QUESTION 11:

What are some facility and treatment options that can serve pedestrians crossing a roadway?

NOTE : Though the 2023 edition of the Manual on Uniform Traffic Control Devices (MUTCD) is referenced in this summary, the 2023 edition had not yet been adopted within Iowa at the time this document was written. The reader is advised to determine the edition of the MUTCD currently in use in Iowa and refer to that edition for guidance. If needed, this summary will be updated when a final decision on the use of the 2023 MUTCD in Iowa is made.

As noted in other summaries within this series, a roadway cross section conversion project is a good time to consider options that serve the needs of pedestrians and bicyclists. These users' needs can be met by facilities that travel parallel to and across motorized traffic flows. Several facilities and treatments that run parallel to vehicle traffic flows are addressed in another summary within this series. The present summary focuses on crossing facility and treatment options that might be used to serve pedestrians and possibly, in some cases, bicyclists.

In a 2018 tech sheet on four-lane undivided to three-lane (four- to three-lane) conversions, the Federal Highway Administration (FHWA) identified several design features related to pedestrians and/or bicyclists that could be incorporated into four- to three-lane conversions (FHWA 2018a). These features include refuge islands, enhanced crosswalks, on-street parking with restrictions on crosswalk approaches, widened sidewalks and landscaped buffers, and bicycle lanes and/or transit lanes (FHWA 2018a). That same year, a more comprehensive list of available strategies for pedestrian safety at uncontrolled crossings, including the introduction of a four- to three lane conversion, was published in the *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* (Blackburn et al. 2018a). Some of these strategies, however, might also be applicable to signalized locations (e.g., bulb-outs).

The material on uncontrolled pedestrian street crossings in the documents noted above was also summarized in the *STEP Guide for Improving Pedestrian Safety at Uncontrolled Crossings* (FHWA 2018b), and a pocket version of the same information was provided in the *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations* (Blackburn et al. 2018b). Both of these documents, along with other valuable information, can be found at https://highways.dot.gov/safety/pedestrian-bicyclist/step/resources. In 2024, these and other documents were used to create a new section in both the Iowa Statewide Urban Design and Specifications (SUDAS) and Iowa DOT design manuals that focuses on pedestrian safety at crossing locations (SUDAS 2024, Iowa DOT 2019). Included in the update are discussions about selecting crossing locations for pedestrian safety measures and some of the design elements of various pedestrian safety measures (SUDAS 2024, Iowa DOT 2019).

This summary describes the implementation and physical characteristics of a few crossing facility and treatment options that primarily serve pedestrians and might be considered as part of a cross section conversion. The treatments discussed in this summary also support the concept of Complete Streets design.

FACILITIES AND TREATMENTS

Several different treatments are available that help pedestrians safely cross a roadway. These range from basic improvements (e.g., painted crosswalks) to higher cost treatments (e.g., overpasses/underpasses). These treatments are often applicable to a wide range of roadway cross section configurations, traffic volumes, and posted speed limits. One helpful tool for the selection of some of these pedestrian crossing treatments at uncontrolled locations is a guidance table provided in FHWA's *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* (Blackburn et al. 2018a). This document is freely available online, and the guidance table noted above appears to have been recreated as part of the 2024 updates to the Iowa DOT and SUDAS design manuals (Iowa DOT 2019, SUDAS 2024).

The sections below discuss ten different pedestrian crossing facilities or treatments. These facilities and treatments include crosswalks and enhanced crosswalk visibility, advance yield here to pedestrians signs and yield lines, in-street pedestrian crossing signs, raised crosswalks, curb extensions, pedestrian signals, pedestrian refuge islands, rectangular rapid flashing beacons (RRFBs), pedestrian hybrid beacons (PHBs), and overpasses/underpasses. More information about most of these measures can be found in Chapter 12 of the Iowa DOT and SUDAS design manuals (Iowa DOT 2019, SUDAS 2024).

Crosswalks and Enhanced Crosswalk Visibility

Crosswalk markings are a basic feature that can be provided for pedestrians crossing a roadway. They can be located at intersections or midblock locations, depending on engineering judgement of pedestrian needs. The Iowa DOT and SUDAS design manuals indicate that marked crosswalks and other safety treatments should be focused on locations where pedestrians are vulnerable due to high pedestrian and vehicle volumes (e.g., major bus stops), where vulnerable populations are present (e.g., senior citizens), and/or where there are difficult intersection geometrics or operations (e.g., wide crossing distances) (Iowa DOT 2019, SUDAS 2024).

The 2023 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) includes a guidance statement that crosswalks should be applied at locations controlled by traffic control signals (Section 3C.02) as well as a standard statement that "[c] rosswalk markings shall be provided at legally established crosswalks at non-intersection locations" (FHWA 2023). The 2023 MUTCD also includes guidance for applying crosswalks at intersection approaches controlled by stop or yield signs, criteria to consider for crosswalks at uncontrolled approaches, and guidance for identifying situations when the installation of other traffic control devices/measures to "reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence" should be considered (FHWA 2023). The 2023 MUTCD includes much more detail than what is shared here and should be reviewed, as applicable, when considering the installation of traffic control devices (e.g., signing and pavement markings). It should be noted that all pedestrian crossings must also meet accessibility requirements.

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Crosswalk markings

In addition to typical crosswalk markings, there are other strategies available to potentially increase drivers' awareness of the presence of a pedestrian crossing. In fact, crosswalk visibility enhancements are an FHWA Proven Safety Countermeasure (FHWA n.d.). It has been shown that high-visibility (longitudinal) pavement markings (e.g., patterns like bar pairs, continental, or ladder) are more visible to drivers than two transverse lines. In addition to these high-visibility crosswalk markings, the FHWA Proven Safety Countermeasure also includes improved lighting; the use of crossing warning signs, especially at midblock (e.g., "Yield Here to Pedestrians"); and the use of enhanced pavement markings and/or in-street signing (FHWA n.d.). The Iowa DOT and SUDAS design manuals describe some of these as separate measures and not part of crosswalk visibility enhancement (noted below as appropriate), but the manuals do include restrictions on the crosswalk approach as one visibility enhancement not noted by FHWA as part of this Proven Safety Countermeasure (Iowa DOT 2019, SUDAS 2024, FHWA n.d.)

Guidance and standards on pavement marking patterns and related topics, of course, can also be found in the MUTCD (FHWA 2023). The FHWA *Crosswalk Marking Selection Guide* (Schroeder et al. 2023) also provides a helpful summary of where to apply supplemental crossing treatments related to speed, volume, and lane configurations.

Advance Yield Here to Pedestrians Signs and Yield Lines

The Iowa DOT and SUDAS design manuals discuss the use of advance yield here to pedestrians signs and advance yield markings as a pedestrian safety measure (Iowa DOT 2019, SUDAS 2024). These signs and markings are placed in advance of marked crosswalks (see the MUTCD) and the yield markings described as "shark's teeth" (FHWA 2023, Iowa DOT 2019, SUDAS 2024). The Iowa design manuals indicate that these measures should be strongly considered at any established crossing on roadways with four or more lanes and/or a speed limit of 35 mph or greater (Iowa DOT 2019, SUDAS 2024).

In-Street Pedestrian Crossing Signs

In-street pedestrian crossing signs are paddle-shaped devices placed within the roadway. As noted in the Iowa DOT and SUDAS design manuals, these devices may be appropriate on two- or three-lane roadways with speed limits of 30 mph or less (Iowa DOT 2019, SUDAS 2024). They are typically placed along the centerline (for two-lane roadways) or lane lines (for three-lane roadways) to alert drivers to the presence of a crosswalk. These devices may not be visible on higher speed, higher volume, and/or multilane roadways (Blackburn et al. 2018a). The 2023 MUTCD (Section 2B.20) includes examples of the signage and additional information on its use (FHWA 2023). The SUDAS and Iowa DOT design manuals also indicate that plans should be in place for the prompt replacement of these signs when they become damaged (SUDAS 2024, Iowa DOT 2019).

Raised Crosswalks

A raised crosswalk is a crosswalk painted on the flat top of a speed table. It is an extension of the sidewalk that allows pedestrians to cross a roadway without a change in grade or curb ramps. An added benefit of a raised crosswalk is that it elevates pedestrians above the roadway surface to increase their visibility to approaching drivers. However, because a raised crosswalk consists of an elevated section of roadway surface, this treatment may not be appropriate on arterials or high-speed roadways; along bus, truck, or emergency routes; and at crossings on curves (Blackburn et al. 2018a, Iowa DOT 2019, SUDAS 2024). Additional information about the application of this measure, including closer consideration of drainage and the possible need for additional markers and training for snowplow drivers, can be found in the Iowa DOT and SUDAS design manuals (Iowa DOT 2019, SUDAS 2024).

Curb Extensions

On roadways with on-street parking, the use of a curb extension at an uncontrolled, signalized, or stop-controlled intersection extends the sidewalk and curb line into the parking lane. This extension reduces the crossing distance for pedestrians and improves the sight distance between drivers and pedestrians. It also removes the potential for parked cars to occupy the crosswalk. Curb extensions, in combination with truck aprons, as necessary, can work well with the effective turning radii of vehicles. The SUDAS and Iowa DOT design manuals list several factors that should be considered when implementing curb extensions at intersections or midblock locations (SUDAS 2024, Iowa DOT 2019). Some of these factors include the need for the width of the extension to be equal to or one foot less than the parking lane width and not extend into bicycle paths; the potential for an extension to create additional space for curb ramps, low-level landscaping, and street furniture; and the need for the length of the extension to be at least 20 feet long on both sides of the crosswalk (SUDAS 2024, Iowa DOT 2019).

Pedestrian Signals

When pedestrian crossings are present at a signalized intersection, a roadway conversion project presents an opportunity to add pedestrian signal heads if they have not already been installed. The pedestrian volumes that warrant pedestrian signal heads are provided in Part 4 of the 2023 MUTCD (FHWA 2023). The 2023 MUTCD also indicates that "[p]edestrian signal heads should be installed for each marked crosswalk at a location controlled by a traffic control signal" (FHWA 2023).

The addition of pedestrian signal heads, particularly at busier intersections, is intended to improve pedestrian safety by providing signals that indicate when pedestrians may cross. Pedestrian signal phases can be concurrent with parallel vehicle movements or exclusive (Daily et al. 2019). Leading pedestrian intervals (LPI) can also be incorporated as a strategy to provide pedestrians with a head start into the roadway before vehicle movements are permitted. This head start provides pedestrians with an opportunity to establish their presence in the crosswalk before conflicting motor vehicle drivers begin their maneuvers. It is also considered a proven safety countermeasure by FHWA (FHWA n.d.). Chapter 4 of the 2023 MUTCD discusses the timing of pedestrian signals (FHWA 2023), and additional discussion about pedestrian signals can be found in *NCHRP Report 812: Signalized Intersections Informational Guide, Second Edition* (Chandler et al. 2013) and the *Signal Timing Manual* (Urbanik et al. 2015).

Pedestrian Refuge Islands

Pedestrian refuge islands are features located in the center of a roadway that serve as a place for pedestrians to wait safely while crossing a roadway. They may be used at uncontrolled as well as signalized crossings. In fact, if a wide intersection cannot be designed and signalized to allow pedestrians to cross the entire roadway, a refuge island must be provided. Pedestrian refuge islands in urban and suburban areas are included, along with medians, as part of an FHWA Proven Safety Countermeasure (FHWA n.d.).

Refuge islands are typically raised, although occasionally they are simply a painted area. If the island is raised, the pedestrian crossing, for accessibility, should cut through the median in a level manner or meet curb ramp requirements (SUDAS 2024, Iowa DOT 2019). The width of a refuge island should also be appropriate for the roadway cross section and sufficient to serve crossing road users.

Iowa LTAP

Raised crosswalk

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Curb extension

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Pedestrian signal head at an intersection

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Pedestrian refuge island

Iowa LTAP

Rectangular rapid flashing beacon under a pedestrian warning sign

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PHB signal

In addition, a pedestrian refuge island should include all of the appropriate signing and pavement markings. Information in the SUDAS and Iowa DOT design manuals indicates that the clear width of a pedestrian access route through a refuge island shall be a minimum of 5 feet and should match the width of the corresponding crosswalk (SUDAS 2024, Iowa DOT 2019). In addition, a jog in the pedestrian route (sometimes with railings) within the refuge island can also be used in some instances so pedestrians are facing the flow of the traffic stream that they will cross. The SUDAS and Iowa DOT design manuals suggest that a refuge island be considered when crossing distances are greater than 50 feet to serve slower pedestrians (SUDAS 2024, Iowa 2019). The design manuals also discuss the minimum width of an island for accessibility, the placement of detectable warning surfaces, and other traffic calming devices that could be installed with a pedestrian refuge island (SUDAS 2024, Iowa 2019).

Rectangular Rapid Flashing Beacons (RRFBs)

RRFBs are user-activated amber light-emitting diode (LED) crossing beacons that supplement warning signs at unsignalized intersections or midblock pedestrian crosswalks (Zegeer et al. 2017). Like some of the other measures discussed in this summary, RRFBs are also an FHWA Proven Safety Countermeasure (FHWA n.d.). These beacons can be activated manually with a push button or by a pedestrian detection system and use an irregular flashing pattern to capture the attention of approaching motorists, alerting them to the presence of pedestrians on the roadside or within a crosswalk. RRFBs can be used in various situations but are quite effective on multilane crossings with speed limits less than 40 mph (SUDAS 2024, Iowa DOT 2019). Work from Oregon (Monsere et al. 2020) discusses best practices for the installation of these devices based on driver and pedestrian behavior. The study found that RRFBs could be considered on three-lane roadways with traffic volumes below 12,000 vehicles per day but that along roadways with traffic volumes greater than 12,000 vehicles per day, the addition of a median refuge island in conjunction with an RRFB increased yielding behavior. The SUDAS and Iowa DOT design manuals reference an FHWA interim approval document (IA-21) that includes additional information about the implementation of these devices in Iowa (SUDAS 2024, Iowa DOT 2019).

Pedestrian Hybrid Beacons (PHBs)

PHBs, sometimes referred to as high-intensity activated crosswalks (HAWKs), are used to warn and control traffic at unsignalized locations and facilitate pedestrian crossings at marked crosswalks (Zegeer et al. 2017). Like some of the other measures discussed in this summary, they are an FHWA Proven Safety Countermeasure (FHWA n.d.). These beacons consist of overhead signal heads with three sections: two red indications above one yellow indication. Signing is also included in the installations to indicate that drivers should stop on red. PHBs remain dark until activated by a pedestrian via a push button. Once activated, they display a series of flashing and solid lights to control vehicle traffic. These signal displays are used in combination with traditional pedestrian signal heads that indicate the pedestrian "walk" and clearance intervals (Blackburn et al. 2018a). Additional information about the application of this measure can be found in the MUTCD (FHWA 2023), the Iowa DOT *Design Manual* (Iowa DOT 2019), the SUDAS *Design Manual* (SUDAS 2024), and the FHWA *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* (Blackburn et al. 2018a).

As noted in the two Iowa design manuals, research indicates that PHBs are most effective on roadways with three or more lanes and with traffic volumes above 9,000 vehicles per day and that PHBs should be strongly considered for all midblock crossings where the speed limit is equal to or greater than 40 mph (SUDAS 2024, Iowa DOT 2019). The application table included in both manuals lists other situations where PHBs can also be strongly considered (SUDAS 2024, Iowa DOT 2019).

Overpasses/Underpasses

Overpasses or underpasses, although not as inexpensive as some of the other measures described in this summary, can also be used to provide a path for pedestrians to cross either over or under the roadway via a bridge or tunnel, respectively. The use of such structures is most common where high traffic and pedestrian volumes are present or where a significant safety issue exists for road users seeking to cross a facility. Regardless of the type of structure used, it is important that it have adequate lighting for nighttime use. It should also be noted that the use of an underpass may introduce public safety concerns, in that some pedestrians may not feel comfortable using a tunnel-like structure, particularly at night, even with ample lighting.

Iowa LTAP

Pedestrian overpass

SUMMARY

This summary describes the potential implementation and characteristics of some pedestrian crossing facilities and treatments that might be considered during cross section conversion projects.

The pedestrian crossing facilities or treatment discussed in this summary include crosswalks and enhanced crosswalk visibility, advance yield here to pedestrians signs and yield lines, in-street pedestrian crossing signs, raised crosswalks, curb extensions, pedestrian signals, pedestrian refuge islands, rectangular rapid flashing beacons, pedestrian hybrid beacons, and overpasses/underpasses. Additional information and details on each of these can found in various other resources and references, including the MUTCD (FHWA 2023), SUDAS *Design Manual* (SUDAS 2024), and Iowa DOT *Design Manual* (Iowa DOT 2019).

References available in: Knapp, K., and D. Veneziano. 2024. *Roadway Cross Section Reconfiguration: Responses to 14 Commonly Asked Questions*. Iowa Local Technical Assistance Program, Institute for Transportation, Ames, IA. https://intrans.iastate.edu/uploads/2024/10/roadway_cross_section_reconfiguration_w_cvr.pdf.