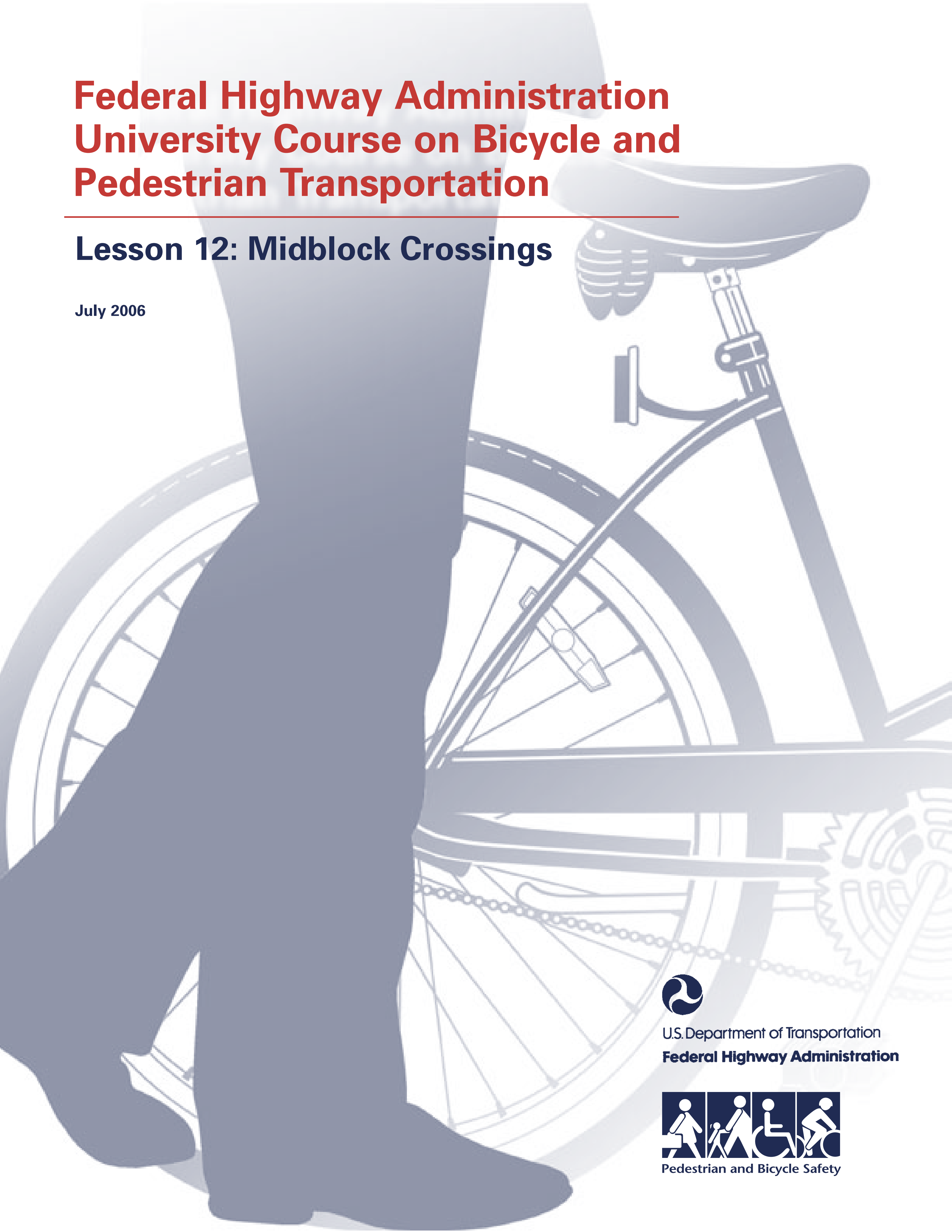

Federal Highway Administration University Course on Bicycle and Pedestrian Transportation

Lesson 12: Midblock Crossings

July 2006

U.S. Department of Transportation
Federal Highway Administration

Pedestrian and Bicycle Safety

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

Table of Contents

List of Figures

LESSON 12

MIDBLOCK CROSSINGS

12.1 Introduction

Designers often assume that pedestrians will cross roadways at established intersections. However, observation of pedestrian behavior clearly indicates that people routinely cross at midblock locations. Pedestrians will rarely go out of their way to cross at an intersection unless they are rewarded with a much improved crossing—most will take the most direct route possible to get to their destination, even if this means crossing several lanes of high-speed traffic.

Well-designed midblock crossings can actually provide many safety benefits to pedestrians when placed in proper locations. This chapter discusses those benefits and explains several basic design principles for midblock crossings. The major sections of this lesson are as follows:

- 12.1 Introduction.
- 12.2 Background.
- 12.3 Medians and Refuge Islands—Powerful Safety Tools.
- 12.4 Advantages of Medians.
- 12.5 Design Considerations for Medians.
- 12.6 Midblock Crossings by Roadway Classification.
- 12.7 Midblock Crossing Design.
- 12.8 Staggered Midblock Crosswalks.
- 12.9 Midblock Crossing and Detection Technology.
- 12.10 Midblock Signals.
- 12.11 Grade-Separated Crossings.
- 12.12 Student Exercise.
- 12.13 References and Additional Resources.

12.2 Background

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. This is helpful advice, especially in downtown locations where signalization is frequent, where cycle lengths are short, where blocks are short, and where intersections are small and compact. But with the advent of the modern suburb, blocks are much longer, signalization is less frequent, some intersections are very wide, and vehicle speeds are much higher than in downtown areas. Under these conditions, crossing at intersections becomes less practical and often more dangerous.

Today's designer is challenged to find workable crossing points to move 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 add risk to themselves and drivers.

This chapter addresses several ways to facilitate nonintersection crossings: medians and refuge islands, midblock crossings, and grade-separated 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 (see figure 12-1). Where there are medians, the pedestrian still may cross at random locations, but because of the increased frequency of acceptable gaps and greatly reduced conflicts, the pedestrian is more likely to find a longer gap and then walk (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.

Figure 12-1. Photo. Midblock crossings are easily located on low-volume, low-speed roadways such as short collectors through neighborhoods.

12.3 Medians and Refuge Islands—Powerful Safety Tools

A median or refuge island is a raised longitudinal space separating the two main directions of traffic. Median islands, by definition, run one or many blocks. Refuge islands are much shorter than medians, with a length of 30.5–76.2 meters (m) (100–250 feet (ft)). Medians and refuge islands can be designed to block side-street or driveway crossings of the main road, as well as block left-turning movements. Because medians reduce turning movements, they can increase the flow rate (capacity) and safety of a roadway.

Medians have become an essential tool in minimizing 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 (DOTs). Based on more than 1609.3 centerline kilometers (km) (1,000 centerline miles (mi)) of conversion from two-way left-turn lanes (TWLTLs) to raised medians, motorist crashes were reduced dramatically. Florida DOT (FDOT) research has shown that pedestrians are at high risk while standing in TWLTLs.[1]

Midblock crossings can be kept simple and are easily located on low-volume, low-speed (40.2–48.3 kilometers per hour (km/h) (25–30 miles per hour (mi/h)) roadways such as short collectors through neighborhoods. When collectors are longer and handle more traffic and higher speeds, medians or refuge islands are helpful and sometimes essential (see figure 12-2). 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 64.4 km/h (40 mi/h).

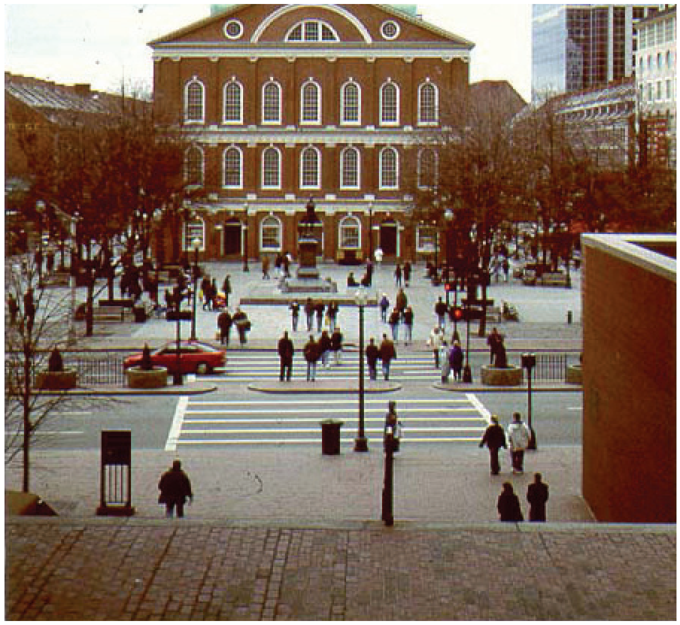

Figure 12-2. Photo. Refuge islands and visible crosswalks are essential on major arterials with higher traffic speeds.

12.4 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 two, four, or even six lanes at a time. This is a complex task requiring accurate decisions. Younger and older pedestrians have reduced gap acceptance skills compared with pedestrians in other age groups. Pedestrians also typically have poor gap assessment skills at night. Many may predict that a car is 61.0 m (200 ft) off when, in fact, it is only 30.5 m (100 ft) away, far too close to attempt a crossing.

Medians Allow More Frequent Gaps

Not only do medians separate conflicts, but they also create the potential for acceptable gaps. On a standard-width, four-lane roadway with a center left-turn lane (19.5 m (64 ft) wide, with five 3.7-m (12-ft) lanes plus two 61.0-centimeter (cm) (24-inch) gutter pans), it takes an average pedestrian traveling 1.2 m/second (s) (4 ft/s) nearly 16 s to cross. Finding a safe 16-second gap in four moving lanes of traffic may be difficult or impossible. In any event, an attempt to cross may require a wait of 3–5 minutes (min). Faced with such a substantial delay, many pedestrians select a less adequate gap, run across the roadway, or stand in the center left-turn lane in hope of an additional gap. If a raised median is placed in the center, the pedestrian now crosses 7.9 m (26 ft) instead. This requires two 8-second gaps (see figures 12-3 and 12-4). These shorter gaps come more frequently. Based on traffic volume and the platooning effects from downstream signalization, the pedestrian may be able to find an acceptable gap in a minute or less.

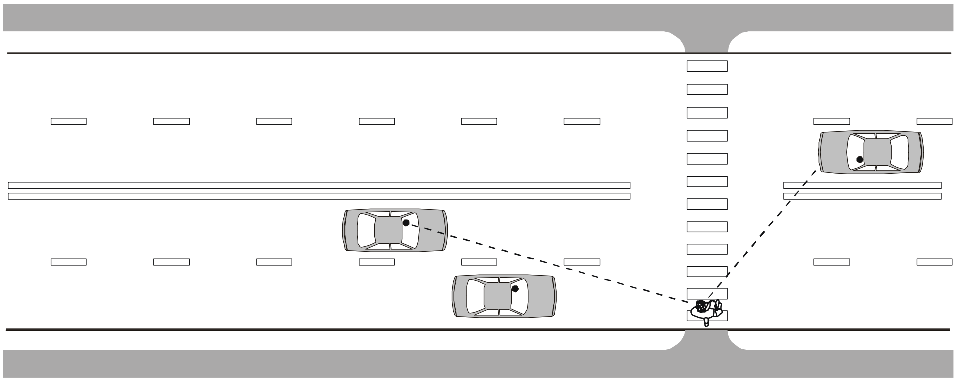

Figure 12-3. Photo. A midblock crossing without median refuge requires the pedestrian to look for gaps in both directions at once.

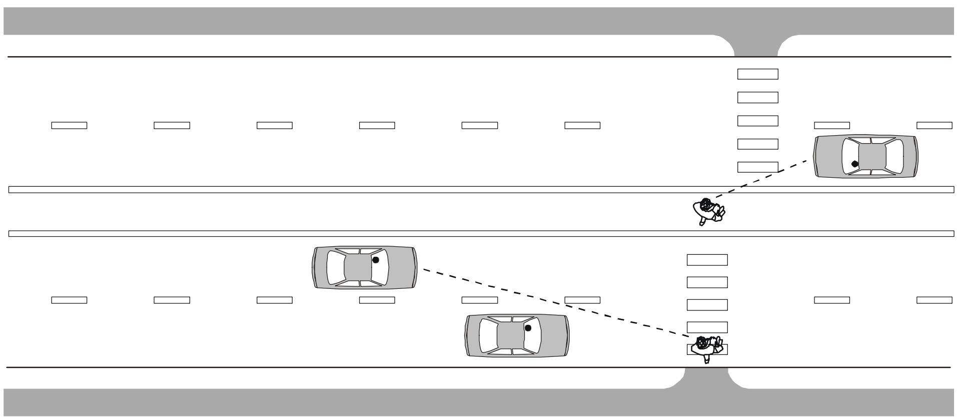

Figure 12-4. Photo. A midblock crossing with a median refuge allows the pedestrian to look for gaps in only one direction at a time.

Medians Are Less Expensive To Build

The reduced construction cost of a median versus a center left-turn lane comes as a surprise to many designers. Grass medians allow natural percolation of water, thus reducing drainage and water treatment costs. Medians do not require a base or asphalt. Curbing is essential in urban sections where medians are typically raised above the level of the street. In general, however, medians average a 5- to 10-percent reduction in materials and labor costs compared to a center left-turn lane.

Medians Are Less Expensive To Maintain

While there is only a slight savings in cost to build a raised median versus a center left-turn lane, there is a substantial savings in maintenance. An FDOT study compared 6.4 km (4 mi) of median versus center left-turn lane maintenance costs and found that medians save an average of 40 percent on maintenance costs based on a 20-year roadway life. More frequent resurfacing, such as every 7 to 9 years, would show much greater savings. This, too, surprises many designers. During the full life of the roadway asphalt, a raised median saves costs associated with sweeping accumulated debris, repainting lines, replacing raised pavement markers, and resurfacing lanes.

12.5 Design Considerations for Medians

Ideally, a median should be at least 2.4 m (8 ft) wide to allow the pedestrian to wait comfortably in the center, 1.2 m (4 ft) from moving traffic. A wider median is necessary if it must also serve the purpose of providing a left-turn bay for motor vehicle traffic at intersections. If the desired 2.4 m (8 ft) cannot be achieved, a width of 1.8 m (6 ft), or 1.2 m (4 ft) will be sufficient. To find the 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 32.2–48.3-km/h (20–30-mi/h) range, the reduction to 3.0 m (10 ft) or even 2.7 m (9 ft) is possible, and may even 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 ramps approved by the Americans with Disabilities Act (ADA) (1:12 grade) can be used. It is best to provide a slight grade (2 percent or less) to permit water and silt to drain from the area. Median cuts work best at midblock crossings.

12.6 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, desired lines for pedestrian movement (see figure 12-5), and adjacent land use. Guidance for median placement on various types of roadways appears below.

Figure 12-5. Photo. Landscaping a median can block midblock access and divert pedestrians to adjacent intersections.

Local Roads

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

Collector Roads

Two-lane collector roads occasionally have medians or 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 16.1-km/h (10-mi/h) speed reduction (from to 64.4 to 48.3 km/h (40 mi/h to 30 mi/h)) 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-percent favorable response from motorists.

When collector roads are widened to four 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. On lower-volume roadways, it is best not to use signalization.

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

- On higher volume roadways.
- Where gaps are infrequent.
- In school zones.
- Where elderly or disabled pedestrians cross.
- Where speeds are high.
- When a number of other factors are present.

Multilane Arterial Highways with Six or More Lanes

On multilane arterials with six 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 that must be interpreted by the pedestrian.

At midblock locations, where vehicle speeds are high, signalization may be the only practical means of helping pedestrians to cross unless as 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 in such a location, the designer must increase the devices used to alert the motorist. The standard pedestrian crossing and advanced crossing symbols with signs measuring 91 by 66 cm (36 by 26 inches) are an absolute minimum for speeds of 64.4 km/h (40 mi/h) or greater. Pavement word symbols can be used as further enhancements. An enhanced crosswalk marking such as a zebra- or ladder-style crossing should be considered. Large overhead signs, flashing beacons, bulb-outs (see figure 12-6), and even flashing overhead signs have been successfully used in some locations.

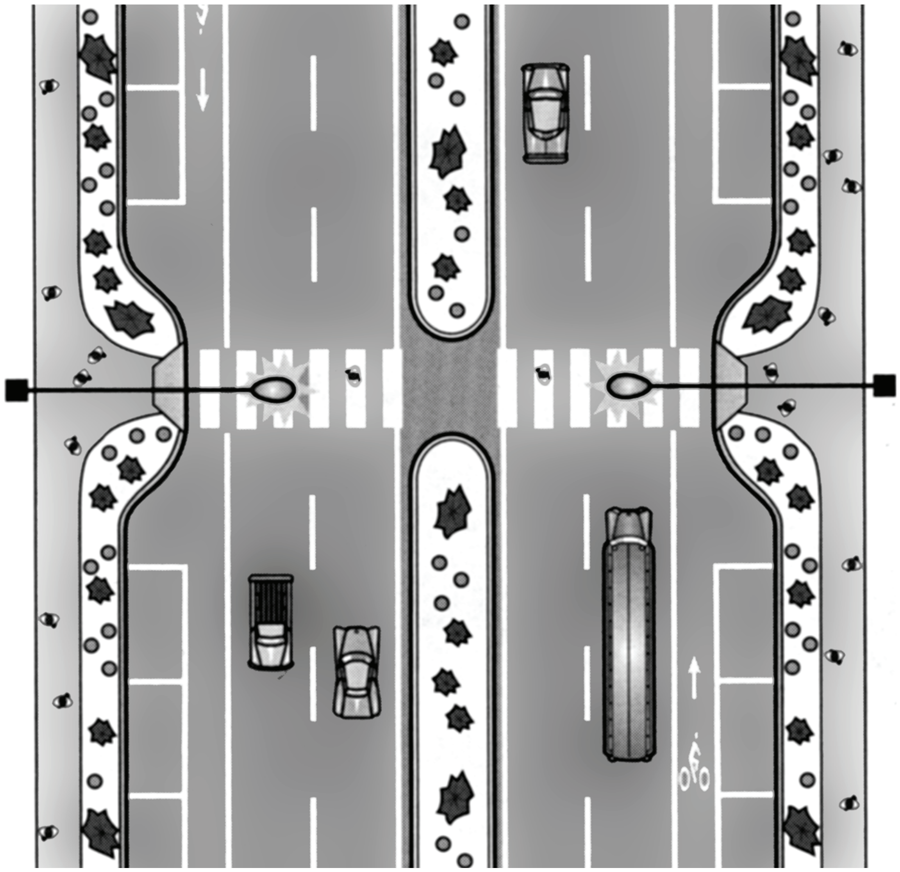

Figure 12-6. Illustration. Midblock crossing curb extensions provide better visibility for motorists and pedestrians.

12.7 Midblock Crossing Design

The design of midblock crossings makes use of warrants similar to those used for standard intersections. Stopping sight distances, effects of grade, cross slope, the need for lighting, and other factors all apply. The design considerations for medians are covered earlier in this lesson. However, there are a number of added guidelines 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 or existing patterns. Use of a high-angle, time-lapse video camera to map pedestrian crossings quickly paints this location, if it is not already well known.

Lighting

Motorists need to see both the pedestrians who stand waiting to cross and those who are already crossing. Either direct or back lighting is effective. Some overhead signs such as in Portland, OR, and Seattle, WA, use overhead lights that identify the pedestrian crossing and also shine down on the actual crosswalk.

Grade-separated crossings at midblock or intersection locations are effective in a few isolated circumstances (see section 12.11 for a further discussion of grade-separated crossings). However, because of their cost and their potentially low use, engineering studies should be conducted by experienced designers. If given a choice, on most roadways, pedestrians generally prefer to cross at grade.

12.8 Staggered Midblock Crosswalks

Staggered crosswalks (or Z-crossings) are treatments in which the crosswalk is split by a median and is offset on either side of the median. This configuration forces pedestrians to turn in the median and face oncoming traffic before turning again to cross the second half of the crosswalk. Notice in figure 12-7 how, in either walking direction, the pedestrian must turn slightly toward traffic before crossing. In order to curtail shortcutting and force pedestrians to follow the intended path, some medians may also have attractive fencing to corral pedestrians in the correct direction (see figure 12-8). One problem with staggered crosswalks is that they may present a challenge for visually impaired pedestrians who are thrown off course by changes in the direction of the walkway leading to the road. A solution is to provide detectable warnings and/or railings to help realign the pedestrian perpendicularly to the roadway just before the crossing.

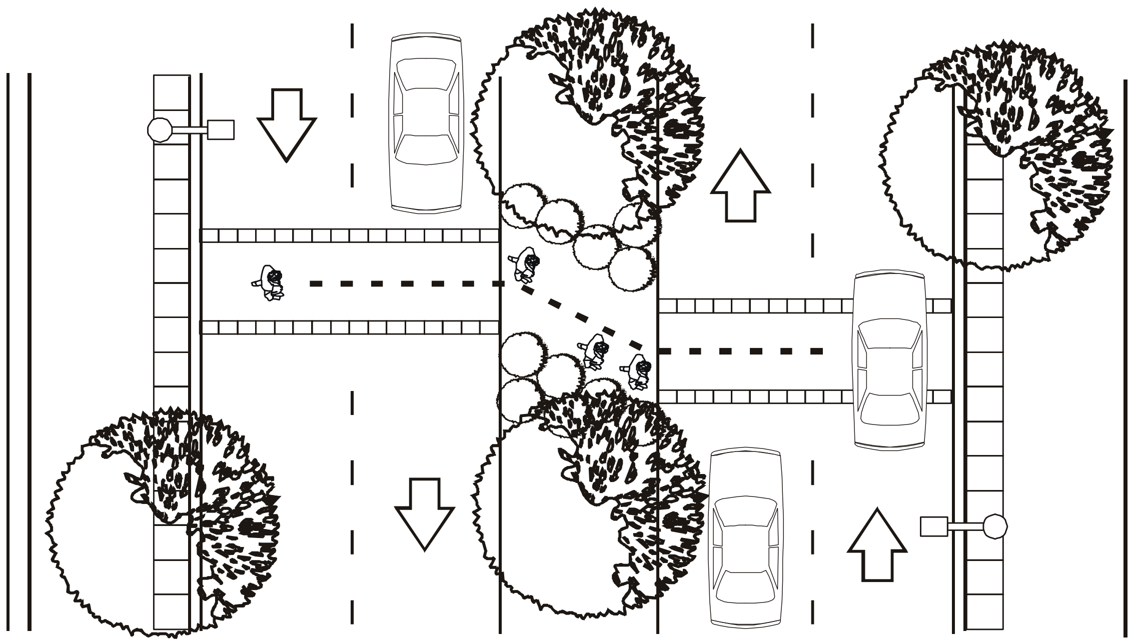

Figure 12-7. Illustration. Diagram of a staggered crossing configuration.

Source: *Southeast Neighborhood Traffic Management Plan*[2]

Figure 12-8. Photo. Staggered crosswalk with fencing.

Source: Pedestrian and Bicycle Information Center (PBIC)
Image Library, http://www.pedbikeimages.org[3]

12.9 Midblock Crossing and Detection Technology

Midblock crossings can be enhanced and made safer by the installation of some of the same crossing and detection technology found at intersections and other walkway locations. Refer to these previous sections for a discussion of these technologies:

- Pavement markings and signing (lessons 10.4–10.8).
- In-pavement flashers (lesson 10.9, "Intelligent Transportation Systems Technology").
- Automated detection devices (lesson 10.9, "Intelligent Transportation Systems Technology").
- Street lighting (lesson 9.5, "Ambience, Shade, and Other Sidewalk Enhancements").
- Pavement surfaces and detectable warning (lesson 9.3, "Basic Sidewalk Elements").
- Other crossing technologies (lesson 11.5, "Crossing and Detection Technology").

12.10 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 must 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 else 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 cycles (i.e., two pedestrian cycles per one vehicle cycle at intersections to reduce pedestrian delay).

If a midblock signal system is used, it is important to place pedestrian pushbuttons in the median. There will be times when some pedestrians start too late or when older pedestrians lack time to cross, even at 0.9 m/s (3 ft/s). In these rare instances, the pedestrian needs to reactivate the signal.

12.11 Grade-Separated Crossings

According to the North Carolina DOT (NCDOT) *Bicycle Facilities Guide*, a grade-separated crossing "provides continuity of a bicycle/pedestrian facility over or under a barrier."[4]

A grade-separated crossing such as a bridge/overpass or a culvert/underpass should be considered when a pedestrian facility meets a barrier like an active multitrack railroad, stream, or freeway (see figure 12-9).

Figure 12-9. Photo. An underpass continues this shared-use bicycle path beneath a four-lane highway with high traffic volume.

Source: *Bicycle Facilities Guide: Types of Bicycle Accommodations*[4]

Some principal planning concerns with grade-separated crossings are:

- This type of facility can be expensive and difficult to implement. For these reasons, advance planning, identification of a source of funds, and a compelling purpose and need are primary factors in obtaining approval for construction of bicycle/pedestrian bridges or underpasses.
- Bicycle/pedestrian grade separations to be included in State highway construction projects should already be identified in locally adopted bicycle or greenway master plans by the time a proposed highway improvement is in the early stages of development.
- Many bicyclists and pedestrians will not use an overpass that is inconvenient. Instead, pedestrians may choose a time-saving and sometimes more hazardous crossing. Fencing or other controls may be required to reinforce the safe crossing point.
- Grade crossings must be accessible; ramps, handrails, landings, etc., must be provided so the facility is accessible to all.

For a grade-separated crossing to be warranted, some of the following circumstances should be present:

- High pedestrian volumes at the location and a high demand to cross.
- A large number of young children who must regularly cross (particularly at locations near schools).
- High volumes of motor vehicles traveling at high speeds along the roadway.
- No convenient alternative crossing places nearby.
- Funding and a specific need for the overpass/underpass.
- An extreme hazard for pedestrians.

Section 7F.02 of the MUTCD states that "experience has shown that overpasses are more satisfactory than underpasses for pedestrian crossings, as overpasses are easier to maintain and supervise."(5) When deciding on the use of an overpass or underpass, be aware of the need to provide artificial lighting to reduce potential crime. Also, pay attention to the existing topography of the proposed site to "minimize changes in elevation for users of overpasses and underpasses and to help insure construction costs are not excessive."(6)

12.12 Student Exercise

Choose an urban site that would be a good candidate for a midblock crossing with a pedestrian refuge island. Document the reasons that people often cross at this site (or would cross, given the opportunity). Photograph the site and prepare a sketch design solution.

12.13 References and Additional Resources

The references for this lesson are:

1. *Florida Pedestrian Planning and Design Guidelines*, Florida Department of Transportation, Tallahassee, FL, 1996, available online at http://www.dot.state.fl.us/Safety/ped_bike/handbooks_and_research/PEDHBTOC.PDF.

2. “Chapter 5: Neighborhood Street Design Guidelines,” *Southeast Neighborhood Traffic Management Plan* (*NTMP*), City of Vancouver, WA, 2003, available online at http://www.ci.vancouver.wa.us/transportation/ntmp/NTMTools/TOOL%2012%20-%20Mid-Block%20Crossing%20for%20Arterial%20Streets.pdf, accessed May 18, 2004.

3. Image Library, Pedestrian and Bicycle Information Center (PBIC), available online at http://www.pedbikeimages.org, accessed May 6, 2004.

4. *Bicycle Facilities Guide: Types of Bicycle Accommodations*, North Carolina Department of Transportation, Raleigh, NC, June 2003, available online at http://www.ncdot.org/transit/bicycle/projects/project_types/Grade_Separated_Crossing.pdf, accessed April 21, 2004.

5. *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, Washington, DC, 2003, available online at http://mutcd.fhwa.dot.gov, accessed April 22, 2004.

6. “Grade Separation Worksheet,” *Kane County Bicycle and Pedestrian Plan: Appendix J*, Kane County Division of Transportation, Geneva, IL, January 2003, available online at http://www.co.kane.il.us/DOT/COM/Bicycle/outline.asp, accessed April 21, 2004.

Additional resources for this lesson include:

- *Design and Safety of Pedestrian Facilities—A Recommended Practice of ITE*, Institute of Transportation Engineers (ITE), Washington, DC1998.
- *Oregon Bicycle and Pedestrian Plan*, Oregon Department of Transportation, Salem, OR, 1995.

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

Publication No. FHWA-HRT-05-107
HRDS-05/07-06(WEB)E