How-to-Develop a Pedestrian Safety Action Plan

Engineering Strategies

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Engineering: Learning Objectives

At the end of this module, you should be able to:

⇒ Describe effective engineering strategies and how to integrate them into your Pedestrian Safety Action Plan
Engineering: Subjects Covered

- **Walking along the road**: the effectiveness of sidewalks and shoulders
- **Street crossings**: human behavior, midblock crossings, crosswalks, medians, signals
- **Pedestrian-friendly intersection design**: geometry, corner radii, curb extensions, islands
- **Signals**: how to make them work for pedestrians
- **Transit**: stop locations & ped crossings
- **Road diets**: creating room for pedestrians
Countermeasures for Walking Along the Road Crashes
Rural Environments: Paved Shoulders

Crash Reduction Factor (CRF) = 70%

6’ width preferred for effectiveness
Urban/suburban Environments: Sidewalks

CRF = 88%

Salem OR
Buffer sidewalks with planter strip/furniture zone:

- Space for trees and street furniture
- Easy to meet ADA at driveways and curb ramps
- More pleasant to walk on.
5 feet needed for two people to walk comfortably side-by-side (or to pass each other)
Mountable curbs are not appropriate on local streets
Sidewalk Corridors—The Zone System

The sidewalk corridor extends from the edge of roadway to the right-of-way and is divided into 4 zones:

- Curb zone
- Furniture zone
- Pedestrian zone
- Frontage zone
The Zone System – Residential Street
The Zone System – Commercial Street

Washington DC
Driveways

Driveways are the source of most conflicts with motor vehicles on sidewalks
Driveways built like intersections encourage high-speed turns
Driveways built like driveways encourage slow-speed turns
Separated sidewalk keeps sidewalk level at driveways
ADA Requirements For Sidewalks

Well-designed sidewalks meet ADA:

- Sidewalks should be clear of obstructions:
  - 3’ min clearance, 4’ proposed
- Sidewalk should have smooth surface
- Sidewalk should be at 2% max cross-slope including at driveways

The zone system creates a safer and more pleasant place to walk, and makes it easier to meet ADA requirements.
Countermeasures for Crossing Crashes
Crossing Crashes: Speed Matters

Speed Affects:

1. Drivers’ field of vision & ability to see pedestrians
2. Drivers’ ability to react and avoid a crash
3. Crash Severity
As speed increases, driver focuses less on surroundings
As speed increases, driver focuses less on surroundings
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As speed increases, driver focuses less on surroundings
Speed Affects Crash Avoidance

High speeds equate to greater reaction and stopping distance
Speed Affects Crash Avoidance

High speeds lead to greater chance of serious injury & death

Pedestrians’ chances of death if hit by a motor vehicle
SOURCE: Killing Speed and Saving Lives, UK Department of Transportation
Crosswalks

Crosswalks are provided to indicate to pedestrians where to cross and to indicate to drivers where to expect pedestrians.
Results of Most Recent Crosswalk Safety Study (Zegeer et al 2002)

Marked (alone) vs. Unmarked Analysis

⇒ Two-lane roads: No significant difference in crash rates

⇒ Multilane roads (3 or more lanes)
  ▪ Under 12,000 ADT: no significant difference in crash rates
  ▪ Over 12,000 ADT w/ no median: crash rate for marked > unmarked
  ▪ Over 15,000 ADT & w/ median: crash rate for marked > unmarked

⇒ Pedestrians are not less vigilant in marked crosswalks:
  ▪ Looking behavior increased after crosswalks installed
One explanation of higher crash rate at marked crosswalks: multiple-threat crash

1st car stops too close, masks visibility for driver in 2nd lane

Solution: advance stop bar (comes later...)
Study Recommendations

1. OK to mark crosswalks on 2-lane roadways
2. On multi-lane roadways, marked crosswalks alone are not recommended on roadways with:
   - ADT > 12,000 w/o median
   - ADT > 15,000 w median*
   - Speeds greater than 40 mph
3. Use raised medians to reduce risk
4. Signals or other treatments should be considered where many young and/or elderly pedestrians

* Note: effect of advance stop bar not studied (none at any observed sites)
Increase Effectiveness Of Crosswalks With:

- Proper location
- High Visibility Markings
- Illumination
- Signing
- Advance Stop Bars
- Median Islands
- Curb Extensions
- Signals
Marked crosswalks must be visible to the DRIVER

What the pedestrian sees
Marked crosswalks must be visible to the DRIVER

What the driver sees (same crosswalk)

Atlanta GA
Crosswalk Visibility

Crosswalk Marking Types
Place longitudinal markings to avoid wheel tracks, reducing wear & tear & maintenance
In-street pedestrian crossing signs

MUTCD signs
Yield or Stop depends on state law

R1-6
R1-6a

Tampa FL
Rectangular Rapid Flash LED Beacon

- Not in MUTCD — received Interim approval from FHWA in July 2008
- Studies indicate motorist yield rates increased from about 20% to 80%
- Beacon is yellow, rectangular, and has a rapid “wig-wag” flash
- Beacon located between the warning sign and the arrow plaque
- Must be pedestrian activated (pushbutton or passive)
Advance Stop or Yield Line: Reduces Multiple-threat Crashes
Multiple Threat Crash Problem

1st car stops to let pedestrian cross, blocking sight lines

2nd doesn’t stop, hits pedestrian at high speed.
Multiple Threat Crash Solution

Advance stop/yield line

1st car stops further back; opening up sight lines

2nd car can be seen by pedestrian
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— Engineering Strategies

R1-5
(Use where local law says yield to pedestrians)

R1-5a

R1-5b
(Use where local law says stop for pedestrians)

R1-5c
Milwaukee WI

Advanced yield line (shark’s teeth) & sign
Advanced stop line and sign
Raised Medians And Islands Reduce Pedestrian Crashes:

At marked crosswalks   CRF = 46%
At unmarked crosswalks  CRF = 39%
Continuous raised median – Basic Principle

Breaks long complex crossing into two simpler crossings
Medians make random crossings safer
Crossing island at marked crosswalk - Same Principle

*Breaks long complex crossing into two simpler crossings*
Islands improve safety at designated crosswalks
Pedestrian Signal
Provide a HOT response
Otherwise pedestrians won't wait for the light
Pedestrian Signal

2-stage crossing increases effectiveness and disrupts traffic less
1. Ped pushes button, waits, crosses to island
2. Ped crosses to island, proceeds to 2nd button
3. Ped on island – pushes button to finish crossing
Countermeasures for Intersection Crashes
Characteristics To Make Intersections Safer For Pedestrians

Pedestrian-friendly intersections are:

- Tight
- Simple
- Square
- Slow speed
- Easy to understand
  - If complex, broken into smaller steps
- Avoid free-flow movements
Curb radius – small radii are safer for pedestrians

Large corner radii:

- Increase crossing distance,
- Make crosswalk & ramp placement more difficult
- Allow high-speed turns by cars
Must consider large vehicles, but don’t choose larger design vehicle than necessary
Curb extensions

Most focus has been on reducing crossing distance
Curb extensions

Most focus has been on reducing crossing distance

Other advantages

- Better visibility (both ways)
- Traffic calming
- Room for street furniture

Curb extensions should be the width of the parking lane and not encroach on bike lanes or travel lanes
Pedestrians wait where they can see, in front of parked cars

Curb ext. places pedestrian where he can see and be seen
Islands at Intersections

Benefits:

- Separate conflicts and decision points
- Reduce crossing distance
- Improve signal timing
- Reduce crashes
Right-Turn Slip Lane: Design for pedestrians

Old Way

Wide Angle

High speed, head turner, low visibility of pedestrians

New proposal

Tighter angle

Slower vehicle speeds, good angle, good visibility of pedestrians

55 to 60 degree angle between vehicle flows.
Countermeasures for Signalized Intersection Crashes
Pedestrian signals should be provided, otherwise pedestrians don’t know when to cross.
Ped head placement: close to crosswalk, visible to pedestrians, especially with long crosswalk

Place ped head here, not here

Height: 7’ – 10’

Poor example

Good example
Pedestrian count-down signal tells pedestrians how much crossing time is left. 25% CRF in San Francisco
Proper Push-button Placement

The MUTCD recommends these dimensions
Protected-Only Left Turn Phasing
CRF up to 70%
Permissive Left Turns

Pedestrians cross at the same time as left-turning car; Drivers turning left on a green ball don’t look for pedestrians.
Permissive Left Turns
Permissive Left Turns
Permissive Left Turns
Protected Left Turns

Pedestrians cross after left-turning car, with thru-traffic; Pedestrian and car not in conflict
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Protected Left Turns
Protected/permissive Left Turns

Pedestrians cross after most left-turning cars (protected phase); Pedestrian and remaining cars are in conflict (permissive phase)
Protected/permissive Left Turns
Protected/permissive Left Turns
Protected/permissive Left Turns
Protected/permissive Left Turns
Protected/permissive Left Turns
Protected/permissive Left Turns: Solutions

1. Provide protected-permissive phasing by default, but revert to protected-only when pedestrian button is pushed
Protected/permissive Left Turns: Solutions

1. Provide protected-permissive phasing by default, but revert to protected-only when pedestrian button is pushed

2. Flashing left Yellow Arrow during steady green ball warns drivers: yield to pedestrians and oncoming vehicles (details next)
Use Short Signal Cycle Length

Long wait causes stacking: pedestrians wait in street, or don’t wait and cross against the signal.
At high-use crosswalks, pedestrians should get a signal at every cycle.
Set pedestrian signal to recall to “Walk” when major street is set to recall to green

Peds shouldn’t have to push a button to cross the minor street
LPI

LPI = Lead Pedestrian Interval

LPI gives pedestrians a head start

Looks like a regular signal to drivers
LPI: WALK comes on 3 seconds prior to the vehicular green; pedestrians can enter crosswalk before turning vehicles arrive there.
Exclusive Pedestrian Phase (Barnes Dance)

Exclusive pedestrian phase increases safety but increases delay for all including pedestrians.
Transit

- Ensure transit stops are convenient and accessible;
- Ensure users can safely cross the street at transit stops.
- Many pedestrian crashes are associated with transit
- “Every transit stop is a pedestrian crossing location”
Road Diets
“Classic Road Diet”

4 to 3 lanes

San Antonio TX
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Road diets: reclaim street space for other uses

- On-street parking
- Median
- Bike Lanes
- Center Turn-Lane

Seattle WA
Reclaiming road space creates room for ped islands

Charlotte NC

Before
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Reclaiming road space creates room for ped islands

Charlotte NC
How to Develop a Pedestrian Safety Action Plan — Engineering Strategies

Reclaiming road space creates room for ped islands
Road Diets

This space was recaptured from a 4th travel lane

Portland OR
Benefits of Road Diets for Pedestrians

- Reduces crossing distance
- Reduces “multiple threat” crash types
- Provides room for crossing island to break crossing into 2 simpler crossings
- Reduces top end travel speeds
- Buffers sidewalk from travel lanes (parking or bike lane)
- Reclaims street space for “higher and better use” than moving peak hour traffic
Engineering Strategies Summary:

- Sidewalks reduce walking along the road crashes
- Human behavior must be considered when choosing street solutions
- Street crossing solution include crosswalks, medians, signals
- Pedestrian-friendly intersections depend on good geometry, tight corner radii, curb extensions, islands
- Signals can be improved for pedestrians
- Road diets create safer conditions for pedestrians
Engineering: Learning Objectives

You should be able to:

→ Describe effective engineering strategies and how to integrate them into your Pedestrian Safety Action Plan
Questions?