PEDESTRIAN COLLISION COUNTERMEASURES

NCHRP Report 500 – Volume 10

Pedestrian Fatalities & Injuries

- Pedestrian fatalities – 4739 (2002 FARS)
- Injuries – 70,000 (2002 NHTSA)
EXHIBIT III-1
Pedestrians Killed in Crashes with Vehicles, 1994–2002 (Source: NHTSA Web site)

EXHIBIT III-2
Pedestrians Injured or Killed in Crashes with Vehicles, 1990–2000 (Source: NHTSA Web site)

Note: A significant number of pedestrian injury crashes requiring emergency room treatment but not reported to police agencies are not included in these reported fatalities and injuries.
Where Pedestrian Collisions Occurred

- Non-fatal crashes
  - 85.7% urban
  - 14.3% rural

- Fatalities
  - 75% urban
  - 25% rural
Location Type

- Pedestrian fatalities in 2000 occurred;
  - 71%, rural areas
  - 78%, non-intersection locations
  - 91%, in good weather
  - 64%, at night

EXHIBIT III-7
## Crash Type Grouping

**EXHIBIT III-11**
Twelve Crash-Type Groupings

<table>
<thead>
<tr>
<th>Definitions of Pedestrian Crash Types</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Midblock: Dart/Dash</td>
<td><img src="image1.png" alt="Example Image" /></td>
</tr>
<tr>
<td>Definition: The pedestrian walked or ran into the roadway and was struck by a vehicle. The motorist's view of the pedestrian may have been blocked until an instant before the impact, and/or the motorist may have been speeding.</td>
<td></td>
</tr>
</tbody>
</table>

| 2. Multiple Threat                   | ![Example Image](image2.png) |
| Definition: The pedestrian entered the traffic lane in front of stopped traffic and was struck by a vehicle traveling in the same direction as the stopped vehicle. The stopped vehicle may have blocked the sight distance between the pedestrian and the striking vehicle, and/or the motorist may have been speeding. | |

| 3. Mailbox or Other Midblock        | ![Example Image](image3.png) |
| Definition: The pedestrian was struck while getting into or out of a stopped vehicle or while crossing the road to/from a mailbox, newspaper box, ice-cream truck, etc. | |

| 4. Failure to Yield at Unsignalized Location | ![Example Image](image4.png) |
| Definition: At an unsignalized intersection or midblock location, a pedestrian stepped into the roadway and was struck by a vehicle. The motorist failed to yield to the pedestrian and/or the pedestrian stepped directly into the path of the oncoming vehicle. | |
5. Bus-Related

Definition: The pedestrian was struck by a vehicle either (1) by crossing in front of a commercial bus stopped at a bus stop, (2) going to or from a school bus stop, or (3) going to or from or waiting near a commercial bus stop.

6. Turning Vehicle at Intersection

Definition: The pedestrian was attempting to cross at an intersection and was struck by a vehicle that was turning right or left.

7. Through Vehicle at Intersection

Definition: The pedestrian was struck at a signalized or unsignalized intersection by a vehicle that was traveling straight ahead.

8. Walking Along Roadway

Definition: The pedestrian was walking or running along the roadway and was struck from the front or from behind by a vehicle.
9. Working/Playing in Road

Definition: A vehicle struck a pedestrian who was (1) standing or walking near a disabled vehicle, (2) riding a play vehicle that was not a bicycle (e.g., wagon, sled, tricycle, skates), (3) playing in the road, or (4) working in the road.

10. Not in Road (Driveway, Parking Lot, Sidewalk or Other)

Definition: The pedestrian was standing or walking near the roadway edge, on the sidewalk, in a driveway or alley, or in a parking lot, when struck by a vehicle.

11. Backing Vehicle

Definition: The pedestrian was struck by a backing vehicle on a street, in a driveway, on a sidewalk, in a parking lot, or at another location.

12. Crossing an Expressway

Definition: The pedestrian was struck while crossing a limited-access expressway or expressway ramp.
Objective I

Reduce pedestrian exposure to vehicles

Strategy A

- Provide sidewalk / walkways and curb ramps
  - Sidewalks on both sides of the street reduce pedestrian crashes by 50-90%
  - Sites with sidewalks are 88% less likely than sites without sidewalks (McMahon, 2002)
Strategy B

- Install or upgrade traffic / pedestrian signals
  - Pedestrian signals should be installed at traffic signals in urban and suburban areas
  - Marked crosswalks should be employed; keep motorists from encroaching
  - Many pedestrians don’t understand pedestrian signals

Pedestrian Signal Timing

- Typically use minimum WALK time of 7 sec. and flashing DON’T WALK for remainder of minimum pedestrian green
- Signal timing scheme
  - Standard
    - WALK starts with parallel green
    - Early release: WALK starts while parallel street in RED, pedestrian occupy crosswalk early
    - Late release: WALK signal starts after green on parallel street, turning vehicles have passed
    - Exclusive turning ‘scramble’ system without diagonal crossing, about 50% reduction in vehicle/pedestrian crashes
Accessible Pedestrian Signals

- Provide audible and/or vibrotactile information
- Informs visually impaired when WALK interval begins
- Audible signals can provide directional guidance, helpful on angle or skewed intersections
- APS technologies
  - “Accessible Pedestrian Signals,” FHWA
  - http://www.access-board.gov/research&training/pedsignals/pedestrian.htm

EXHIBIT V-9
Accessible pedestrian signals (APS) provide audible and/or vibrotactile information to assist visually impaired pedestrians on when to cross the street. (Photo by David Harkey)
Signal Enhancements

- Including
  - Automated pedestrian detectors
  - Larger traffic signals
  - Countdown signals
- Automated pedestrian detectors
  - Use infrared or microwave technology
- Automated detectors can track pedestrians and extend the clearance interval if necessary
- Pedestrian countdown signals count down the seconds left to finish crossing
Right-Turn on Red (RTOR)

- RTOR can increase crash risk to pedestrian
- MUTCD constrains RTOR
  - With an exclusive pedestrian phase
  - Where an unacceptable number of pedestrian conflicts result with RTOR

Strategy G

- Construct pedestrian refuge islands and raised medians
  - Raised medians can serve as pedestrian refuge
  - Median crossings must be accessible by curb ramps or cut-throughs
  - Non-traversable medians reduce pedestrian/vehicle crashes over undivided and TWLTL
Pedestrian/Vehicle Crashes by Median Type

<table>
<thead>
<tr>
<th>Median Type</th>
<th>Intersection Crashes/100 million entering vehicles</th>
<th>Intersection Crashes/100 million vehicle miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undivided</td>
<td>2.32</td>
<td>6.69</td>
</tr>
<tr>
<td>TWLTL</td>
<td>2.48</td>
<td>6.55</td>
</tr>
<tr>
<td>Non-traversable</td>
<td>0.97</td>
<td>3.86</td>
</tr>
</tbody>
</table>

Crossing Islands

- Raised crossing island allows pedestrians to concentrate on one direction at a time
- Crossing islands should be illuminated
- Signs, markings, and reflectors are used to demonstrate ‘pedestrian environment’
Full Street Closure

- All traffic is blocked
- Should accommodate easy access by pedestrians and bicyclists
- Emergency vehicles should have access
Pedestrian Street

- Eliminate all motor vehicles
  - Deliveries may be permitted off-peak
- Allow some motor vehicle traffic, at very low speeds
- Risk in the restricted area dropped to 29% but rose by 30% outside the area

Objective II

Improve sight distance and/or visibility between motor vehicles and pedestrians
Strategy D

- Provide crosswalk enhancements
  - Supplement crosswalk with warning signs
  - In-pavement flashing lights are embedded on both sides of crosswalk
  - Crosswalk markings should be visible

EXHIBIT 7-24
Example of Crosswalk Marking Patterns (Note: Neither the solid crosswalk nor the dashed lines (which are common in Europe) are included in the 2000 MUTCD.)
Marked vs Unmarked Crosswalk

• Zeeger study in 2002 showed;
  – On two-lane roads comparing an unmarked crosswalk and a marked crosswalk (with no supplementary treatments), no difference in safety
  – On multi-lane roads with ADT above 12,000 veh. per day, an unmarked crosswalk has a lower accident rate than a marked crosswalk (with no supplementary treatments)
Strategy E

• Implement lighting/crosswalk illumination measures
  – Well-placed lighting and adequate lighting level improve pedestrian safety
  – Perth, Australia experience 62% reduction in pedestrian/vehicle crashes at night after flood lighting the crosswalk
  – Signing and illumination of crosswalks saw 43% reduction in nighttime pedestrian/vehicle crashes

Strategy F

• Eliminate screening by physical objects
  – Sight distance
    • Crosswalks should not be placed close to horizontal or crest vertical curves
  – Parking
    • No parking should be located within 20 ft. in advance of crosswalks (MUTCD)
Utility Poles, Signs and Street Furniture

- Properly designed street corner should not obscure pedestrians
Vehicles Yielding Too Close to Crosswalk

- Vehicle should not stop so close to the crosswalk that pedestrians are screened by the vehicle
- Crashes can occur
  - If a pedestrian steps out behind yielding vehicle
  - If a vehicle trailing the yielding vehicle pulls around to pass
- Place stop line 20-50 ft. before crosswalk
- Compliance of such marking is high and reduces conflicts 76-77%

EXHIBIT V-29
Installing advance yield markings along with a sign instructing motorists to yield can reduce the chance of a pedestrian crash and also reduce the likelihood of a rear-end collision. (Photo by Michael Povinelli)
Strategy G

• Signals to alert motorists that pedestrians are coming
  – Electronic signs that indicate direction pedestrians are crossing
  – Overhead LED pedestrian signs show the driver the direction the pedestrian is crossing

EXHIBIT V-31
Electronic signs that show the direction that pedestrians are crossing is an effective way to increase driver yielding behavior. (Photo by Ron Van Houten)
Pedestrian-Activated Yellow Beacon

- Use of overhead pedestrian signs with flashing beacons are not very effective
- Reasons:
  - Yellow flashing warning beacons are not specific to pedestrians
  - Beacon timed for a slow pedestrian may mislead drivers if a screening vehicle is present

In-Pavement Lighted Markers

- At uncontrolled crossings
  - Both sides of the crosswalk are lined with embedded LEDs in RPMs
Objective III

Reduce vehicle speeds
Strategy H
Narrow the Roadway

• Reduce lane widths to 10-11 ft. (excess pavement striped for bike lane or shoulder)
• Extend sidewalks and landscaped areas
• Add parallel parking
• No evidence to justify this strategy

Strategy I
Install Traffic Calming Measures

• Serpentine street
• Chicane
• Choker
• Speed humps and speed tables
• Woonerf
EXHIBIT V-40
A chicane consists of alternatively placed curb extensions into the street which creates a horizontal shift in traffic and reduced vehicle speeds. (Photo by Dan Burden)

EXHIBIT V-41
Chokers narrow a street and force motorists to slow down. (Photo by Dan Burden)
EXHIBIT V-42
Flat-top speed humps are referred to as speed tables. (Photo by Dan Burden)

EXHIBIT V-43
A woonerf is a “living street” that is shared by pedestrians, bicyclists, and low-speed motor vehicles. (Photo by Michael Ronkin)
Strategy J
Install Traffic Calming Intersections

• Traffic calming measures reduce the volume and speed of cars through neighborhoods
  – Curb radius reduction
    • Reduces speed of turns
    • Shortens pedestrian crossing distance
    • Improves sight distance

Install Mini-Circles

• Force drivers to reduce speeds to maneuver around them
• May be useful where traffic volumes don’t warrant a signal or stop sign
Curb Extensions

- Bulb-out or neck-downs reduce effective street width
- Improve sight distance
- Demonstrate a pedestrian environment

Raised Intersection

- Intended to slow vehicles through the intersection
Modern Roundabout

- Constructed with central islands of ~50-100 ft. to control speeds
- Speeds in roundabout 15-30 mph
- Injury crashes reduced 73%
- No specific impact on pedestrian safety. Splitter island helps pedestrian safety
- ADA suit in process to require traffic signals at roundabouts
Design Element: Roundabouts

- Where practical, limit roundabouts to one-lane entrances, exits and one lane of circulatory traffic
- Limit inscribed circle to 100 ft. diameter
- Set back pedestrian crossings a minimum of 25 ft. (7.5 m) behind yield line

Design Element: Roundabouts

- Use raised splitter islands to:
  - Control wrong way movements
  - Calm traffic
  - Provide pedestrian refuge
- Design pedestrian crosswalk as a “cut through”