TTI: 0-7036

Roundabouts for High-Speed and Rural Locations

Product 0-7036-P1

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE

COLLEGE STATION, TEXAS

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Roundabouts for High-Speed and Rural Locations

Project 0-7036 Research Findings and Guidelines

Presenter:

Literature Review

- Benefits of roundabouts
- Types and features of roundabouts
- Common items from guidance outside of Texas

Benefits

Safety Benefits

Reduced number of conflict points

Lower speeds approaching and within the intersection

Capacity Benefits

Higher capacity than stop or signal control

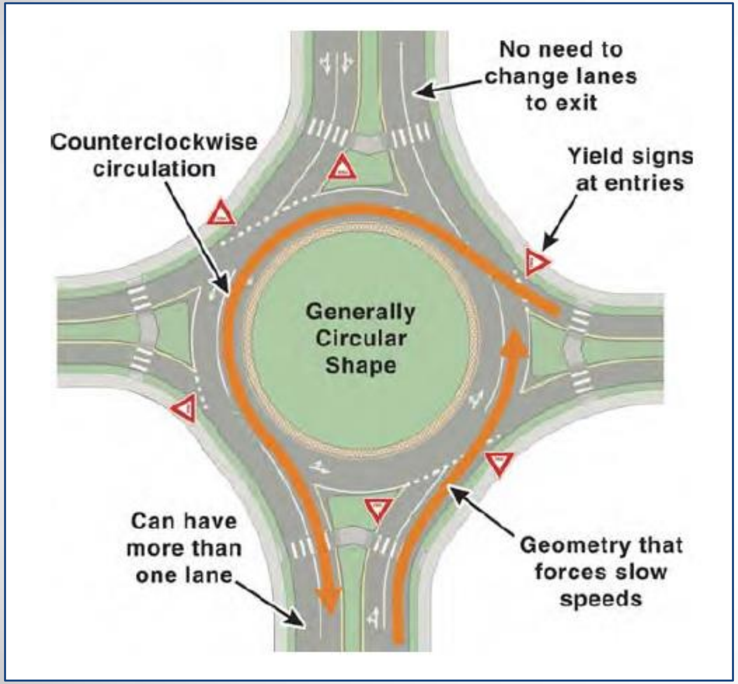
All vehicles must slow, but not all vehicles need to stop

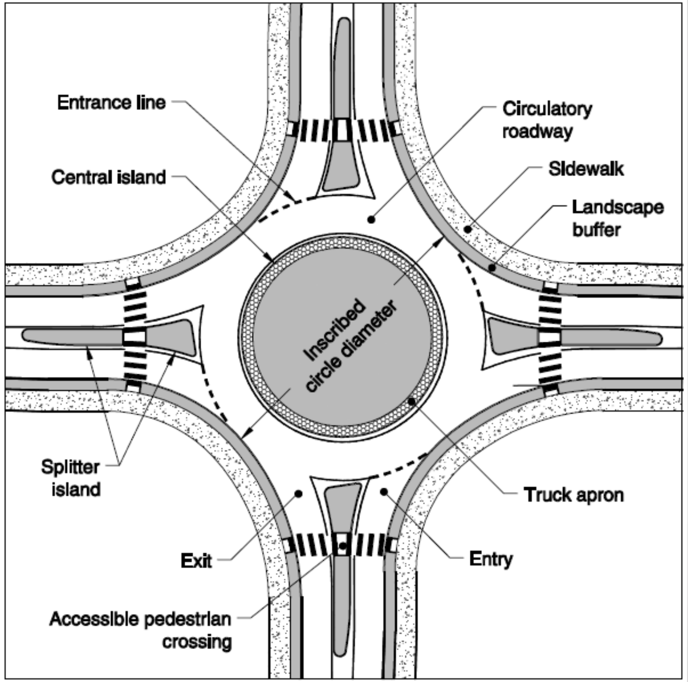
Roundabouts

- Commonly found in urban/ suburban locations, also used for high-speed/rural intersections

Image Credits: Marcus Brewer

Key Roundabout Features





Three Types of Roundabouts

Design Element	Mini	Single-Lane	Multilane
Desirable maximum entry design speed	15-20 mph	20-25 mph	25-30 mph
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45-90 ft	90-180 ft	150-300 ft
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis*	Up to approximately 15,000 vpd	Up to approximately 25,000 vpd	Up to approximately 45,000 vpd for two-lane roundabout
*Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs. Source: Adapted from NCHRP Report 672, Exhibit 1-9, Page 1-12			

Roundabout Design Guidance

- NCHRP 672 = current national reference
  - Discussion of high-speed
  - Discussion of OSOW
- Selected states as primary (KS, WA, WI)
- Other states from those (GA, LA, ME, MN)

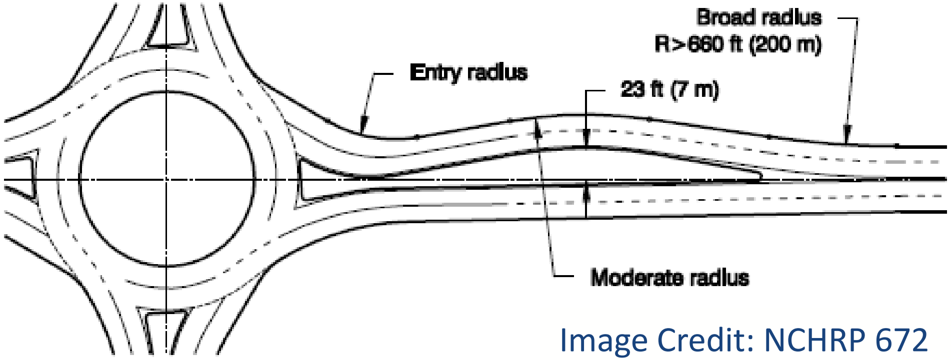
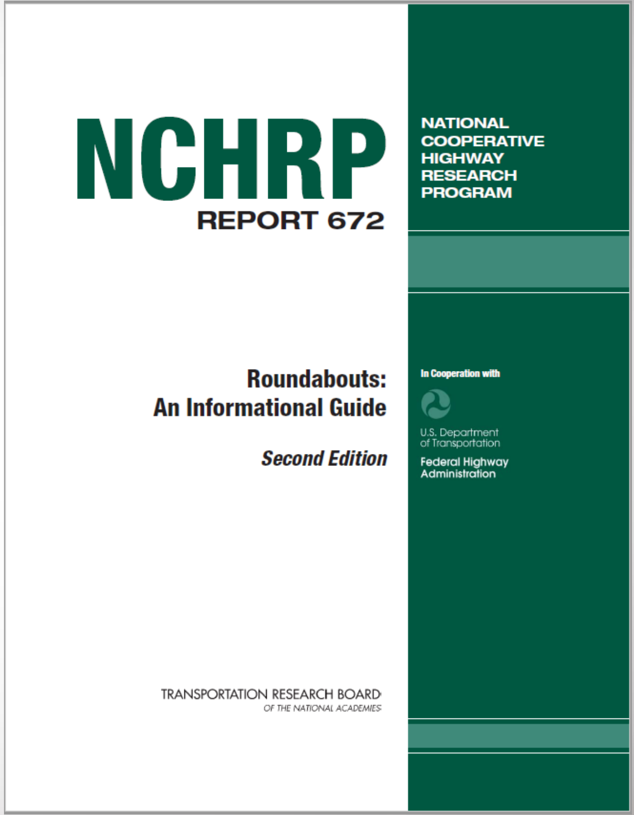


Image Credit: NCHRP 672



Roundabout Design Guidance

- Key features:
  - Balance lower circulating speeds with higher approach speeds
  - Selection of appropriate design vehicle(s)
  - Speed reduction elements on approaches (curves, extended splitter island with curb)
  - Larger central island, truck apron, wider lanes compared to urban / low-speed
  - Supplemental TCDs and lighting in advance and at the intersection

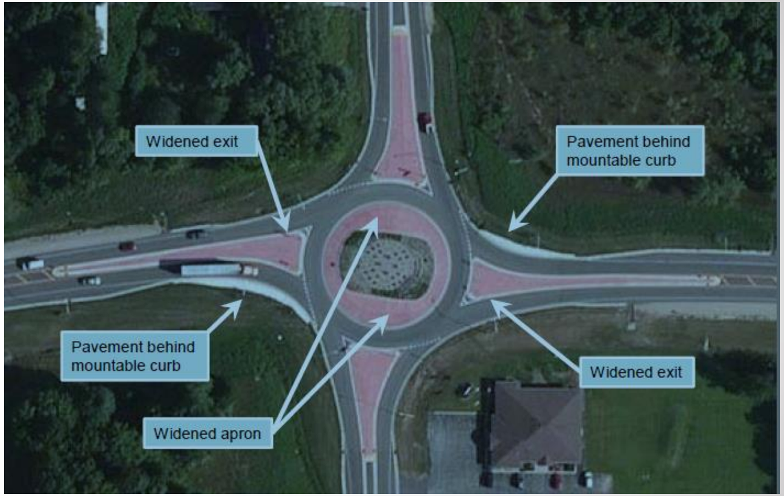


Image Credit: Mark Lenters & Hillary Isebrands

Roundabout Design Guidance

- Research supports:
  - Specific design elements on approach and in intersection
  - TCDs to supplement design and provide advance notice
  - Improvements in crash reduction and injury reduction

Image Credit: NCHRP 672

Field Studies and Simulation

Activities and Findings

Identify Field Study Locations

- Desired criteria:
  - Rural or suburban area
  - At least one approach with posted speed limit of 45 mph or higher
  - High demand of large vehicles, especially OSOW vehicles
- Limited sites in Texas
- Variety of locations outside of Texas
- Collected data at one Texas site and two Kansas sites

Cane Island Parkway at Commerce Parkway/Parkside Street (Katy, TX)

Image Credit: Google Earth

US-75 at K-31 / K-268 (Lyndon, KS)

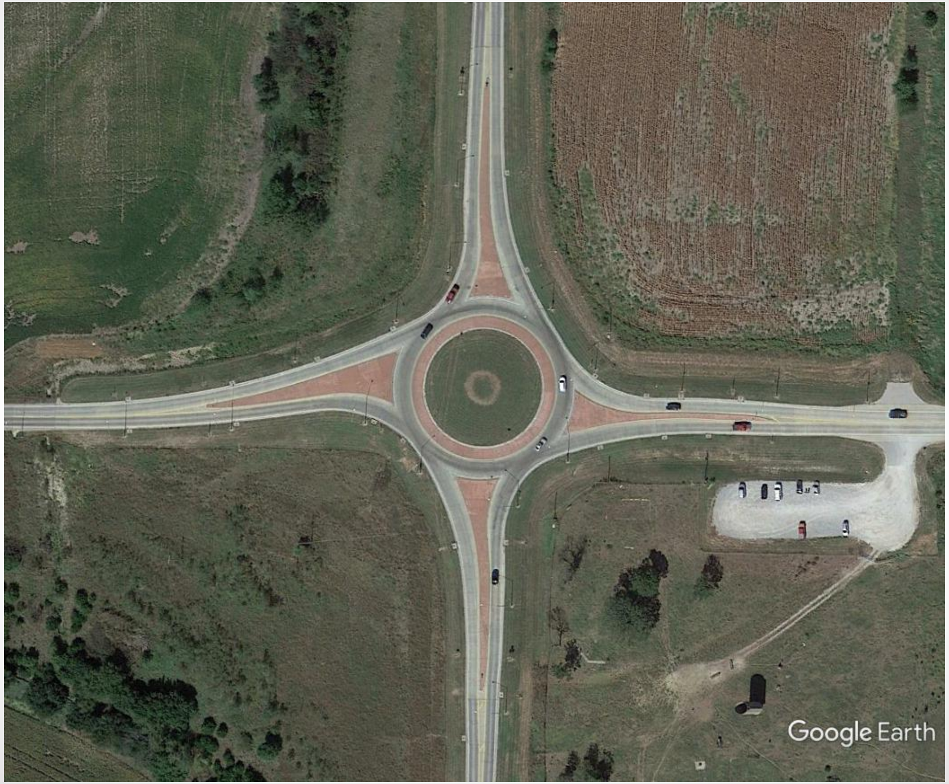


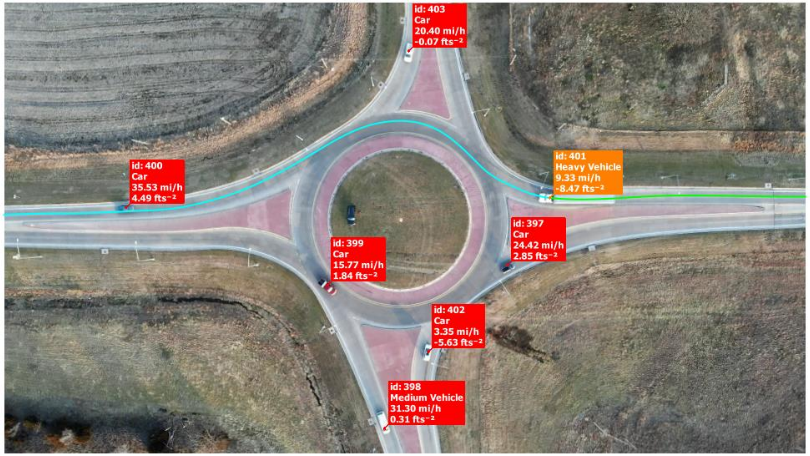
Image Credit: Google Earth

US-400 at K-47 / Washington Street (Fredonia, KS)

Image Credit: Google Earth

Field Data Collection

- Texas site: traditional methods
  - Video, lidar, and counters for traffic data
  - Manual data reduction
  - Photographs, aerial mapping, field notes for site characteristics
- Kansas sites: new methods
  - Drone-based video data collection
  - Algorithm-based reduction
  - Aerial mapping, KDOT notes for site characteristics



Field Data Collection

- Limitations on traditional methods
  - Counter sensor locations
  - Counter spot speeds
  - Video field of view
  - Difficult to reduce efficiently and effectively
- Advantages to new methods
  - Drone position (entire intersection in single view)
  - Faster reduction; speed profiles, O-D matrix generated automatically
  - Caveats: define algorithm gates, conduct QC on results

Hourly Traffic Demand

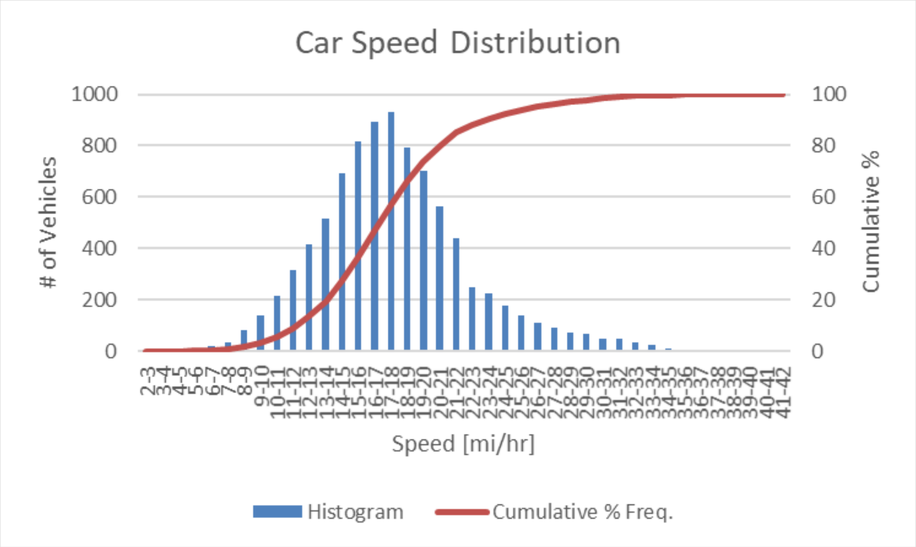
Site	Day of Week	Vehicle Type			Heavy Vehicle Percent (%)	Total Vehicles
		Car	Medium	Heavy		
		(Min, Max)	(Min, Max)	(Min, Max)	(Min, Max)	(Min, Max)
Fredonia	Weekend	(293, 420)	(2, 18)	(21, 41)	(6.5, 9.9)	(321, 478)
	Weekday	(272, 435)	(8, 53)	(36, 56)	(9.4, 11.6)	(317, 502)
Lyndon	Weekend	(391, 470)	(0, 9)	(10, 23)	(2.3, 5.1)	(407, 486)
	Weekday	(360, 623)	(4, 29)	(28, 95)	(4.3, 18.1)	(429, 657)

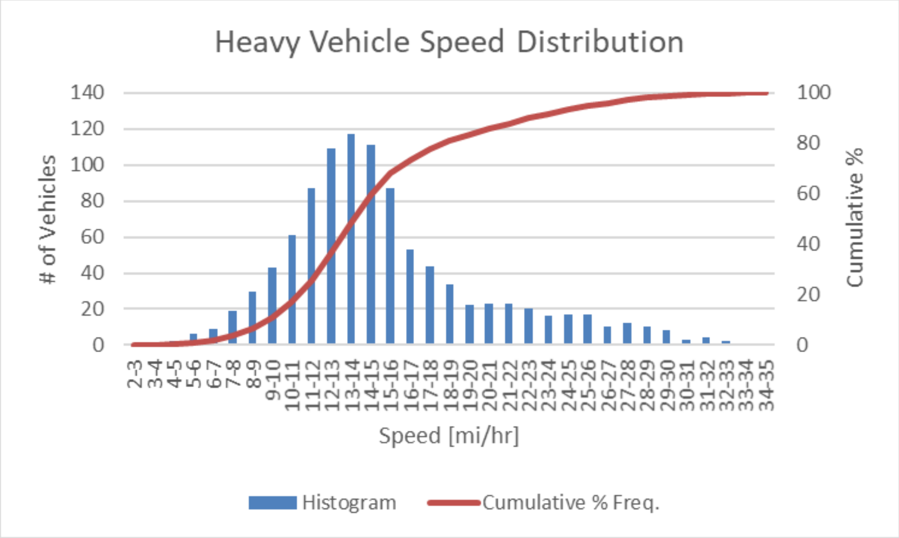
Average Travel Time

Site	Vehicle Type	WB LT	WB RT	NB LT	EB LT	EB TH	SB LT
Fredonia	Car	21.1	9.7	26.0	20.9	14.6	25.6
	Medium	28.7	12.4	23.8	NA	16.4	33.3
	Heavy	19.9	9.2	27.8	24.4	14.3	28.6
	All	22.1	10.0	26.1	21.1	14.6	26.8
Lyndon	Car	7.9	17.9	23.6	15.4	20.6	22.5
	Medium	6.6	22.9	30.0	20.0	22.9	29.0
	Heavy	13.4	20.4	20.1	15.8	N/A	N/A
	All	8.0	18.2	23.7	15.6	20.6	22.9

Vehicle Count and Speeds

Site Location	Vehicle Type				Total
	Car	Medium	Heavy	OSOW	
Fredonia	8906	320	1003	31	10233
Lyndon	9827	260	970	4	11061





Simulation

- Several simulation models developed to investigate effects of spacing
- Base condition from field data at Fredonia
- Key parameters were modified to create different scenarios

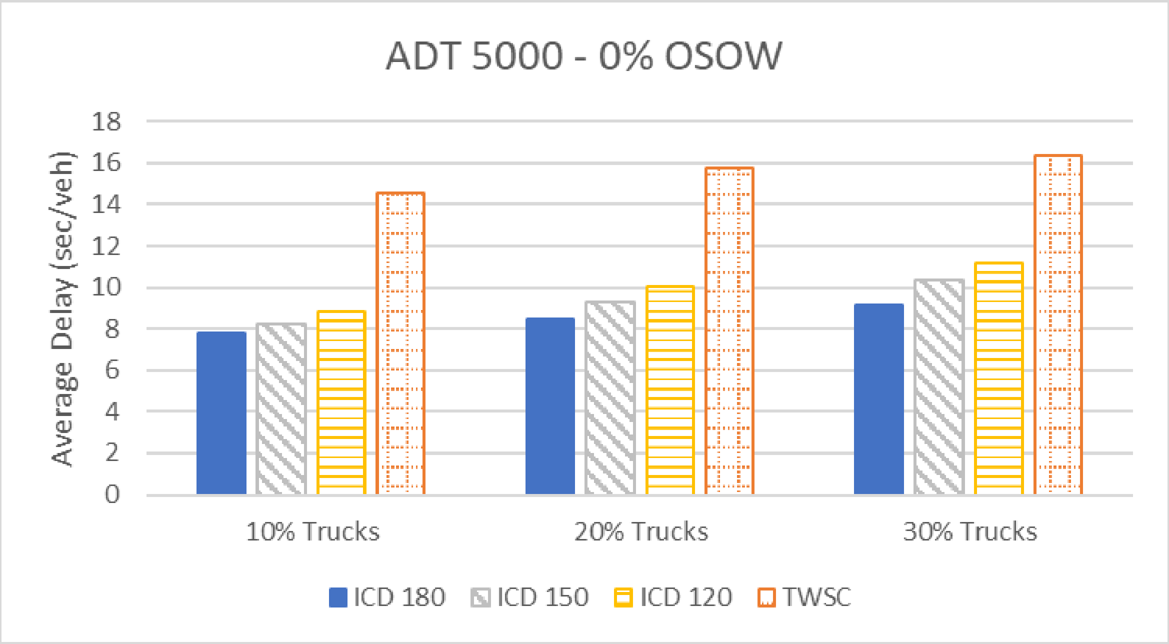
Main Models:

- TWSC
- ICD = 180 ft
- ICD = 150 ft
- ICD = 120 ft

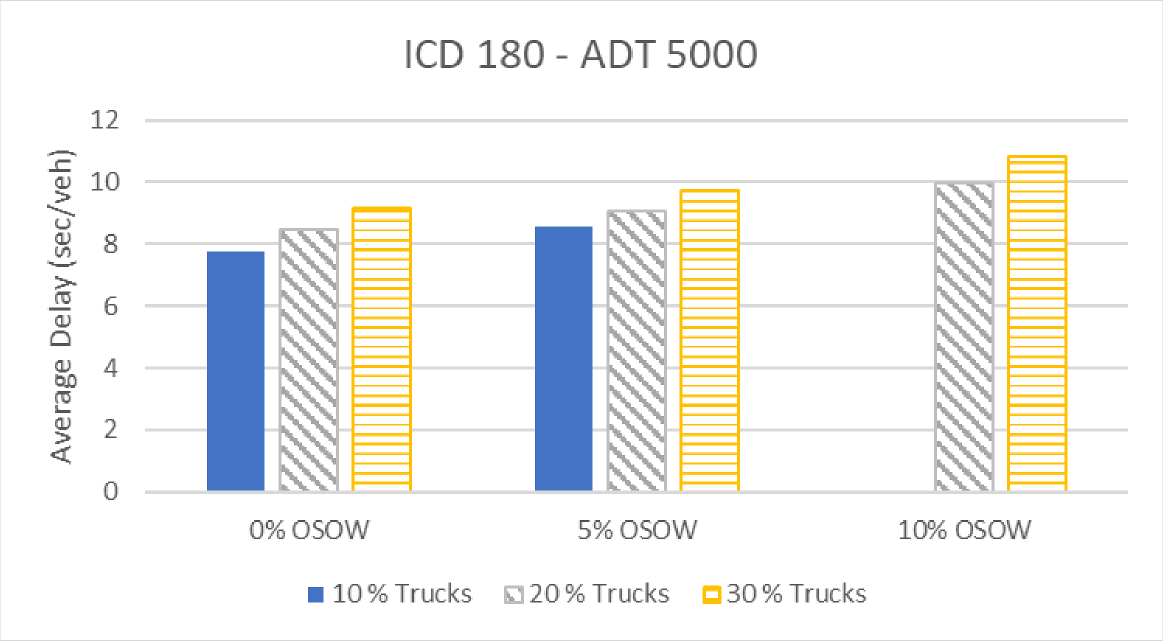
For each model:

- ADT: 5,000, 10,000, 15,000 vpd
- Truck percentage: 10, 20, 30 percent
- OSOW percentage: 0, 5, 10 percent

Average Delay of ADT = 5K and OSOW = 0



Average Delay of ICD = 180 and ADT = 5K



Traffic Load	ICD 180 ft				ICD 150 ft				ICD 120 ft				TWSC			
	All	Car	Truck	OSOW	All	Car	Truck	OSOW	All	Car	Truck	OSOW	All	Car	Truck	OSOW
5000 ADT_10% Truck_0% OSOW	A	A	A	N/A	A	A	A	N/A	A	A	B	N/A	B	B	B	N/A
5000 ADT_10% Truck_5% OSOW	A	A	A	B	A	A	B	B	A	A	B	B	B	B	A	B
5000 ADT_20% Truck_0% OSOW	A	A	A	N/A	A	A	A	N/A	A	A	B	N/A	B	B	B	N/A
5000 ADT_20% Truck_5% OSOW	A	A	A	B	A	A	B	B	A	A	B	B	B	B	B	B
5000 ADT_20% Truck_10% OSOW	A	A	A	B	A	A	B	B	A	A	B	C	B	B	B	B
5000 ADT_30% Truck_0% OSOW	A	A	A	N/A	A	A	A	N/A	A	A	A	N/A	B	B	B	N/A
5000 ADT_30% Truck_5% OSOW	A	A	A	B	A	A	A	B	A	A	B	C	B	B	B	B
5000 ADT_30% Truck_10% OSOW	A	A	A	B	A	A	B	B	A	A	B	C	B	B	B	B
10000 ADT_10% Truck_0% OSOW	A	A	B	N/A	A	A	C	N/A	B	A	C	N/A	F	F	F	N/A
10000 ADT_10% Truck_5% OSOW	A	A	C	C	B	A	C	D	C	B	D	D	F	F	F	F
10000 ADT_20% Truck_0% OSOW	B	A	C	N/A	B	A	C	N/A	C	C	D	N/A	F	F	F	N/A
10000 ADT_20% Truck_5% OSOW	B	B	C	D	C	B	D	D	C	C	D	E	F	F	F	F
10000 ADT_20% Truck_10% OSOW	C	B	C	D	C	C	D	D	C	C	D	E	F	F	F	F
10000 ADT_30% Truck_0% OSOW	B	B	C	N/A	C	B	D	N/A	C	C	D	N/A	F	F	F	N/A
10000 ADT_30% Truck_5% OSOW	C	B	C	D	C	C	D	D	D	C	E	E	F	F	F	F
10000 ADT_30% Truck_10% OSOW	C	C	D	D	D	C	E	E	D	D	E	E	F	F	F	F
15000 ADT_10% Truck_0% OSOW	C	C	D	N/A	C	C	E	N/A	E	E	F	N/A	F	F	F	N/A
15000 ADT_10% Truck_5% OSOW	D	D	E	E	D	D	E	F	F	E	F	F	F	F	F	F
15000 ADT_20% Truck_0% OSOW	D	D	E	N/A	E	E	F	N/A	F	F	F	N/A	F	F	F	N/A
15000 ADT_20% Truck_5% OSOW	E	E	F	F	F	F	F	F	F	F	F	F	F	F	F	F
15000 ADT_20% Truck_10% OSOW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
15000 ADT_30% Truck_0% OSOW	F	E	F	N/A	F	F	F	N/A	F	F	F	N/A	F	F	F	N/A
15000 ADT_30% Truck_5% OSOW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
15000 ADT_30% Truck_10% OSOW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

Key Findings

- Roundabouts in rural/high-speed locations rare in Texas, but more common elsewhere and used successfully
- Roundabouts can accommodate heavy and OSOW vehicles with high-speed approaches
- Roundabouts more efficient in accommodating trucks, OSOW, and overall volumes than TWSC
- Larger roundabouts process more vehicles, even with high OSOW

Guidelines

Key Features

- Balance between lower circulating speeds and higher approach speeds
- Selection of appropriate design vehicle(s)
- Speed reduction elements on approaches (curves, extended splitter island with curb)
- Larger central island, truck apron, and wider lanes compared to urban/low-speed roundabouts
- Supplemental traffic control devices and lighting in advance of and at the intersection

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For more…

https://tti.tamu.edu/documents/0-7036-R1.pdf