High Speed Approaches At Roundabouts

RTE

Roundabouts & Traffic Engineering

www.roundabouts.us

INTRODUCTION

- Mobility & Growth = High Speed Roadways with Increasing Congestion & Crossroads
- Stop/Go/Slow-down/Speed-up/Stop/Go
- Enforced Pauses to Flow Unnecessary
- Slow All Traffic = Faster Travel Times
- Threat of Fast Vehicles on HSA is Eliminated
- Benefits of Slowing All vs. Stopping Phases
- Solution: Modern Roundabout Coupled with Good Geometric Design & Adequate Mitigation Measures for High Speeds
- Self Regulating Device – User Controlled
- Roadway Harmony, Multi-functional

PURPOSE

- More Roundabouts Are Being Proposed & Designed on High Speed Roadways
- The Question Continually Asked Is: "Are Roundabouts Appropriate on High Speed Roadways?" (North America)
- Most Other Countries Worldwide Prefer Roundabouts on High Speed Roadways, But What About North America?
- Hence, RTE Was Asked to Produce In-Country Results For Several Roundabouts Proposed on High Speed Roadways
- This Presentation Provides Brief Highlights of the *High Speed Approaches At Roundabouts* Publication

High Speed Approaches At Roundabouts: Report Objectives

- **Objective 1:** Evaluate *Perceived* Concern of High Speed Approaches at Roundabouts
- **Objective 2:** Present Safety Statistics & Data of Roundabouts Worldwide with High Speed Approaches (H.S.A.)
- **Objective 3:** Conduct Case Studies of Existing Roundabouts in N.America w/ H.S.A.
- **Objective 4:** Demonstrate Geometric Design Treatments Currently Used for High Speed Conditions
- **Objective 5:** Recommend Additional Design Treatments for H.S.A. at Roundabouts

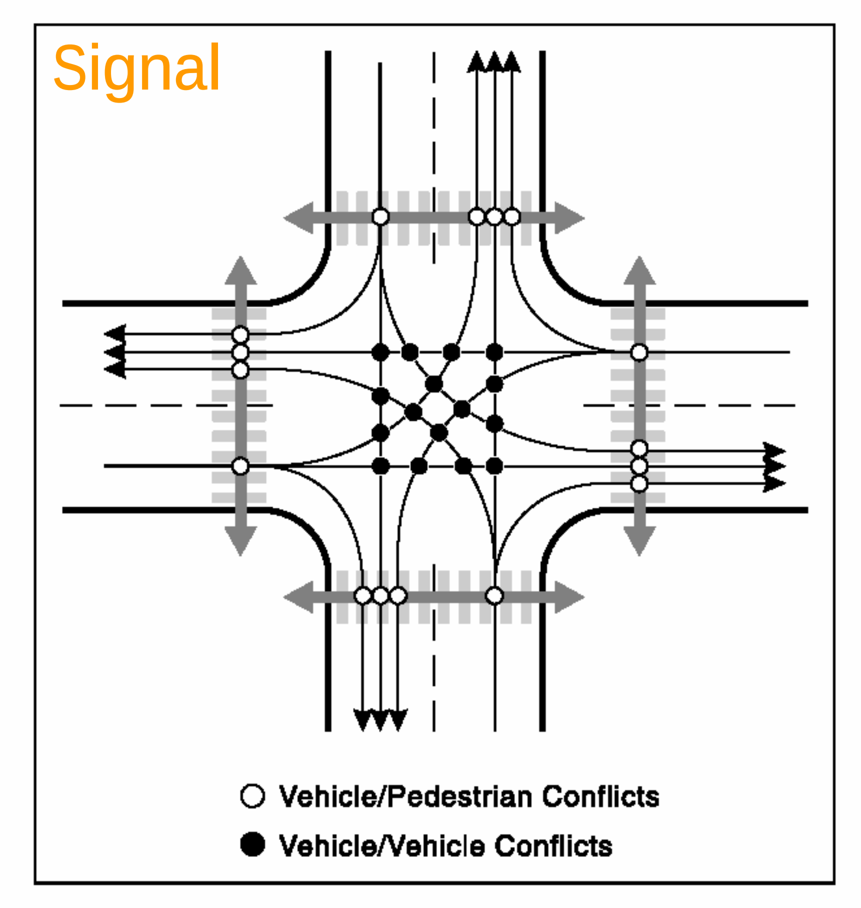
High Speed Approach Data

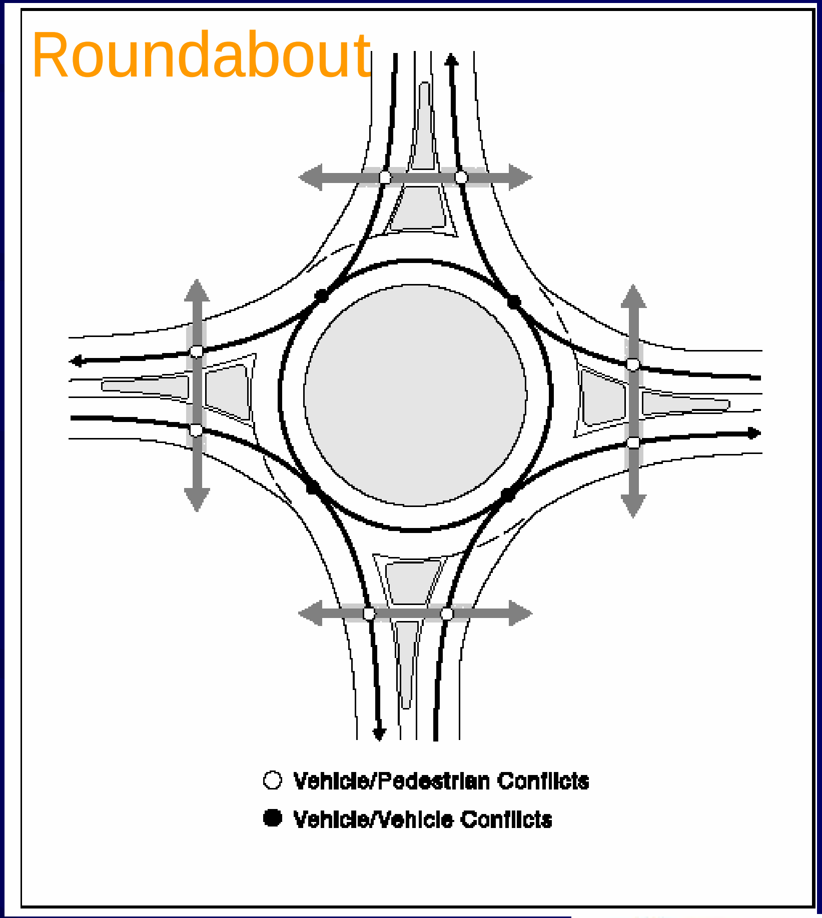
- Very Few of These Type Studies Exist in U.S.
- RTE & ORE Sought Worldwide Resources
- Safety Data Research (TRL, MSHA, WSDOT, IIHS, FHWA, ITE, QDMR, Design Specialists)
- Comparative Before/After Data at Roundabouts Converted from Signals
- High Speed Case Studies with Before & After Crash and/or Speed Data
- High Speed Geometric Design Treatments
- High Speed Non-Geometric Treatments

Average Safety Statistics Summary From Multiple Data Sources

- 40% Reduction in All Crash Types Combined / PDO
- 80% Reduction in Injury Accidents
- 90% Reduction in Fatalities
- 30% Reduction for Pedestrian and Bicycles
- Up to a 75% Reduction in Delay
- ***Results Consistent With International Studies***

Why Are Roundabouts Safer Intersections?

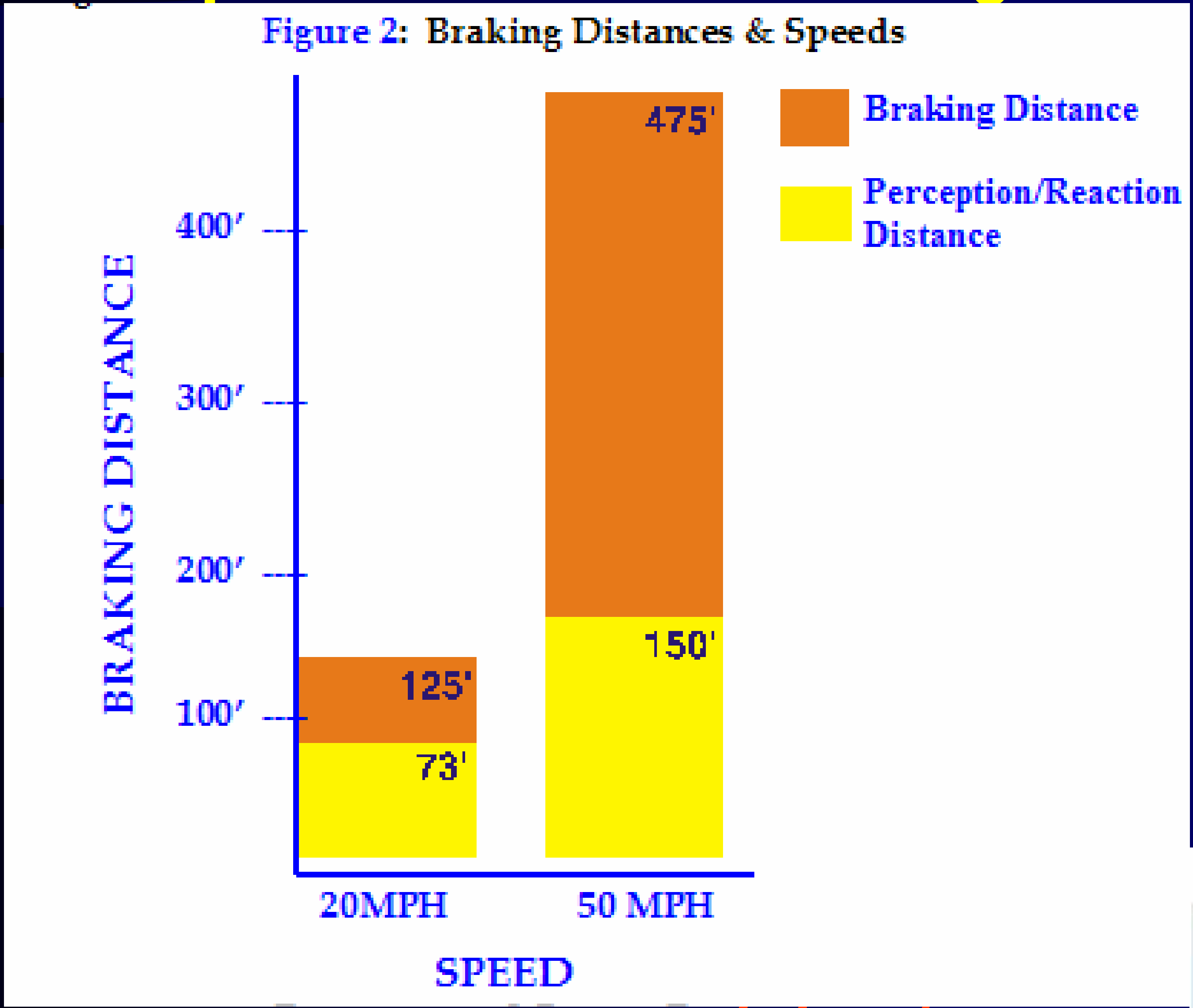




Vehicle & Pedestrian Safety

Why are Roundabouts Safer?

Lower Speeds = Shorter Braking Distance



Scott Ritchie, P.E.

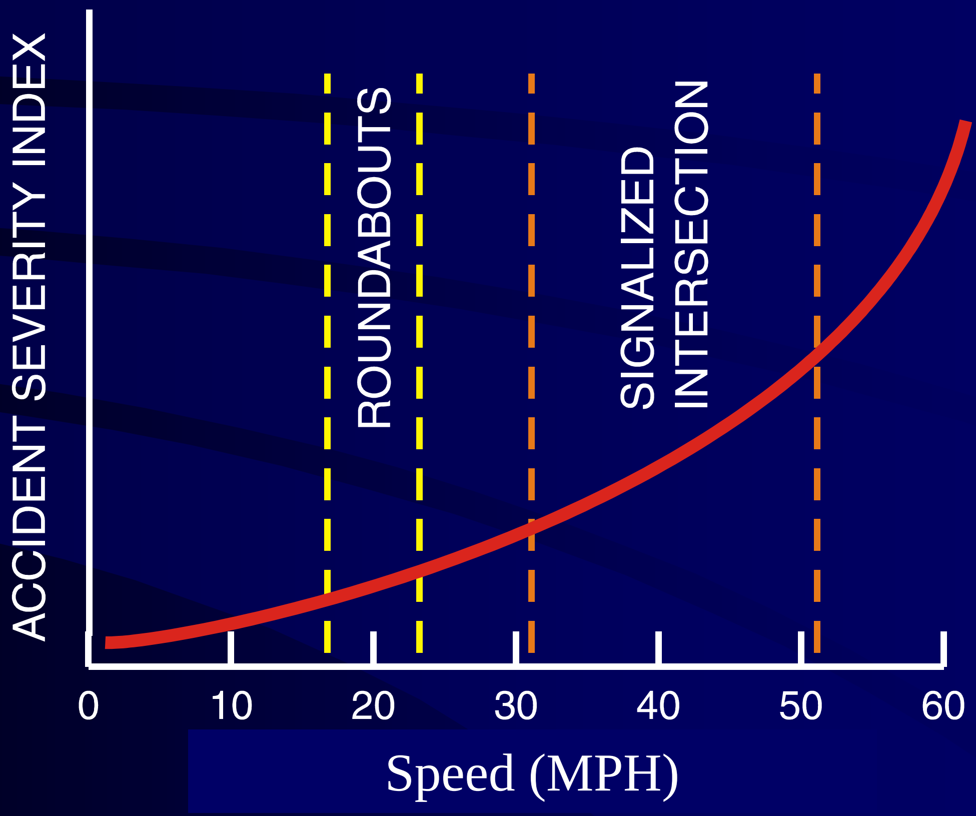
Roundabouts & Traffic Engineering

Why Roundabouts...Safety

Injury Producing Right Angle
Crashes Are Eliminated

Why are Roundabouts Safer?

Accident Severity



Accidents Avoided At Roundabouts

Roundabouts & Traffic Engineering

Maryland State Hwy Administration

- E. Myers' *Accident Reduction with Roundabouts* Reported 5 High Speed Intersections
- Data: 3Yrs Before/ 3Yrs After Roundabout Constr.
- Summary Results:
  - 59% Overall Accident Reduction
  - Avg of 5.56 Accidents Before
  - Avg of 2.3 Accidents After
  - Injury Accidents Reduced by 80%
  - All Intersections: Reduced Frequency & Severity

Maryland State Hwy Administration

Table 2: Maryland Accident Severity Comparison

3 Years Before and After Data for All Roundabouts

Crash Type	Number Of Accidents		Average Accident Cost	Total Accident Cost	
	Before	After		Before	After
Angle	62	8	$125,971	$7,810,202	$1,007,768
Rear-End	6	10	$80,231	$481,386	$802,310
Sideswipe	2	1	$60,819	$121,638	$60,819
Left-turn	11	1	$95,414	$1,049,554	$95,414
Opposite Direction	1	0	$307,289	$307,289	$0
Single Vehicle	3	20	$59,851	$179,553	$1,197,020
TOTALS	85	40	3.0	$9,949,622	$3,163,331

Source: Accident Reduction With Roundabouts, Myers

RTE High Speed Approach Tables.xls

TRL LR 1120

- Injury Accident Research Comparisons at 84 U.K. Roundabouts at Both Low & High Speeds
- Further Analyzed Accident Type & Road User
- Accident Freq. By Type are Related to Flow & Geometry Using Empirical Regression Eqns.
- Data Conveys Less Crashes & Acc. Rate for Small ICDs with **Flare** on High-Speed Roads Compared to Low Speed Sites
- Data Shows Accident Severity & Freq Less at High Speed Roundabouts vs. Low Speed
- Entry Curvature and Angle Between Arms were Major Contributing Factors

TRL LR 1120

Table 3: Roundabout Crash Types & Rates

Accidents Statistics By Roundabout Type & Speed

Roundabout Category	Operating Speeds (MPH)	Total # of Accidents	Avg Accident Rate	Percentage By Accident Type				
				Entering / Circulating	Approach	Single Vehicle	Other	Ped
Small	30 - 40	497	37.1	72.2%	6.6%	7.5%	9.7%	4.0%
	50 – 70	150	28.7	67.3%	8.0%	10.7%	12.0%	2.0%
Conventional (No Flare)	30 - 40	146	21.2	16.4%	18.6%	37.6%	19.2%	8.2%
	50 – 70	193	28.7	24.9%	26.9%	29.0%	17.1%	2.1%
Two-Lane	30 - 40	244	22.5	21.7%	24.2%	24.2%	18.4%	11.5%
	50 – 70	197	22.4	16.8%	29.9%	32.5%	17.8%	3.0%

Source: TRL, LR 1120 *RTE High Speed Approach Tables.xls*

TRL LR 1120

TABLE 4: Roundabout Accident Severity

Crash Statistics By Roundabout Type & Speed

Roundabout Category	Operating Speeds (MPH)	Number of: Sites	Junction Years	Accidents: Fatal	Serious	Slight	Total	Accident Frequency/ Junction/Yr	Severity %
Small	30 - 40	25	113.4	2	86	409	497	4.38	18
	50 – 70	11	53	1	20	129	150	2.83	14
Conventional (No Flare)	30 - 40	11	61.9	3	37	106	146	2.36	27
	50 – 70	11	62.2	0	30	163	193	3.1	16
Two-Lane	30 - 40	14	72.5	1	30	213	244	3.37	13
	50 – 70	12	68.3	0	22	175	197	2.88	11

Source: TRL, LR 1120 *RTE High Speed Approach Tables.xls*

High Speed Case Study: Novelty Hill Washington DOT

- SR 203/124th St Stop Control, Rural High Speed, High Accidents
- *Perceived:* “Roundabouts are unsafe on high speed roads.” → Study Required
- Local Signal Comparison Freq/Severity at 9 HS/LS Intersections Prev. Stop
- Acc Results → Increase in Rates & Severity After Signal
- Compared HS Signals to HS Roundabouts in U.K.
- Resulted in 50-80% Reduction in Injury & Fatalities

Washington DOT

- Final Decision: Build SR 203/ 124th Roundabout
- Completed October 2004
- Past Eight Months, No Reported Collision Problems
- No Speed Studies Planned

- Positive Results Over Previous Intersection Control Type with No High Speed Problems Identified

RTE
Roundabouts & Traffic Engineering

Scott Ritchie, P.E.

www.roundabouts.us

HS Case Study: Ancaster Roundabout

- Unsignalized Rural High Speed Arterial Intx 575' from Hwy 403
- Before / After Crashes & Speeds Analyzed
- 31 Crashes from 1988-2002 (10 Injuries)
- After Roundabout → 5 Single Vehicle Accidents Only – Why?
- All Night, All at HS EB Entry, 2 Drunk Drivers
- Design? High Speeds?
- Design Speed Study = OK
- Lack of Landscaping!

Case Study: Ancaster Roundabout

- Design Works With Rural High Speed Approach
- Elongated Splitter Island
- Adequate Deflection
- 6 Point Speed Corridor Study Conducted

HS Case Study: Ancaster Roundabout

- Results Tabulated →
- 6 Point Speeds All Reduced
- Mostly Nearest Roundabout
- Due to Single Veh Acc, City Installed Delineators at High-Speed Approach →
- See-through problem: Needs Landscaping!

Table 9: Wilson Street Speeds Before & After Construction

Measured Speeds at the Ancaster Roundabout Reported at 85th Percentile

Wilson Street / Meadowbrook Drive / Hamilton Drive

Survey Location	Direction	Before Roundabout	After Roundabout	Change of Speed
Point 1	EB	48	39	-9
	WB	48	36	-12
Point 2	EB	47	26	-21
	WB	48	32	-16
LOCATION OF MODERN ROUNDABOUT				
Point 3	EB	46	28	-18
	WB	50	24	-26
Point 4	EB	44	37	-6
	WB	47	36	-11
Point 5	EB	42	43	1
	WB	43	42	-1
Point 6	EB	42	42	0
	WB	43	41	-2

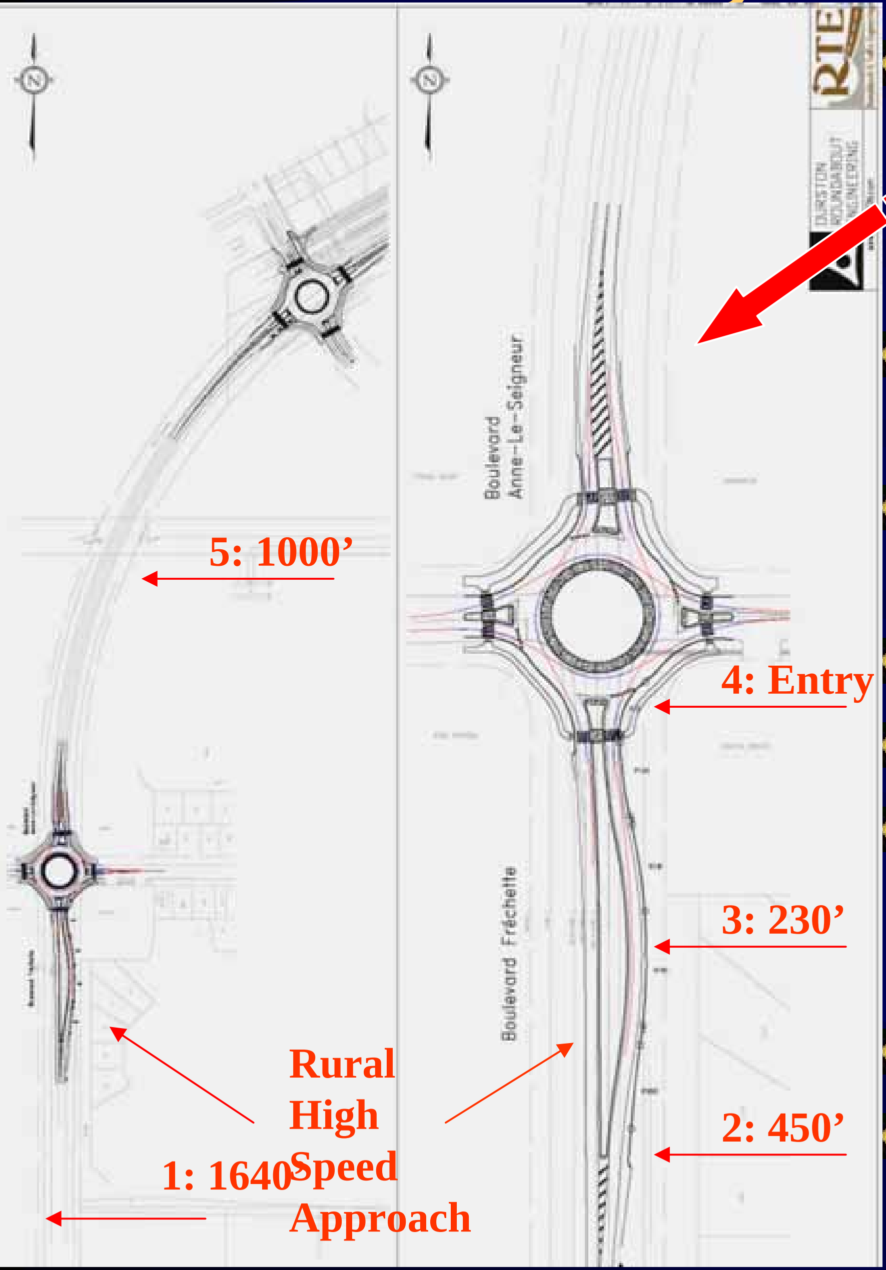
Source: ORE/RTE *RTE High Speed Approach Tables.xl*

Roundabouts & Traffic Engineering

Scott Ritchie, P.E.

www.roundabouts.us

HS Case Study: Chambly Roundabout



- Speed Studies Conducted to Compare Predicted Design Speeds & Post Construction Speeds at Rural High Speed Site
- Long Splitter Island, Curvilinear Approach in Design
- Post Roundabout Speed Study at 5 Points along HS Roadway
- 1: 55mph, 85th=63mph, Avg=58
- 2: 85th=45mph, Avg=39mph
- 3 & 4: Speeds are Lower Than Predicted Fast Path Design Speed w/ Highest Actual Speed =20mph
- 5: 85th=41, Avg=39
- Results are positive!

Roundabouts & Traffic Engineering

Table 10: Chambly Speed Predictions Before Construction

Based on Design Plan Set Fast Path Speeds

Fréchette & Anne-Le-Seigneur Boulevard

Design Parameter	Southbound R1	Southbound R2	Northbound R1	Northbound R2	Westbound R1	Westbound R2	Eastbound R1	Eastbound R2
Radius (ft)	137.8	59.1	111.5	68.9	154.2	59.1	144.4	65.6
Speed (mph)	24	17	22	18	25	17	24	17

ed Approach Tables.xls

Table 11: Chambly Speeds After Construction

Calculations Based on Actual Measured Speeds

Survey Location	Average Speed	85th Percentile Speed	Highest Speed	Lowest Speed	Posted Speed
Point 1	58	63	69	45	55
Point 2	39	45	54	26	55
Point 3	29	32	38	21	55
Point 4 (Entry)	**13**	**16**	**20**	**8**	55
LOCATION OF MODERN ROUNDABOUT					
Point 5	37	41	45	26	45

Source: ORE/RTE *RTE High Speed Approach Tables.xls*

Roundabouts & Traffic Engineering

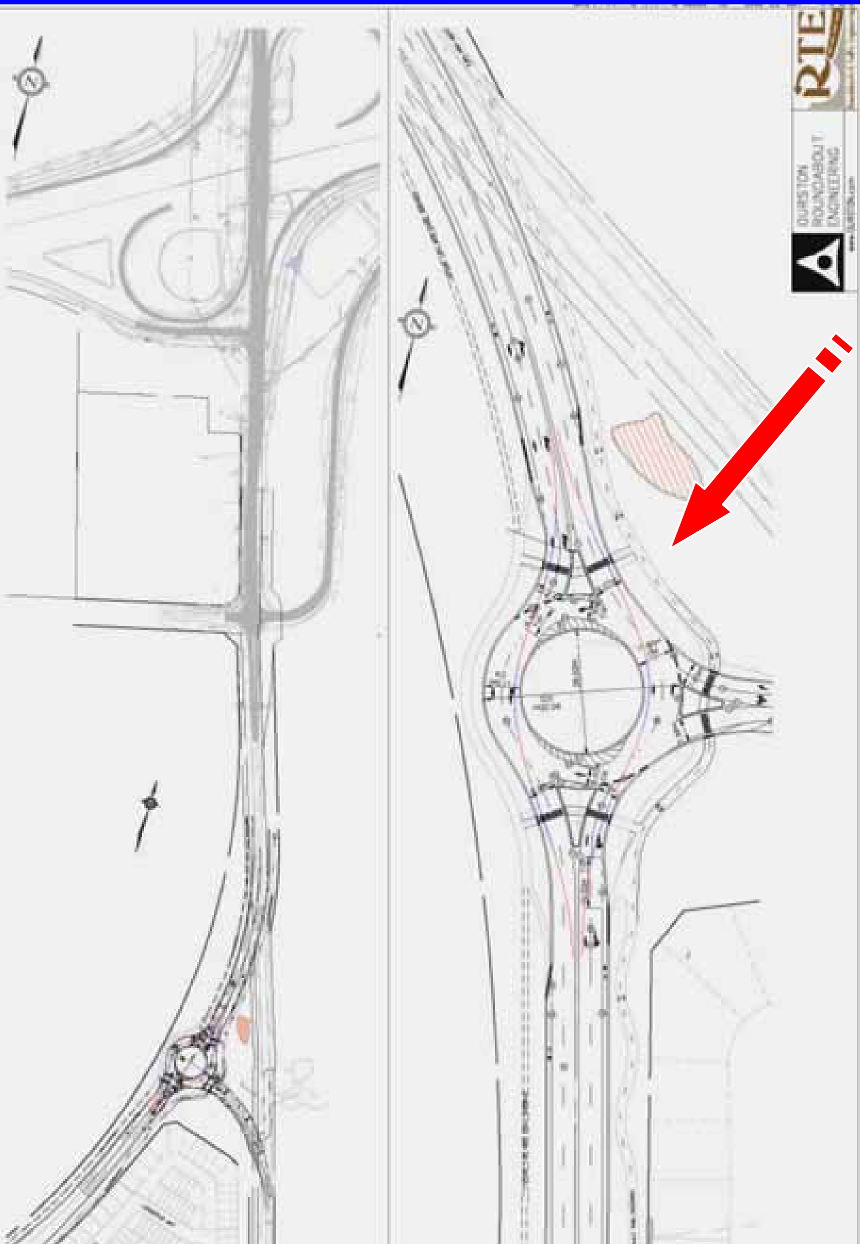
Case Study: Chambly Roundabout

Again, Landscaping Needed

Looking NB at High Speed Approach

Looking SB at High Speed Approach

HS Case Study: Townline Roundabout



- Previous Stop Control had High Crash Rates due to High Speeds
- Studies Conducted to Compare Design Speeds & Post Construction Speeds along High Speed Roadway
- "T" Intersection, No Long Splitter Islands or Curvilinear Approaches
- Before: 85th = 47mph
- Predicted Fastest Path Speeds: 30 mph SB, 32 mph NB (at Entry)
- After: NB 85th = 20 mph, SB = 21 Highest Entry Speeds 23 / 26 mph
- No Accident Problems Identified
- Results are positive
- Good Maptype Signs!
- & Arrow-shaped Exits

Townline Case Study:

Table 13: Townline Predicted Speeds

Based on Design Plans Fastest Path Speeds
Townline Road / Can Amera Parkway

Design Parameter	Southbound		Northbound	
	R1	R2	R1	R2
Radius (ft)	252.6	157.5	305.1	114.8
Speed (mph)	30	24	32	21

d Approach Tables.xls

Table 14: Townline Speeds After Construction

Based on Actual Measured Speeds Conducted After Construction
Townline Road / Can-Amera Parkway

Speeds (mph)	Northbound		Westbound		Southbound	
	Entering	Exiting	Entering	Exiting	Entering	Exiting
Average	16	25	20	26	16	24
Standard Deviation	3	4	5	4	4	3
85th Percentile	20	30	25	30	21	27
High	23	37	29	34	26	30
Low	11	16	3	14	11	19

Source: ODE/RTE *RTE High Speed Approach Tables.xls*

RTE
Roundabouts & Traffic Engineering

REPORT CONCLUSIONS

- Report Provides Case Studies and Statistics at Hundreds of Roundabouts Studied by Roundabout Specialists, Jurisdictions & Organizations Throughout the Globe.
- Common Results → Self Regulating Modern Roundabout is Proven to be The Safest At Grade Intersection Type
- Statistically, Roundabouts are the Most Appropriate Control for Intersections with High Speed Approaches
- Case Studies Acknowledge Roundabouts on High Speed Roadways Are Acceptable, Function Well, & Preferred
- Yet, Evidence is Still Needed to Form Geometric / Safety Performance Relationships on High Speed Approaches
- U.K. Relationships Should Not Be to the Contrary in N.A.
- Yet, Additional Design Treatments Are Still Recommended

Recommended Geometric Design Treatments for H.S.A. at Roundabouts

- Sufficient Deflection at Entry is Key!
- Proper Entry Design Correlating to the Fastest Path Design Speeds that Are Consistently Slow For All Approaches
- Entry Design Correlates to Circulating Speeds with Appropriate Speed Differential (Less than 12 mph)
- Entries are Visible To Driver With Properly Extended Curb & Gutter

Entry Design & Deflection is Key

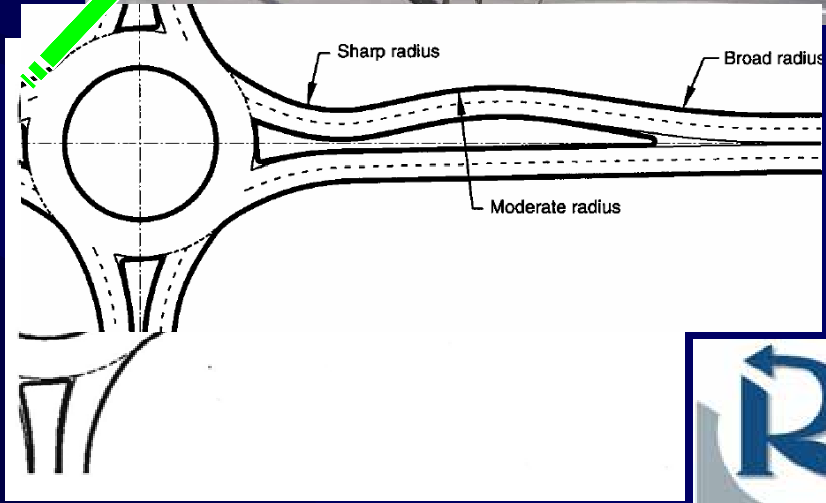
Inadequate Deflection!

Courtesty: Phil Demosthenes

US 6 / Post Rd - Avon, CO

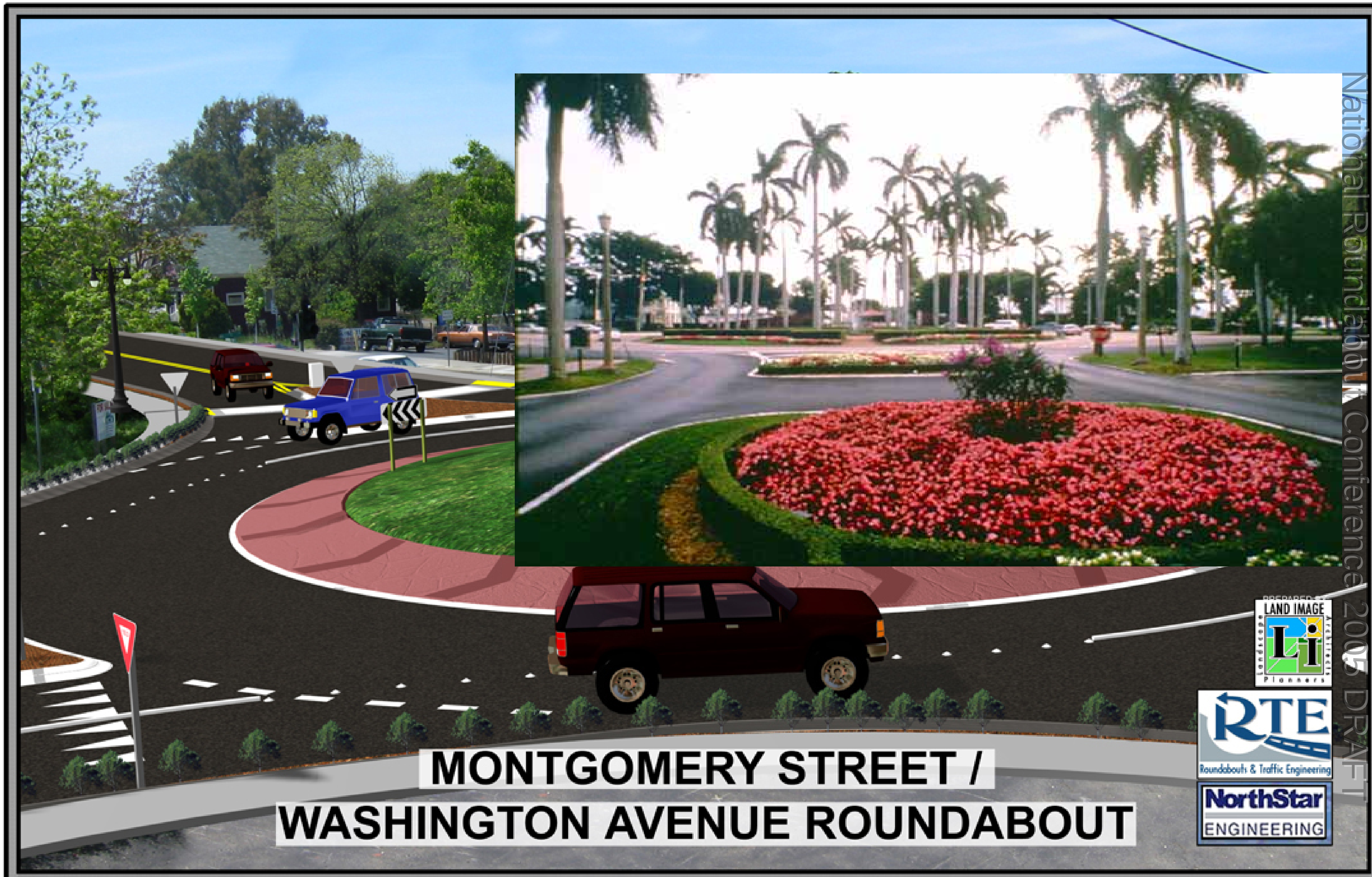
Recommended Geometric Design Treatments for H.S.A.R.

- Extend Splitter Islands to SSD Differential
- Curvilinear Approaches Still Need More Research, but May Prove Appropriate – *Recommend Caution*
- Appropriate Vertical Design of Roadways, Circulating Roadway, & Truck Apron (Visible)
- Consider Two-lane Entry with Short Flare Length
- Consult a Roundabout Specialist!



Roundabouts & Traffic Engineering

Recommended Non-Geometric



Recommended Non-Geometric Design Treatments for H.S.A.R.

- Avoid Excessive Signing
- Increased Chevron Signs On Central Island
- Long Hatched Areas (Striping), as an Alternative to Long Splitter Islands
- Repeat Lane Assignment Arrows
- Thermoplastics Not Paint
- Transverse Yellow Bar Markings
- Internally Illuminated Bollards
- Internally Illuminated Exit Signs (i.e. Vail, CO)

Final Remarks

- Make Roundabout & Need to Slow Down Clear to Driver at SSD with Treatments such as Long Splitter Islands, Extended Curbing, Bar Markings, Thermoplastic, Hatching & Striping
- Make Roundabout Visible During Day with Foliage, Chevrons, and Illuminated Bollards;
- Avoid Excessive Signing: Hinders Driver's Ability to See the Roundabout, Peds, & YIELD
- Make Roundabout Visible During Night with Illuminated Bollards, Extended Chevrons, Illuminated Signs (Internally/ Externally), & Street Lighting
- Add Side Friction with Planters, Curbing, Trees, Splitter Islands, Etcetera
- Ensure Proper Geometric Design: Deflection, Speeds, Fast Paths, Entry Radii
- Roundabouts With High Speed Approaches Are Appropriate If Designed Correctly!