Pedestrian/Vulnerable User Safety and Design Implementation

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INTRODUCTION

Problem

Of all the user groups on public streets and highways, pedestrians are among the most vulnerable, particularly in terms of fatalities and serious injuries. These issues are discussed in "Safer Vulnerable Road Users: Pedestrians, Bicyclists, Motorcyclists, and Older Users" by C. Zegeer and W. Hunter. The magnitude of the problem is shown in this pedestrian fatality numbers from that paper, shown in Figures 1 and 2.

All international and US studies have determined roundabouts were found to reduce the severity and number of accidents for pedestrians.

Figure 1: Long-term pedestrian fatality trend.(Source: NHTSA, 2007).

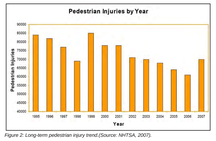

Figure 2: Long-term pedestrian injury trend.(Source: NHTSA, 2007).

U.S. Pedestrian Safety Resources

"Roundabouts in the United States," NCHRP Report 572, 2007. This report, the result of research conducted under NCHRP Project 3-65, "Applying Roundabouts in the United States," presents methods of estimating the safety and

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"The Effects of Roundabouts on Pedestrian Safety," John R. Stone, KoSok Chae, Sirisha Pillalamarri, North Carolina State University, Raleigh, 2002.

"Safety Effect of Roundabout Conversions in the United States Empirical Bayes Observational Before-After Study," Bhagwant N. Persaud, Richard A. Retting, Per E. Garder, and Dominique Lord.

"Effects on Road Safety of Converting Intersections to Roundabouts Review of Evidence from Non-U.S. Studies," Rune Elvik.

FOUNDATIONAL DESIGN ELEMENTS THAT PROMOTE PEDESTRIAN SAFETY

1) Geometrics / Minimizing Crossing Distances and Laneages

Safety benefits can be derived from limiting the number of entry and circulating lanes to the minimum necessary while still meeting acceptable operational objectives, which can vary depending on the context and project objectives. Matching capacity to demand, minimizing laneage, reducing conflict points, and simplifying decision-making all increase pedestrian safety.

One common way to better accommodate pedestrians and improve their safety is to reduce their crossing distance. Reducing crossing distance decreases a pedestrian's exposure to traffic, which may be particularly helpful to pedestrians who are disabled or elderly. It also reduces the amount of time needed for the pedestrian phase, which reduces the delay for all other vehicular and pedestrian movements at the intersection. Three common methods of reducing pedestrian crossing distance are:

- **Match Capacity to Demand**
- **Minimize Laneage = Reduce Conflict Points**
- **Simplify Decision-Making**

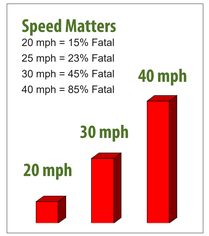
2) Safety Design Principles/ Speed Control

For many pedestrian crashes, speed is an important factor; high speeds reduce the possibility of crash avoidance, and increase the likelihood of a severe injury or fatality. Cities that have made concerted efforts to reduce pedestrian crashes use speed reduction as a primary tool. Speed reduction must be a matter of both policy (by setting lower speed limits) and design. However, simply lowering speed limits on streets where motorists can go fast is usually ineffective. Streets must be redesigned to encourage lower speeds. Engineering countermeasures to reduce speed have been analyzed for potential effectiveness by the FHWA.

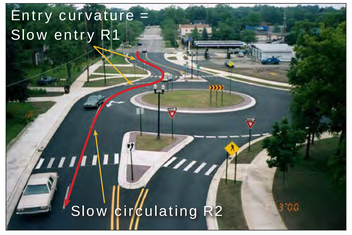
- **Fast Path Criteria**
- **Maximize Angle Between Arms**
- **Minimize Number of Arms**
- **Landscaping/Sight Distance**
- **Illumination**

https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/

Speed Matters
20 mph = 15% Fatal
25 mph = 23% Fatal
30 mph = 45% Fatal
40 mph = 85% Fatal



Average vehicular speeds at ped crossing dictated by geometry acceleration rate of 4-7 ft/sec^2 and distance to crossings - 18mph



3) Improving Driver Messaging/ Information Processing

- Optimize signing and pavement markings to provide clear and easily understood information
- Line types, weight, arrangement all important
- Minimize detection, reading and processing time
- Maximize comprehension

Redundant Information

Sign Clutter

PHB AND RRFB

Are These Appropriate for Roundabouts?

Mid-block Crossings

Signalized

PEDESTRIAN CROSSINGS

NCHRP 674 Chapter 7 – Interpretation and Application Policy Implications

- While the U.S. Access Board draft PROWAG specifies a pedestrian-actuated signal at two-lane roundabout crosswalks with pedestrian facilities, the ADA allows equivalent facilitation in all implementations of requirements. Consequently, other treatments that provide equivalent accessibility are acceptable.
- This is to allow for improvements in technology, developments in materials or research, or the implementation of new ideas and information
- It is up to the designer and/or constructing jurisdiction to provide justification for installation decisions in the case of an ADA complaint design.
- Speed control is paramount.

1) Hawk

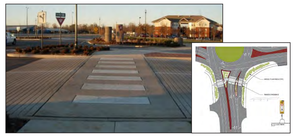
- Inconclusive results

2) RRFB

- Similar yield rates as a raised crossing

3) Raised Crossing

- Similar yield rates as RRFB



4) Wayfinding Treatment

- Pedestrian crossing with bollards

POSITIVE DRIVER GUIDANCE

Pedestrian Signage Alternatives: Traditional W11-2 vs. R1-6

The W11-2 sign placement obstructs the view of the Yield and One Way signs

Replacing the W11-2 sign with the more compact R1-6 In-Street Pedestrian Crossing sign is a solution to the problem

Problem

We have concerns with the application of standard (W11-2) pedestrian signage. Given the proximity of the pedestrian signage to other important signage, there is potential for view obstruction. In particular, the close spacing of W11-2 Pedestrian signs and Yield signs at roundabout entrances reduces the view of Yield signs.

Alternative Solution

We have worked with agencies (with concurrence from FHWA-MUTCD office) to implement the Pedestrian Crossing sign R1-6 to replace the W11-2, to improve overall messaging. The R1-6 pedestrian sign is located closer to the driver eye level, increasing driver awareness and visibility of the Yield and other important signing. Additionally, the height variability improves visibility to all signs.

Based on our research into pedestrian signing we found that the R1-6 style Ped sign was developed to improve target values for the ped signing for use in lower speed contexts, since the standard W11-2 with its higher mounting height (forcing drivers to look up when we want them focused on the roadway in front of them) was not achieving the desired objectives of informing drivers of the pedestrian crossings.

CASE STUDY: 66th and Portland Aves,. Richfield, MN

Summary

As part of a comprehensive safety optimization, a number of signing and marking changes were made that included:

- Replacing the W11-2 standard "pedestrian crosswalk warning" sign with the R1-6 "yield to pedestrians in crosswalk" sign, with a lowered placement height (to driver eye level), making this and all signs clearer and more visible to drivers.

Results:

- **30% improved vehicular yielding rates to pedestrians**
- **84% reduction in lane-discipline issues (left turn from outside lane).**
- **20% reduction in lane changes at entrance and exits.**

Summary of Yield Rates

	Pre	Post
Condition	**2010**	**2012**
General Yield rate	**39.18%**	**67.29%**
Average # of cars not yielding	2.22	1.6
Ave # of peds when yield	1.4	1.38
Ave # of peds when not yield	1.2	1.18
From Island, yield rate	45.45%	64.87%
From Sidewalk, yield rate	31.86%	70.59%
From Entrance, yield rate	51.84%	77.64%
From Exit, yield rate	23.39%	56.54%
Car on near lane, yield rate		72.83%
Car on far lane, yield rate		60.55%

Source: John Hourdos

BEFORE → **AFTER**

Driver confusion due to signing and markings

Sign clutter

Photo: City of Richfield, MN

Improved driver comprehension via signing and pavement marking changes

Improved visibility

Photo: City of Richfield, MN

Pedestrian yield rates/data by John Hourdos, Research Associate Professor, University of MN / Director, Minnesota Traffic Observatory.

Source: Hourdos, J. Effect of Signing and Lane Markings on the Safety of a Two-Lane Roundabout: Research Project Final Report 2014-04, Minnesota Dept. of Transportation, Research Services & Library, St. Paul, Minnesota, 2014.