

Pedestrian Safety and Accessibility Considerations at Modern Roundabouts

Presented by:

Dr. Bastian Schroeder

Institute for Transportation Research and
Education (ITRE) at North Carolina State
University

Dr. Hillary Isebrands

Safety and Design Technical Service Team,
FHWA Resource Center

March 7, 2012



FHWA Office Of Safety Proven Safety Countermeasures

<http://safety.fhwa.dot.gov/provencountermeasures/>

1. Roundabouts (Intersection)
2. Corridor Access Management (Intersection)
3. Backplates with Retroreflective Borders (Intersection)

4. “Road Diet” (Pedestrian and Intersection)
5. Pedestrian Hybrid Beacon (Pedestrian and Intersection)
6. Medians and Pedestrian Crossing Islands in Urban and Suburban Areas (Pedestrian)

7. Longitudinal Rumble Strips and Stripes on 2-Lane Roads (Roadway Departure)
8. Enhanced Delineation and Friction for Horizontal Curves (Roadway Departure)
9. Safety Edge_{SM} (Roadway Departure)

Today's presentation

- ⇒ Introduction and housekeeping
- ⇒ *Audio issues? Dial into the phone line instead of using "mic & speakers"*
- ⇒ PBIC Trainings
<http://www.walkinginfo.org/training>
- ⇒ Registration and Archives at
<http://www.walkinginfo.org/webinars>
- ⇒ Questions at the end
- ⇒ Follow-up E-mail with certificate of attendance for 1.5 hours of instruction



Pedestrian Safety and Accessibility Considerations at Modern Roundabouts

Bastian Schroeder, Ph.D.

March 7, 2012

FHWA/PBIC Webinar

Outline

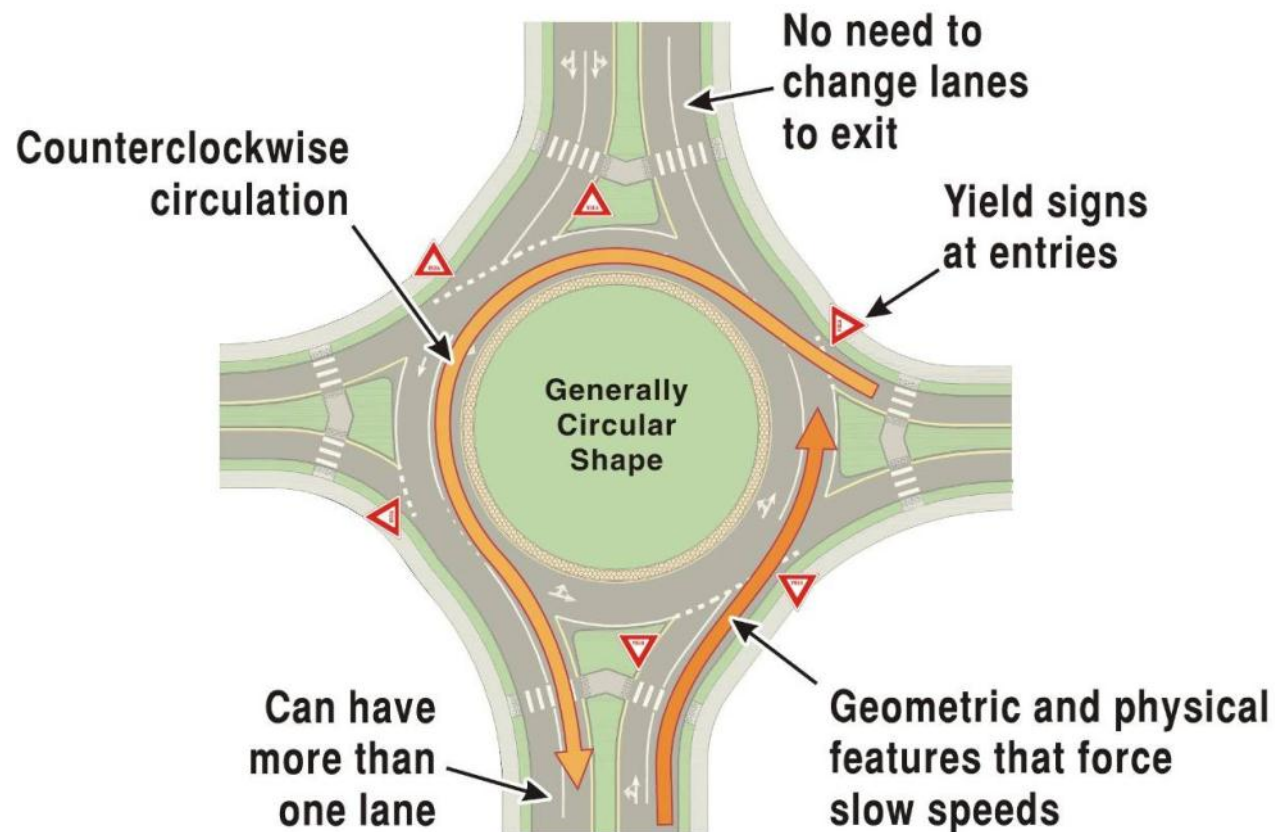


-
- Roundabout Accessibility Challenges
 - US Access Board Position
 - NCHRP Report 674 Overview
 - Other Accessibility Research
 - Conclusion

Key Roundabout Characteristics



- Circular shape, yield control on entry, and geometric features that create a low-speed environment



Other Round Intersections



(Large) Traffic Circle, Pinehurst, NC



Traffic-Calming Circle, Austin, TX

Roundabout Accessibility Challenges



- **The crossing task for blind pedestrians**

- Finding the crosswalk
- Aligning to cross
- **Deciding when it is safe to cross**
- Maintaining alignment during crossing

- **Confounding challenges**

- Uninterrupted flow (no signal)
- Potentially high speeds
- Ambient noise at crosswalk
- Non-straight geometry
- Low driver yield compliance

- **Treatments available**



US Access Board Position



- Proposed Guidelines for Public Rights-of-Way
 - Pedestrian crossing easily located for wayfinding
 - Signalization Requirement for Two-Lane Approaches
 - <http://www.access-board.gov/prowac/>



Roundabouts without Pedestrian Facilities



US23, Livingston County, MI

I-17 Phoenix, AZ

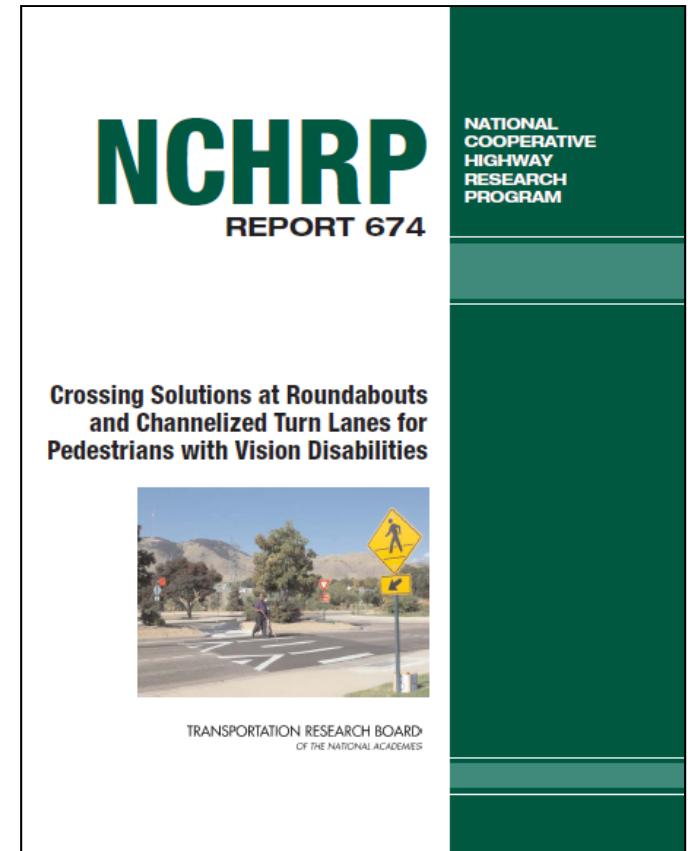


Kansas 68, Miami County, KS

NCHRP Report 674



1. Introduction
2. Synthesis of Literature
3. Methodology
4. Analysis Framework
5. Results
 - Performance Measures
 - Participant Feedback
6. Study Extensions
 - Mixed-Priority Delay Models
 - Simulation Approach
7. Interpretation and Application
8. Detailed Appendices



Overview



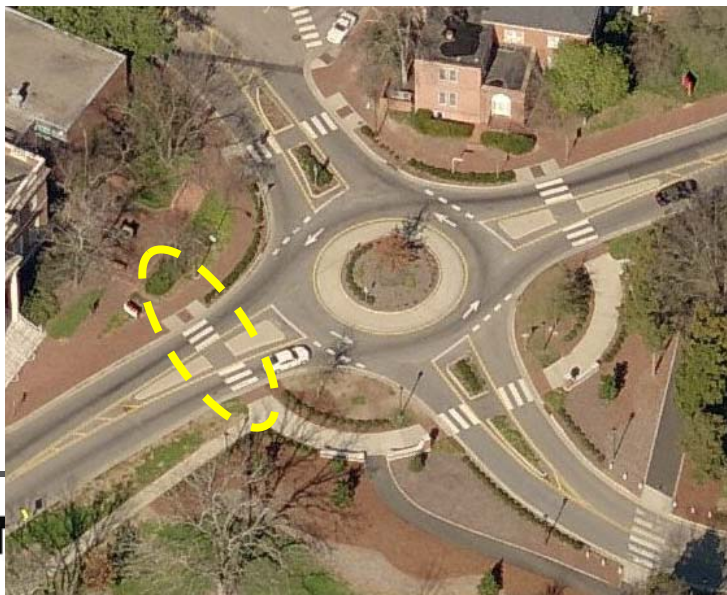
- NCHRP Report 674
 - ... establishes common “language” and performance measures for ongoing accessibility debate
 - ... contains field data for twelve studies at five intersections, 56 blind participants, and 3,300 crossing attempts
 - ... presents an initial assessment of new crossing treatments, particularly for two-lane roundabouts
 - ... provides ways to extend the research results through statistical modeling and simulation
 - ... establishes a baseline for future research in this area to assure compatibility of results.
- The report does not give warrants or requirements for treatment installation

NCHRP 674 Study Results



- Channelized Turn Lane
 - Two approaches pre and post treatments
 - Sound Strips with and without flashing beacon
- Single-Lane Roundabout
 - Three sites – no treatments tested
 - Two in pre condition only
 - One pre and post without treatment
- Two-Lane Roundabout
 - Two approaches pre and post treatments
 - Pedestrian Hybrid Signal or HAWK
 - Raised Crosswalk

Evaluation of Single-Lane RBTs.



- Three sites tested
- Three different cities
- No treatments installed
- Varying geometries
- Range of volumes
- Different participants and driving culture

Single-Lane RBT Results



- Tested **Single-Lane Roundabouts** appear to not pose unreasonable crossing difficulties to most blind travelers, provided that
 - Speeds are low through good roundabout design
 - Drivers are courteous and yield the right-of-way
 - Appropriate detectable warnings are installed
 - Blind travelers received O&M instruction specific to roundabout crossings
- Some participants did have difficulties
 - One site had high intervention rate (3.9%)
 - Another site had high delay (85th percentile delay 35.4 seconds per lane)

Two-Lane Roundabout Golden Rd. @ Johnson Rd., Golden, CO



<http://www.itre.ncsu.edu>

Raised Crosswalk



Pedestrian Hybrid Beacon (HAWK Signal)

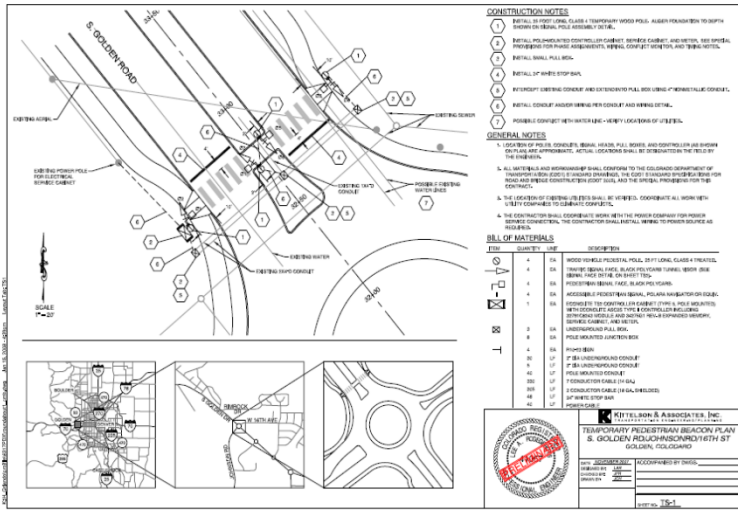
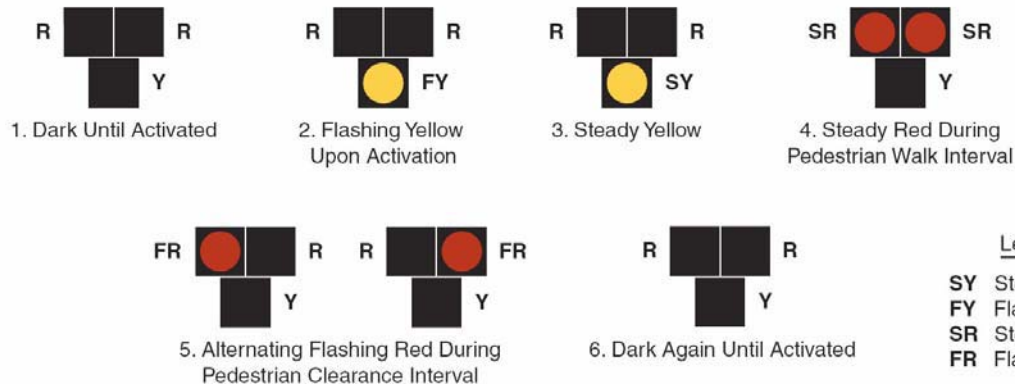


Figure 4F-3. Sequence for a Pedestrian Hybrid Signal



Two-Lane Roundabout Results



- Raised Crosswalk
 - Average delay decreased (17 sec to 8 sec)
 - 85th percentile delay decreased (30 sec to 13 sec)
 - O&M interventions decreased (2.8% to 0%)
 - ... but some “risky” events observed

- Pedestrian Hybrid Beacon
 - Average delay decreased (16 sec to 6 sec)
 - 85th percentile delay decreased (30 sec to 8 sec)
 - O&M interventions decrease (2.4% to 0%)
 - **...but high vehicle red-light violations (12.6%)**

Two-Lane RBT Findings



- **Two-lane roundabouts** are challenging without additional treatments
 - Speed and volumes are higher
 - Multiple-threat situations are biggest risk
 - Treatments proved effective in reducing speeds, increasing yields, and creating crossing opportunities
 - Treatments reduced delay and interventions (risk)
 - Raised crosswalk exhibited more multiple threat and (perceived) risk than PHB
 - PHB had concerning rate of vehicle red-light violations

Oakland County, Michigan Study



- Oakland County, Michigan
 - Two 2x3 lane roundabouts
 - Rectangular Rapid-Flashing Beacons (RRFB)
 - Pedestrian Hybrid Beacons (PHB)



<http://www.rcocweb.org/Lists/Publications/Attachments/127/>

PHB Installation in Oakland County, MI



RRFB Installation in Oakland County, MI



Oakland County Results



Pedestrian Hybrid Beacon	Condition	Two-Lane	Three-Lane
Interventions (%)	Pretest	6.4%	11.4%
	Posttest	0.9%	0.4%
Average Delay (sec.)	Pretest	17.1	21.2
	Posttest	11.3	12.9

Rectangular Rapid-Flash Beacon	Condition	Two-Lane (Entry/Exit)	Three-Lane (Entry/Exit)
<i>Estimated</i> Interventions (%)	Pretest	7.5% / 23.8%	12.5% / 23.2%
	Posttest	0.0% / 16.4%	7.6% / 18.9%
Average Delay (sec.)	Pretest	20.8 / 22.2	35.2 / 30.5
	Posttest	17.1 / 18.8	19.8 / 24.8

Ongoing Research Efforts



- FHWA Evaluation of RRFBs at Multi-Lane RBTs
 - Investigate eight RRFB approaches
 - Explore alternatives to PHB and Signalization
 - Expected Completion in 2014
 - Data collection at OR/WA sites in May 2012
 - Additional sites needed

- ITE Accessible Roundabouts Task Force

Closing Thoughts



- Access Board Notice of Proposed Rulemaking (NPR) received extensive comments, which are being reviewed
- Treatment alternatives (non-signalized) need more research to solidify results
- Capitalizing on momentum of national accessibility debate and existing treatment installations
- More research is forthcoming and should emphasize compatibility with the 674 framework
- *FHWA is looking for municipalities willing to assist with RRFB accessibility evaluation.*

Pullen-Stinson Roundabout, Raleigh, NC with one-lane crossings, low speeds, and landscaping strip (need DWs)



Credit:www.skysiteaerial.com

Two-lane roundabout in Gatineau, Canada with *zig-zag* signalized crossing and landscaping that guides to crosswalk (need DWs)




Multi-Lane Roundabout in Bad Aibling, Germany with ped./bike underpass and *distal* crosswalks (need DWs)



ITRE Website Resources



NC STATE UNIVERSITY [FIND PEOPLE](#) | [LIBRARIES](#) | [MYPACK PORTAL](#) | [CAMPUS MAP](#)

 **ITRE**
Institute for Transportation Research and Education
at North Carolina State University

**Exploring and advancing transportation systems
through research, education and technical assistance.**

[About ITRE](#)
[Contact Us](#)
[Location and Directions](#)
[Site Index](#)
[Search ITRE](#)
[Staff Directory](#)

[ITRE Home](#) [Research](#) [Training & Education](#) [Technical Assistance](#) [Centers & Programs](#) [News & Events](#)

Research

[ITRE Home](#) » [Research](#) » [Blind Pedestrians Access to Roundabouts](#)

Blind Pedestrians Access to Roundabouts and Other Complex Intersections

The Institute for Transportation Research and Education (ITRE) is centrally involved in research addressing questions and concerns of pedestrian accessibility to roundabouts and complex intersections. The focus of this ITRE research branch is on **accessibility concerns at modern roundabouts and signalized intersections with channelized right turn lanes**. Both types of facilities pose challenges to pedestrians who are blind, including:

- Presence of free-flowing traffic (typically) not controlled by a signal
- Elevated levels of background noise generated by other movements at the intersection
- Curved vehicle trajectories that make it difficult to discern traffic patterns
- Lack of reliably auditory cues that can be used to identify crossing opportunities
- Mixed-priority crossing challenges, where pedestrians can cross either in a large gap between vehicles, or in front of a stopped (yielding vehicle)
- Unreliable driver behavior, where only some proportion of traffic yields to pedestrians
- Inconsistent use of wayfinding cues that can help the pedestrian to find the intended crossing location

Additional Information

- » [Research Roadmap](#) (PDF:128KB)
- » [Publications and Presentations](#)
- » [Press Releases](#)
 - > [ITRE Research Improving Safety for Sight-Impaired Pedestrians](#) (PDF: 214KB)
 - > [ITRE's Roundabout Research Presented at National Conference](#) (PDF:45KB)



<http://www.itre.ncsu.edu/ITRE/research/Pedestrian-Accessibility/index.html>

Thank You for Your Time!



Bastian J. Schroeder

+1-919.515.8565

Bastian_Schroeder@ncsu.edu

Institute of Transportation Research & Education (ITRE)
North Carolina State University, Centennial Campus, Box 8601
Raleigh, NC 27695-8601, Fax: (919) 515-8898



<http://www.itre.ncsu.edu>

Pedestrian Safety and Accessibility Considerations at Modern Roundabouts

Roundabouts: Slow and Safe

Presented by:

Hillary Isebrands, PE, PhD
FHWA Resource Center Safety Design Engineer

March 7, 2012

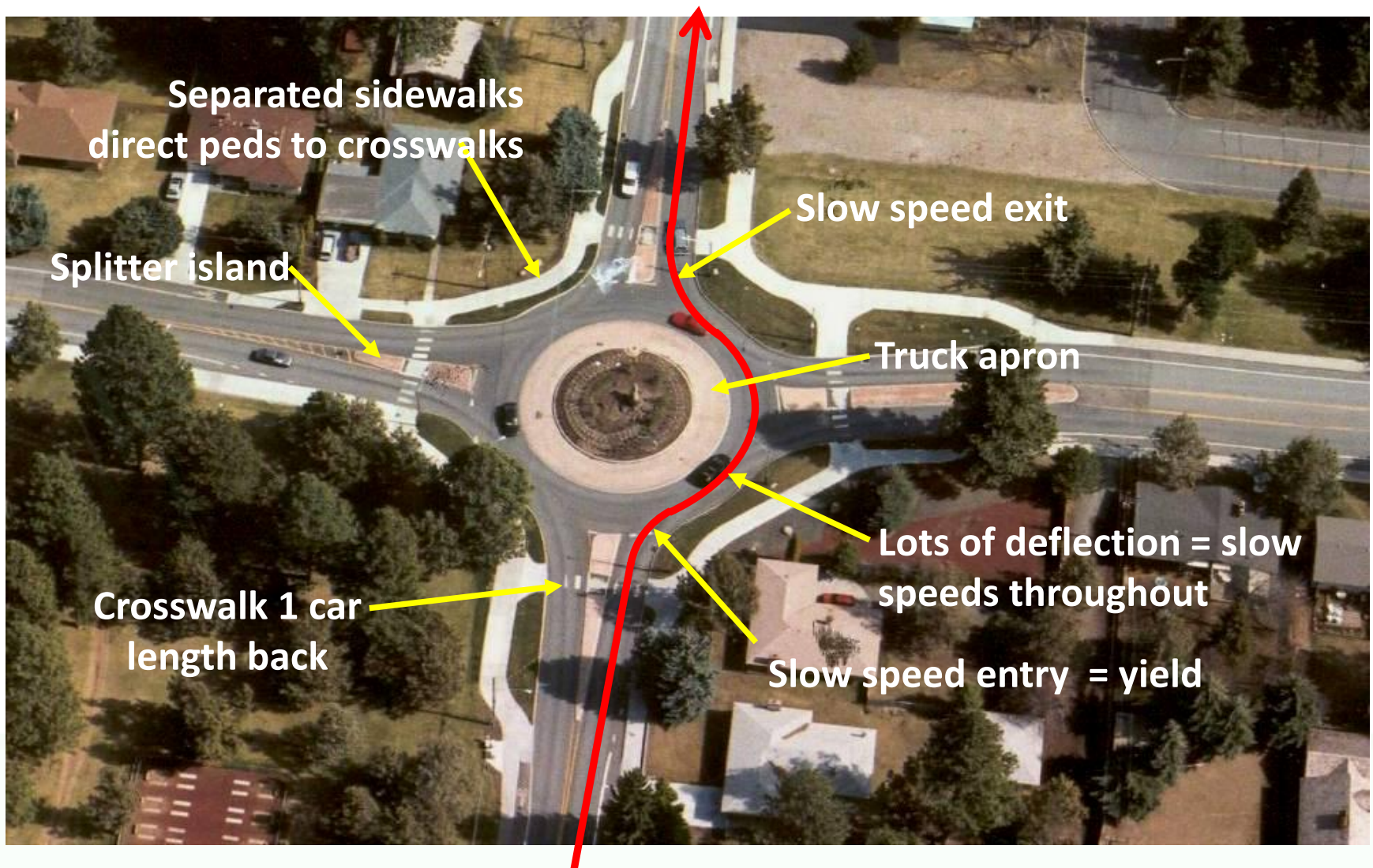


Roundabout Safety: Learning Objectives

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

- ⇒ Describe the roundabout features that contribute to safety
- ⇒ Describe the safety benefits for pedestrians and motor vehicles at roundabouts
- ⇒ Identify the FHWA initiatives supporting roundabout implementation

Essential roundabout characteristics



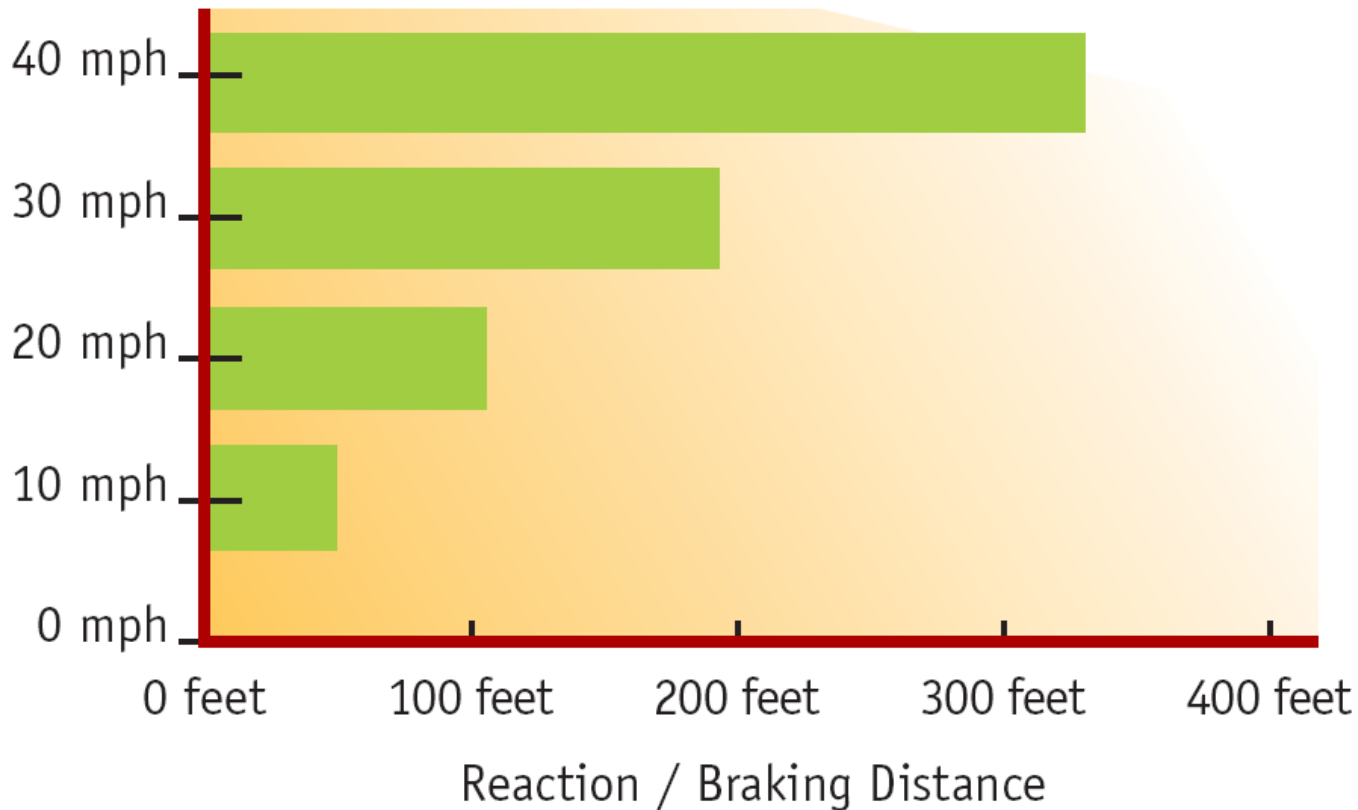
Why are Roundabouts SAFE for Pedestrians?

- ⇒ Slower speeds for all motorists
- ⇒ Shorter crossing distances – Reduced exposure
- ⇒ Reduced conflict points
- ⇒ Only crossing one direction of travel at a time
- ⇒ Refuge (splitter) island



Photo credits: Isebrands

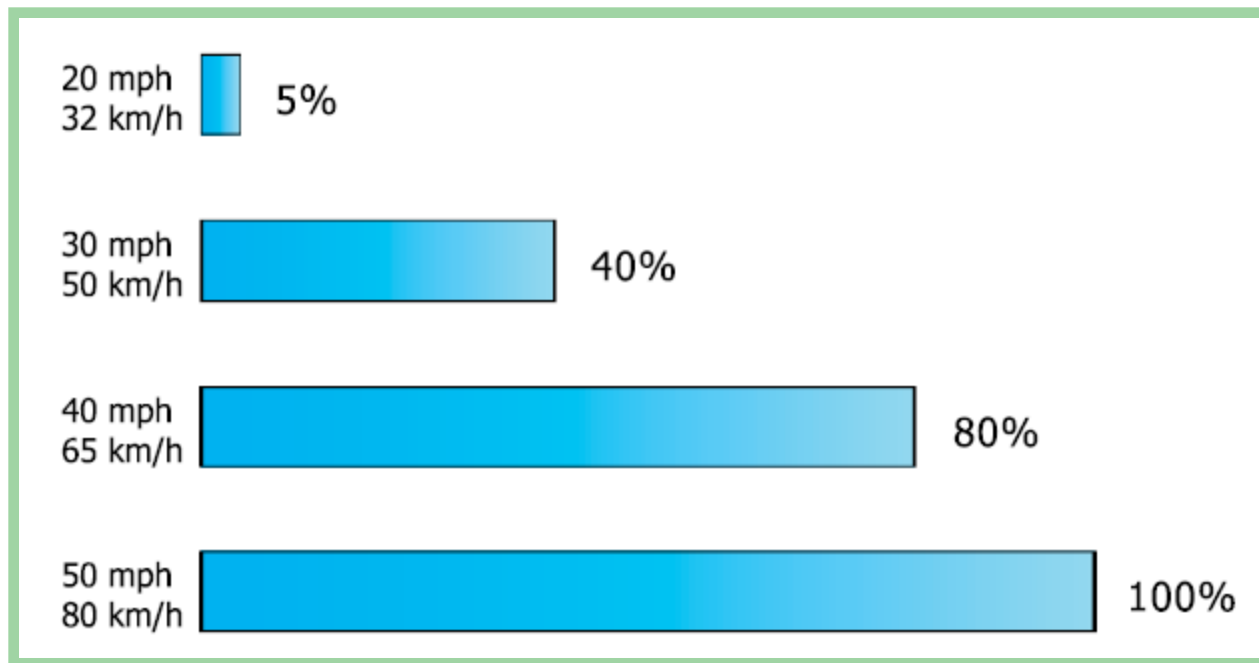
Speed Affects Crash Avoidance



High speeds equate to greater reaction and stopping distance

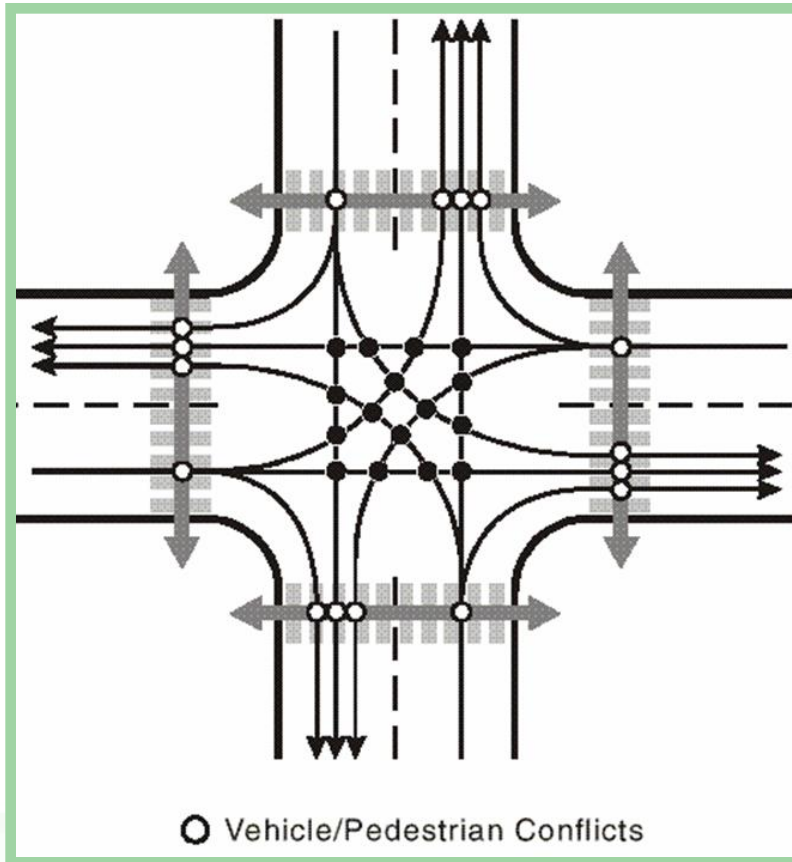
Speed Affects Crash Severity

Chance of death if Pedestrian Hit by a Motor Vehicle

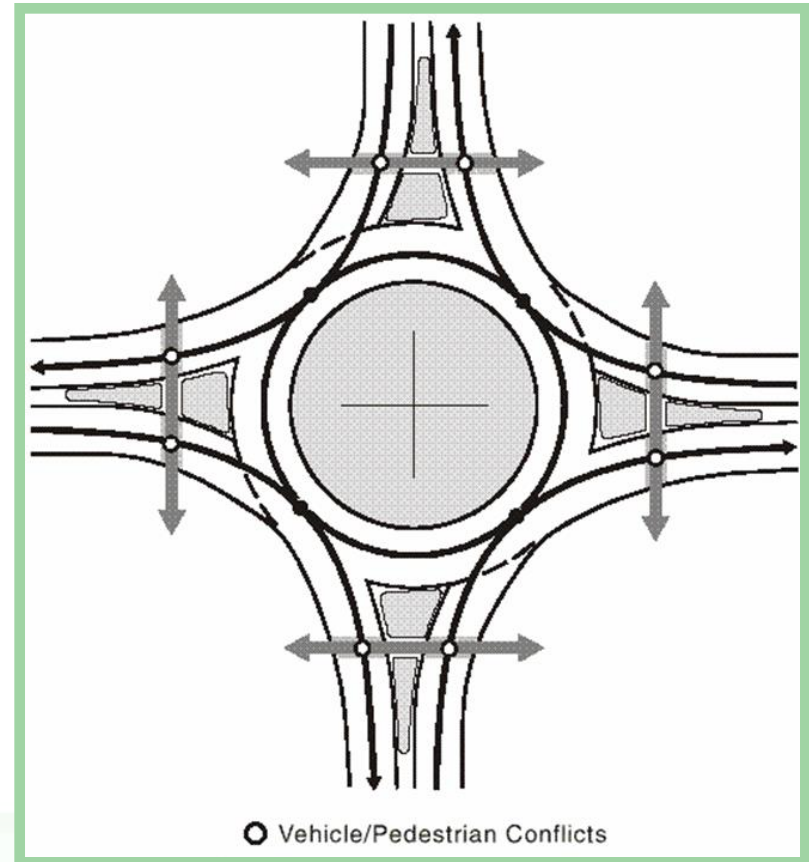


Source: NHTSA 1999

Vehicle-Pedestrian Conflicts at Intersections



16 Conflicts



8 Conflicts

Pedestrian Crash Data

⇒ US Data

- Limited Data
- 5 Reported Crashes at 39 Roundabouts (on 139 legs) over an average crash history of 3.8 years (NCHRP 572 – 2007)

⇒ International Data

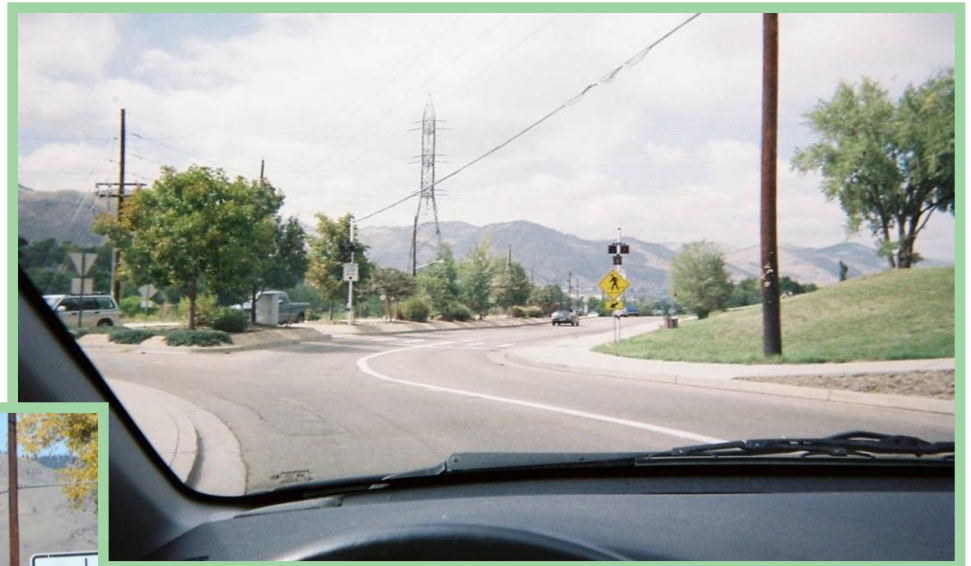
- UK - 0.33 Crashes/Million Trips @ roundabouts vs. 0.67 Crashes/Million Trips @ Signals (1984)
- Dutch Study - 73% Reduction in all pedestrian crashes and 89% reduction in pedestrian injury crashes (1993)



Photo Source: Ken Sides

Good Design is Paramount

- ⇒ Location of Crosswalks
- ⇒ Speeds of Vehicles
- ⇒ Sight Distance
- ⇒ Visibility of Crosswalks



NCHRP 672 – Roundabouts: An Informational Guide, Second Edition

- ⇒ **Sidewalks should be set back from the edge of the circulatory roadway (assists with wayfinding)**
- ⇒ **Recommended sidewalk width of 6ft (10ft if shared with bicyclists)**
- ⇒ **A typical and minimum crosswalk setback is 20 ft from the yield line**
- ⇒ **Raised crosswalks can encourage slow vehicle speeds where pedestrians cross**

Asheville, NC – College Street



Photo Credits: City of Asheville, NC & Anthony Butzek



Asheville, NC – College Street



Brown County, WI School Campus

Bicycles at School



Recently, Lineville Intermediate School (formerly Bay View) has been in the news regarding our policy for riding bicycles to school. Officially, we have strongly discouraged our students from riding bicycles to school and recently have not allowed bicycles ridden to school to be kept on school property. Our issue has always been the safety of our students. The Brown County Sheriff's Department had previously designated all of the roads leading to Lineville School as hazardous to pedestrians, and therefore, we have bussed all of our students to school.

The Sheriff's Department has now lifted the "hazardous road" designation for Cardinal Lane from the Mountain Bay Bike Trail north to Lineville Road due to road improvements for that section of the road. In addition, the Sheriff's Department indicated that a crossing guard must be located at the intersection of Cardinal Lane and Lineville Road for students to move through that intersection. The Village of Howard has secured a crossing guard for the roundabout corner of Lineville and Cardinal. The crossing guard will be present during the following times on school days: 7:00 a.m. until 7:30 a.m. and 2:30 p.m. until 3:00 p.m. Therefore, we will allow students to commute on the designated "safe" road to ride bicycles to school and park them on school property.

Our dilemma is that some of our students may want to bike to school on roads that are narrow and have no bike lanes. We continue to discourage those students from riding bicycles to school. However, our policy will be to let that remain a parental decision. The improvements to Lineville Road have slowed traffic in front of school, and the bicycle lanes on Cardinal Lane have helped to ease some of our safety considerations with students biking to school. Now that the Village of Howard has begun crossing guard service at the Cardinal-Lineville roundabout, we will allow students to park bicycles on

South Golden Road - Golden, Colorado

Photo Source: City of Golden

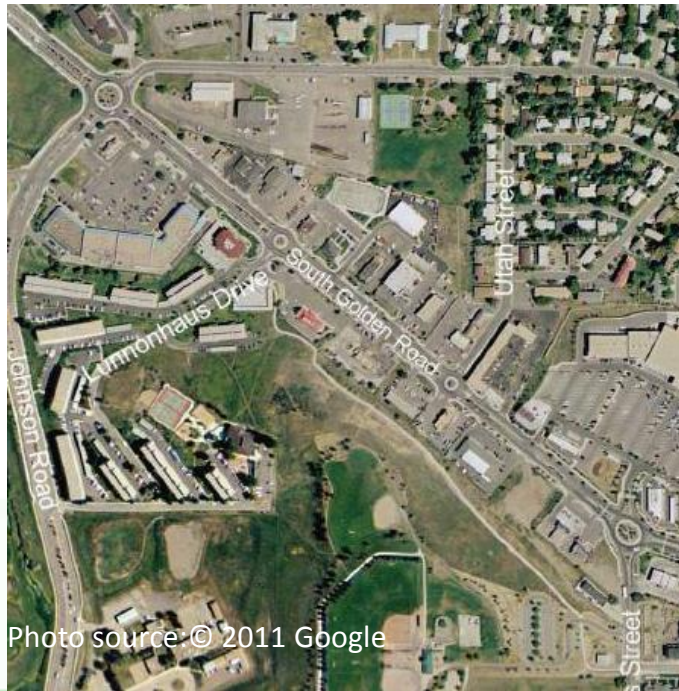


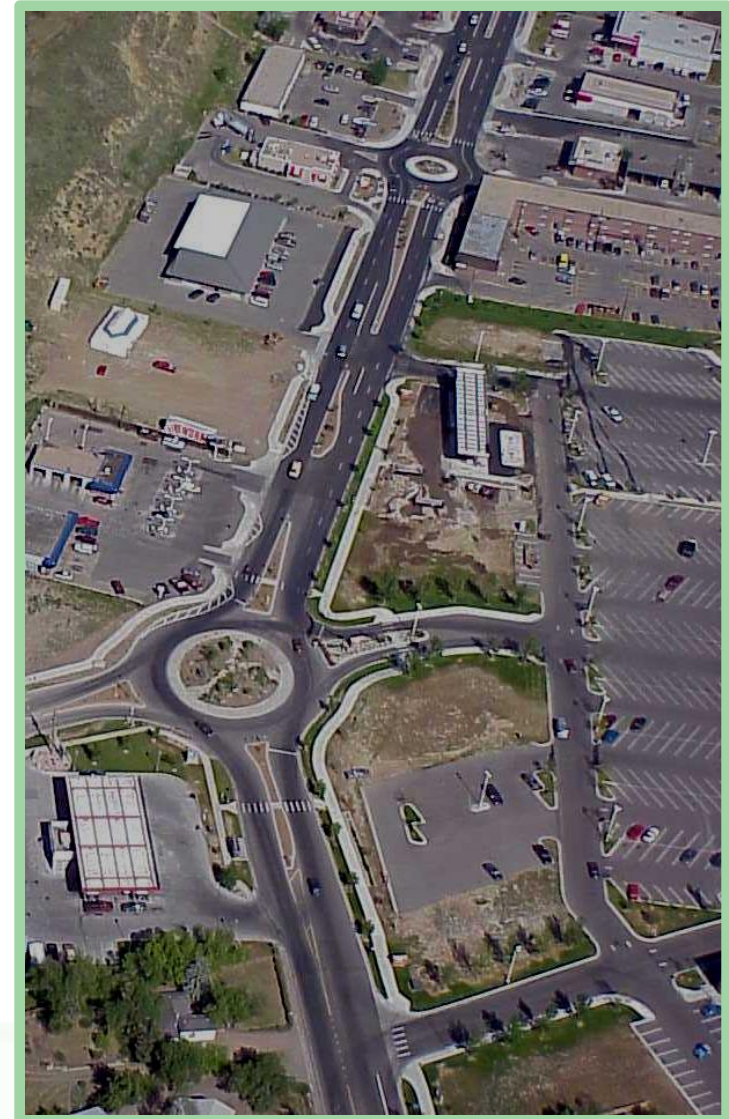
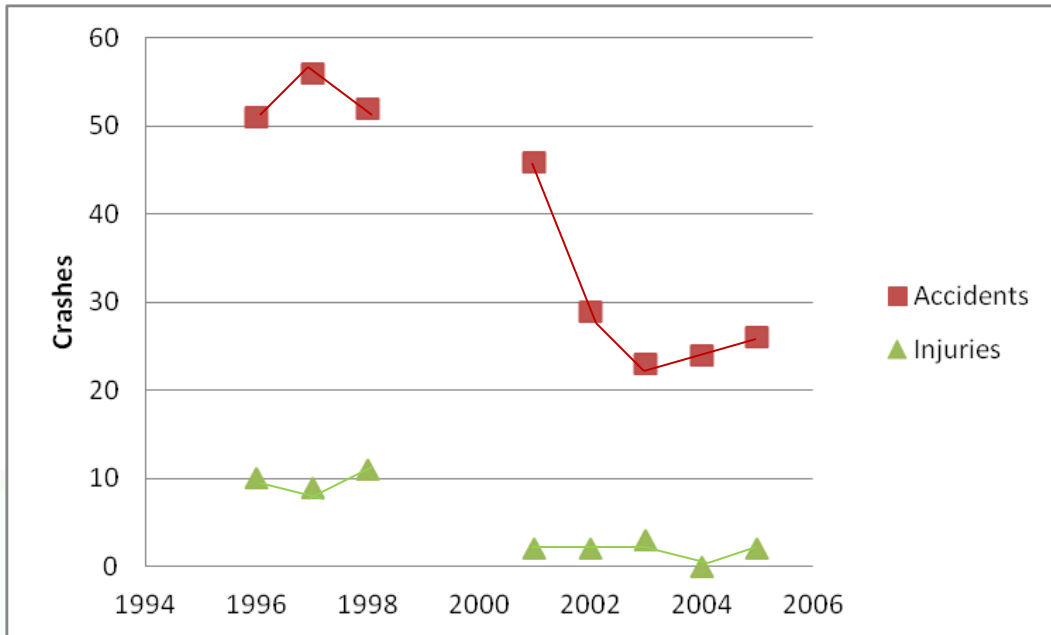
Photo source: © 2011 Google



Photo Source: Isebrands

Safety Statistics

BEFORE	85 th Percentile Speeds	AFTER
47 mph		33 mph
53 (3 yrs)	Total Crashes/Yr (Ave)	30 (5 yrs)
10 (3 yrs)	Injury Crashes/Yr (Ave)	1.8 (5 yrs)



Arlington, TX – Rangers Stadium

Nolan Ryan Expy./Road to Six Flags



2012 FHWA Proven Safety Countermeasures

Proven Safety Countermeasures Web Site



Scan the code at right
to go directly to the
Web site!

The **NEW** Proven Safety Countermeasures Web site is now available!

This Web site will be your one-stop shop for information on the **latest** FHWA-recommended set of research-proven safety countermeasures and FHWA **guidance** on countermeasure considerations. The updated list of proven countermeasures was developed based on recent safety research to address **intersection, roadway departure, and pedestrian** issues wherever they may occur.

Many of these countermeasures are low-cost solutions, and FHWA encourages its partners to consider implementing these countermeasures broadly, as appropriate, to reap the benefits of using solutions that are known to save lives.

UPDATED! FHWA-Recommended and Proven Countermeasures:



Roundabouts



Medians and Pedestrian
Crossing Islands in Urban and
Suburban Areas



Longitudinal Rumble Strips and
Stripes On Two-Lane Roads



"Road Diet"
(Roadway Reconfiguration)



Corridor Access Management



Safety EdgeSM



Pedestrian Hybrid Beacon



Backplates with Retroreflective
Borders



Enhanced Delineation and
Friction for Horizontal Curves



U.S. Department of Transportation
Federal Highway Administration

LEARN MORE TODAY!

<http://safety.fhwa.dot.gov/provencountermeasures>



Roundabout Education

⇒ Internally & Externally



U.S. Department of Transportation
Federal Highway Administration

Contact Us | Instructions & Help | Related Pages

Welcome to the FHWA Office of Safety's

Roundabout Outreach and Education Toolbox

This Toolbox is designed to be a highly useable, online reference that connects transportation professionals with outreach resources from across the country to help them obtain public support for roundabouts. It includes:

- ✓ Case studies of outreach success stories
- ✓ Outreach implementation guidance
- ✓ Products including presentations, videos and brochures

Simply use the form to the right to search or browse the Toolbox to find the resources you need.



Help Grow the Toolbox!

Have a public outreach success story with roundabouts? Share it with others by submitting your case study, outreach strategy, or related products/media. We'll add it to the Toolbox!
[Contact Us »](#)

Search the Toolbox

OR

Browse by Attribute

Select one or more browse options below to narrow your results.

Outreach Strategy Select one...	Outreach Product Type Select one...
Roundabout Complexity Select one...	Roundabout Setting Select one...
Implementation Stage Select one...	Geographic Region Select one...
Target Audience Select one...	State Select one...

Roundabouts Peer to Peer (P2P) Program



- ⇒ Accelerate the rate of roundabouts implementation across the U.S.
- ⇒ Facilitate timely access to key, peer-based expertise
- ⇒ Create and foster relationships within the roundabouts community



Program Access & Contacts



⇒ RoundaboutsP2P@dot.gov or
(866) P2P-FHWA [727-3492]

⇒ Program Website

<http://safety.fhwa.dot.gov/intersection/roundabouts/P2P>

Roundabouts Peer Assistance

Accelerating Roundabout Implementation in the United States

- ⇒ **Effectiveness of Rectangular Rapid Flashing Beacon (RRFB) Treatments at Multilane Pedestrian Crossings at Roundabouts**
- ⇒ **Operational Analysis: Reassessment of and Guidance on Roundabout Capacity Analysis Procedures**
- ⇒ **Assessment of the Environmental Characteristics of Roundabouts**
- ⇒ **Forensic Analysis and Investigation of Severe Crashes at Roundabouts**

Roundabout Safety: Learning Objectives

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

- ⇒ Describe the roundabout features that contribute to safety
- ⇒ Describe the safety benefits for pedestrians and motor vehicles at roundabouts
- ⇒ Identify the FHWA initiatives supporting roundabout implementation

Contact Information

Hillary Isebrands, PE, PhD

Highway Safety Engineer

FHWA Resource Center Safety and Design

Technical Service Team

Lakewood, CO

720-963-3222

hillary.isebrands@dot.gov

Questions and Discussion

Thank you!

- ⇒ Archive at <http://www.walkinginfo.org/webinars>
 - Downloadable and streaming recording, transcript, presentation slides
- ⇒ Questions?
 - Email webinars@hsrc.unc.edu