a restricted zone

DUI

Sidewalks

Where sidewalks are provided, no pedestrian shall, unless required by other circumstances, walk along and upon the portion of a roadway paved for vehicular traffic. Where sidewalks are not provided, any pedestrian walking along and upon a highway shall, when practicable, walk only on the shoulder of the left side of the roadway, facing traffic. Sidewalks are bidirectional, and pedestrians walk both with and against traffic.

Designers need to be aware that, on

multilane highways, pedestrians are not likely to cross to the other side. Sidewalks on both sides of all urban multilane roadways are essential for the safety of pedestrians and motorists. Paved shoulders in rural areas will benefit the lower number of pedestrians likely to be traveling in these locations.

Pedestrian Control Signals

There is widespread confusion on the use of these signal phases. According to a recent American Automobile Association financed research project, 51% of the American public does not know the meaning of a flashing *DON'T WALK*. A *WALK* phase permits pedestrians facing such a signal to cross the roadway in the direction of the signal and requires motorists to yield the right-of-way. A flashing *DON'T WALK* signal means that no pedestrian shall start to cross the roadway, but any pedestrian who has entered or partially entered the roadway may proceed to the far sidewalk or safety zone. A steady *DON'T WALK* means that no pedestrians should be in the roadway.

When Do Pedestrians Have the Right of Way?

On Sidewalks

The driver of a vehicle shall yield the right of way to any pedestrian on a sidewalk. Since bicycles are vehicles, bicyclists must yield to pedestrians on sidewalks.

In Crosswalks

The driver of a vehicle shall stop and remain stopped to allow a pedestrian to cross the roadway within an unmarked or marked crosswalk when the pedestrian is upon or within one lane of the half of the roadway upon which the vehicle is traveling or onto which it is turning. *Half of the roadway* means all traffic lanes carrying traffic in one direction of travel, and includes the entire width of a one-way

roadway.

Every driver of a vehicle shall exercise due care to avoid colliding with any pedestrian or any person propelling a human-powered vehicle, and exercise proper precaution upon observing a child or any obviously confused or incapacitated person upon a roadway.

Notwithstanding the foregoing provisions, every driver of a vehicle shall exercise due care to avoid colliding with any pedestrians upon any roadway and shall give warning by sounding the horn when necessary and shall exercise proper precaution upon observing any child or any obviously confused or incapacitated person upon a roadway.

Other Drivers

Whenever any vehicle is stopped at a marked crosswalk or at any unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of a vehicle approaching from the rear shall not overtake and pass such stopped vehicle.

When Do Pedestrians Yield the Right of Way?

- ◆ Every pedestrian crossing a roadway at any point other than within a marked or unmarked crosswalk at an intersection shall yield the ROW to all vehicles upon the roadway.
- ◆ Between adjacent intersections at which traffic signals are in operation, pedestrians shall not cross at any place except in a marked crosswalk.
- ◆ Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the ROW to all vehicles upon the roadway.
- ◆ No pedestrian shall, except in a marked crosswalk, cross a roadway at any other place than by a route at right angles to the curb or by the shortest route to the opposite curb. No pedestrian shall cross a roadway intersection diagonally unless authorized by official traffic control devices.
- ◆ No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close that it is impossible for the driver to yield.
- ◆ No pedestrian shall enter or remain upon any bridge or approach thereto beyond a bridge signal gate, or barrier indicating a bridge is closed to through traffic, after a bridge operation signal indication has been given.
- ◆ No pedestrian shall pass through, around, over, or under any crossing gate or barrier at a railroad grade crossing or bridge while such gate or barrier is closed or is being opened or closed.

Bicyclists

Bicyclists may use sidewalks in some states. In others they may use sidewalks until the age of 14. Generally, bicyclists cannot ride bicycles on sidewalks in business districts (check local ordinances). When riding on sidewalks, bicyclists:

- ◆ Must yield to pedestrians, using care to pass
- ◆ Have the same rights and responsibilities as pedestrians at driveways and intersections
- ◆ Although granted the right of way at driveways, bicyclists coming from the motorist's right often go undetected. For this reason, every effort should be made to provide on-road facilities to support bicycle traffic where it can be best detected, and where it minimizes the impact on pedestrians.

Definitions

AASHTO — American Association of State Highway and Transportation Officials.

AASHTO publishes a number of guidelines for highway and other design and construction which is often an unofficial or official set of guides for a given city, county or state.

ACCESS MANAGEMENT — The principles, laws and techniques used to control access to highways.

ADA — The Americans with Disabilities Act; civil rights legislation passed in 1990, effective July 1992.

ADT — Average Daily Traffic. The measurement of the average number of vehicles passing a certain point each day on a highway, road, street or path.

AUDIO-TACTILE — A special signal and control that alerts visually impaired pedestrians when to cross a particular roadway. Some experimental models also remind pedestrians to search before leaving the curb.

ARTERIAL (ROAD) — A road designated to carry traffic, mostly uninterrupted, through an urban area, or to different neighborhoods within an urban area.

BARNES DANCE — An exclusive phase on a signal where all vehicular traffic is stopped and pedestrians are permitted to cross in multiple directions.

BARRICADE — A portable or fixed barrier having object markings, used to close all or a portion of the right-of-way to vehicular and/or pedestrian traffic.

CHANNELIZING LINE — A line which directs traffic and indicates that traffic should not cross but may proceed on either side.

COLLECTOR (ROAD) — A road designated to carry traffic between local streets and arterials, or from local street to local street.

CROSS SECTION or TYPICAL CROSS SECTION or TYPICAL — Diagrammatic presentation of a highway or path profile which is at right angles to the centerline at a given location.

CROSSING, PUFFIN — An experimental British crosswalk (Pedestrian User Friendly Intelligent Crossing) which uses modern computers, video cameras and sensors to permit pedestrians to cross midblock in greater safety. The system monitors the approach of vehicles and pedestrians, gives the right crossing cycle length for a pedestrian based on observed speed, and alerts pedestrians if a motorist is not going to stop.

CROSSWALK — (a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the traversable roadway whether marked or unmarked; (b) Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface.

DESIGN STANDARDS — The specific values selected from the roadway design criteria become the design standards for a design project. These standards will be identified and documented by the designer.

EDGE LINE — A painted or applied line to designate the edge of the road (6-8 inches, or 150-200 mm)

ENHANCEMENT FUNDS — Under ISTEA, independent funds for bicycling and walking facilities, trails, and eleven other activities.

FRONTAGE ROAD — A road designed and designated to serve local traffic parallel and adjacent to a highway or arterial street.

GRADE — A measure of the steepness of a roadway, bikeway or walkway, expressed as a ratio of vertical rise per horizontal distance, usually in percent. For example, a 5% grade equals a 5 meter rise over a 100 meter horizontal distance.

GRADE SEPARATION — The vertical separation of conflicting travelways with a structure. An overpass and a tunnel are examples of common grade separations used to avoid conflicts.

HIGHWAY — A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

INTERSECTION — The area embraced within the prolongation or connection of the lateral curb lines, or, if none, then the lateral boundary lines of the roadways of two highways which join one another at, or approximately at, right angles; or the area within which vehicles traveling upon different highways joining at any other angle may come in conflict.

ISLAND — An area within a roadway from which vehicular traffic is intended to be excluded, together with any area at the approach thereto occupied by protective deflecting or warning devices.

ISLAND, CHANNELIZING — A traffic island located in a roadway area to confine specific movements of traffic to specific channels.

ISLAND, DIVISIONAL OR MEDIAN — A traffic island, usually elongated and narrow, following the course of the roadway to separate traffic moving in the same or opposite directions and sometimes used as a pedestrian refuge.

ISLAND, LOADING — A pedestrian island especially provided for the protection of transit vehicle users.

ISLAND, TRAFFIC — An island designed to separate or direct streams of vehicle traffic. Included are both divisional and channelizing islands.

ISTEA — The Intermodal Surface Transportation Efficiency Act enacted in 1991. Federal legislation guiding the expenditure of federal highway funds.

MEDIAN LANE — A speed change and storage lane within the median to accommodate left-turning vehicles and

sometimes used as a pedestrian refuge.

MEDIAN — The portion of a divided highway separating traveled ways for traffic in opposite directions and sometimes used as a pedestrian refuge.

MULTIUSE PATH/TRAIL (BIKE PATH, BIKE TRAIL) — Any bikeway that is physically separated from motorized vehicular traffic by an open space or barrier. It is either within the highway right of way or within an independent right of way. Due to a lack of pedestrian facilities, most bike paths/trails are commonly designed and referenced as multiuse paths or trails.

MUTCD — *The Manual on Uniform Traffic Control Devices*, approved by the Federal Highway Administration as a national standard for the placement and selection of all traffic control devices on or adjacent to all highways open to public travel.

PATHWAY — Simply-kept graded or improved pedestrian-vehicle separation.

PAVEMENT — That part of a roadway having a constructed surface for the facilitation of vehicular traffic.

PAVEMENT MARKINGS — Painted or applied lines or legends placed on a roadway surface for regulating, guiding, or warning traffic.

PEDESTRIAN — A person in or adjacent to a trafficway, not in or on any vehicle or other device used for transportation, sport, or recreation.

PEDESTRIAN ADVISORY COMMITTEE — Most metropolitan areas and some counties have a politically appointed group of citizens and technicians who oversee pedestrian planning and provide technical review of local pedestrian facilities. These groups are known as Pedestrian Advisory Committees (PAC's) and are usually associated with Metropolitan Planning Organizations (MPO's).

PEDESTRIAN CLEARANCE INTERVAL — The time of display of the *DON'T WALK* indication following the *WALK* interval

before opposing vehicles receive a green indication.

PEDESTRIAN DETECTOR — A detector, usually of the push-button type, installed near the roadway and capable of being operated by hand.

PEDESTRIAN PHASE (PEDESTRIAN MOVEMENT) — A traffic phase allocated to pedestrian traffic.

A. COMBINED PEDESTRIAN-VEHICLE PHASE — A traffic phase wherein pedestrians are directed to move on certain crosswalks parallel to the through vehicular movement and wherein vehicles are permitted to turn across the said crosswalks.

B. SEMI-EXCLUSIVE PEDESTRIAN VEHICLE PHASE — A traffic phase wherein pedestrians are directed to move on certain crosswalks with parallel or other vehicular movements, but vehicles are not permitted to turn across the said crosswalks during the pedestrian movement.

C. LEADING PEDESTRIAN PHASE — Signal phasing wherein an exclusive pedestrian phase, in advance of the minor street vehicular green phase, is provided for pedestrians crossing the main street only.

D. EXCLUSIVE PEDESTRIAN PHASE — A traffic phase wherein pedestrians are directed to move on any crosswalk or cross the intersection diagonally during an exclusive phase while all vehicles are stopped (Also called Barnes Dance).

PEDESTRIAN SIGNAL — A traffic control signal which is erected for the exclusive purpose of directing pedestrian traffic at signalized locations.

PEDESTRIAN REFUGE ISLAND — A pedestrian island designed for the use and protection of pedestrians. A pedestrian island included the safety zone together with the area at the approach occupied or outlined by protective deflecting or warning devices. This includes loading islands.

RIGHT-OF-WAY — A general term

denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

RIGHT OF WAY — The right of one vehicle or pedestrian to proceed in a lawful manner in preference to another vehicle or pedestrian.

ROADWAY — That portion of the highway, including shoulders. Sidewalks are outside of the roadway, but inside the highway right-of-way.

ROADWAY DESIGN CRITERIA — Criteria for the design of new or major reconstruction projects on the Florida State Highway System. These criteria are found in Chapter 2 of the Roadway Plans Preparation Manual. Design criteria for resurfacing, restoration, and rehabilitation are presented in Chapter 25 of the Roadway Plans Preparation Manual.

ROUNDABOUT — A circular or other shaped object placed in the center of an intersection, along with channel islands on all approaches, that restrict entering speed and flow direction of traffic. Roundabouts require a yield upon entry, and are an alternative to signalization at some intersections. Generally pedestrians and motorists benefit from roundabouts.

RRR PROJECTS — Specific roadway improvement projects that include Resurfacing, Restoration and Rehabilitation of roadways. These projects use a different pot of funds than new construction.

RULES OF THE ROAD — That portion of a motor vehicle law that contains regulations governing the operations of vehicular and pedestrian traffic.

SHOULDER (PAVED) — That portion of a highway which is contiguous to the travel lanes, allowing motor vehicle use in emergencies, for specialized use of pedestrians and bicyclists, and for lateral support of base and surface courses.

SHY DISTANCE — The distance between the edge of a travelway and a fixed object. Also, the separation distance a roadway user

needs to feel safe operating near a fixed object.

SIDEWALK — That portion of a highway designed for preferential or exclusive use by pedestrians.

SIGHT DISTANCE — The distance a person can see along an unobstructed line of sight.

SKEW ANGLE — The angle formed between a roadway, bikeway or walkway and an intersecting roadway, bikeway, walkway or railroad line, measured away from the perpendicular.

SLIP LANE — A raised island near the corner of an intersection that permits vehicular right turning traffic to move independent of signalization. Properly designed slip lanes are helpful to pedestrians, while poorly designed slip lanes can create problems. (Also **ISLAND**, **CHANNELIZED**.)

STOP BAR, STOP LINE — A pavement marking placed in the roadway at the location where a motorist is expected to stop. Typically this line is placed 4 feet in front of the crosswalk.

STOP BAR, STOP LINE, ADVANCED — A special placement of a stop bar or line, usually 50 feet in advance of a midblock crossing. Used in this location, it is possible to give motorists and pedestrians advance notice of any unsafe movement.

STRUCTURE — A bridge, overpass, retaining wall or tunnel.

TRAFFIC — Pedestrians, ridden or herded animals, vehicles, streetcars, and other conveyances either singly or together while using any highway for purpose of travel.

TRAFFIC-ACTUATED SIGNAL — A type of traffic control signal in which the intervals are varied in accordance with the demands of traffic as registered by the actuation of detectors.

A. SEMITRAFFIC-ACTUATED SIGNAL — A type of traffic-actuated signal in which means are provided for traffic

actuation on one or more but not all approaches to the intersection.

B. FULL TRAFFIC-ACTUATED SIGNAL — A type of traffic-actuated signal in which means are provided for traffic actuation on all approaches to the intersection.

TRAFFIC CONTROL SIGNAL — Any device whether manually, electronically, or mechanically operated by which traffic is alternately directed to stop and permitted to proceed.

TRAFFIC CONTROL DEVICES — Signs, signals or other fixtures, whether permanent or temporary, placed on or adjacent to a travelway by authority of a public body, having jurisdiction to regulate, warn or guide traffic.

TRAFFIC MARKINGS — All lines, patterns, words, colors, or other devices, except signs, set into the surface of, applied upon, or attached to the pavement or curbing or to objects within or adjacent to the roadway officially placed for the purpose of regulating, warning, or guiding traffic.

TRAFFIC SIGN — A traffic control device mounted on a fixed or portable support whereby a specific message is conveyed by means of words or symbols, officially erected for the purpose of regulating, warning, or guiding traffic.

TRAFFIC VOLUME — The given number of vehicles that pass a given point for a given amount of time (hour, day, year). See **ADT**.

TRUNCATED DOMES — Raised domes cut off at the top, usually a quarter in size, that are positioned to alert a visually impaired pedestrian of their final approach to a train platform, a curb ramp, or some other point of danger.

UNIFORM VEHICLE CODE — Model statutes specifically designed to provide the content and language of legislation needed to give uniformity to the “rules of the road” and traffic control devices.

VEHICLE — Any device in, upon or by which any person or property is or may be transported or drawn upon a highway and includes vehicles that are self-propelled or powered by any means. Includes legally