Complete Streets
Select Treatments

March 2015

SELECT TREATMENTS

This gallery presents select engineering and design treatments that can used by transportation planners and roadway design engineers in creating, reconstructing, and retrofitting streets to safely accommodate multiple users and modes. Specific context, existing community plans and priorities, current accepted standards and design guidelines, the professional judgment of project planners and engineers, and other factors will determine final designs.

Treatments presented here are divided into two broad categories, "Intersections and crossing locations" and "Traffic calming." The treatments focus on accommodating pedestrians (including transit users) and bicyclists because they are the roadway users whose safety, comfort, and convenience are least likely to be included or adequately accommodated in current roadway design. At the same time, they are also the road's most vulnerable users, accounting for a disproportionately high percentage of fatal and serious-injury crashes.1 Unless explicitly disallowed (e.g. on expressways), pedestrians and cyclists can nearly always be expected in significant numbers in urban and suburban areas. Such areas comprise the large majority of northeastern Illinois.

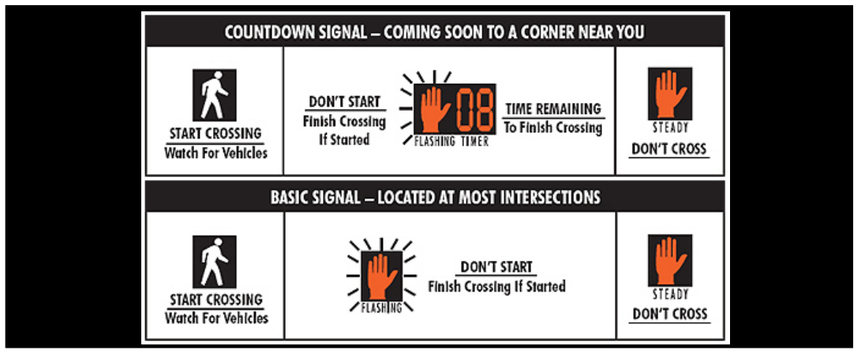
The list of treatments provided here is not meant to be exhaustive. Similarly, the information provided on each of the individual treatments is not intended to be final and definitive. For most treatments, numerous, detailed studies on their application, effectiveness, designs, and implementation exist. Practitioners should consult such materials when developing project scopes and designs. We provide links to some of the most important resources — and, when applicable, to regulatory authority — for the individual treatments.

Major additional resources for design standards and guidance, related to safety, accessibility, and mobility for non-motorized and multimodal travel, can be found in Appendix xx.

1 Nationally, pedestrian deaths account for an average of 12 to 14 percent of all traffic fatalities each year. Bicyclists account for 1.9 to 2.2 percent of fatalities. Estimates from the 2009 National Household Travel Survey indicate that only 11.4 percent of all trips are made by walking or bicycling. In addition to crashes, public health data indicate that a lack of physical activity, and a decline in bicycling and walking in particular, plays a major role in the hundreds of thousands of deaths each year that result from heart attacks, strokes, and other preventable diseases. For more information, see the Pedestrian and Bicycle Information (PBIC) Pedestrian and Bicyclist Crash Statistics webpage – http://www.pedbikeinfo.org/data/factsheet_crash.cfm – and the PEDSAFE Pedestrian Crash Statistics webpage at http://www.pedbikesafe.org/PEDSAFE/guide_statistics.cfm.

Images (clockwise from main image):

Accommodating transit.
Source: Flickr, Complete Streets.



Pedestrian countdown signals

Definition

Pedestrian countdown signals consist of a standard pedestrian signal head, with an added display showing a countdown of the remaining crossing time.

The countdown timer may start either at the beginning of the pedestrian WALK phase, but the MUTCD recommends starting the timer at the onset of the flashing DON'T WALK. The former is feasible only in jurisdictions that do not use "rest in walk" mode and/or that have all fixed-time signals.

Countdown signals are required by the MUTCD to be installed whenever pedestrian signal heads are warranted as part of intersection signalization or reconstruction. Signals may be supplemented with audible or other messages to make crossing information accessible for all pedestrians. Note that accessible pedestrian signals are called for at all new signals and at "all altered portions of existing facilities… the maximum extent feasible" in the proposed PROWAG.

Objective

To provide information to pedestrians about the amount of time remaining to safely cross the street at signalized intersections.

Advantage

Easily understood by most people.

Helps pedestrians judge whether there is sufficient time to cross. Provides certainty as regards the duration of the flashing DON'T WALK phase.

Especially helpful to mobility-challenged, elderly pedestrians, and adults accompanying small children.

Challenge

May not be easily understood by children or other persons with limited counting ability.

Does not benefit vision-impaired pedestrians.

Countdown signal technology will not currently work for railroad-preempted traffic signals (i.e. at signalized crossings near rail lines).

Resources

Pedestrian Safety: Report to Congress (August 2008) http://safety.fhwa.dot.gov/ped_bike/legis_guide/rpts_cngs/pedrpt_0808/pedrept_0808.pdf (See pp. 12-13).

PedSafe Case Studies: Countdown signals http://www.walkinginfo.org/pedsafe/case_studies2.cfm?op=C&subop=f&CM_NUM=38.

Pedestrian Countdown Indication—Market Research and Evaluation http://www.dot.state.mn.us/trafficeng/signals/news/ped%20countdown.pdf.

Accessible Pedestrian Signals: A Guide to Best Practices http://www.apsguide.org/index.cfm.

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov/ (See Chapter 4E).

Images (clockwise from main image):

Pedestrian countdown signal.
Source: Flickr, NYC Department of Transportation.

Additional examples:
Sources: Dan Burden; Dan Burden; Tara MacIsaac, The Epoch Times; Paul Krueger, Flickr; Delaware Department of Transportation.

Curb ramps, landings, and detectable warning tiles

Definition

Wheelchair ramps create a smooth, navigable transition from sidewalk level to roadway level, defined by a maximum slope angle. Landings are areas at the top of a ramp where a wheelchair can stop and turn. Detectable warning tiles are textured surfaces along pedestrian routes to notify visually impaired pedestrians that they are entering or leaving a roadway or other motor vehicle travel way.

Objective

To provide access between the sidewalk and roadway for people using wheelchairs or strollers, and for pedestrians with mobility impairments who may have trouble negotiating curbs.

Advantage

Provides accessible transition between pedestrian ways and street crossings.

'Channelizes' pedestrian movements and orients visually impaired pedestrians in the correct direction for crossing within a marked crosswalk.

Emphasizes the presence of and the need to expect pedestrians in the area.

Challenge

May require additional ROW or other roadway or roadside modifications.

Maintenance, snow removal on truncated dome tiles may be difficult and add cost.

Resources

Public Rights-of-Way Accessibility Guidelines (PROWAG) http://www.access-board.gov/prowac/nprm.htm (See Chapters R303, R304, and R305).

ADA Best Practices Tool Kit for State and Local Governments http://www.ada.gov/pcatoolkit/toolkitmain.htm (See Chapter 6).

FHWA Designing Sidewalks and Trails for Access: Part II Best Practices Design Guide http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/sidewalks207.cfm (Chapter 7).

Pedestrian and Bicycle Information Center—Curb Ramps http://www.walkinginfo.org/engineering/roadway-ramps.cfm.

ADAAG Requirements for Detectable Warnings http://www.access-board.gov/adaag/dws/update.htm.

Images (clockwise from main image):

Example of a curb extension.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden; Dan Burden, pedbikeimages.org; Dan Burden; Carl Sundstrom, pedbikeimages.org.

High-visibility crosswalks

Definition

A location indicated as an appropriate place for pedestrians to cross a street or vehicular way by marking the crossing location with high visibility crosswalk pavement markings.

High visibility crosswalks typically make use of longitudinal or “continental,” or “ladder” style pavement markings, which are highly visible to approaching traffic.

Typically, crosswalks installations should be done in conjunction with other enhancements that physically reinforce the crosswalks and reduce vehicle speeds (signage, RRFB or other beacons, stop- or signal-control, lighting, etc.).

Objective

To warn motorists to expect pedestrian crossings and to indicate preferred crossing locations.

Advantage

Increases visibility of the pedestrian crossing area.

Warns drivers that pedestrian traffic is to be expected.

Defines the space for pedestrian crossing and attracts pedestrians to the appropriate crossing point.

Challenge

May give pedestrians a false sense of security.

Resources

Manual on Uniform Traffic Control Devices
http://mutcd.fhwa.dot.gov./ (See Section 3B.18).

Pedestrian and Bicycle Information Center, Crosswalks
http://www.walkinginfo.org/engineering/crossings-crosswalks.cfm.

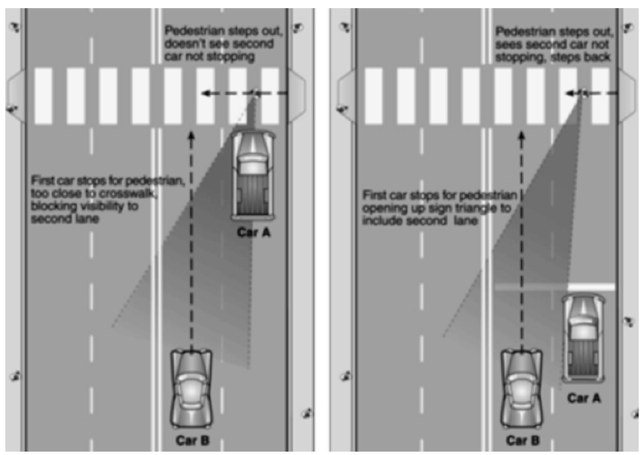
Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines http://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf.

Guidelines for the Installation of Marked Crosswalks, Virginia DOT
http://www.virginiadot.org/business/resources/Marked_20Crosswalks_20Final_20Guidelines_2012-14-05.pdf.

Images (clockwise from main image):

Example of a high-visibility crosswalk.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Manual on Uniform Traffic Control Devices (MUTCD) 2009; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Laura Sandt, pedbikeimages.org; Dan Burden, pedbikeimages.org.



Advance stop lines

Definition

Advance stop or yield lines are standard markings which indicate the point behind which vehicles are required to stop or yield in compliance with a traffic control device, but placed further back on the approach to an intersection or marked crossing.

Advance stop/yield lines are typically placed between 4 and 50 feet behind a crossing location, depending on circumstances and conditions, and are 12 to 24 inches wide.

Objective

To encourage motorists to stop farther away from the marked crosswalk, to improve lines of sight and increase safety at intersections.

Advantage

Increases pedestrians' visibility to vehicles.

Gives a motorist who initially fails to see the crosswalk more time to stop.

May increase effective turning radii for large vehicles at tight intersections.

May increase the visibility of cyclists by providing a space for cyclists to stop.

May help overcome the "multiple threat" crash problem.

Challenge

If limit lines are too far back, visually-impaired pedestrians may not hear the sound cues that tell them that vehicles have stopped to allow them to cross the street.

Images (clockwise from main image):

Example of advance stop lines.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Pedsafe, pedbikeimages.org; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Zolk, Flickr.

Resources

The Effects of Advance Stop Lines and Sign Prompts on Pedestrian Safety in a Crosswalk on a Multi-lane Highway, by Ron Van Houton http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1286120/.

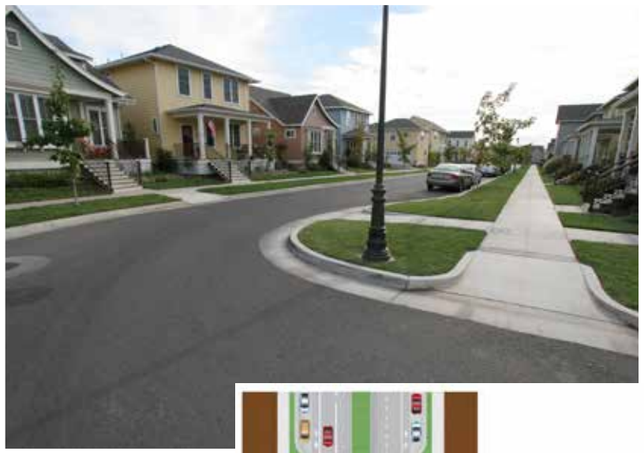
Pedestrian and Bicycle Information Center, Crossing Enhancements http://www.walkinginfo.org/engineering/crossings-enhancements.cfm.

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Section 3B.16).

Nevada DOT Streetsmart Brochure http://www.rtcwashoe.com/PubTrans/documents/MultipleThreatCrash.pdf.

Pedestrian and Bicycle Information Center Presentation (See slides 61-67) http://www.walkinginfo.org/training/pbic/collateral/pbic_webinar_crossings_zegeer.pdf.

Steps to a Walkable Community—Advance Stop Lines http://walksteps.org/tactic_category/design-engineering/#advance-stop-lines.



Curb extensions

Definition

Curb extensions or 'bulb outs' are extensions of the curb line into the street, across the parking lanes to the edge of the travel lane. They are appropriate only where there are on-street parking lanes.

Objective

Curb extensions or 'bulb outs' are extensions of the curb line into the street, across the parking lanes to the edge of the travel lane. They are appropriate only where there are on-street parking lanes.

Advantage

Reduces the distance and time that pedestrians travel in the street.

Increases pedestrian visibility and the ability to see oncoming traffic.

Adds sidewalk space, which can be used for various pedestrian or ancillary uses, including the installation of curb ramps/landings on narrow sidewalks or additional greenspace/landscaping.

Helps slow the speed of turning vehicles by tightening corner radii.

Prevents drivers from parking too close to a crosswalk.

Has significant traffic-calming effects, and potential for streetscaping/street beautification projects.

Challenge

Eliminates the buffer (parked cars) between the pedestrian waiting at the curb and passing vehicles.

May be difficult to for moving vehicles to see and creates an obstacle for street sweepers and snowplows.

May require landscaping or other means to guide visually-impaired pedestrians to crosswalks.

May result in the loss of on-street parking.

May create drainage problems or trash accumulation

May increase the potential for conflicts between bicyclists and motorists on some (higher speed) roads.

Impacts the turning ability of trucks and other large vehicles. (This issue, however, can be mitigated by the use of mountable apron/curb area. For an example of this type of adaptation, see 'pillow' type curb extension discussed at http://seattletransitblog.com/2013/01/31/a-pillow-of-cement/.)

Resources

Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition, AASHTO, 2004 https://bookstore.transportation.org/item_details.aspx?id=119.

FHWA Context Sensitive Solutions http://contextsensitivesolutions.org/content/topics/css_design/design-examples/flexible-design-elements/curb-extensions-m/.

Pedestrian Safety Impacts of Curb Extensions: A Case Study http://contextsensitivesolutions.org/content/reading/impacts_curb_ext/resources/PedSafetyCurbExt/.

Safe Routes to School Guide http://guide.saferoutesinfo.org/pdf/SRTS-Guide_full.pdf (Chapter 3, pp. 39-40).

Images (clockwise from main image):

Example of a curb extension.
Source: National Association of City Transportation Officials (NACTO), Flickr.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Michelle Weisbart, Living Streets; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Michelle Weisbart, Living Streets; Dan Burden, pedbikeimages.org.

Raised center median/pedestrian refuge island

Definition

Center median refuge islands are raised barrier areas placed in the center of the roadway separating opposing lanes of traffic, through which a crosswalk passes.

Objective

To provide a place for pedestrians crossing a street to wait safely for a suitable gap in traffic or for the WALK phase of a pedestrian signal.

Advantage

Enables pedestrians to focus on crossing one side of a roadway, with traffic moving in one direction only, at a time.

Divides crossings in shorter segments.

Can improve visibility of pedestrians.

May help slow vehicle speeds by making the roadway appear narrower.

Can serve access management goals, such as preventing or limiting left-turns.

Can help beautify streets with plantings and landscaping.

Challenge

Can complicate snow plowing/removal.

May require additional ROW and/or narrowing of vehicle lanes.

Resources

Pedestrian and Bicycle Information Center, Raised Medians http://www.walkinginfo.org/engineering/crossings-crosswalks.cfm.

FHWA Designing Sidewalks and Trails for Access: Part II Best Practices Design Guide http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/sidewalks208.cfm (Section 8.7).

Public Rights-of-Way Accessibility Guidelines (PROWAG) http://www.access-board.gov/prowac/nprm.htm (See Chapters R305.2.4).

Signalized Intersections: Informational Guide (FHWA) http://www.fhwa.dot.gov/publications/research/safety/04091/08.cfm#chp81 (Section 8.1).

ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach http://www.ite.org/css/ (Chapter 9).

PEDSAFE Case Studies: Medians http://www.walkinginfo.org/pedsafe/pedsafe_curb1.cfm?CM_NUM=12.

City of San Francisco Better Streets Guide http://www.sfbetterstreets.org/find-project-types/pedestrian-safety-and-traffic-calming/traffic-calming-overview/medians-and-islands/.

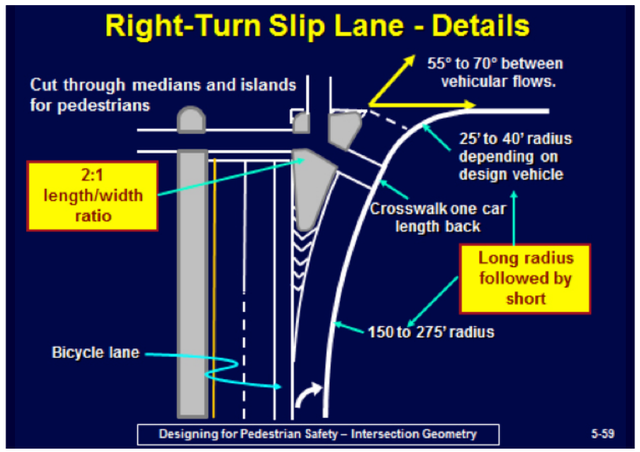
Pedestrian Refuge Island Safety Audit http://www.ite.org/Membersonly/techconference/2001/CCB01A31.pdf.

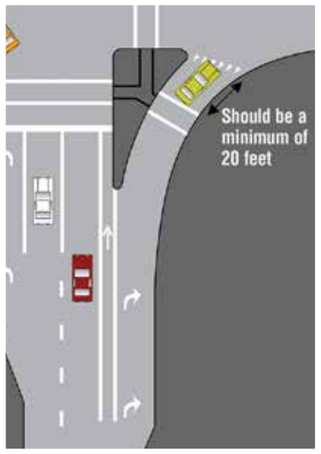
FHWA Proven Safety Countermeasures: Medians and Crossing Islands http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_011.htm.

Images (clockwise from main image):

Cyclist utilizing a center median/pedestrian refuge island.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Source: Dan Burden.





Raised 'pork chop' pedestrian refuge island/ right-turn slip lane

Definition

Pork chop islands are triangular raised islands placed between a right-turn slip lane and through-travel lanes. They channelize vehicular traffic and provide a refuge for pedestrians crossing a roadway, where they can wait for a suitable gap in traffic or for the WALK phase of a pedestrian signal. Current best practice and recommended design for curb radius consists of a two-center compound curve design.

Objective

To channelize right-turning vehicles in a manner that keeps turning speeds low, allows for good sightlines for pedestrians and for drivers of turning vehicles, and minimizes exposed crossing distance for pedestrians.

Advantage

Balances need for larger turning radii with pedestrian safety and mobility goals.

Allows pedestrians to focus on crossing one portion of a roadway at a time.

Divides crossing distance into shorter lengths and provides a safe place for pedestrians to stand when they do not have sufficient time to complete a crossing.

Improves visibility and sightlines for pedestrians and for drivers.

Improves signal timing and overall operations for intersection.

Challenge

Added obstruction in roadway; can be an obstacle to snow plowing and removal.

Visually impaired pedestrians may be unaware of the presence of refuge islands and find the accessible pedestrian way difficult to follow.

May require additional ROW.

Subsequent slip lanes, unless properly designed, may create turning radii that encourage drivers to speed around corners.

Resources

NCHRP Report 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_674.pdf.

PedSafe Countermeasures: Improved Right-Turn Slip-Lane Design http://www.walkinginfo.org/pedsafe/pedsafe_curb1.cfm?CM_NUM=15.

Pedestrian and Bicycle Information Center, Crosswalks http://www.walkinginfo.org/engineering/crossings-crosswalks.cfm.

FHWA Proven Safety Countermeasures: Medians and Crossing Islands http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_011.htm.

Images (clockwise from main image):

Example of a "pork chop" pedestrian refuge island.
Source: Dan Burden.

Additional examples:
Sources: Federal Highway Administration (FHWA), Designing for Pedestrian Safety; FHWA, Designing for Pedestrian Safety; FHWA, Designing Road for an Aging Population; FHWA, Designing for Pedestrian Safety.

Raised crosswalks and intersections

Definition

Raised crosswalks are elevated above roadway pavement in the form of an elongated speed hump with a flat section in the middle and at-grade with adjacent sidewalks. A raised intersection is a plateau covering the entire intersection, including crosswalks, on level with surrounding sidewalks, with ramps on all vehicular approaches.

Objective

To control and calm traffic speeds approaching and then traversing a crosswalk and/or intersection, and thereby improve the safety of pedestrians at these locations.

Advantage

Reduced traffic speeds at crosswalks and intersections.

Increased crossing convenience for pedestrians (since the grade change is eliminated).

May support urban design, streetscaping, and placemaking goals.

Challenge

Boundary between the sidewalk and street is not readily detectable by visually impaired pedestrians unless tactile cues are installed on sidewalk at each end of the crosswalk.

Cost of installation.

Resources

FHWA: The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior http://www.fhwa.dot.gov/publications/research/safety/pedbike/0104.pdf.

FHWA: Toolbox of Countermeasures and their Potential Effectiveness for Pedestrian Crashes http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_tctpepc/ped_tctpepc.pdf.

PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System – Raised Pedestrian Crossings http://www.walkinginfo.org/pedsafe/pedsafe_curb1.cfm?CM_NUM=27.

PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System – Raised Intersections http://www.walkinginfo.org/pedsafe/pedsafe_curb1.cfm?CM_NUM=26.

ITE Traffic Calming Measures—Raised Intersection http://www.ite.org/traffic/raised.asp.

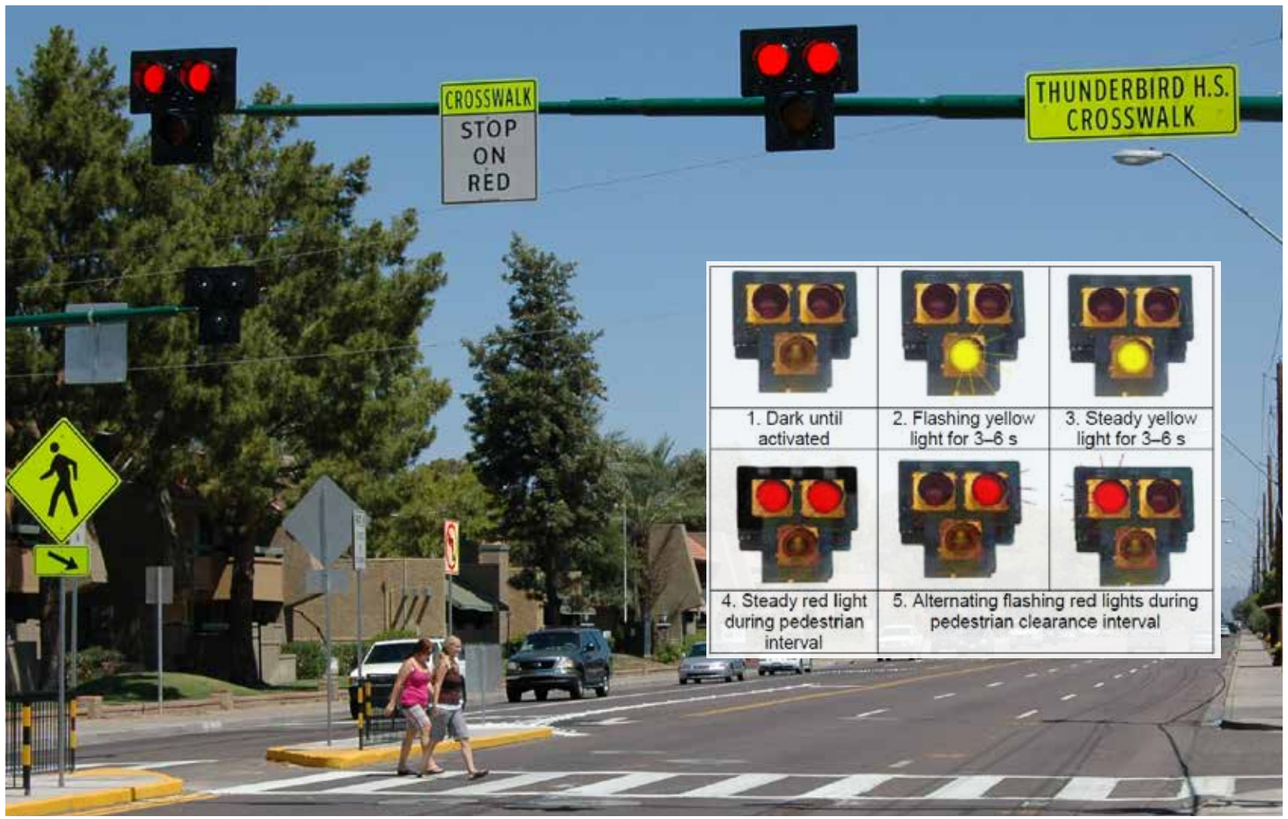
ITE Traffic Calming Measures—Speed table http://www.ite.org/traffic/table.asp.

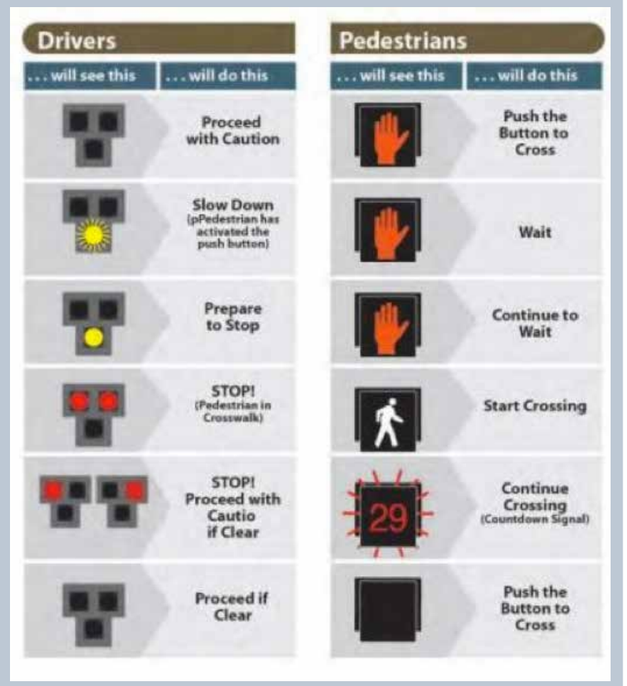
NCHRP Report 500 — A Guide for Reducing Collisions Involving Pedestrians http://safety.transportation.org/htmlguides/peds/description_of_strat.htm#91c3 (Sections 9.1.C2 and C3).

Images (clockwise from main image):

Example of a raised crosswalk.
Source: Dan Burden.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; citymaus, Flickr; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Dan Burden.





Pedestrian crossing beacons — Pedestrian hybrid beacon (HAWK)

Definition

A pedestrian hybrid beacon (or High-intensity Activated crosswalk — HAWK) is a special type of hybrid beacon used to warn and control traffic at an unsignalized marked crossing location to assist pedestrians in crossing the roadway. HAWKs should include accessible pedestrian signals with a locator tone to inform visually impaired pedestrians that activation of the signal is required to cross the street and to indicate onset of the WALK interval.

Objective

The pedestrian hybrid beacon is intended to stop vehicular traffic when a pedestrian activates the signal and intends to cross. It provides a high-intensity protected pedestrian crossing at unsignalized intersections or mid-block locations with high traffic volumes.

Advantage

Higher compliance rate for drivers stopping for pedestrians.

Minimizes delay for vehicular traffic.

Encourages safer pedestrian crossing behaviors at mid-block locations and uncontrolled intersections.

Challenge

Drivers have a tendency to remain stopped when it is safe to proceed.

Dark (unactivated) signal display may be confusing to motorists, conveying, for example, a power outage.

Resources

Pedestrian Hybrid Beacon Guide—Recommendations and Case Study http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa14014/fhwasa14014.pdf.

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Section 4F).

FHWA Proven Safety Countermeasures: Pedestrian Hybrid Beacon http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_012.htm.

Safety Effectiveness of the HAWK Pedestrian Crossing Treatment http://www.fhwa.dot.gov/publications/research/safety/10042/10042.pdf.

Pedestrian and Bicycle Information Center—Webinar on HAWK signals http://www.walkinginfo.org/training/pbic/pedfocus_webinar_11-30-2011.cfm.

Images (clockwise from main image):

Example of a pedestrian hybrid beacon at a crosswalk.
Source: Mike Cynecki, pedbikeimages.org.

Additional examples:
Sources: PedSafe; Mike Cynecki, pedbikeimages.org; Sree Gajula, pedbikeimages.org; Pedsafe, Living Streets.

Pedestrian crossing beacons — rectangular rapid flashing beacon

Definition

An RRFB device is a pedestrian-activated ("push button") beacon system located at the roadside and acting as a supplement to pedestrian warning signs at unsignalized intersections or mid-block crosswalks. The beacon employs an irregular flash pattern similar to the stutter flash used on emergency vehicles. RRFB devices must be used in conjunction with other treatments, such as warning and regulatory signage, advance stop/yield markings, marked and/or raised crosswalks, etc.

Objective

To alert drivers to the presence of pedestrians and their intention to cross the roadway.

Advantage

Increases driver yielding rates.

When used together with other treatments, RRFBs can reduce the incidence of "multiple-threat" crashes at crosswalks on multi-lane roads.

Allows for normal traffic flow when not actuated — i.e. it is only "on" when actually needed.

Relatively low cost — can be powered by solar or AC.

Challenge

Interim approval status with FHWA.

Pedestrians may misinterpret the flashing light and not wait for traffic to stop before entering the crosswalk.

Resources

MUTCD, Efficacy of Rectangular-shaped Rapid Flash LED Beacons
http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgrpt/index.htm.

FHWA, Safety Treatment Summaries: Rectangular Rapid Flash Beacon (RRFB http://safety.fhwa.dot.gov/intersection/resources/techsum/fhwasa09009/.

Evaluation of the Rectangular Rapid Flashing Beacon at Pinellas Trail Crossing in St. Petersburg, Florida
http://katana.hsrc.unc.edu/cms/downloads/FDOT_BA784%2EvaluationRectangularRapidFlashBeaconStPetersburgFlorida.pdf.

Evaluating Pedestrian Safety Countermeasures
http://www.fhwa.dot.gov/publications/publicroads/11marapr/03.cfm.

Evaluation of Pedestrian and Bicycle Engineering Countermeasures: Rectangular Rapid-Flashing Beacons, HAWKs, Sharrows, Crosswalk Markings, and the Development of an Evaluation Methods Report
http://www.fhwa.dot.gov/publications/research/safety/pedbike/11039/11039.pdfBA784%2EvaluationRectangularRapidFlashBeaconStPetersburgFlorida.pdf.

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Images (clockwise from main image):

Example of a rectangular rapid flashing beacon at a crosswalk.
Source: Michael Frederick, pedbikeimages.org.

Additional examples:
Sources: Dan Burden; Carol Kachadoorian, Pedsafe; Lara Justine, Flickr; Steven Vance, Flickr.

Pedestrian crossing beacons — overhead flashing beacon

Definition

Overhead flashing beacons are pedestrian-activated flashing amber beacons installed on traffic signal poles and mast arms at uncontrolled crossing locations, typically along with regulatory/warning signage.

Objective

To increase driver awareness when approaching a marked crosswalk at an uncontrolled location, and to alert drivers to the presence of pedestrians and their intention to cross the roadway, so that drivers will stop for pedestrians.

Advantage

Increases driver compliance with laws to stop/yield for pedestrians in crosswalks.

Increases driver awareness of the presence of pedestrians.

Allows for normal traffic flow when not actuated.

Challenge

Does not have a steady red signal indication requiring traffic to stop.

Relatively high installation cost and some maintenance costs.

Visually-impaired may not know to activate the beacon.

Resources

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov/ (See Section 4L.03).

NCHRP Report: Improving Pedestrian Safety at Unsignalized Crossings http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf.

ITE Journal Review: NCHRP Report: Improving Pedestrian Safety at Unsignalized Intersections http://www.ite.org/membersonly/itejournal/pdf/2007/JB07EA34.pdf.

Guidelines for the Installation of Marked Crosswalks (Virginia DOT) http://www.virginiadot.org/business/resources/Marked_20Crosswalks_20Final_20Guidelines_2012-14-05.pdf (Page 19).

Pedestrian Crossings: Uncontrolled Locations guidebook (Minnesota LTAP) http://www.mnltap.umn.edu/publications/handbooks/documents/ped_guidebook.pdf (Pages 22 and 23).

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Images (clockwise from main image):

Example of an overhead flashing crosswalk beacon.
Source: Dan Burden.

Additional examples:
Source: Dan Burden, pedbikeimages.org.

High-visibility signage — In-street stop/yield signs

Definition

A regulatory sign mounted in the center of relatively low speed streets at uncontrolled marked crossings, which reminds motorists of the law stating that they must stop for pedestrians in crosswalks.

Objective

To provide additional notice to motorists that they are approaching a pedestrian crossing, and to encourage them to slow down and stop for pedestrians in a crosswalk.

Advantage

Increases compliance with the law requiring motorists to stop for pedestrians in crosswalks.

Provides a more visible warning of the presence of a crosswalk.

Calms/slows traffic.

Designed to bend over and then bounce back to its normal vertical position when struck by a vehicle.

Challenge

Effectiveness may decrease as drivers become habituated to them (resulting from pervasive use and familiarity).

Are subject to damage from being hit by motor vehicles, and therefore must be replaced relatively often.

Resources

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Section 2B.12).

Pedestrian Safety Engineering and ITS-Based Countermeasures Program for Reducing Pedestrian Fatalities, Injury Conflicts, and Other Surrogate Measures: Final System Impact Report http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_scdproj/sys_impact_rpt/index.cfm#toc (Chapter 2).

Non-Motorized User Safety: A Manual for Local Rural Road Owners (FHWA) http://safety.fhwa.dot.gov/local_rural/training/fhwasa010413/nonmotorize.pdf.

Crosswalk Signing and Marking Effects on Conflicts and Pedestrian Safety in UIUC Campus http://ict.illinois.edu/groups/tol/reports/TOLseries22.pdf.

ITE Safe Routes to School Briefing Sheet—School Area Traffic Control http://www.ite.org/safety/SRTS/07.SchoolAreaTrafficControl.pdf.

Pedestrian and Bicycle Information Center—Effect of In-Street Crosswalk Signs http://www.walkinginfo.org/faqs/answer.cfm?id=3455.

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Images (clockwise from main image):

Example of high-visibility in-street signage.
Source: Peter Speer, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Dan Burden, Dan Burden, pedbikeimages.org; Lyubov Zuyeva, pedbikeimages.org; Dan Burden, pedbikeimages.org.

High-visibility signage — warning signs

Definition

Signs that visually alert motorists of the potential for pedestrians, bicyclists, or other non-motorized users along or crossing the roadway. (Note that for additional visibility, larger sign sizes can be used.)

Objective

To improve pedestrian safety at crossings and along roadways by using high visibility (fluorescent yellow-green) warning signs indicating the presence of pedestrians and cyclists.

Advantage

Encourages motorists to operate their vehicles with caution and to accommodate pedestrian and bicycle traffic as necessary.

Attracts drivers' attention to areas of potential conflict between motorized and non-motorized traffic.

Challenge

As with all signage, overuse along roadways may negate their effectiveness over the long term.

Works best when combined with enforcement and/or education efforts.

Resources

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Section 2C.41).

Using Signs and Markings to Enhance Intersection Safety http://www.ite.org/Membersonly/annualmeeting/2004/AB04H1303.pdf.

Pedestrian and Bicycle Information Center — Street Crossings http://www.walkinginfo.org/problems/problems-crossing.cfm.

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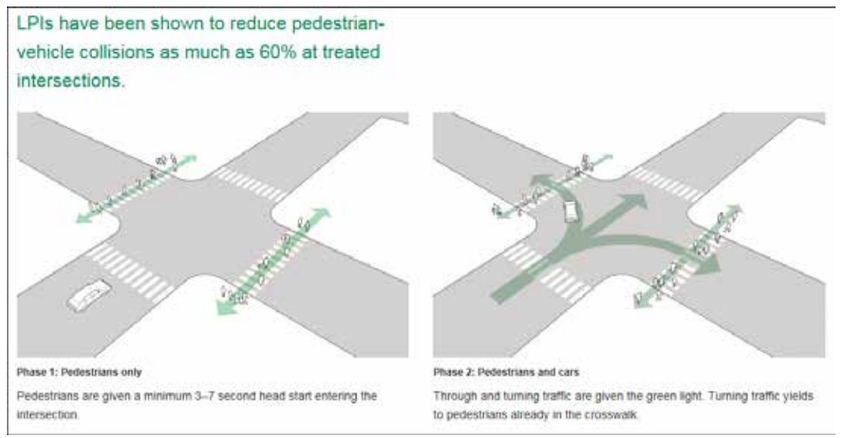
Images (clockwise from main image):

Example of high-visibility warning signs.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; WikiThreads, Flickr.



Leading pedestrian interval/turn restrictions

Definition

Signal timing adjustments designed to minimize conflicts between pedestrians and motorists. The four major adjustments are:

- A leading pedestrian interval (LPI) provides pedestrians with a few seconds of lead time prior to the onset of the associated vehicle phase.
- Slower walking rates (2.5 to 3.5 feet per second) may be programmed at intersections with or without pedestrian signal heads to account for young children, mobility-impaired, or elderly pedestrians.
- A leading pedestrian interval (LPI) provides pedestrians with a few seconds of lead time prior to the onset of the associated vehicle phase.
- Lagging left turn provides pedestrian with a few seconds of lead time prior to the onset of a protected left-turn phase.
- Right-turn on red restrictions often improves pedestrian safety

Objective

To provide adequate crossing times or to minimize conflicts between pedestrians and motorists at signalized intersections.

Advantage

Low-cost.

Makes signalized intersections more pedestrian-friendly.

Reduces conflicts between pedestrians and turning vehicles.

Challenge

May increase signal cycle length and vehicle delay.

Can create safety problems for vision-impaired pedestrians, since the traffic surge sound may be mistaken for parallel through traffic or is delayed, which would diminish crossing time for vision-impaired pedestrians.

Resources

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Section 4E.06).

FHWA Pedestrian Safety Improvements — Countermeasures (RTOR Restrictions) http://safety.fhwa.dot.gov/saferjourney/library/countermeasures/44.htm.

Pedestrian and Bicycle Information Center — Signals and Signs http://www.walkinginfo.org/engineering/crossings-signals.cfm.

PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System http://www.walkinginfo.org/pedsafe/pedsafe_curb1.cfm?CM_NUM=41.

BIKESAFE: Bicycle Countermeasure Selection System (Turning Restrictions) http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=20.

Selecting Leading or Lagging left-Turn Signal Phases for Coordinated Intersections http://www.academia.edu/1335226/Selecting_Leading_or_Lagging_Left-Turn_Signal_Phases_for_Coordinated_Intersections.

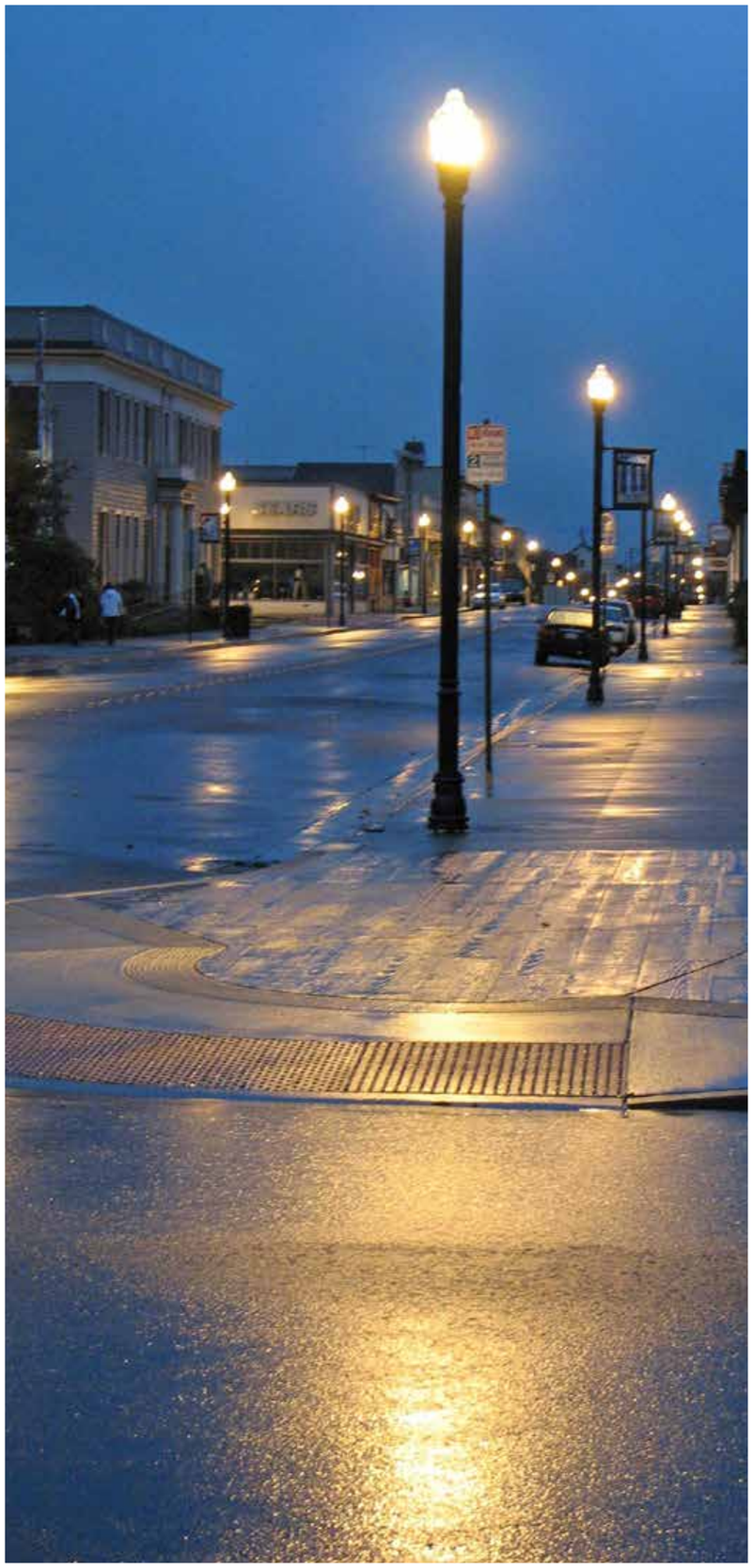
Chicago Pedestrian Plan (Tool Numbers 7 and 8, pp. 26-27) http://chicagopedestrianplan.org/pedestrian-plan/.

Streetsfilm.org video on LPI http://www.streetfilms.org/lpi-leading-pedestrian-interval/.

Images (clockwise from main image):

Example of a leading pedestrian interval/turn restriction.
Source: Axleuk, Flickr.

Additional examples:
Sources: M.V. Jantzen, Flickr; Dylan Passmore, Flickr; William Yurasko, Flickr; National Association of City Transportation Officials (NACTO) .



Lighting improvements

Definition

Street lighting includes roadway and pedestrian-scale lighting in the public ROW near high pedestrian and bicycle activity locations, conflict areas, transit stops, etc.

Objective

To illuminate pedestrians, improve their safety and comfort, and enhance security by providing levels of lighting that are oriented toward pedestrian and bicyclist activity.

Advantage

Improves safety for pedestrians, bicyclists, and other roadway users at intersections and along roadways by improving visibility during nighttime, dawn, and dusk hours.

Lighting fixtures and illumination can contribute to urban design, streetscape, and placemaking goals.

Can improve security and deter crime.

Challenge

Installation and maintenance costs, especially if permitting agencies require extending the (enhanced) lighting beyond a specific spot, intersection, or crossing.

ROW constraints may not allow installation of lighting.

Resources

American National Standards Institute RP-8-00—Roadway Lighting http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI%2FIESNA+RP-8-00.

Design and Evaluation of Effective Crosswalk Illumination http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-003.pdf.

City of San Francisco Better Streets Guide — Street Lighting http://www.sfbetterstreets.org/find-project-types/streetscape-elements/street-lighting/.

Effects of Roadway Lighting Level on the Traffic and Pedestrian Safety http://www.ce.siue.edu/faculty/hzhou/publication/Effects%20of%20Roadway%20Lighting%20on%20Night-Time%20Crashes%20.pdf.

Pedestrian and Bicycle Information Center—Roadway Lighting Improvements http://www.walkinginfo.org/engineering/roadway-lighting.cfm.

Informational Report on Lighting Design for Midblock Crosswalks http://www.fhwa.dot.gov/publications/research/safety/08053/index.cfm.

FHWA Pedestrian Facilities Users Guide — Providing Safety and Mobility http://ntl.bts.gov/lib/18000/18900/18916/PB2002103024.pdf (Page 48ff).

Images (clockwise from main image):

Example of lighting improvement.
Source: Ron Bloomquist, pedbikeimages.org.

Additional examples:
Source: Dan Burden, pedbikeimages.org.

Exclusive, all-ways pedestrian crossing

Definition

Also known as a "pedestrian scramble" or "Barnes Dance," the all-way pedestrian crossing is an intersection at which the signal cycle includes a phase in which vehicular traffic is stopped in all directions, and pedestrians can cross in any direction/on any leg, including diagonally.

Objective

To reduce or eliminate conflicts between vehicles and pedestrians, and simultaneously, to allow intersections to operate more efficiently when large volumes of pedestrians prevent vehicles from making turns.

Advantage

Can significantly reduce pedestrian crashes at intersections with high pedestrian volumes and high volumes of turning vehicles.

Can enhance overall efficiency of intersection (again, at intersections with high pedestrian volumes).

Low-cost (if intersection is already signalized).

Can be implemented where other solutions (road-widening, new signals, etc.) are impossible (lack of ROW) or infeasible (high cost).

Functions best at intersections with large volumes of turning traffic and large numbers of pedestrian-vehicle conflicts arising from turns.

Challenge

Compliance can be low since pedestrians must wait through two or more vehicle phases, which can reduce safety benefits.

Understanding of the purpose and the operation of this type of intersection signalization can be difficult for both pedestrians and motorists. As a result, adequate signage and pavement markings must be provided, along with educational outreach program.

Can be confusing for pedestrians with visual impairments.

May eliminate the ability to synchronize timing with adjacent traffic signals.

Resources

FHWA, Highway History — Where was the first Walk/Don't Walk sign installed, Addendum: The Barnes Dance http://www.fhwa.dot.gov/infrastructure/barnes.cfm/.

StreetsWiki: Pedestrian Scramble http://streetswiki.wikispaces.com/Pedestrian+Scramble.

Wikipedia: Pedestrian scramble http://en.wikipedia.org/wiki/Pedestrian_scramble.

FHWA Report — Pedestrian Signalization Alternatives (1985) http://katana.hsrc.unc.edu/cms/downloads/PedestrianSignalizationAlternatives1985.pdf.

Atlantic Cities — A Brief History of the Barnes Dance (Dec. 18, 2012) http://www.theatlanticcities.com/commute/2012/12/brief-history-barnes-dance/4189/.

Oakland Chinatown Pedestrian Scramble: An Evaluation (2003) http://escholarship.org/uc/item/3fh5q4dk#page-1.

Images (clockwise from main image):

Example of an all-ways pedestrian crossing.
Source: Zolk, Flickr.

Additional examples:
Sources: thisisbossi, Flickr; Dan Burden; Ian Muttoo, Flickr.

Grade-separated crossing

Definition

Structure built to provide a pedestrian way across high-speed, high volume roadways by means of either an overpass (bridge) or underpass (tunnel).

Objective

To provide complete separation of pedestrians and cyclists from motor vehicle traffic.

Advantage

Improves pedestrian and bicyclist safety by eliminating conflicts with vehicular traffic.

Eliminates the potential for vehicular delay.

Challenge

Some travelers may still try to cross the roadway at-grade.

High design, materials, and construction costs; in addition, grade separations often requires extensive ROW acquisition and modifications to adjacent properties.

May raise security concerns/issues.

Resources

Pedestrian and Bicycle Information Center — Pedestrian Overpasses/ Underpasses http://www.walkinginfo.org/engineering/crossings-overpasses.cfm.

Pedestrian and Bicycle Information Cente— Pedestrian Grade Separation Locations: A Priority Ranking System http://www.walkinginfo.org/library/details.cfm?id=2428.

PEDSAFE Case Studies: Medians—Overpass/ Underpass http://www.walkinginfo.org/pedsafe/case_studies2.cfm?op=C&subop=a&CM_NUM=6.

FHWA Pedestrian Safety Improvements — Countermeasures (Overpasses/ Underpasses) http://safety.fhwa.dot.gov/saferjourney/library/countermeasures/07.htm.

FHWA Designing Sidewalks and Trails for Access: Part II Best Practices Design Guide http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/chap4b.cfm#gra2 (Section 4.4.10: Grade-Separated Crossings).

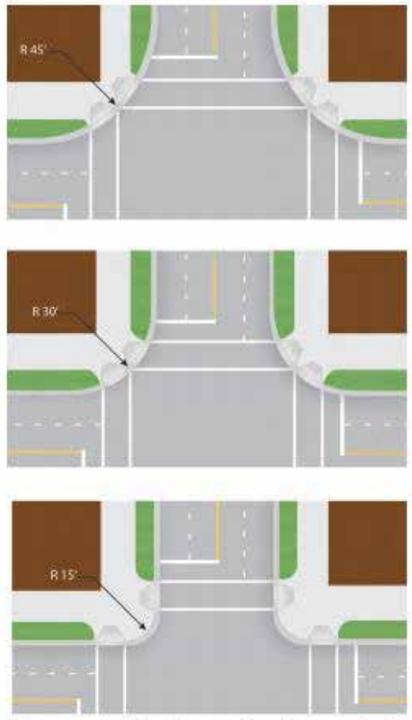
FHWA: Signalized Intersections: Informational Guide http://www.fhwa.dot.gov/publications/research/safety/04091/09.cfm (Chapter 9.1.6—Grade-Separate Pedestrian Movements).

Safe Routes to School Guide—Pedestrian and Bicycle Bridges and Tunnels http://guide.saferoutesinfo.org/engineering/pedestrian_and_bicycle_bridges_and_tunnels.cfm.

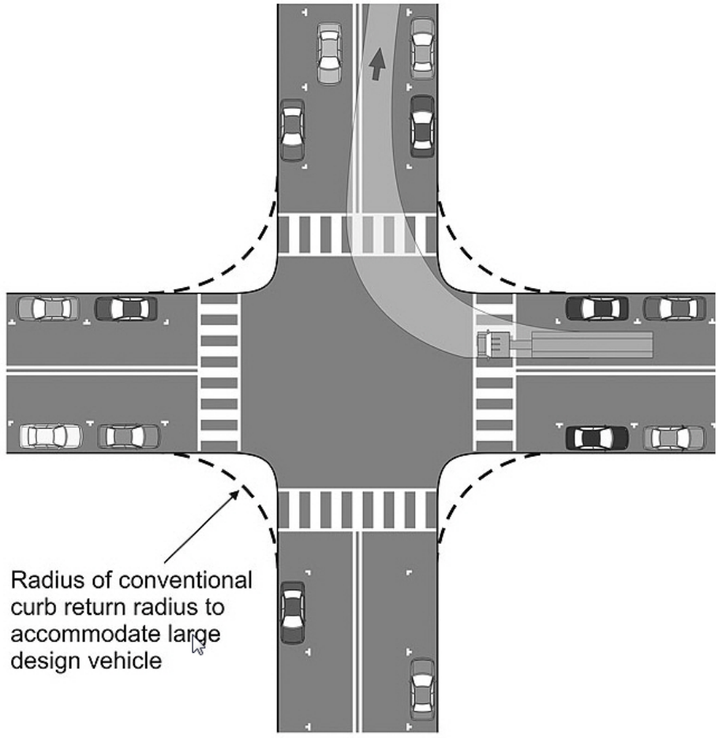
Images (clockwise from main image):

Example of a grade-separated crossing.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Kathy Eisenman, pedbikeimages.org; Laura Sandt, pedbikeimages.org; Julia Diana, pedbikeimages.org; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org. .



Tighter corner radii reduce crossing distance and slow turning traffic (Credit: Michele Weisbart)



Reduced curb radii

Definition

Reduction in the length of the radii defining the curved connection of curbs in the corners formed by the intersection of two streets or other vehicular ways. It is important to note that the curb radius can often be reduced without affecting the effective turn radius.

Objective

To shorten crossing distances and reduce vehicle speeds during turning movements.

Advantage

Reduces speed of turning vehicles, which may also reduce crashes and crash severity.

Shortens crossing distances, which benefits vehicles with a shorter cycle length at signalized intersections.

Increases visibility of pedestrians and improves their view of oncoming traffic.

Requires less ROW.

Challenge

May adversely affect the turning movements of large vehicles. (This issue can be mitigated by the use of mountable apron/curb area. For an example of this type of adaptation, see 'pillow' type curb extension discussed at http://seattletransitblog.com/2013/01/31/a-pillow-of-cement/.)

Images (clockwise from main image):

Diagram of reduced curb radii.
Source: Institute of Transportation Engineers (ITE).

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Steven Vance, Flickr; Michael Hintz; Chicago Metropolitan Agency for Planning; Michele Weisbart, Living Streets Manual.

Resources

ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach http://www.ite.org/css/ (Chapter 10).

FHWA Pedestrian Safety Improvements — Countermeasures (Curb Radii) http://safety.fhwa.dot.gov/saferjourney/library/countermeasures/09.htm.

NACTO Urban Street Design Guide – Turn Radii http://nacto.org/usdg/corner-radii/.

BIKESAFE: Bicycle Countermeasure Selection System http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=16.

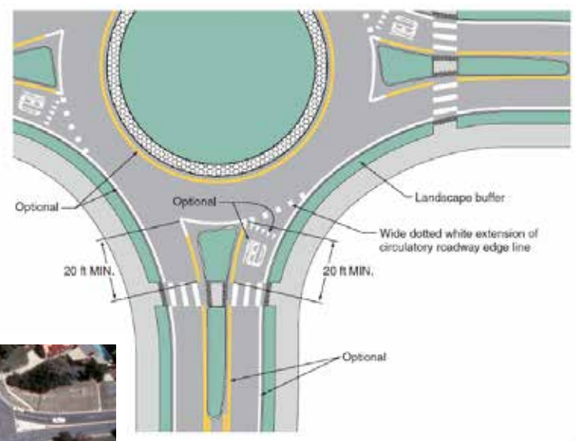
City of San Francisco Better Streets Plan http://www.sf-planning.org/ftp/BetterStreets/docs/Draft_BSP_5_Street_Designs.pdf (Chapter 5.2).

FHWA Designing Sidewalks and Trails for Access: Part II Best Practices Design Guide http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/sidewalks208.cfm (Chapter 8.3).

Wisconsin Guide to Pedestrian Best Practices: Chapter 5—Designing Pedestrian Facilities http://www.dot.wisconsin.gov/projects/state/docs/ped-guide-chap5.pdf (Section 5.2.1.4).

Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition, AASHTO, 2004 https://bookstore.transportation.org/item_details.aspx?id=119 (Chapter 3.3.1).

Signalized Intersections: Informational Guide http://www.fhwa.dot.gov/publications/research/safety/04091/03.cfm (Sections 3.5 and 3.51).



Modern roundabout

Definition

A circular intersection with yield-control for all entering traffic, channelized approaches, counter-clockwise circulation, and appropriate geometric curvature to ensure travel speeds of less than 30 mph. The adjective 'modern' is used to distinguish newer circular intersections conforming to the characteristics of roundabouts from older-style 'rotaries' and 'traffic circles'.

Objective

To maintain traffic flow at lower speeds through an intersection with the goal of reducing overall delay, collisions, and collision severity at the intersection (when operating within roundabout design capacity). Can replace signalized and stop-controlled intersections.

Advantage

Operational efficiency—maintains flow of traffic, reducing delay to roadway vehicles (motorized and bicyclists). Lower operating cost than signalized intersection.

Improved safety through reduction of crossing conflicts, total number of conflict points, and severity of conflict points. Safety benefits can extend to pedestrians.

Provides environmental benefits by reducing vehicle delay and the number and duration of stops compared with signalized or all-way stop-controlled alternatives.

By facilitating U-turns, roundabouts can assist in larger, access management strategies.

Can have traffic calming effects and aesthetic benefits, serving as 'gateways' or 'transition points' between higher speed (rural) roads and lower speed (urban) environments.

Challenge

Pedestrians with vision impairments may not be able to obtain necessary information to navigate the intersection safely.

Bicycle lanes are not recommended within the circulatory roadway of roundabouts, as it has been demonstrated internationally to have adverse safety effects.

Multi-lane roundabouts lose many of the safety benefits of single-lane roundabouts. In general, multilane roundabouts are not recommended in areas with high levels of pedestrian and bicycle activity.

Can require more ROW to install and/or cost more than other common intersection types.

May require additional educational efforts and activities to ensure roadway users understand how to operate within roundabout.

Resources

Roundabouts: An Informational Guide, Second Edition http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf.

FHWA Proven Safety Countermeasures: Roundabouts http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_005.htm.

Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_674.pdf.

Pedestrian Access to Modern Roundabouts: Design and Operational Issues for Pedestrians who are Blind http://www.access-board.gov/research/roundabouts/bulletin.htm.

Manual on Uniform Traffic Control Devices http://mutcd.fhwa.dot.gov./ (See Chapter 3.C and Sections 2B.43-45).

ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach http://www.ite.org/css/ (Chapter 10—Modern Roundabouts).

Roundabout Outreach and Education Toolbox http://safety.fhwa.dot.gov/intersection/roundabouts/roundabouttoolbox/.

FHWA Intersection Safety—Roundabouts: Technical Implementation and Tools, Research, Resources http://safety.fhwa.dot.gov/intersection/roundabouts/.

NYDOT Guidance for Roundabout Users — Information and animations of vehicular, pedestrian and bicycle movements https:// www.dot.ny.gov/main/roundabouts/guide-users.

Lake County Roundabouts Case Study http://www.cmap.illinois.gov/documents/10180/262443/LakeCountyRoundabouts.pdf.

Images (clockwise from main image):

Example of a modern roundabout.
Source: Federal Highway Administration, "Designing for Pedestrian Safety."

Additional examples:
Sources: Manual on Uniform Traffic Control Devices (MUTDC); Chicago Metropolitan Agency for Planning; Chicago Metropolitan Agency for Planning; Carl Sundstrom, pedbikeimages.org; Dan Burden, pedbikeimages.org.

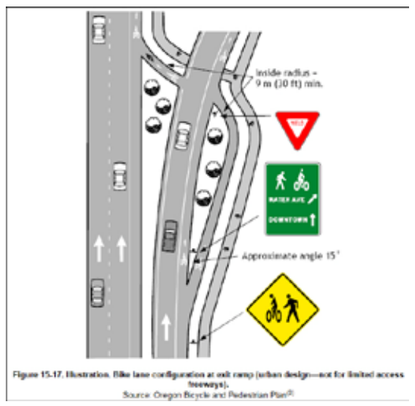
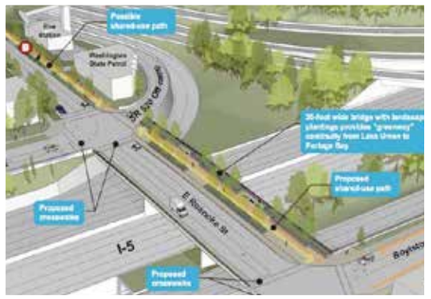


Figure 15-17. Illustration. Bike lane configuration at exit ramp (urban design—not for limited access freeways).
Source: Oregon Bicycle and Pedestrian Plan[2].



South end of Fanita Bike Path on north side of Navajo Road, just west of exit from southbound Highway 125. January 7, 2004

Pedestrian-and bicycle-friendly interchanges

Definition

A grade-separated intersection between an urban roadway (arterial, collector, or local road) and a freeway or limited-access highway, where the design of the freeway ramps and the bridge or underpass carrying the urban roadway is designed to ensure pedestrian and bicyclist access and safety.

Objective

To provide safe and convenient access and mobility for pedestrians and bicyclists at and across freeway/roadway interchanges.

Advantage

Improved safety from designs that reduce or eliminate high speed free flowing vehicular movements onto freeway and/or when merging with urban roadway.

Marginal cost for major (construction) projects is minimal.

Helps to eliminate significant barriers to bicycle and pedestrian travel between communities and destinations.

Challenge

Too costly to do as a retrofit—must be part of new interchange construction or complete reconstruction project.

Safety and mobility goals can be difficult to balance.

Resources

Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges (2014) http://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=RP-039.

Bicycle and Pedestrian Safety Needs at Grade-Separated Interchanges (NJDOT, updated 2008) http://www.bikewalktwincities.org/sites/default/files/Interchange_final_report_FINAL_080508.pdf.

Caltrans "Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians," Chapter 9 — Interchanges http://www.dot.ca.gov/hq/traffops/survey/pedestrian/Complete-Intersections-A-Guide-to-Reconstructing-Intersections-and-Interchanges-for-Bicyclists-and-Pedestirans.pdf.

PedSafe — Pedestrian Accommodations at Complex Interchanges http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=30.

Bikes & Freeway Interchanges: Getting Your DOT To Do It Right (presentation at Pro Bike / Pro Walk 2006) http://www.bikewalk.org/2006conference/vconference/presentations/BikeandFreewayInterchanges.pdf.

KIPDA Interchange—Bicycle / Pedestrian Safety Study http://www.kipda.org/files/pdf/transportation_division/Information/KIDPA_Interchange_Bike-Ped_FINAL_Report.pdf.

Images (clockwise from main image):

Example of a pedestrian-friendly interchange.
Source: Federal Highway Administration, "Designing for Pedestrian Safety."

Additional examples:
Sources: Google Streetview; Philip Erdelsky, San Diego County Red Routes; Washington State Department of Transportation, Flickr; Oregon Cycle and Pedestrian Plan; Aaron Volkening, Flickr; Chicago Metropolitan Agency for Planning; Washington State Department of Transportation. .

The following section presents design treatments focused on traffic calming or speed management. While treatments vary in terms of the context in which they are most effective and the specific conditions or behaviors that they are intended to address, they all have the overarching goal of controlling or limiting motor vehicle speed and the points of conflict between vehicles and other road users.

Some additional important sources of information on these and other traffic calming and speed management measures are listed in Appendix xx.

"Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users."

-ITE Traffic Calming Definition
ITE Journal, July 1997

Images (clockwise from main image):

Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Payton Chung, pedbikeimages.org; Dan Burden, pedbikeimages.org; Larry Shaeffer, pedbikeimages.org.

Speed humps and tables

Definition

Speed humps and speed tables (also speed bumps, speed cushions, and speed pillows) are vertical-deflection traffic calming devices that extend across a street, perpendicular to the direction of travel. (Humps usually taper near the drain gutter to allow unimpeded bicycle travel.)

Speed humps are typically made of asphalt and are 3-6 inches high at their center and anywhere from 8-14 feet in travel length. The traditional 12-ft hump has a design speed of 15 to 20 mph. Primarily used on lower-volume residential streets.

Speed tables are essentially flat-topped speed humps. They typically have a height of 3 to 6 inches and a travel length of 20 to 25 feet. Typical 22 foot speed tables usually consist of a 10 foot plateau with 6 foot approaches on either side. Typically used on local and collector streets or main roads through small communities.

Objective

To reduce motor vehicle speeds and/or volumes with a goal of increasing safety and reducing crashes.

Advantage

Proven to be effective in reducing travel speeds.

Self-enforcing.

Relatively inexpensive.

May reduce traffic volume by discouraging non-resident traffic.

Speed tables are generally preferred by emergency response departments over 12 to 14-foot speed humps.

Images (clockwise from main image):

Example of a speed hump.
Source: Gina Coffman.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Dan Burden; Dan Burden; Dan Burden; Dan Burden; Mike Cynecki, pedbikeimages.org.

Challenge

May be opposed by emergency response agencies when they believe that the speed humps will delay or damage emergency response vehicles. (Should not be used on critical emergency response routes.)

Increase in costs and complexity of resurfacing and maintenance.

Can increase roadway noise.

Potential drainage issues on some streets.

Must be designed, built, and maintained to prevent motor vehicle passenger and bicyclist discomfort. (May need to specify a construction tolerance.)

Resources

PedSafe—Speed Humps
http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=35.

PedSafe—Speed Tables
http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=36.

ITE Updated Guidelines for the Design and Application of Speed Humps (2007)
http://www.ite.org/traffic/documents/AB07H1101.pdf.

ITE Traffic Calming Measures - Speed Hump
http://www.ite.org/traffic/hump.asp.

ITE Traffic Calming Measures - Speed Table
http://www.ite.org/traffic/table.asp.

Traffic Calming: Speed Humps and Speed Cushions (2011) http://nacto.org/wp-content/uploads/2012/06/Berthod-C.-2011.pdf.

A Matched Case–Control Study Evaluating the Effectiveness of Speed Humps in Reducing Child Pedestrian Injuries http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448312/.

A Study on Speed Humps
http://www.ctre.iastate.edu/Research/roadhump/.

Operational Effectiveness of Speed Humps in Traffic Calming http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.376.1696&rep=rep1&type=pdf.

Towards a North American Geometric Design Standard for Speed Humps
http://www.ite.org/traffic/documents/JAB00A30.pdf.

Mini circles (neighborhood traffic circles)

Definition

Raised circular medians (traffic circles) constructed in the center of residential intersections. Vehicles must change their travel path to maneuver around the circle, which, though uncommon, may also be controlled by “stop” or “yield” signs on approaches.

Objective

To reduce motor vehicle speeds, manage traffic, and improve safety at intersections in residential areas.

Advantage

Can significantly reduce travel speeds and the likelihood and severity of pedestrian (and other) crashes. This benefit can be especially useful near schools or other areas where children are present.

Promote a more consistent rate of travel on streets that encourages pedestrian and bicycle usage.

Can have a positive aesthetic value and enhance the quality of the streetscape through landscaping and other enhancements.

Provide an opportunity for community activity in residential areas, with citizens installing and maintaining plantings or other enhancements.

Self-enforcing treatment, which calms two streets at once.

Challenge

Can limit the turning ability of larger vehicles. (This can be mitigated by the use of aprons/mountable curbs. Traffic circles are not recommended at intersections with high volumes of large trucks and buses turning left.)

Care must be taken not to limit sightlines required for safe operation of vehicles and travel generally.

May require the removal of parking spaces near the intersection in order to allow trucks and other larger vehicles space to maneuver.

Installation requires assessment of the needs of blind pedestrians for whom traffic circles can be a barrier or cause confusion.

Mid-block speeds may not decline. (Can be combined with speed humps for mid-block control.)

Resources

ITE Traffic Calming Measures — Neighborhood Traffic Circle http://www.ite.org/traffic/circle.asp.

PedSafe — Mini Circles http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=34.

FHWA Technical Summary: Mini Roundabouts http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10007/.

“Neighborhood Traffic Calming: Seattle’s Traffic Circle Program” http://www.usroads.com/journals/rmej/9801/rm980102.htm.

Images (clockwise from main image):

Example of a neighborhood traffic circle.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Heather Bowden, pedbikeimages.org; Carl Sundstrom, pedbikeimages.org; .

Chokers

Definition

Chokers are curb extensions or ”bulb outs”(see “Curb extensions” treatment discussed above), located mid-block, which narrow a street by extending the sidewalk or widening the planting strip.

Objective

Chokers are curb extensions or ”bulb outs”(see “Curb extensions” treatment discussed above), located mid-block, which narrow a street by extending the sidewalk or widening the planting strip.

Advantage

Reduce speeds.

Provide a good location for a mid-block crossing (when such a crossing is needed).

Will not generally cause delays or difficulties for emergency response and other large vehicles.

Provide opportunity for aesthetic enhancements (landscaping, signage, furnishings, etc.)

Challenge

Effect on vehicle speeds may be limited due to the absence of any vertical or horizontal deflection.

May require the elimination of some on-street parking.

May require additional effort or measures for effective snow removal.

Resources

ITE Traffic Calming Measures — Choker
http://www.ite.org/traffic/choker.asp.

PedSafe—Chokers http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=32.

Fehr & Peers Trafficcalming.org—Chokers
http://trafficcalming.org/measures/chokers/.

Safe Routes to School Online Guide:
Slowing Down Traffic — Chokers and Chicanes
http://guide.saferoutesinfo.org/engineering/chokers_and_chicanes.cfm.

Images (clockwise from main image):

Example of a choker/traffic calming, Boulder, Colorado.
Source: Dan Burden.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Dan Burden; Dan Burden, pedbikeimages.org; Dan Burden; City of Charlotte.

Chicanes and serpentine design

Definition

An S-shaped curve in the vehicle driving path, created by offset curb extensions or by curving alignment (horizontal deflection), in an otherwise straight segment of roadway. Also called deviations, serpentines, reversing curve, twists, and staggerings.

Objective

To slow motor vehicle traffic, reduce cut-through traffic, and increase drivers' attention to and awareness of the surroundings. Usually installed on low-volume residential streets.

Advantage

Speed reduction.

Can dissuade cut-through traffic.

Heightens driver awareness and attention.

Provide opportunity for aesthetic enhancements (landscaping, signage, furnishings, etc.).

Can be created with on-street parking (parallel or diagonal).

Challenge

Can be relatively costly to install.

May require the elimination of some on-street parking.

Can be difficult for drivers to see/understand at nighttime, which can be a safety problem.

May cause snow removal and street cleaning difficulties.

Must be designed so as to prevent high-speed weaving.

Resources

ITE Traffic Calming Measures — Chicane http://www.ite.org/traffic/chicane.asp.

PedSafe — Chicane http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=33.

Fehr & Peers Trafficcalming.org — Chicanes http://trafficcalming.org/measures/chicanes/.

Project for Public Places — Traffic Calming 101 — Chicanes http://www.pps.org/reference/livememtraffic/#CHICANES.

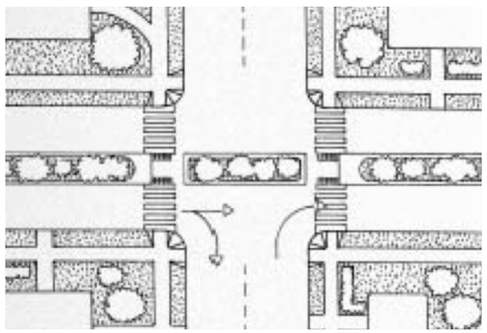
Mid-Block Speed Control: Chicanes and Speed Humps http://www.seattle.gov/transportation/docs/ITErevfin.pdf.

Traffic calming - an assessment of selected on-road chicane schemes http://www.trl.co.uk/online_store/reports_publications/trl_reports/cat_traffic_engineering/report_traffic_calming_-_an_assessment_of_selected_on-road_chicane_schemes.htm.

Images (clockwise from main image):

Example of a chicane and serpentine design
Source: Dylan Passmore, Flickr.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Richard Drdul, Flickr; Richard Drdul, Flickr; Dan Burden; Dan Burden, pedbikeimages.org.



Diverters and partial street closures

Definition

Diverters are barriers placed diagonally across an intersection, blocking through movements and creating two separate, L-shaped streets. Partial closures are barriers that block travel in one direction for a short distance on otherwise two-way streets. Both treatments can be designed to maintain two-way bicycle access.

Objective

To reduce motor vehicle traffic volumes and cut-through traffic on local, neighborhood streets.

Advantage

Reduces traffic volumes and cut-through traffic.

Ability to maintain full pedestrian and bicycle access.

Diverters do not close a street, only a redirection of traffic.

May have a crime prevention effect.

Provide opportunities for landscape treatments/streetscaping.

Challenge

Cause circuitous routes, increased travel times and volumes on nearby streets.

Emergency vehicle access must be considered. (All diverters and closures types can be designed to allow emergency vehicle access.)

May cause snow removal and street cleaning difficulties.

No reduction in vehicle speeds beyond the closed street segment.

Resources

ITE Traffic Calming Measures — Closure http://www.ite.org/traffic/closure.asp.

PedSafe — Diverter http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=41.

Fehr & Peers Trafficcalming.org — Volume Control (Full closures, half closures, diagonal diverters, median barriers) http://trafficcalming.org/.

Streetswiki: Traffic Calming — Traffic Diverters http://streetswiki.wikispaces.com/Traffic+Diverters.

BikeSafe: Bicycle Countermeasure Selection System — Traffic Diversion http://www.pedbikesafe.org/BIKESAFE/countermeasure.cfm?CM_NUM=29.

NCHRP Report 500, Volume 10 — A Guide for Reducing Collisions Involving Pedestrians (see "Strategy 9.1 A4 Provide Vehicle Restriction/Diversion Measures," p. V-25 ff. http://safety.transportation.org/htmlguides/peds/assets/PEguide.pdf.

Images (clockwise from main image):

Example of a diverter and partial street closure
Source: Adam Fukushima, pedbikeimages.org.

Additional examples:
Sources: Steven Vance, Flickr; Federal Highway Administration (FHWA); VeloTraffic, Flickr; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org.

Gateways/transition zones

Definition

Geometric roadway design and/or physical landmark in the public ROW, which communicates a change in context and signals the transition from a higher speed roadway and/or rural context to lower speed residential or commercial district.

Objective

To compel motorists to reduce travel speed and to be alert to the presence of pedestrians and other roadway users, as well as different movements and operations, upon entering a commercial, business, or residential district from a higher speed roadway. Gateways and transition zones can also be used to create a unique image, community identity, or sense of place.

Advantage

Reduction in speed.

Can provide the opportunity and space for other important information or infrastructure (signage, lighting, access management, etc.).

Can contribute to aesthetics and to place-making efforts.

Increased motorist awareness.

Challenge

Can be difficult and complex to design in order to achieve treatment objectives, which generally are more than one.

May require acquisition or use of private land.

May face political / community opposition.

Maintenance responsibility.

Resources

MassDOT "Project Development & Design Guide," Chapter 16: Traffic Calming, Section 16.5.10: Gateways http://www.massdot.state.ma.us/Portals/8/docs/designGuide/CH_16.pdf.

PedSafe — Gateways http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=37.

Streetswiki: Traffic Calming — Gateway Treatment http://streetswiki.wikispaces.com/Gateway+Treatment.

Traffic Calming: A Comprehensive Approach (presentation, slide 26) http://www.mtc.ca.gov/services/arterial_operations/downloads/trafficcalming/Abridged_Comprehensive_Approach.pdf.

Evaluation of Gateway and Low-Cost Traffic-Calming Treatments for Major Routes in Small, Rural Communities (Iowa DOT, 2007) http://www.ctre.iastate.edu/reports/traffic-calming-rural.pdf.

"Traffic Calming," UK Department for Transport, Local Transport Note 1/07, Chapter 7: Gateways and entry treatments http://assets.dft.gov.uk/publications/local-transport-notes/ltn-1-07.pdf.

Traffic in Villages: Safety and Civility for Rural Roads: Entry points (Dorset, England, p. 16) http://www.hamilton-baillie.co.uk/_files/_publications/50-1.pdf.

Images (clockwise from main image):

Gateway/transition zone, Lincoln Square, Chicago, Illinois.
Source: worldstreetphotos.com, Flickr.

Additional examples:
Sources: Dan Burden; MR38, Flickr; puroticorico, Flickr; Dan Burden, pedbikieimages.org; jarkatmu, Flickr.

Landscaping

Definition

The use of plantings and landscaping elements in the public ROW to provide separation between motorists, pedestrians, and/or cyclists, reduce vehicle speeds or volumes, and provide a more pleasant street environment for all.

Objective

To slow traffic by creating the appearance of a narrower roadway and to enhance the roadway environment for all users, especially pedestrians.

Advantage

Improved safety through slower motor vehicle speeds.

Can provided much needed shade for active travelers on hot days.

Enhanced environment for roadway users and for adjacent businesses and/or residences.

Can create opportunities for, and be used in conjunction with, other safety and operational treatments and/or traffic calming measures.

Can be of use for stormwater management and biodiversity efforts, and can help mitigate heat-island effect and improve air quality.

Can help create community or neighborhood identity.

Challenge

Cost of installation and maintenance responsibility.

Encroachment of plantings on sightlines, which can create safety issues for traffic and in terms of crime.

Resources

PedSafe — Landscaping http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=38.

University of Washington, Green Cities: Good Health — Safe Streets http://depts.washington.edu/hhwb/Thm_SafeStreets.html.

Landscape Design in the Clear Zone: The Effect of Landscape Variables on Pedestrian Health and Driver Safety (Texas A&M University, 2002) http://d2dtl5nnlpfror.cloudfront.net/swutc.tamu.edu/publications/papers/167425TP2.pdf.

City of Seattle, Streetscape Design Guidelines, 6.5.10 — Landscaping for Traffic Calming http://www.seattle.gov/transportation/rowmanual/manual/6_5.asp.

Landscape Ecology and Rural Roads: Traffic Calming for improving both landscape and wildlife? http://swutc.tamu.edu/publications/papers/167425TP2.pdf.

Images (clockwise from main image):

Landscaping example, Mole Hill, Vancouver, BC.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org; Eric Lowry, pedbikeimages.org; Laura Sandt, pedbikeimages.org; Dan Burden.

Pavement treatments

Definition

Special pavement markings, surface materials, and/or textures (cobbles, bricks, stamped pavement, color, etc.) that differentiate one part of the roadway network from other parts or areas. Can be used to highlight a pedestrian crossing, a whole intersection, or an entire street block.

Objective

To reduce vehicular speeds, and alert drivers to areas where pedestrians may be present and to the land use "context." Often used in "main street" areas where there is significant pedestrian activity.

Advantage

Can reduce vehicle speeds over an extended distance.

Can have positive aesthetic value.

Can be combined with speed tables, raised crosswalks, and raised intersections (see above).

Challenge

May present difficulties for pedestrians with mobility impairments (wheelchair users, visually-impaired, etc.).

May become slippery for pedestrians and bicycles in wet conditions.

Can make crosswalks less visible.

Increased costs for installation and maintenance.

Resources

FHWA "Designing Sidewalks and Trails for Access – Part II of II: Best Practices Design Guide" (Chapter 9: Traffic Calming, Section 2.4: Textured pavement) http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/10chapter9.pdf.

PedSafe — Specific Paving Treatments http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=39.

Fehr & Peers Trafficcalming.org — Textured Pavement http://trafficcalming.org/measures/textured-pavement/.

Streetswiki: Traffic Calming — Textured Pavement http://streetswiki.wikispaces.com/Textured+Pavement.

MTC Safety Toolbox: Pavement legends for pedestrians http://www.mtc.ca.gov/planning/bicyclespedestrians/tools/pavementLegends/index.htm.

Images (clockwise from main image):

Example of a pavement treatment.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden; Dan Burden; Max Bushell, pedbikeimages.org; Dan Burden, pedbikeimages.org; Dan Burden, pedbikeimages.org.

Speed display signs

Definition

An interactive sign, generally constructed of a series of LEDs, that displays vehicle speed as motorists approach. Can be permanently placed or deployed as a temporary, mobile unit. Also known as speed trailers or speed indicator signs, driver feedback signs, etc.

Objective

To reduce vehicular speeds by making drivers aware when they are driving at unsafe or illegal speeds.

Advantage

Relatively low cost.

Portability — i.e. signs can be moved from one location to another.

Good for site specific or problem areas (construction sites, schools, etc.).

No impact on emergency vehicle response times.

Have greatest effect on drivers that are exceeding the posted speed and when speed limit is also posted/ indicated.

Challenge

More effective if perception of regular enforcement (and threat of citation) exists at site.

Not effective on multi-lane roadways with significant traffic volumes.

May loose effectiveness when not actually in place (i.e. unless they are permanently installed), and may only be effective for short distances, near the sign.

Can cause some drivers to speed up to see how they can get the sign to read. (To avoid this, signs can simply flash “Speeding” message instead of displaying travel speed.)

Resources

Efficacy of Radar Speed Monitoring Displays in Reducing Vehicle Speeds http://solutions.3m.com/3MContentRetrievalAPI/BlobServlet?locale=en_US&lmd=1172092092000&assetId=1171989595608&assetType=MMM_Image&blobAttribute=ImageFile.

Evaluation of Dynamic Speed Display Signs http://trb.metapress.com/content/3028rr500u381630/.

SRTS Guide – Speed Trailers http://guide.saferoutesinfo.org/enforcement/speed_trailer.cfm.

Images (clockwise from main image):

Example of a speed display sign.
Source: Richard Drdul, Flickr.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Lyubov Zuyeva, pedbikeimages.org; MTSOfan, Flickr.

Shared streets, plazas, and pedestrian malls

Definition

Pedestrian-priority and pedestrian-only streets and adjacent areas in the public ROW. Shared streets (a.k.a. woonerfs, home-zone streets, festival streets) are usually in commercial areas or residential neighborhoods (home zones) where streets are relatively low volume and narrow. Shared streets typically do not have boundaries such as lanes, curbs, sidewalks, etc., and motorists are encouraged to travel at approximately 10-15 mph. Vehicles can be slowed by placing trees, planters, parking areas, and other obstacles in the street.

Objective

To make streets and adjacent areas within public ROWs safe and conducive to public uses and activities beyond transportation alone.

Advantage

Provides public space for social activities and play by local residents and/or visitors.

Gives priority to active transportation modes and lifestyles.

Can be used to advance economic development goals.

Challenge

Cost may be high.

Innovative nature of shared streets heightens resistance (from community, businesses, traditional traffic engineers, and/or elected officials), so, educational effort may need to be substantial.

Resources

PedSafe — Shared Streets http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=67.

MTC Safety Toolbox: Woonerf http://www.mtc.ca.gov/planning/bicyclespedestrians/tools/woonerf/index.htm.

Where the Sidewalk Doesn't End: What Shared Space has to Share http://www.pps.org/reference/shared-space/.

The Woonerf—A Social Invention in Urban Structure http://www.ite.org/traffic/documents/JJA81A17.pdf.

Streetswiki: Traffic Calming—Woonerf http://streetswiki.wikispaces.com/Woonerf.

Shared Streets Case Studies (Community Design + Architecture) http://www.smgov.net/uploadedFiles/Departments/PCD/Plans/Bergamot-Area-Plan/Shared-Space-Streets.pdf.

"Designing the Future — Shared Space: Qualitative Research," UK Department for Transport http://nacto.org/docs/usdg/shared_space_qualitative_research_dickens.pdf.

"Shared Space," UK Department for Transport, Local Transport Note 1/11, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3873/ltn-1-11.pdf.

"Shared Streets and Alleyways — White Paper" (Draft) http://nacto.org/docs/usdg/shared_streets_and_alley_ways_witte.pdf.

Databank Shared Space (in Dutch) http://shared-space.org/.

Images (clockwise from main image):

Example of a shared street.
Source: Dan Burden, pedbikeimages.org.

Additional examples:
Sources: Dan Burden, pedbikeimages.org; Andy Hamilton, pedbikeimages.org; Charlie Zeeger, pedbikeimages.org; Charlie Zeeger, pedbikeimages.org; Dan Burden; amseaman, Flickr.

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