8. PEDESTRIAN CROSSINGS

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(Credit: Kimley-Horn and Associates, Inc.)

INTRODUCTION

Walking requires two important features in the built environment: people must walk along streets and they must get across streets. Crossing a street should be easy, safe, convenient, and comfortable. While pedestrian behavior and intersection or crossing design affect the street crossing experience, motorist behavior (whether and how motorists stop for pedestrians) is the most significant factor in pedestrian safety.

Crossings are a necessary part of the pedestrian experience (Credit: Luisa Fernanda Arbeláez)

Pedestrian networks and vehicle networks overlap at intersections, posing conflicts between different modes of travel. A number of tools exist to improve pedestrian safety and to make crossing streets easier. Effective traffic management can address concerns about traffic speed and volume. A motorist driving more slowly has more time to see, react, and stop for a pedestrian. The number of pedestrians also influences motorists; in general, motorists are more aware of pedestrians when more people walk. Most tools to address crossing challenges are engineering treatments, but tools from the enforcement, education, and planning toolboxes are also important.

> *"I just want to be able to cross the street safely."*
> - *City of Deerfield Beach Mayor Peggy Noland*

Marked crosswalks guide pedestrians to walk at the safest location. To a lesser extent, marked crosswalks also alert vehicle operators to the potential presence of pedestrians, although crosswalks can be less visible from the perspective of moving traffic, which is one reason for supplementing crosswalks with pedestrian warning (W11-2) signs. Providing marked crosswalks is only one of the many possible engineering measures. When considering how to provide safer crossings for pedestrians, the question should *not* be: "Should I provide a marked crosswalk?" Instead, the question should be: "What are the most effective measures that can be used to help pedestrians safely cross the street?" For example, crossings often need to be supplemented with median refuges, flashing beacons, and signage. Deciding whether to mark or not mark crosswalks is only one consideration in creating safe and convenient pedestrian crossings.

This chapter describes a number of measures to improve pedestrian crossings, including marked and unmarked crosswalks, raised crossing islands and medians, beacons, and lighting.

ESSENTIAL PRINCIPLES OF PEDESTRIAN CROSSINGS

The following principles should be incorporated into every pedestrian crossing improvement:

Curb extensions and medians make crossing four-lane streets safer and more manageable. Note the use of an in-street pedestrian crossing sign to alert motorists. (Credit: Dan Burden)

- Pedestrians must be able to cross roads safely. FDOT and local governments have an obligation to provide safe and convenient crossing opportunities.
- The safety of all street users, particularly more vulnerable groups, such as children, the elderly, and those with disabilities, and more vulnerable modes, such as walking and bicycling, must be considered when designing streets.
- Pedestrian crossings must meet accessibility standards and guidelines (see Chapter 7 "Universal Pedestrian Access" for more information).

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site consistent with the FHWA Highway Safety Manual. For example, if a median refuge island at an existing crosswalk is expected to reduce the number of crashes by 23 percent, the CMF will be 1 – (23/100) = 0.77.

Real and perceived safety must be considered when designing crosswalks — crossing the street must be "comfortable."

- Crossing treatments that have the best crash modification factors (CMFs) should be used when designing crossings.
- Safety should not be compromised to accommodate traffic flow.
- Good crossings begin with appropriate speed. In general, urban arterials should be designed to a maximum of 30 mph or 35 mph.
- Every crossing is different and should be selected and designed to fit its unique environment.

The following issues should also be considered when planning and designing crossings.

- Ideally, uncontrolled crossing distances should be no more than 28 feet, which allows for two 11-foot lanes and one 6-foot bicycle lane. This would allow pedestrians to cross

an uncontrolled crossing in 8 seconds, assuming a conventional walking speed of 3.5 feet per second.

- Uncontrolled crosswalks should still be considered if the crossing distance is greater than 28 feet within a context sensitive approach, such as in locations where transit passengers cross the street, in urban transects (T4, T5 or T6), where marked crosswalks would effectively channel pedestrians to a single crossing location, and unsignalized intersections with no signalized crossing within 600 feet (see *Accessing Transit: Designing Handbook for Florida Bus Passenger Facilities*, Florida State University (2008), accessed from FDOT Transit website).
- Uncontrolled crosswalks on streets wider than 28 feet should be augmented with additional crossing safety devices. Ideally, streets wider than 28 feet should be divided (effectively creating two streets) by installing a median or crossing islands, especially when traffic volumes are greater than 12,000 vehicles per day. According to *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations* (Zegeer et al, 2005), on multi-lane roads with traffic volumes above 12,000 vehicles per day, having a marked crosswalk alone (without other substantial crossing safety improvements) was associated with a higher pedestrian crash rate compared to an unmarked crosswalk. Substantial crossing safety improvements were considered to include raised medians, speed-reducing measures (traffic calming), traffic signals, and beacons.
- The number of lanes crossed should be limited to a maximum of three lanes per direction on all roads (plus a median or center turn lane).
- There must be a safe, convenient crossing at every transit stop.
- Double (or triple) left or right turns concurrent (permissive) with pedestrian crossings at signalized intersections must never be allowed.
- Avoid concurrent movements of motor vehicles and people at signalized intersections, with the exception of right-turns from single lanes, which should be supplemented with R10-15 signs and tight corner radii to control speeds.
- People should never have to wait more than 90 seconds to cross at signalized intersections.
- Pedestrian signals should be provided at all signalized crossings where pedestrians are allowed.
- Marked crosswalks should be provided on all approaches of signalized intersections.
- Locations where pedestrian bulb-outs can be provided can enhance the viability of a crossing location.

MUTCD R10-15 sign
(Credit: Kimley-Horn and Associates, Inc.)

FLORIDA STATE STATUTES RELATED TO PEDESTRIAN CROSSINGS

Florida traffic laws for pedestrians and drivers are found in *Florida State Statute 316.003*, *316.075*, and *316.130*. A brief summary is provided below.

- Crosswalks may be marked or unmarked and carry the same legal definition whether marked or unmarked.
- Any intersection of two public streets is a legal crossing, and is therefore a strong candidate to include marked crosswalks, signage, and pedestrian crossing safety infrastructure.
- Mid-block crossing outside a crosswalk is allowed if in either direction, the nearest intersection is unsignalized.
- A driver is obligated to yield the right-of-way to a pedestrian lawfully crossing in a crosswalk. Safe yielding may require stopping.
- A crosswalk is legally present on each leg of an intersection whether marked or unmarked.

PERFORMANCE MEASURES

Performance measures are typically used to study uncontrolled crossing locations. Performance measures establish how well a crossing is performing. In all cases, baseline data should be collected to allow for before and after analysis. Performance measures for pedestrian crossings include the following.

- The number of pedestrians crossing at a particular crossing location increases.
- The pedestrian crash rates descrease (for an accurate determination, entire corridors should be analyzed since crashes at any one location may be infrequent).
- Pedestrian fatalities and serious injuries should decrease.
- The numbers of children, seniors, and people with disabilities crossing the street should reflect their percentage in the vicinity population.

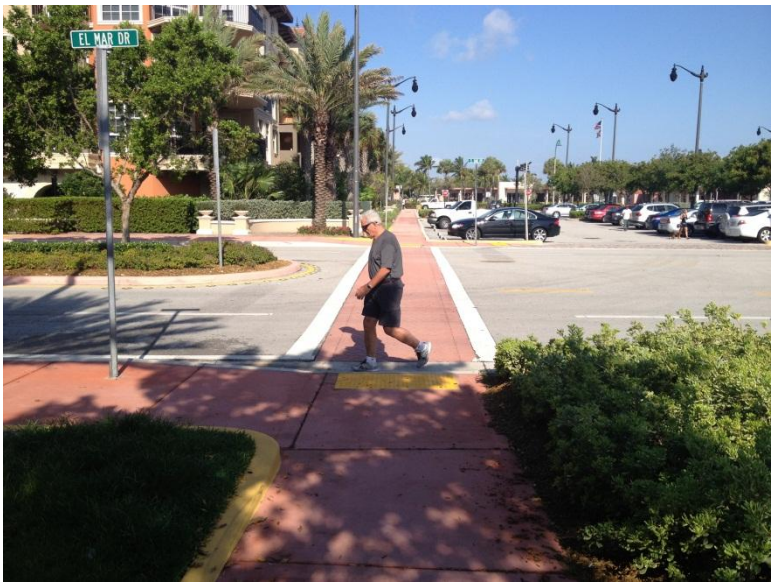
Lively streets with many pedestrians and comfortable crossing environments indicate a walkable neighborhood, such as Lauderdale-By-The-Sea
(Credit: Kimley-Horn and Associates, Inc.)

- The speed of motorists either turning at an intersection or traveling at a mid-block crossing descreases.
- Motorists do not block intersections (including crosswalks).
- At uncontrolled intersections, the percentage of motorists who stop for pedestrians goes up (measure compliance with stop or yield requirement in local vehicle code).

PEDESTRIAN CROSSING TOOLBOX

Many engineering measures may be used at a pedestrian crossing, depending on site conditions and potential users. Marked crosswalks are commonly used at intersections and sometimes at mid-block locations. Marked crosswalks are often the first measure in the toolbox followed by a series of other measures that are used to enhance and improve marked crosswalks. The decision to mark a crosswalk should not be considered in isolation, but rather in conjunction with other measures to increase awareness of pedestrians. Without additional measures, marked crosswalks alone may not increase pedestrian safety, particularly on multi-lane streets.

MARKED CROSSWALKS



Marked crosswalk. If decorative treatment is applied it shall be bordered by solid white line crosswalk markings. (Credit: Kimley-Horn and Associates, Inc.)

Crosswalks are present by law on all approaches of all intersections, whether marked or unmarked, whether signalized or unsignalized, unless the pedestrian crossing is specifically prohibited by signs. At mid-block locations, crosswalks only exist where marked. Note that mid-block crossings are legally allowed if the nearest intersection in each direction is unsignalized. Crosswalks should be considered at mid-block locations where there is strong evidence that pedestrians want to cross there, due to origins and destinations across from each other and an overly long walking distance to the nearest controlled crossing (see mid-block crossing sub-section below). Marked crosswalks alert drivers to expect crossing pedestrians and direct pedestrians to desirable crossing locations. Although many motorists are unaware of their precise legal obligations at crosswalks, the Florida Uniform Traffic Control Law requires drivers to yield to pedestrians in any crosswalk, whether marked or unmarked. Marking crosswalks at every intersection is not necessary or desirable.

Crosswalk Markings

According to the MUTCD, the minimum crosswalk marking shall consist of solid white lines. They shall not be less than 6 inches or greater than 24 inches in width. FDOT Standard Index 17346 states that crosswalk lines shall be a minimum of 12 inches in width. Local jurisdictions should follow the 12 inch minimum standard for crosswalk markings.

Placement

The best locations to install marked crosswalks are as follows.

- All signalized intersections
- Crossings near transit locations
- Shared use path crossings
- High-pedestrian land use generators
- School walking routes
- Where there is a preferred crossing location due to sight distance
- Where needed to enable comfortable crossings of multi-lane streets between controlled crossings spaced at convenient distances
- Unsignalized intersections in urban transects (T4, T5, or T6)
- Unsignalized intersections with no signalized crossing within 600 feet

Controlled Intersections

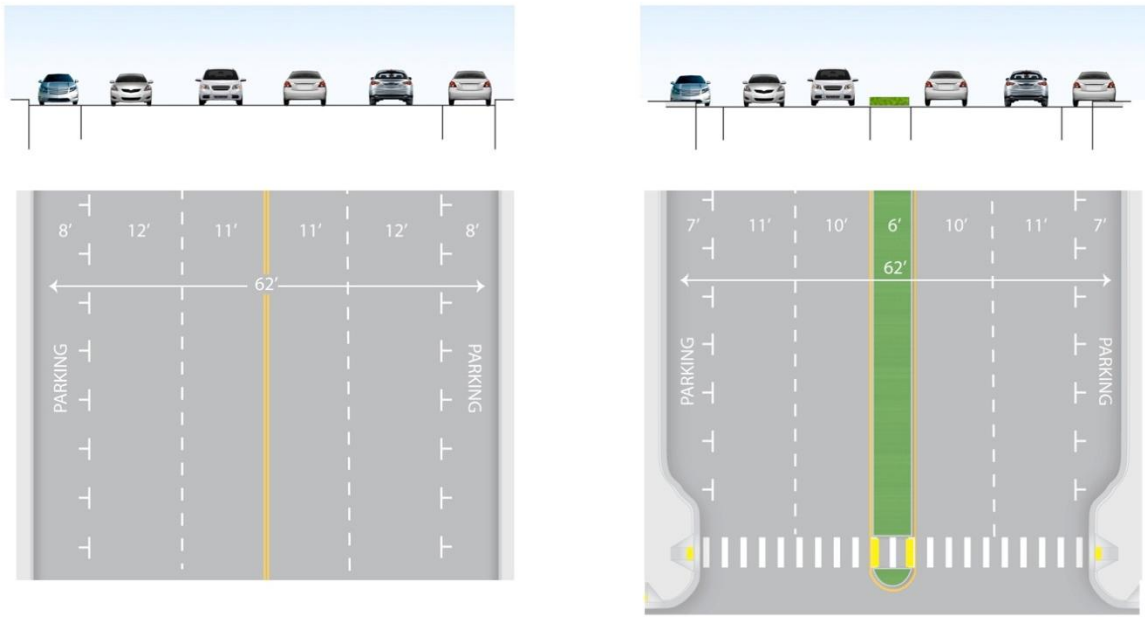
Intersections can be controlled by traffic signals or STOP signs. Marked crosswalks should be provided on all intersection legs controlled by traffic signals, unless the pedestrian crossing is specifically prohibited by signs. Marked crosswalks may be considered at STOP-controlled intersections. Factors to be considered include high pedestrian volumes, high vehicle volumes, school zone location, high volume of elderly or disabled users, or other safety related criteria.

Pedestrian crossing at a controlled intersection
(Credit: Luisa Fernanda Arbeláez)

Uncontrolled Intersections

Intersections without traffic signals or STOP signs are considered uncontrolled intersections. The decision to mark a crosswalk at an uncontrolled intersection should be guided by an engineering study. Factors considered in the study should include vehicular volumes and speeds, roadway width and number of lanes, stopping sight distance and triangles, distance to the next controlled crossing, night time visibility, grade, origin-destination of trips, left turning conflicts, and pedestrian volumes. The engineering study should be based on the FHWA study, *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations* (Zegeer et al, 2005). The following list provides some of the key recommendations from the study.

Pedestrian crossing at an uncontrolled intersection
(Credit: Kimley-Horn and Associates, Inc.)



Uncontrolled crossings of four-lane streets can be difficult to cross without special treatments like medians and curb extensions.
(Credit: Michele Weisbart)

- It is permissible to mark crosswalks at uncontrolled locations on two-lane roadways.
- On multi-lane roadways, uncontrolled marked crosswalks *should be enhanced by additional safety features* under the following conditions (the other tools listed in this section can be considered to enhance the crosswalk):
    - ADT > 12,000 w/o median
    - ADT > 15,000 w/ median
    - Speeds greater than 40 mph
- Raised medians can be used to reduce risk.
- Signals or other treatments should be considered where there are many young and/or elderly pedestrians.

Mid-block Crosswalks

A mid-block crosswalk can be controlled or uncontrolled.

Controlled mid-block pedestrian crossing; note traffic signal structure overhead
(Credit: Kimley-Horn and Associates, Inc.)

A controlled mid-block crosswalk includes a traffic signal to control motor vehicles based on pedestrian-actuation of the signal. Although the pedestrian crossing traffic signal is not the sole solution to facilitating pedestrian access to street crossings, it is often a necessary solution at multi-lane facilities having high vehicular volume. The mid-block pedestrian signal should be guided by an engineering study and a comparison to the signal warrants found in the MUTCD.

Uncontrolled mid-block crosswalks can also be provided under certain circumstances. The criteria for marking an uncontrolled mid-block crosswalk provided below are adapted from the Center for Urban Transportation Research (CUTR) report *Pedestrian Safety at Midblock Locations* (Chu, 2006).

Uncontrolled mid-block pedestrian crossing
(Credit: Kimley-Horn and Associates, Inc.)

- Pedestrian Demand. Any block under consideration for a possible mid-block crosswalk should show a well-defined pattern of pedestrian generators, pedestrian attractors, and pedestrian flow between them. Considerations should also include presence of bus stops. Sufficient pedestrian crossing demand generally is 25 pedestrians during the peak hour

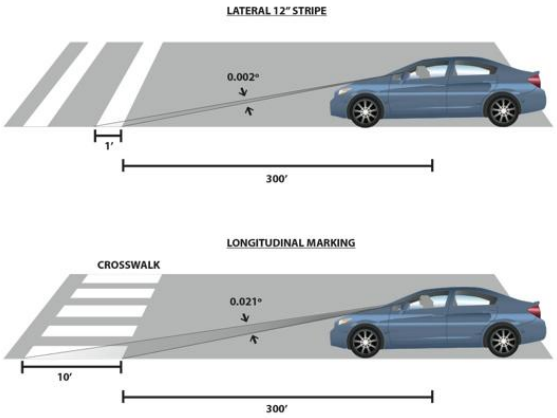
of pedestrian crossing traffic or 75 pedestrians during the peak four hours of pedestrian crossing traffic.

- Shared-Use Path Crossing. Well-designed mid-block crosswalks should be strongly considered at any mid-block location that is an integral part of a designated shared-use path regardless of demand.
- Existence of Alternatives. The minimum distance to the nearest controlled or protected crossing is 300 feet. A well-designed crossing should be provided at least every 660 feet in urbanized areas.
- Traffic Volume. For local streets, a minimum threshold for average daily traffic typically falls in the range of 1,500 to 3,000. Above the following average daily traffic and speed thresholds as presented in the Uncontrolled Intersections sub-section, mid-block crossings should be augmented with enhanced safety devices.
    - ADT > 12,000 w/o median
    - ADT > 15,000 w/ median
    - Speeds greater than 40 mph
- Stopping Sight Distance. Stopping sight distance should be calculated and compared to minimum sight distance criteria found in the FDOT *Plans Preparation Manual* (PPM) Chapter 2 or AASHTO guidance. The consideration of sight distance should account for the presence of on-street parking when applicable.
- Lighting. A minimum illumination level of 2.5 horizontal foot-candles shall be used for both approaches. When regular street lighting is not present or is inadequate to reach this minimum illumination level, separate crosswalk lighting shall be installed. Crossing locations with high night-time demand should include separate crosswalk lighting, which may include in-street lighting.

These basic safety criteria are consistent with MUTCD guidance and help achieve the objective of increasing positive effects of marked crosswalks while reducing negative behavioral adaptation.

<u>Frequency of Marked Crosswalks at Uncontrolled Locations</u>

Along urban streets, a well-designed crossing should be provided at least every 1/8 mile (660 feet). Marked crosswalks should be spaced so people can cross at preferred locations. If people are routinely crossing streets at non-preferred locations, consideration should be given to installing a new crossing. Pedestrians need crossings with appropriate devices (islands, curb extensions, advanced yield lines, etc.) on multi-lane streets where there are strong desire lines.



Longitudinal crosswalk markings are more visible than lateral crosswalk markings
(Credit: Michele Weisbart)

Special Emphasis Crosswalks

Because of the low approach angle at which pavement markings are viewed by drivers, the use of longitudinal stripes in addition to or in place of transverse markings can significantly increase the visibility of a crosswalk to oncoming traffic. While research has not shown a direct link between increased crosswalk visibility and increased pedestrian safety, special emphasis crosswalks have been shown to increase motorist yielding and channelization of pedestrians, leading the Federal Highway Administration to conclude that high-visibility pedestrian crosswalks have a positive effect on pedestrian and driver behavior.

FDOT special emphasis crosswalk; note this design may have been improved by a channelization island for refuge
(Credit: Kimley-Horn and Associates, Inc.)

Colored and stamped crosswalks should only be used at controlled locations, and should always be bordered by white lines.

Local jurisdictions should be consistent with FDOT criteria for special emphasis crosswalks

- Lines must always be white
- Longitudinal stripes must be 24 inches wide
- Longitudinal stripes should be spaced to avoid the wheel-paths of vehicles up to a maximum spacing of 60 inches.

Decorative crosswalk treatments made of distinctive materials can become uneven over time.
(Credit: Ryan Snyder)

Crosswalks and Accessibility

The Pedestrian Access Route continues through the crosswalk and must conform to the surface condition, width, and slope requirements discussed in Chapter 7, “Universal Pedestrian Access.”

Longitudinal crosswalk markings provide the best visibility for pedestrians with limited vision.

Decorative crosswalk pavement materials should be chosen with care to ensure that smooth surface conditions and high contrast with surrounding

pavement are provided. Textured materials within the crosswalk are not recommended. Without reflective materials, these treatments are not visible to drivers at night. Decorative pavement materials often deteriorate over time and become a maintenance problem while creating uneven pavement. The use of color or material to delineate the crosswalks as a replacement of retro-reflective pavement marking should not be used, except in slow speed districts where intersecting streets are designed for speeds of 20 mph or less.

Raised Crossing Islands/Medians

Staggered median crossing
(Credit: Marcel Schmaedick)

Raised islands and medians are the most important, safest, and most adaptable engineering tool for improving street crossings. *Note on terminology: a median is a continuous raised area separating opposite flows of traffic. A crossing island is shorter and located just where a pedestrian crossing is needed.* Raised medians and crossing islands are commonly used between intersections when blocks are long (500 feet or more in downtowns) and in the following situations:

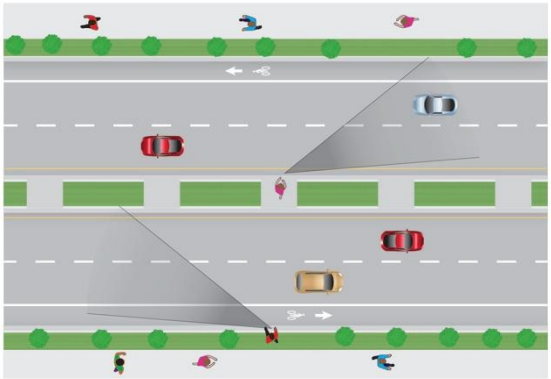
- Speeds are higher than desired
- Streets are wide
- Traffic volumes are high
- Sight distances are poor

Raised islands have nearly universal applications and should be placed where there is a need for people to cross the street. They are also used to slow traffic.

Raised crossing islands and medians have been identified by FHWA as the most effective tool to enhance crossing safety (*Pedestrian Countermeasure Policy Best Practice Report*, FHWA, and *Pedestrian Safety Engineering and ITS-Based Countermeasures*, FHWA).

Reasons for Efficacy

The use of raised crossing islands and medians changes a complex task, crossing a wide street with traffic coming from two opposing directions all at once, into two simpler and smaller tasks. With their use, conflicts occur in only one direction at a time, and exposure time can be reduced from more than 20 seconds to just a few seconds.



Medians and crossing islands allow pedestrians to complete the crossing in two stages.
(Credit: Michele Weisbart)

On streets with traffic speeds higher than 30 mph, it may be unsafe to cross without a median island. At 30 mph, motorists travel 44 feet each second, placing them 880 feet out when a pedestrian starts crossing an 80-foot wide multi-lane road. In this situation, this pedestrian may still be in the last travel lane when the car arrives there; that car was not within view at the time he or she started crossing. With an island on multi-lane roadways, people would cross two or three lanes at a time instead of four or six. Having to wait for a gap in only one direction of travel at a time significantly reduces the wait time to cross. Medians and crossing islands have been shown to reduce crashes by 40 percent (*Designing for Pedestrian Safety course,* FHWA).

As a general rule, crossing islands are preferable to signal-controlled crossings due to their lower installation and maintenance cost, reduced waiting times, and their safety benefits. Crossing islands are also used with road diets, taking four-lane undivided, high-speed roads down to better performing three-lane roadways (two travel lanes and a center turn lane); portions of the center turn lane can be dedicated to crossing islands. Crossing islands can also be used with signals.

Angled pedestrian crossings through pedestrian refuges (as shown in the photo below) force pedestrians to look for oncoming vehicles.

Angled median crossing
(Credit: Paul Zykofsky)

<u>Where to Place Crossing Islands</u>

Crossing islands are often used for trails, high pedestrian flow zones, transit stations, schools, work centers, and shopping districts.

Multiple tools can be employed to improve uncontrolled crossings.
(Credit: Dan Burden)

<u>Design Detail</u>

Crossing islands, like most traffic calming features, perform best with both tall trees and low ground cover. This greatly increases their visibility, reduces surprise, and lowers the need for a plethora of signs. When curves or hill crests complicate

Crossing islands: Berkeley, CA
(Credit: Ryan Snyder)

crossing locations, median islands are often extended over a crest or around a curve to where motorists have a clear (six second or longer) sight line of the downstream change in conditions. Lighting of median islands is essential. The suggested minimum width of a crossing island is 6 feet. When used on higher speed roads, and where there is space available, inserting a 45-degree bend to the right helps orient pedestrians to the risk they encounter from motorists during the second half of their crossing.

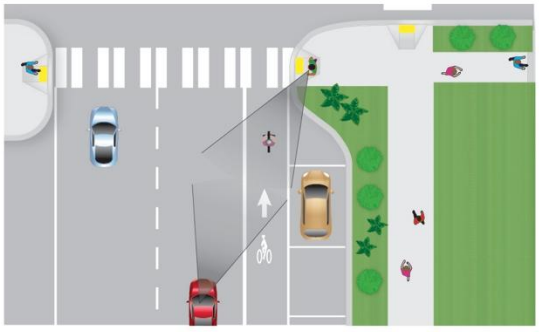
RAISED CROSSWALKS

Raised crosswalks slow traffic and put pedestrians in a more visible position. They are trapezoidal in shape on both sides and have a flat top where the pedestrians cross. The level crosswalk area must be paved with smooth materials; any texture or special pavements used for aesthetics should be placed on the beveled slopes, where they will be seen by approaching motorists. They are most appropriate in areas with significant pedestrian traffic and where motor vehicle traffic should move slowly, such as near schools, on college campuses, in Main Street retail environments, and in other similar places. They are especially effective near elementary schools where they raise small children by a few inches and make them more visible.

Raised crosswalk
(Credit: Toole Design Group)

CURB EXTENSIONS

Curb extensions extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, visually and physically narrowing the roadway, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street. Reducing street widths improves signal timing since pedestrians need less time to cross.



Curb extensions
(Credit: Michele Weisbart)

Motorists typically travel more slowly at intersections or mid-block locations with curb extensions, as the restricted street width sends a visual cue to slow down. Turning speeds are lower at intersections with curb extensions (curb radii should be as tight as is practicable). Curb extensions also prevent motorists from parking too close to the intersection.

Curb extensions also provide additional space for two curb ramps and for level sidewalks where existing space is limited, increase the pedestrian waiting space, and provide additional space for pedestrian push button poles, street furnishings, plantings, bike parking and other amenities. A benefit for drivers is that extensions allow for better placement of signs (e.g., stop signs and signals).

Example of curb extensions
(Credit: Marcel Schmaedick)

Curb extensions are generally only appropriate where there is an on-street parking lane. Where street width permits, a gently tapered curb extension can reduce crossing distance at an intersection along streets without on-street parking, without creating a hazard. Curb extensions must not extend into travel lanes or bicycle lanes.

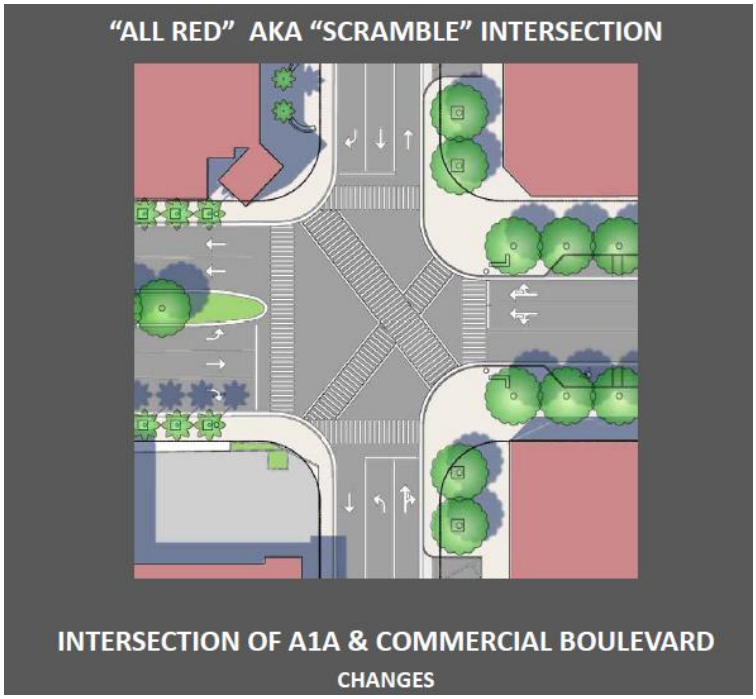
Curb extensions can impact other aspects of roadway design and operation as follows:

- May impact street drainage and require catch basin relocation
- May impact underground utilities
- May require loss of curbside parking, though careful planning often mitigates this potential loss, for example by relocating curbside fire hydrants, where no parking is allowed, to a curb extension
- May complicate delivery access and garbage removal
- May impact street sweepers
- May affect the turning movements of larger vehicles such as school buses and large fire trucks

ALL-PEDESTRIAN PHASES

Exclusive pedestrian phases (i.e. pedestrian 'scrambles') may be used where turning vehicles conflict with very high pedestrian volumes and pedestrian crossing distances are short. Although pedestrians can cross in any direction during the pedestrian phase, pedestrians typically have to wait for both vehicle phases before they get the walk signal again. This creates delay for pedestrians travelling straight, but can be mitigated by allowing pedestrians continuing along the same direction to get a WALK signal during the green signal phase and while turns are prohibited for traffic. Diagonal crosswalk markings are consistent with 2009 MUTCD Chapter 3B.18.

Proposed all-pedestrian phase and diagonal crosswalk markings (Credit: City of Lauderdale-By-The-Sea)



Proposed all-pedestrian phase and diagonal crosswalk markings (Credit: City of Lauderdale-By-The-Sea)

SIGNS

Signs can provide important information to improve road safety by letting people know what to expect, so they can react and behave appropriately. Sign use and placement should be done judiciously, as overuse breeds noncompliance and disrespect. Too many signs create visual clutter.

Pedestrian warning sign (MUTCD W11-2) with diagonal downward pointing arrow

Regulatory signs, such as STOP, YIELD, or turn restrictions, require driver actions and can be enforced. Warning signs provide information, especially to motorists and pedestrians unfamiliar with an area.

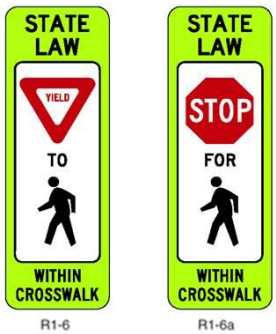
Advance pedestrian warning sign with distance plaque (Credit: Kimley-Horn and Associates, Inc.)

Advance pedestrian warning signs or pedestrian warning signs with distance supplemental plaques should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area. The fluorescent yellow/green (FYG) color is designated specifically for pedestrian, bicycle, and school warning signs (Section 2A.10 of the 2009 MUTCD) and should be used for new and replacement installations. This bright color attracts the attention of drivers.

Sign R1-5 should be used in conjunction with advance yield lines, as described below. Sign R1-6 may be used on median islands, where they will be more visible to motorists than signs placed on the side of the street, especially where there is on-street parking. Since Florida is a "yield" state, local jurisdictions should use R1-5, R1-5a, and R1-6 signs. It should be noted that *Florida State Statute 316* recognizes that the act of yielding may include stopping.

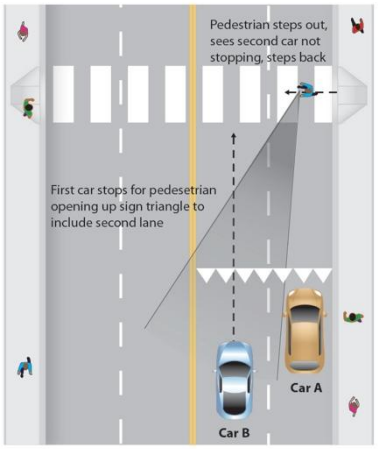
All signs should be periodically checked to make sure that they are in good condition, free from graffiti, reflective at night, and continue to serve a purpose.

All sign installations need to comply with the provisions of the MUTCD.



Advanced Yield/Stop Lines

Stop lines are solid white lines 12 to 24 inches wide, extending across all approach lanes to indicate where vehicles must stop in compliance with a stop sign or signal. Advance stop lines reduce vehicle encroachment into the crosswalk and improve drivers' view of pedestrians. At signalized intersections a stop line is typically set back between 4 and 6 feet.



Advanced yield markings (Credit: Michele Weisbart)

At uncontrolled crossings of multi-lane roads, advance yield lines can be an effective tool for preventing multiple threat vehicle and pedestrian collisions. Section 3B.16 of the MUTCD specifies placing advanced yield markings 20 to 50 feet in advance of crosswalks, depending upon location-specific variables such as vehicle speeds, traffic control, street width, on-street parking, potential for visual confusion, nearby land uses with vulnerable populations, and demand for queuing space. Thirty feet is the preferred setback for effectiveness at many locations. This setback allows a pedestrian to see if a car in the second (or third) lane is stopping after a driver in the first lane has stopped.

Lighting

Lighting is important to include at all pedestrian crossing locations for the comfort and safety of the road users. Lighting should be present at all marked crossing locations. Lighting provides cues to drivers to expect pedestrians earlier.

Proper placement of crosswalk illumination (Credit: Michele Weisbart)

FHWA HT-08-053, *The Information Report on Lighting Design for Mid-block Crosswalks*, found that a vertical illumination of 20 lux in front of the crosswalk, measured at a height of 5 feet from the road surface, provided adequate detection distances in most circumstances. Although the research was constrained to mid-block placements of crosswalks, the report includes a brief discussion of considerations in lighting crosswalks co-located with intersections. The same principle applies at intersections. Illumination just in front of crosswalks creates optimal visibility of pedestrians.

Other good guidance on crosswalk lighting levels comes from the Illuminating Engineering Society of North America (IESNA) intersection guidance to illuminate pedestrians in the

crosswalk to vehicles (see the image below image). Crosswalk lighting should provide color contrast from standard roadway lighting.

Table 8.1 Recommended Illumination by Street Type

Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification [FC]		
	High	Medium	Low
Major / Major (boulevard)	3.4 fc	2.6 fc	1.8 fc
Major / Collector (boulevard/avenue)	2.9 fc	2.2 fc	1.5 fc
Major / Local (avenue)	2.6 fc	2.0 fc	1.3 fc
Collector / Collector (avenue)	2.4 fc	1.8 fc	1.2 fc
Collector / Local (street)	2.1 fc	1.6 fc	1.0 fc
Local / Local (street)	1.8 fc	1.4 fc	0.8 fc

FC stands for "foot candle" and is defined as the amount of illuminance on a 1 square foot surface of which there is uniformly distributed flux of one lumen. ANSI-IESNA RP-8-00, *Roadway Lighting*, p. 15

RECTANGULAR RAPID FLASHING BEACON (RRFB)

The RRFB uses rectangular-shaped high-intensity LED-based indications, flashes rapidly in a wig-wag "flickering" flash pattern, and is mounted immediately between the crossing sign and the sign's supplemental arrow plaque.

Rectangular rapid flashing beacon (RRFB) crossing safety device with median refuge (Credit: Kimley-Horn and Associates, Inc.)

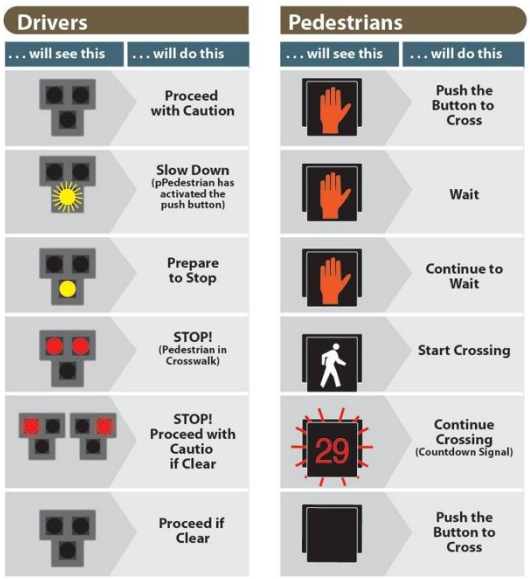
The FHWA Office of Transportation Operations has reviewed available data and considers the RRFB to be highly successful for the applications tested (uncontrolled crosswalks). The RRFB offers significant potential safety and cost benefits because it achieves very high rates of compliance at a very low cost compared to other more restrictive devices such as full mid-block signalization. The components of the RRFB are not proprietary and can be assembled by any jurisdiction with off-the-shelf hardware. The FHWA believes that the RRFB has a low risk of safety or operational concerns. However, because proliferation of RRFBs in the roadway environment to the point that they become ubiquitous could decrease their effectiveness, use of RRFBs should be limited to locations with the most critical safety concerns, such as pedestrian and school crosswalks at uncontrolled locations, as tested in the experimentation.

The RRFB has received Interim Approval via FHWA's "Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons" (IA-11) dated July 16, 2008.

PEDESTRIAN HYBRID BEACON

A pedestrian hybrid beacon is used to warn and control traffic at an unsignalized location so as to help pedestrians cross a street or highway at a marked crosswalk.

A pedestrian hybrid beacon can be used at a location that does not meet traffic signal warrants or at a location that meets traffic signal warrants but a decision has been made to not install a traffic control signal. A minimum number of 20 pedestrians per hour is needed to warrant installation. This is substantially less than the 93 minimum needed for a signal installation.



Pedestrian hybrid beacon phases (Credit: Michele Weisbart)

If beacons are used, they should be placed in conjunction with signs, crosswalks, and advanced yield lines to warn and control traffic at locations where pedestrians enter or cross a street or highway. A pedestrian hybrid beacon should only be installed at a marked crosswalk.

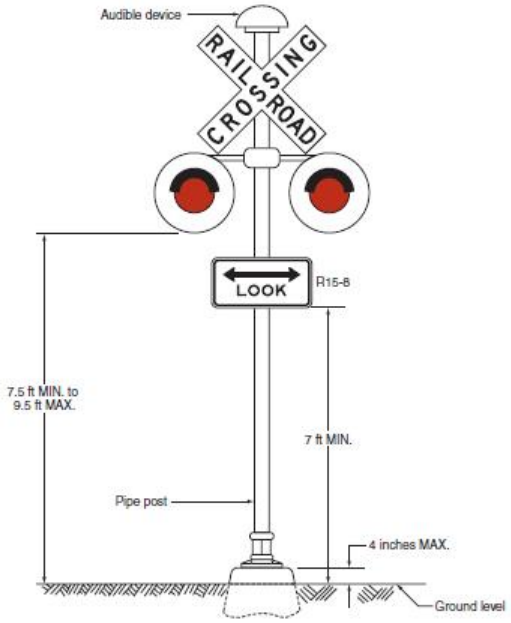
Installations should be performed according to the MUTCD Chapter 4F, "Pedestrian Hybrid Beacons."

PEDESTRIAN TOOLBOX FOR RAILROAD CROSSINGS

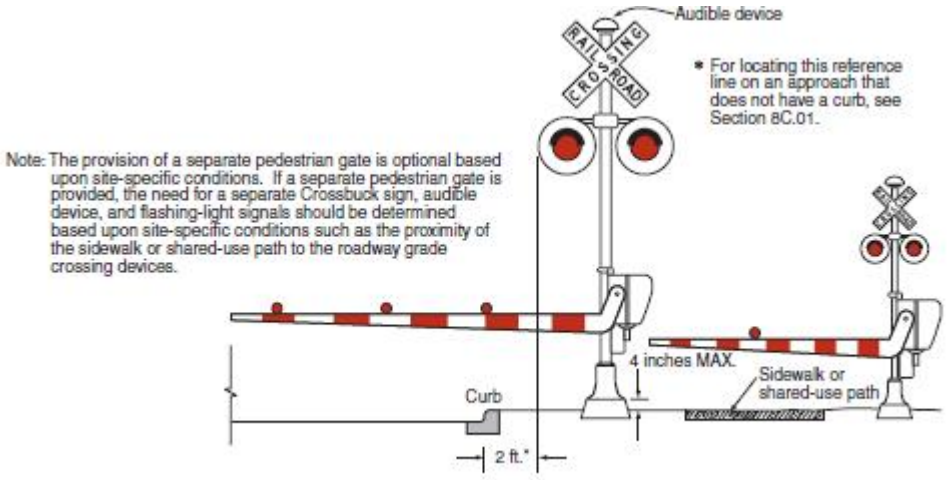
Pedestrian crossings of railroad tracks apply a special set of tools. The following are the primary tools to apply.

- Pedestrian gates
- Channelization of pedestrians through gates and across tracks
- Warning flashers
- Signs
- Audible signals

More details can be found in the MUTCD.



Flashing-light signal assembly for pedestrian railroad crossing
(Source: 2009 MUTCD Figure 8C.4)



Separate pedestrian gate at a railroad crossing
(Source: 2009 MUTCD Figure 8C.6)