

PEDESTRIAN TREATMENTS

Description

Each major street intersection involves through- or cross-traffic movements on one or more of the roads and may involve turning movements between these roadways. Such movements may be facilitated by various geometric designs and traffic controls, depending on the type of intersection. Alleviating intersection design problems can reduce congestion and improve safety, particularly for pedestrians.

The average number of Texas pedestrian fatalities for the past five years is about 400 per year. Texas is considered an opportunity state by the Federal Highway Administration due to the high number of pedestrian crashes. A variety of engineering (e.g., geometric design, traffic control device) treatments along with enforcement and education treatments have the potential to improve safety at pedestrian crossings.

Target Market

- Areas with pedestrian activities or areas near job centers or neighborhoods.
- Locations with safety concerns for pedestrians.
- Locations with wide or difficult crossings for pedestrians, such as crossings on high-speed roadways.

There are potential applications at intersections and on segments of many types: urban or rural, signalized or unsignalized, arterial or collector. Most treatments are targeted toward intersections on arterial streets because of their higher traffic volume and speeds. Focusing only on locations with high current pedestrian volumes will miss locations that could generate more pedestrian activity with better designs.



Cost:	●●●○○
Time:	Moderate
Impact:	Spot
Who:	City / State
Hurdles:	Right-of-Way

How Will This Help?

Pedestrian treatments are common at intersections, particularly those in urban areas. Existing treatments, however, may not be sufficient to properly accommodate the pedestrian demand at a given location. For example, in dense urban areas where pedestrian volumes are heavy, it may be necessary to provide additional channelization and guidance to pedestrians crossing near intersections. Crossing the street could expose the pedestrian to a very high risk of being struck by a vehicle, and it may be necessary to prohibit certain pedestrian crossings or to provide supplemental traffic control for an effective crossing opportunity for the pedestrians. Examples of pedestrian treatments are listed in the table.

Examples of Pedestrian Treatments

Engineering - Traffic Control Devices	Engineering - Geometric	Enforcement	Education
Advance stop or yield line and sign	Barrier – median	Targeted (specific locations, corridors or treatments)	Education of traffic officers
Beacons	Barrier – roadside/sidewalk (railing or fencing)	Targeted (specific violation types)	Public awareness campaigns
		Staged or decoy behavior by officers (e.g. officer acting as pedestrian to see if vehicles stop, ticketed if they do not)	Public involvement workshops
Crosswalk marking patterns	Bus stop location	High-visibility (public notification, officer in conspicuous locations)	Curriculum-based education
Flags	Curb extension	Warnings (handing out education materials instead of tickets as a prelude to ticketing)	Media-based education
In-roadway warning lights	Illumination		One-time instruction
In-street pedestrian crossing signs	Overpass and underpasses		Skills based training
Leading pedestrian interval	Raised crosswalk		Virtual reality
Marked crosswalk	Refuge island		Non-English translation of education materials
Motorist warning signs	Road diet		
Pedestrian countdown	Sidewalks		
Pedestrian hybrid beacon (also known as the HAWK)			
Pedestrian scramble phase			
Puffin crossing			
Rectangular rapid flashing beacon			
Traffic control signal			

The following are summaries on selected pedestrian treatments. See documents in the For More Information or Reference sections for additional information on pedestrian treatments.

Selection of Pedestrian Treatments

TCRP/NCHRP Report 112/562 Appendix A provides guidelines on pedestrian crossing treatments to consider at uncontrolled intersections.¹ It includes worksheets that can be used to select treatments based on total pedestrian delay at the crossing.

Marked Crosswalks

Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops. Crosswalk markings are classified as basic or high visibility. Basic crosswalk markings consist of two transverse lines. High visibility markings consist of longitudinal lines parallel to traffic flow with or without transverse lines. The most authoritative study to date on the effectiveness of crosswalk pavement markings was performed in the late 1990s.^{2, 3} The study found that as traffic volumes, speeds, and street

widths increase, greater crash frequency was present when only crosswalk markings (i.e., no signs or beacons) are used as compared to no crosswalk markings. The study recommendations indicate that the issue should not be whether to provide crosswalk markings on these high-volume, high-speed streets. Instead, the recommendations point to the necessity of providing other treatments in addition to crosswalk markings that will provide a safer street crossing for pedestrians.

Advance Stop or Yield Line and Sign

With the advance stop/yield line treatment, advance yield lines (i.e., pavement markings) place the traditional stop or yield line 20 to 50 ft upstream of the crosswalk. The lines are often accompanied by YIELD HERE TO PEDESTRIAN signs. Advance yield lines address the issue of multiple-threat crashes on multilane roadways, where one vehicle stops for a pedestrian in the crosswalk but inadvertently screens the pedestrian from the view of vehicles in other lanes. Several studies have documented that advance yield lines decrease pedestrian-vehicle conflicts and increase driver yielding at greater distances from the crosswalk.^{4, 5, 6, 7}

For more information, please refer to: <http://mobility.tamu.edu/mip/strategies.php>.

Rectangular Rapid-Flashing Beacon

The rectangular rapid-flashing beacon (RRFB) flashes in an eye-catching sequence to draw drivers' attention to the sign and the need to yield to a waiting pedestrian. Each side of a light-emitting diode (LED) flasher illuminates in a wig-wag sequence (left and then right). A recent study¹ evaluated RRFBs at 22 sites and found an increase in yielding behavior at all locations. During the baseline period the average yielding for all of the sites was four percent before installation of the RRFBs. Data collected over a two year period at 18 of the sites confirmed that the RRFBs continue to succeed at encouraging drivers to yield to pedestrians, even over the longer term. By the two year follow-up, the researchers determined that the introduction of the RRFB was associated with yielding that ranged between 72 and 96 percent. The evidence for change was overwhelming and persisted for the duration of the study.

In July 2008, FHWA issued an interim approval for optional use of RRFBs as warning beacons to supplement standard pedestrian or school crossing signs at crosswalks across uncontrolled approaches (See http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm).

Pedestrian Hybrid Beacon

The pedestrian hybrid beacon (also known as the HAWK) is located both on the roadside and on mast arms over the major approaches to an intersection (see the figure on the next page for an example). The head of the pedestrian hybrid beacon consists of two red lenses above a single yellow lens. It is normally dark, but when activated by a pedestrian, it first displays a few seconds of flashing yellow followed by a steady yellow change interval, and then displays a steady red indication to drivers, which creates a gap for pedestrians to use to cross the major roadway. During the flashing pedestrian clearance interval, the pedestrian hybrid beacon changes to a wig-wag flashing red to allow drivers to proceed after stopping if the pedestrian has cleared the roadway, thereby

reducing vehicle delays. The device was developed in Tucson, Arizona, a city that now has over 100 installations with many at school crossings.

A recent FHWA study conducted a before-and-after evaluation of the safety performance of the pedestrian hybrid beacon⁸ and found:

- A 29 percent reduction in total crashes (statistically significant).
- A 15 percent reduction in severe crashes (not statistically significant).
- A 69 percent reduction in pedestrian crashes (statistically significant).

FHWA added the pedestrian hybrid beacon to the MUTCD in the 2009 edition (see Chapter 4F). The MUTCD includes guidelines for the installation of the pedestrian hybrid beacons for low-speed roadways where speeds are 35 mph or less, and high-speed roadways where speeds are more than 35 mph.

Barrier – Median

The purpose of barriers in the median is to encourage pedestrian crossings at crosswalks by discouraging them at undesirable locations. As part of a larger study on pedestrian countermeasures, median fence barriers were installed at two sites: one in Washington, D.C., with a four foot fence; and, one in New York City with a six foot fence.¹⁰ At one site, the median fence barrier had two gaps, each located at an intersecting minor street. After installation of the barrier, researchers interviewed pedestrians to gauge their reactions to the treatment. Regarding crosswalk use: 61 percent of the pedestrians identified the barrier as the reason for using the crosswalk. When asked whether the barrier affected the manner in which they crossed the street: 52 percent stated it had no effect and 48 percent indicated the only effect was to force them to cross at the intersection. Of those who were crossing midblock before the installation: 61 percent did so out of convenience, with about half of them indicating



Example of a Pedestrian Hybrid Beacon treatment in Austin, Texas (source: TTI)

they would use the crosswalk only if midblock traffic volumes were “very heavy.”

Leading Pedestrian Interval

A leading pedestrian interval is a three- to seven-second phase for pedestrians to begin their crossing, which occurs during an all-red phase for motor vehicles. A 2010 before and after study with comparison groups found a 59 percent reduction in pedestrian-vehicle crashes associated with a leading pedestrian interval.¹¹ Previous investigations found a five percent reduction in crashes as shown in the FHWA brief.¹²

Refuge Islands

Refuge in the median, particularly for high-volume, high-speed multilane roads can help to facilitate pedestrian crossings at intersections. Median islands can also help to manage motor vehicle traffic and provide comfortable left-turn bays. Furthermore, medians are a useful tool in access management to restrict turning movements that can increase congestion and delay on major streets.

When crossings are too wide, pedestrians may not be able to cross during available gaps without protection of a signal. By having pedestrians make vehicle gap judgments one direction at a time, median refuge islands simplify the street-crossing task. Recent refuge island designs incorporate an angled or staggered pedestrian opening, which better

aligns pedestrians to face the second direction of oncoming traffic (see the figure on the next page). Additionally, it is possible to raise median refuge islands above the street surface or to delineate median refuge islands using markings on the roadway.

In 1994, several kinds of medians, including undivided multi-lane roadways, two-way left-turn lanes, and raised curb medians were reviewed.^{13, 14} Raised curb facilities were associated with lower pedestrian crash rates, but the authors reported both raised and two-way left-turn lanes medians significantly reduced the number and severity of vehicular crashes at the study sites. The study on marked crosswalks reported a 39 percent crash reduction for a raised median at an uncontrolled marked crosswalk and a 46 percent reduction in crashes for a raised median at an uncontrolled unmarked crosswalk.

At two signalized intersections in San Francisco and a midblock location in Las Vegas, officials installed median refuge islands. The researchers surmised that the installation of a median refuge island at a midblock location was effective in increasing driver yielding to pedestrians and reducing pedestrian delay, while the median refuge islands at the signalized intersections appeared to be less effective at altering driver and pedestrian behaviors.¹⁵ The researchers also reported on an offset pedestrian opening in two other median islands, one of which is shown in figure on the next page. The offset is a type of channelization that encourages pedestrians to turn and walk parallel to the traffic they are crossing; it provides refuge for pedestrians in terms of physical separation from traffic and ensures they are facing the traffic before crossing the second half of the roadway. The research team measured large, significant increases in driver yielding at both sites.



Raised Median with Angled Opening(www.pedbikeimages.org / Dan Burden)

Implementation Examples

The city of Garland, Texas, installed a rectangular rapid flashing beacon with a school crossing. The figure on the first page illustrates the sign used in Garland. Data for the one site showed that compliance rates of drivers yielding to pedestrians improved markedly with the rectangular rapid-flashing beacon device in place, from less than one percent before installation to approximately 80 percent after. Compliance rates of drivers during school zone periods were similar between the before and after periods, typically between 80 and 100 percent, because of the presence of a crossing guard.

Application Principles and Techniques

These are only a few of the possible treatments for congested and crash-prone intersections or locations where pedestrians are having difficulties in crossing the road. The key is to identify the source of the congestion and/or the pedestrian challenges. If pedestrian or bicycle traffic has increased, it may be necessary to apply additional treatments focused on those users.

Issues

Right-of-way constraints can be a factor in pedestrian and bike treatments, depending on the nature of the treatment. Installing a raised median could be done within the footprint of an existing two-way left-turn lane. If there is no

separation between opposing traffic, additional right-of-way may be needed. For other pedestrian and bike treatments, education and enforcement may be more important to their success, in training users where to cross the street or how to properly approach the intersection in a bicycle lane.

Who Is Responsible?

States and cities are generally the responsible agencies for maintaining roads. For roadways on the state highway system, the local office of the department of transportation may take responsibility. On city roads, however, the local government typically controls the construction and management of intersections and related treatments. In either case, the improvements should be coordinated with local citizens and businesses to ensure that the road, bike lanes, sidewalk, and other features serve the adjacent land.

Project Timeframe

Some pedestrian treatments are relatively simple to install and can be completed in a short timeframe, as little as a day. Others require design and construction that will take longer, especially if right-of-way is needed.

Cost

The costs for pedestrian treatments vary considerably depending on the design, site conditions, and whether the treatment requires additional utility or drainage improvements. A sign or markings can be in the range of hundreds of dollars while the installation of a pedestrian hybrid beacon could be \$100,000 to \$150,000.

Data Needs

The development surrounding the intersection, the number of lanes on the major road, and the number of streets approaching the intersection should be considered. The vehicle, pedestrian, and bike volumes, the intersection crash history, average speed, and typical delay should also be known when improving the intersection. Other

useful data items include the access management plan, right-of-way availability, the road width, surrounding intersection design, sight distance, and available financial support.



Raised Median with Offset Opening

Pedestrian Treatment Best Practice

- Type of Location: All roads (except freeways).
- Agency Practices: Training and coordination of state and municipal personnel; coordination between planning, design, safety, operations, and enforcement.
- Frequency of Reanalysis: Annually.
- Supporting Policies or Actions Needed: Focus on improving conditions for pedestrians, capability to fund improvements.
- Complementary Strategies: Intersection turn lane improvements.

For More Information

Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E. S. Park, J. Whitacre, N. Lalani, D. Lord. (2006). *Improving Pedestrian Safety at Unsignalized Crossings*. TCRP Report 112/NCHRP Report 562. Transportation Research Board, Washington, DC. available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

Neuman, T.R., Pfefer, R., Slack, K.L., Hardy, K.K., D. W. Harwood, I. B. Potts, D. J. Torbic, E.R.K. Rabbani. *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. Volume 5: A Guide for Addressing Unsignalized Intersection Collisions*. NCHRP Report 500, Transportation Research Board, Washington, DC, 2003. Federal Highway Administration.

Manual on Uniform Traffic Control Devices. Federal Highway Administration, Washington, DC, 2009.

Fitzpatrick, K., S.T. Chrysler, R. Van Houten, W.W. Hunter, and S. Turner. *Evaluation of Pedestrian and Bicycle Engineering Countermeasures: Rectangular Rapid-Flashing Beacon, Hawk, Sharrow, Crosswalk Markings, and the Development of an Evaluation Methods Report*. Report No. FHWA-HRT-11-039, Federal Highway Administration, Washington, DC, 2011. available at: <http://www.fhwa.dot.gov/publications/research/safety/pedbike/11039/11039.pdf>

References

1. Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E. S. Park, J. Whitacre, N. Lalani, D. Lord. (2006). *Improving Pedestrian Safety at Unsignalized Crossings*. TCRP Report 112/NCHRP Report 562. Transportation Research Board, Washington, DC. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf.
2. Zegeer, C. V., J.R. Stewart, H.H. Huang, and P.A. Lagerway. (2002). *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines*. http://katana.hsrb.unc.edu/cms/downloads/Effects_Un_MarkedCrosswalks_Summary.pdf. Accessed: August 12, 2011.

3. Zegeer, C. V., J.R. Stewart, H. Huang, and P. Lagerway. "Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Analysis of Pedestrian Crashes in 30 Cities." Transportation Research Record 1773. Transportation Research Board, National Research Council, Washington, DC., 2001, pp. 56-68.
4. Turner, P., A. Ferraro, B. McGovern, L. Malenfant, R. Van Houten. *Making Crosswalks Safer for Pedestrians: Application of a Multidisciplinary Approach to Improve Pedestrian Safety at Crosswalks in St. Petersburg, Florida*. Center for Urban Transportation Research (CUTR), University of South Florida, Tampa, Florida, July 2000.
5. Van Houten, R. "The Effects of Advance Stop Lines and Sign Prompts on Pedestrian Safety in a Crosswalk on a Multilane Highway". In *Journal of Applied Behavioral Analysis*, 1988. Volume 21, pp. 245-251.
6. Van Houten, R., and L. Malenfant. "The Influence of Signs Prompting Motorists to Yield before Marked Crosswalks on Motor Vehicle-Pedestrian Conflicts at Crosswalks with Flashing Amber". In *Accident Analysis & Prevention*, 1992, Vol. 24, No. 3, pp. 217-225.
7. Van Houten, R., J.E.L. Malenfant, and D. McCusker. "Advance Yield Markings: Reducing Motor Vehicle-Pedestrian Conflicts at Multilane Crosswalks with Uncontrolled Approach". Transportation Research Record 1773. Transportation Research Board, Washington, DC., 2001.
8. Shurbutt, J., and Van Houten, R. *Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks*. Report No. FHWA-HRT-10-043, Federal Highway Administration, Washington, DC. 2010,
<http://www.fhwa.dot.gov/publications/research/safety/pedbike/10043/10043.pdf>.
9. Fitzpatrick, K., and Park, E.S. *Safety Effectiveness of the HAWK Pedestrian Crossing Treatment*. Report No. FHWA-HRT-10-042, Federal Highway Administration, Washington, DC., 2010,
<http://www.fhwa.dot.gov/publications/research/safety/10042/10042.pdf>.
10. Berger, W. G. *Urban Pedestrian Accident Countermeasures Experimental Evaluation Studies*. (Vol. Vol. I – Behavioral Evaluation Studies. Vol. II – Accident Studies. Vol. III – Appendix A). Report No. DOT-HS-801-346, 347, and 348, National Highway Traffic Safety Administration, 1975.
11. Fayish, A., and F. Gross "Safety Effectiveness of leading Pedestrian Intervals Evaluated by a Before-After Study with Comparison Groups". Transportation Research Record 2198. Transportation Research Board, National Research Council, Washington, DC., 2010.
12. Huang, H., and C. Zegeer. "The Effects of Pedestrian Countdown Signals in Lake Buena Vista". University of North Carolina at Chapel Hill Highway Safety Research Center, Chapel Hill, NC., 2000.
13. Bowman, B. L., and R.L. Vecellio. "Effects of Urban and Suburban Median Types on both Vehicular and Pedestrian Safety". Transportation Research Record 1445. Transportation Research Board, Washington, DC., 1994.
14. Bowman, B. L., and R.L. Vecellio. (1994). "Assessment of Current Practice in Selection and Design of Urban Medians to Benefit Pedestrians". Transportation Research Record 1445. Transportation Research Board, Washington, DC., 1994.
15. Pécheux, K., J. Bauer, and P. McLeod. *Pedestrian Safety and ITS-Based Countermeasures Program for Reducing Pedestrian Fatalities, Injury Conflicts, and Other Surrogate Measures Draft Zone/Area-Wide Evaluation Technical Memorandum*, 2009. http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_scdproj/sys_impact_rpt/index.cfm#toc Accessed; April 20, 2011.