A Review of Roundabout Speeds in north Texas

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ABSTRACT

This paper presents a review of roundabout operating speeds in north Texas. Multiple types of roundabouts were studied including single lane, multilane and hybrid single lane with right-turn bypass lanes. The primary focus of the study was on a cluster of four single lane roundabouts that have been perceived as either “fast” or “slow” by local officials. Speed data was collected at the entry and exiting crosswalks of the studied intersections using automated traffic counters. The collected speed data was then compared across the locations to serve as a performance check of the various roundabouts studied. The study also serves to provide firm data to local governments documenting operating speeds at these specific locations.

INTRODUCTION

Roundabouts have seen significant growth in the last 10 years in the north Texas region surrounding Dallas and Fort Worth. By most accounts, the first modern roundabout in north Texas was constructed in 1996 in Addison. By the end of 2004 there were approximately 13 modern roundabouts across the north Texas region, with the majority constructed within single family housing developments and others within commercial office developments. Figure 1 depicts roundabouts in north Texas by the end of 2004.

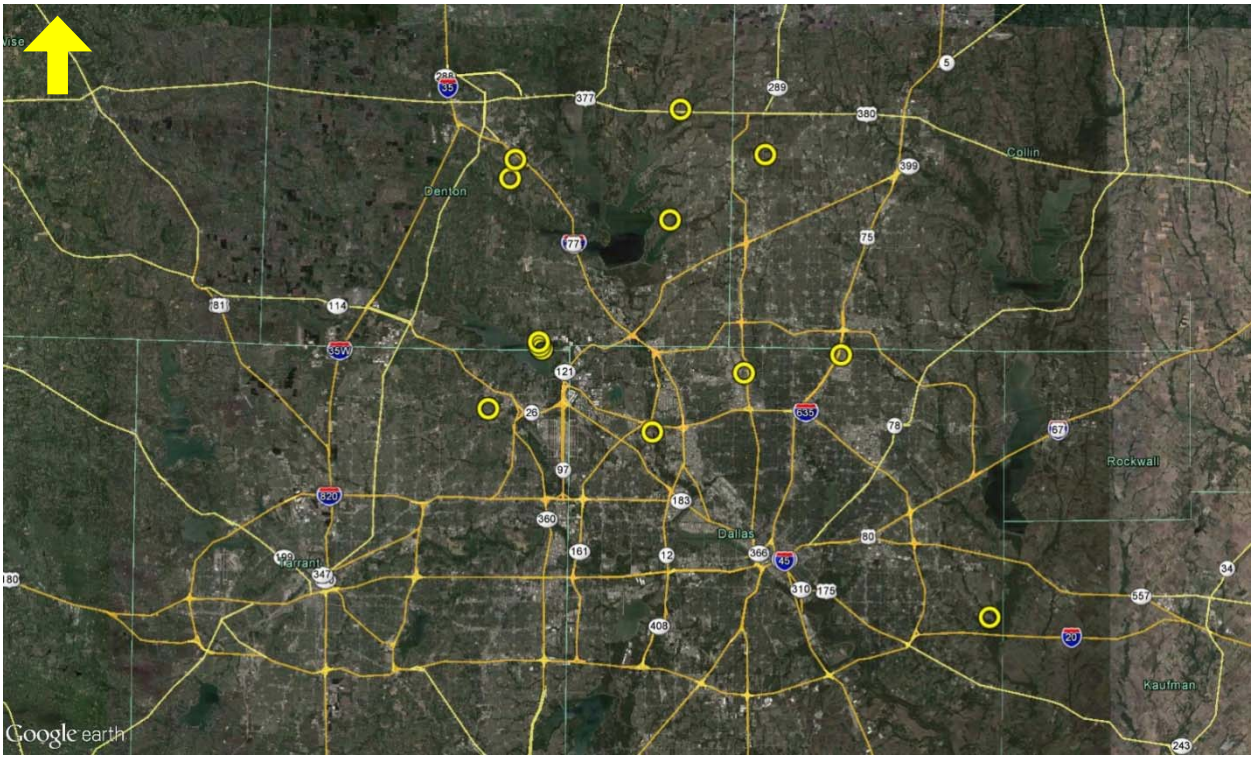

Figure 1. Roundabouts in the Dallas-Fort Worth region (end of 2004)

Since 2004, roundabouts have become far more accepted across the region. A total of at least 50 roundabouts are now on the ground in north Texas, with many more being planned. Many are now on the collector or arterial street networks. Some are multilane, but the majority are single lane. Figure 2 depicts north Texas area roundabouts as of October 2013.

One area of the region where roundabouts have been very successful in efficiently and safely moving traffic is in Tarrant County. The cities of Southlake and Colleyville have constructed roundabouts at many of the major intersections on the local street system. There are currently eight roundabouts in these two cities. Two additional roundabouts are currently under construction and at least three more are planned. With the presence of such a concentration of roundabouts in a small area, there are various perceptions within the community related to the operating speeds of about the intersections.

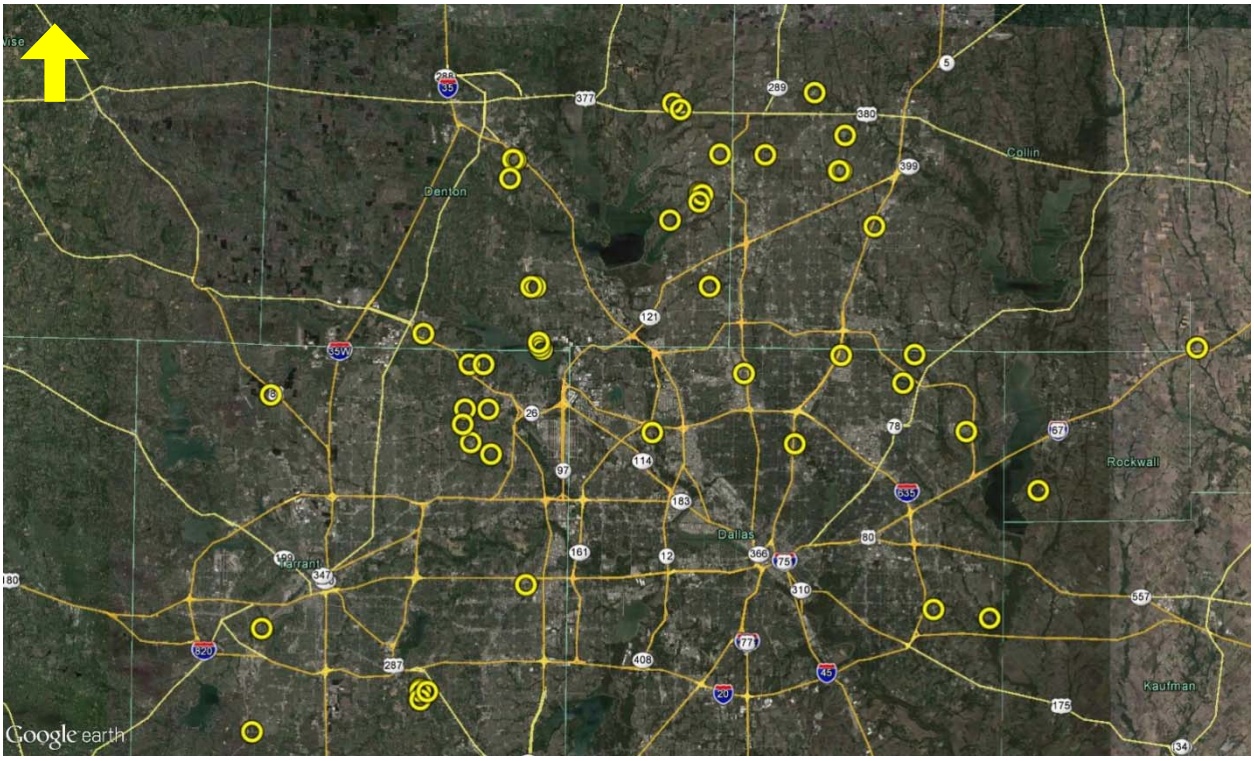

Figure 2. Roundabouts in the Dallas-Fort Worth region (as of October 2013)

Over time, some of the roundabout intersections in northeast Tarrant County have been perceived as having "fast" or "slow" traffic by both public officials and professional engineers that live and work in the area. These perceptions have directly influenced the design process of subsequent roundabouts. This study is an attempt to document some of the operational characteristics of a sampling of roundabouts to determine if speed differences exist between the legs and between the locations. Geometric characteristics such as inscribed circular diameter, entry width and exit width are also explored. Additionally, the measured speeds are compared to the anecdotal impressions of a roundabout being fast or slow.

SITE SELECTION

For this study, four primary intersections were selected for a close examination and review of speed data. Two of these locations were strictly single lane roundabouts; while two locations had either vane island right-turn bypass lanes or a dedicated right-turn lane on an entering approach. A vane island is a small raised channelizing island that separates the right turn bypass lane from the circulating lane of the roundabout.

These four locations were chosen for their close proximity to each other allowing flexibility with respect to data collection and traffic observation. The four primary sites of interest are described in Table 1. Included in the table are street names, approximate inscribed circular diameter (ICD) as measured from aerials or from plans where available. All four of the single lane study sites were located in Tarrant County.

In addition to the four primary sites, two multilane roundabouts were selected for review. Speeds were collected at a total of three multilane entries and three multilane exits. Both of the

multilane roundabouts selected were located in Dallas County. These two locations are also included in Table 1.

A total of 21 roundabout entries were included in the study along with 19 roundabout exits. Of the 21 entries, three (3) were multilane entries to multilane roundabouts, two (2) were island separated right-turn bypass lane entries at single lane roundabouts, two (2) were two-lane entry to a single lane roundabout where the right lane is a turn-only lane, and the remaining 14 were single lane entries to single lane roundabouts.

Of the total 19 roundabout exits studied, three (3) were multilane exits from multilane circulatory roadways and the remaining 16 were single lane exits from single lane roadways.

TABLE 1. Site Information

ID	Road A	Road B	Type	ICD (feet)	Notes
S1	Continental	White Chapel	Single lane	120	
S2	Continental	Carroll	Single lane	130	
S3	John McCain	Pleasant Run	Single lane	105	Right-turn lanes on north/south legs
S4	Glade	Pool	Single lane	100	Right-turn bypass lanes with vane islands on north and east legs.
M1	Belt Line	Pioneer	Multilane	175	Five-legged intersection.
M2	Quorum	Addison Circle	Multilane	185	

SPEED DATA COLLECTION

Speed data was collected at the crosswalks on the study entry or exit leg at each intersection. A more predictable vehicle path was obtainable in the crosswalks and was the primary reason for situating the data collection tubes in this area. A sample photo of the data collection setup is shown in Figure 3.

As the study effort is primarily focused on the perception of an intersection as fast or slow, the use of automated counters allowed for the collection of large data sets that provided flexibility in analysis. Vehicle speeds collected throughout an entire day revealed the nature of vehicle speeds for both free flow and yielding vehicles as they travelled across the crosswalk and measurement area.

The data set is limited in that an entering motorist that yielded or stopped for conflicting traffic within the roundabout cannot be readily identified from one that entered without being impeded by circulating traffic. For the purposes of this study the limitation is acceptable because the authors are concerned more with the relationship between operating speeds and the anecdotal perceptions of the intersections held within the community. It is reasonable to assume that the upper ranges of the speed data are indicative of free flowing and non-conflicting entry or exit traffic.

Figure 3. Data collection configuration (photo from Joseph Short)

DATA COLLECTION RESULTS

The roundabouts studied were previously listed and assigned an ID number in Table 1. For the ease of reference in data tables the following naming convention will be used to identify the movement, site, and leg of the intersection. A sample reference code is XX-YY-L. The first two characters are either EN to designate an entry movement or EX to designate an exit movement. The second two characters in the code designate the Site ID from Table 1. The final character(s) designates the specific leg of the intersection. Thus, a reference code of EX-M1-SE represents the exit movement on the southeast leg of intersection M1. Similarly, EN-S2-N would represent the entry movement on the north leg of intersection S2.

Operational Speeds at Roundabout Entries

Table 2 presents a summary of the operational speed data gathered at 21 roundabout entries at the study sites. The data illustrate similar operating speeds across the study locations, with the speeds generally occurring in the 15 MPH to 20 MPH range. The maximum speed observed at any of the 21 entries studied was 48 MPH. The speed occurred at location EN-M2-S which is a multilane entry to the first modern roundabout in north Texas. The speeds documented in Table 2 indicate that in all but one instance, the 85th percentile entry speed was below 25MPH.

TABLE 2. Roundabout Entry Operating Speed Information

Location	Count	Mean (mph)	Mode (mph)	Median (mph)	15th Percentile (mph)	85th Percentile (mph)	Max (mph)	Std. Dev.	Variance	Perception[1]
EN-S1-E	2,156	15.3	18	16	10	20	29	4.6	21.5	None
EN-S1-N	2,809	15.2	16	15	10	21	31	5.2	27.5	
EN-S1-S	2,130	14.4	16	15	9	19	28	4.6	21.1	
EN-S1-W	2,158	15.3	17	16	10	20	28	4.6	21.1	
EN-S2-E	4,759	19.1	19	19	17	21	27	2.5	6.2	Fast
EN-S2-N	1,938	13.9	18	14	8	19	27	5.1	26.1	
EN-S2-S	5,310	18.5	19	19	16	21	33	3.6	13.1	
EN-S2-W	3,351	15.6	20	16	9	21	30	5.3	28.1	
EN-S3-E	2,323	17.5	21	18	12	23	32	4.8	23.4	None
EN-S3-N	2,919	17.6	19	18	14	21	33	3.9	15.3	
EN-S3-S	2,288	15.4	18	16	11	20	31	4.3	18.5	
EN-S3-W	2,994	16.8	19	17	11	22	33	4.8	23.4	
EN-S4-E	2,236	18.8	22	19	12	26	36	6.5	42.1	Slow
ENRT-S4-E	869	14.6	15	15	13	17	22	2.2	4.8	
EN-S4-N	1,748	11.8	11	12	8	15	26	3.7	13.3	
EN-S4-S	1,374	14.5	14	14	11	19	30	4.0	15.9	
ENRT-S4-S	803	16.7	18	17	14	20	27	3.1	9.4	
EN-S4-W	3,226	16.3	16	16	12	21	32	4.4	19.1	
EN-M1-SW	3,385	15.7	20	18	8	20	33	5.4	29.6	None
EN-M1-NE	3,643	14.1	16	14	9	19	31	4.3	18.2	
EN-M2-S	3,497	19.6	21	20	15	23	48	4.3	18.2	None

[1] A goal of this study was to obtain data to evaluate the local perception of site S2 as "fast" and site S4 as "slow."

Anecdotally, location S2 is referred to as a "fast" roundabout due to it being one of the larger single lane roundabouts in the northeast Tarrant County area (ICD=130 feet). Location S4 was constructed with a small ICD, approximately 100 feet in size, in an effort to constrain speeds. Figure 4 depicts the mean entry speeds for both location S2 and location S4. It does appear that location S4 has slightly slower average entering speeds. Figure 5 illustrates a comparison of the 85th percentile speeds at location S2 and S4 and once again, S4 appears to have slightly slower operating speeds than S2.

When compared to intersection S2, S4 appears to have lower speed operation, however, it is interesting to note that location EN-S4-E had the second highest maximum entry speed of any of the study entries at 36 MPH and the highest 85 percentile speed of 26 MPH.

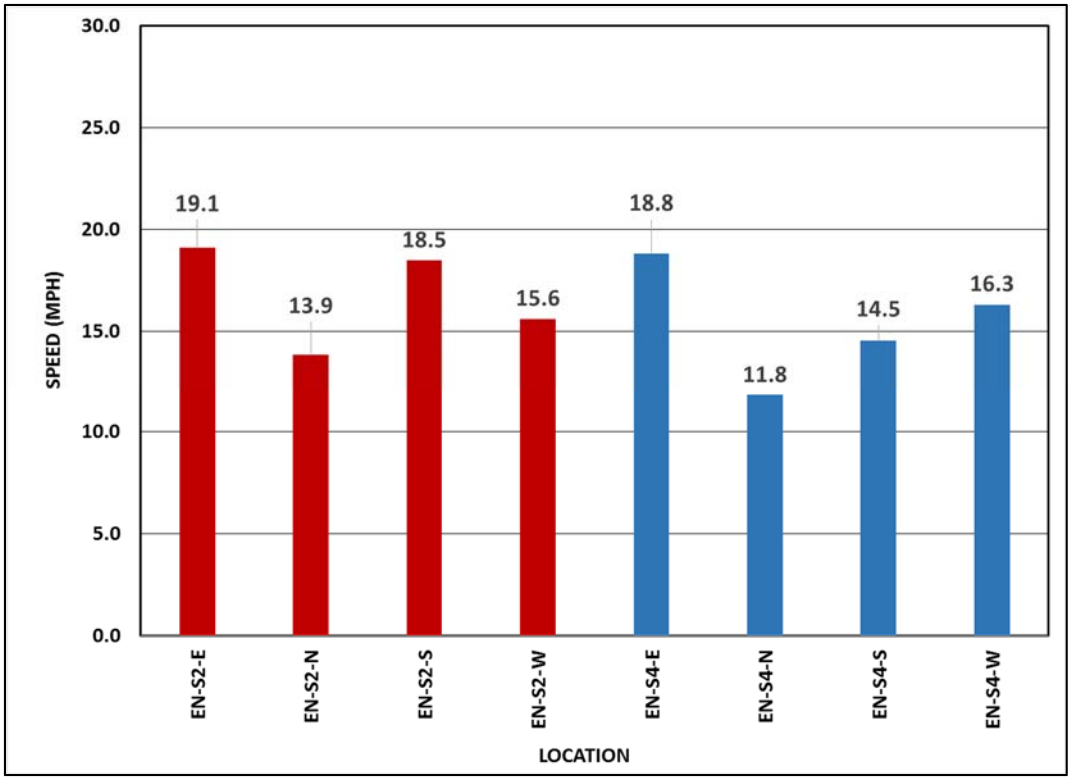

Figure 4. Mean Entry Speeds (Location S2 vs Location S4)

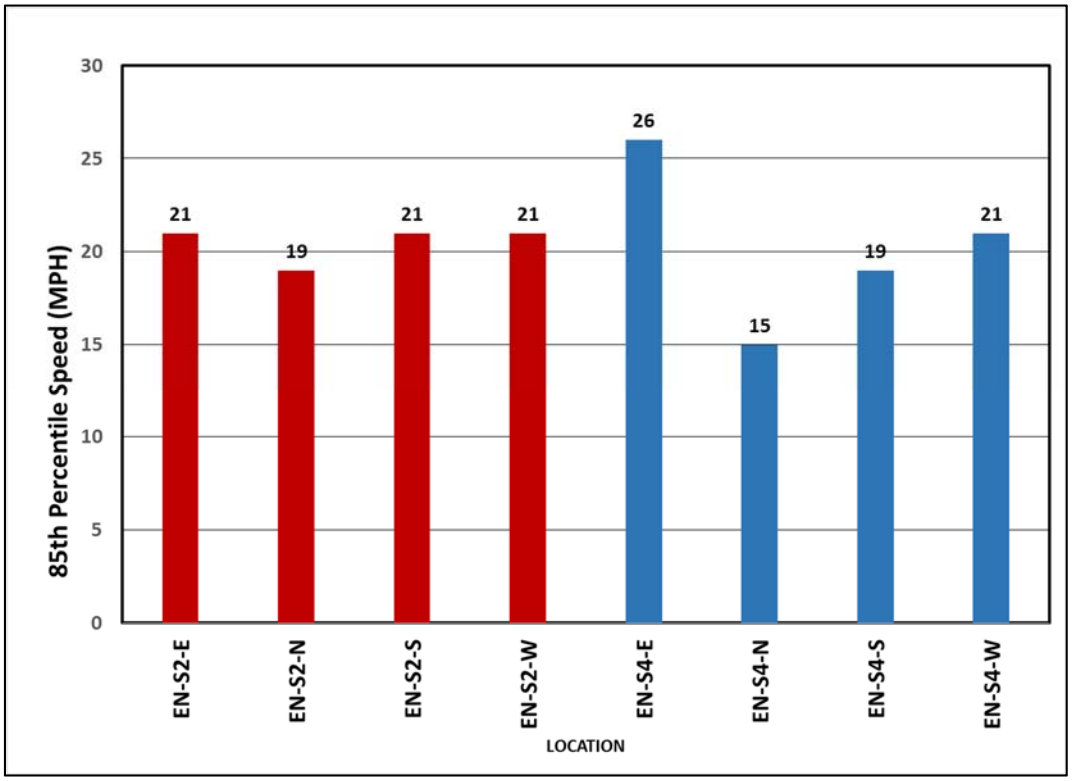

Figure 5. 85th Percentile Entry Speeds (Location S2 vs Location S4)

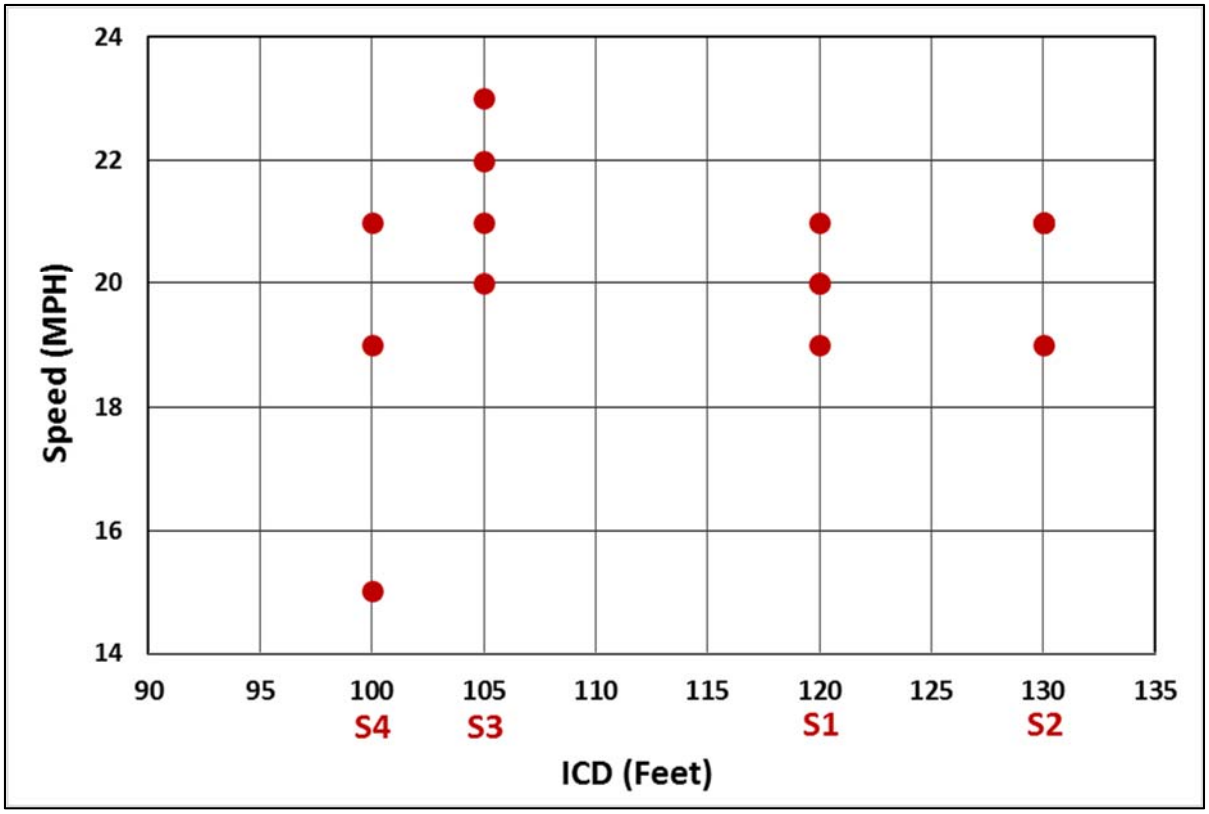

Figure 6. ICD versus 85th Percentile Entry Speed (locations S1, S2, S3, and S4)

No clear relationship between ICD and entry speed is evident in the data shown in Figure 6. This is somewhat to be expected given that entry speeds can be controlled by entry width, entry radius, and entry angle. It is interesting to note however that location S3, with a 105 foot ICD appears to have somewhat higher 85th percentile entry speeds than the other locations.

The speed data collected, as expected, generally exhibited a normal distribution. An example is shown in Figure 7.

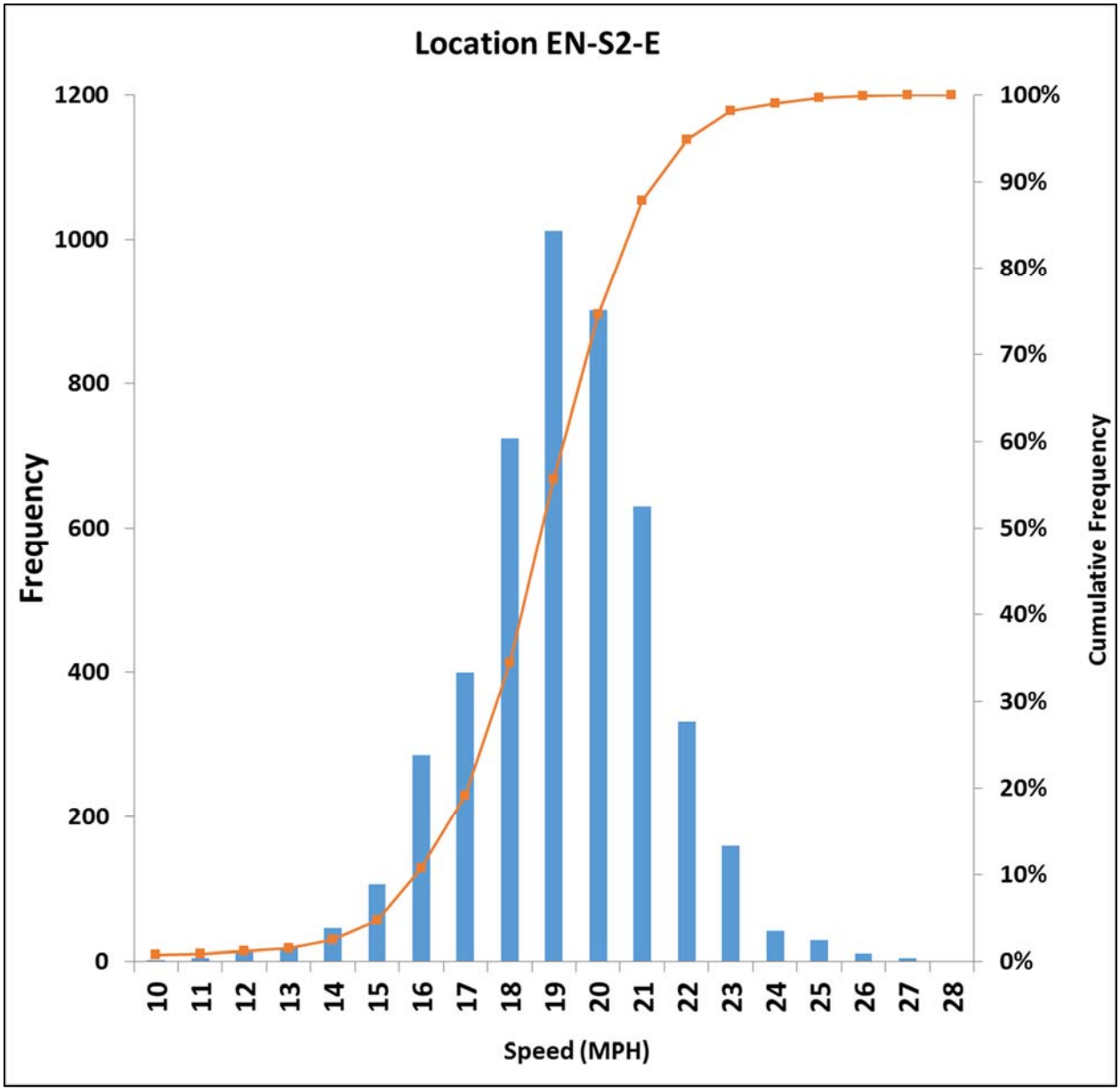

Figure 7. Sample Entry Speed Distribution

Operational Speeds at Roundabout Exits

Roundabout exit speeds were also of interest in this study. Table 3 presents the operating speed summary information at the exit legs of the roundabouts. In general, exiting speeds were higher at the studied sites than at the entries. This is consistent with roundabout operation elsewhere. The max speeds observed in the data collection were considerably higher than the 85th percentile exit speeds. In some instances, the maximum observed speed was 16 to 20 MPH higher than the 85th percentile speeds.

TABLE 3. Roundabout Exit Operating Speed Information

Location	Count	Mean (mph)	Mode (mph)	Median (mph)	15th Percentile (mph)	85th Percentile (mph)	Max (mph)	Std. Dev.	Variance	Perception[1]
EX-M1-SE	4,752	20.6	21	21	18	24	37	3.1	9.3	None
EX-M1-SW	2,147	22.3	21	22	19	26	36	3.6	12.8	
EX-M2-N	2,956	21.5	22	22	18	25	37	3.5	12.0	None
EX-S1-E	1,399	22.2	21	22	19	26	41	3.7	13.4	None
EX-S1-N	3,743	15.5	16	16	11	20	31	4.7	21.9	
EX-S1-S	983	22.2	21	22	17	28	58	6.3	39.2	
EX-S1-W	1,551	18.5	18	18	16	21	29	2.7	7.4	
EX-S2-E	551	13.1	15	14	5	19	33	6.3	40.2	Fast
EX-S2-N	2,443	19.5	18	19	17	22	33	3.0	8.9	
EX-S2-S	4,759	19.1	19	19	17	21	27	2.5	6.2	
EX-S2-W	3,325	21.1	21	21	19	23	34	2.4	5.7	
EX-S3-E	1,806	19.8	20	20	17	22	28	2.4	5.7	None
EX-S3-N	3,228	21.3	21	21	19	24	38	2.8	8.0	
EX-S3-S	2,400	18.1	18	18	16	20	36	2.4	5.6	
EX-S3-W	3,463	21.6	21	21	18	25	45	3.4	11.6	
EX-S4-N	746	14.3	14	14	12	17	28	2.6	6.7	Slow
EX-S4-S	692	23.0	22	23	20	27	42	4.1	16.6	
EX-S4-W	3,364	23.5	25	23	20	27	43	3.8	14.3	

[1] A goal of this study was to obtain data to evaluate the local perception of site S2 as "fast" and site S4 as "slow."
[2] Site EX-S4-E is omitted due to an obvious malfunction.

In order to review some of the anecdotal perceptions of the study intersections, the exit speeds were reviewed to determine if any patterns seem evident. A few of the area public officials tend to believe that the smaller the ICD, the slower the speeds. This belief persists independent of the actual exit design of the roundabouts. As discussed previously, intersection S2 is frequently viewed as the "faster" intersection between intersection S2 and S4. Based on the data, and as shown in Figure 8, the 85th percentile exit speeds are actually slower at S2 than at S4.

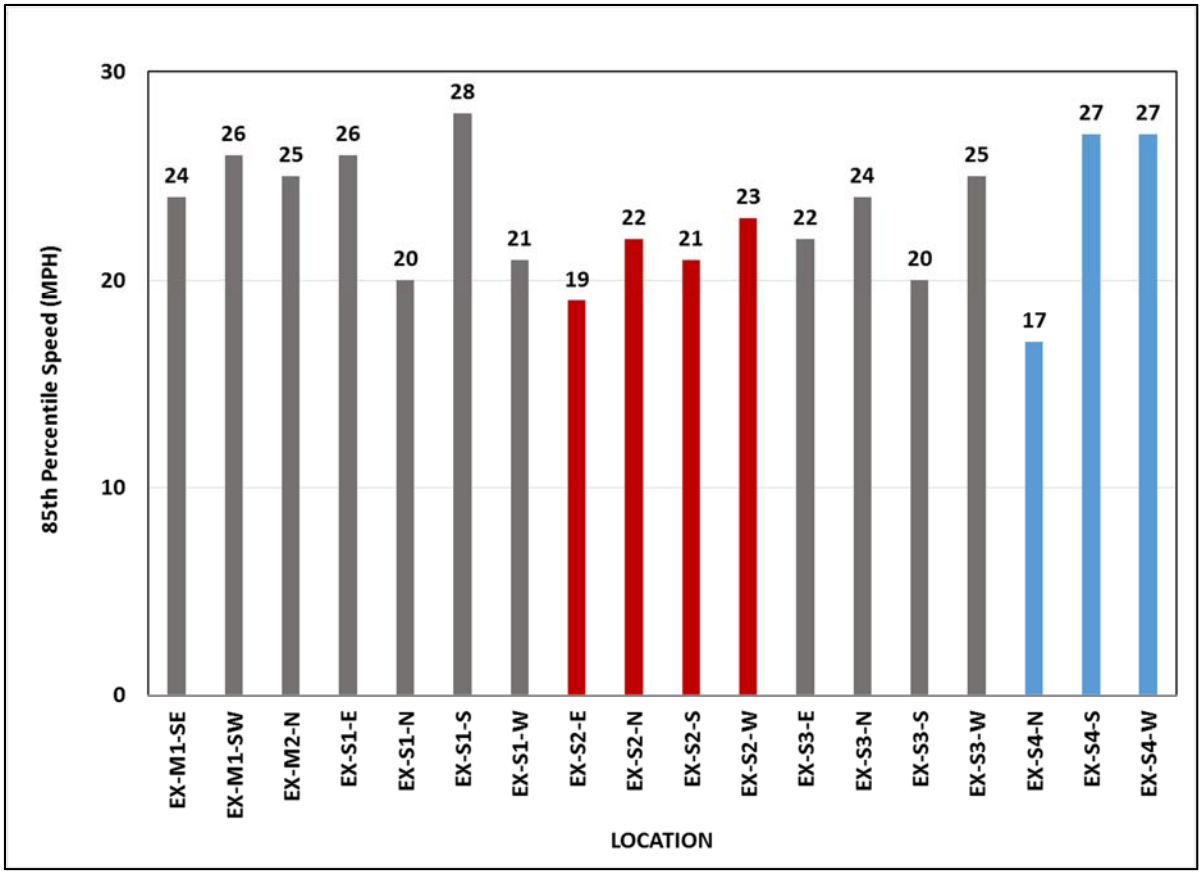

Figure 8. 85th Percentile Exit Speeds

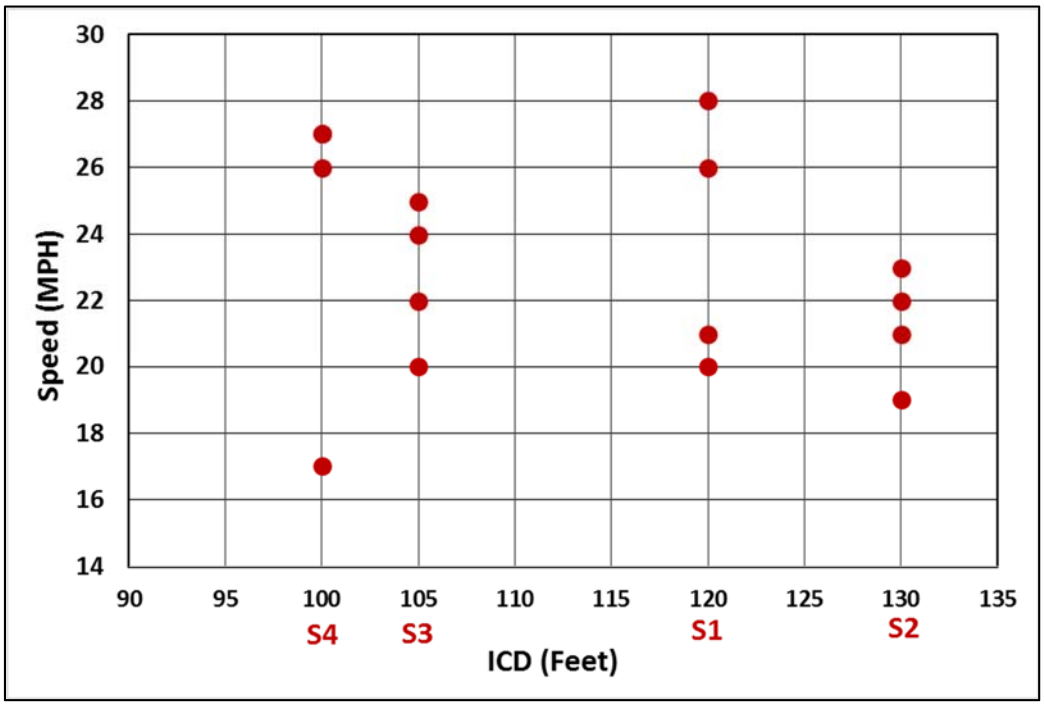

Figure 9. ICD versus 85th percentile exit speeds

Interestingly, the largest ICD single lane roundabout in the study (S2) has the tightest grouping of 85th percentile speeds, some of which are lower than the speeds experienced at the smaller 100 (S4) and 105 (S3) foot ICD intersections. Like the entry data, the exit data appears to be normally distributed in most instances. Figure 10 illustrates the exit speed frequency distributions for location S3, a single lane roundabout with a 105 foot ICD.

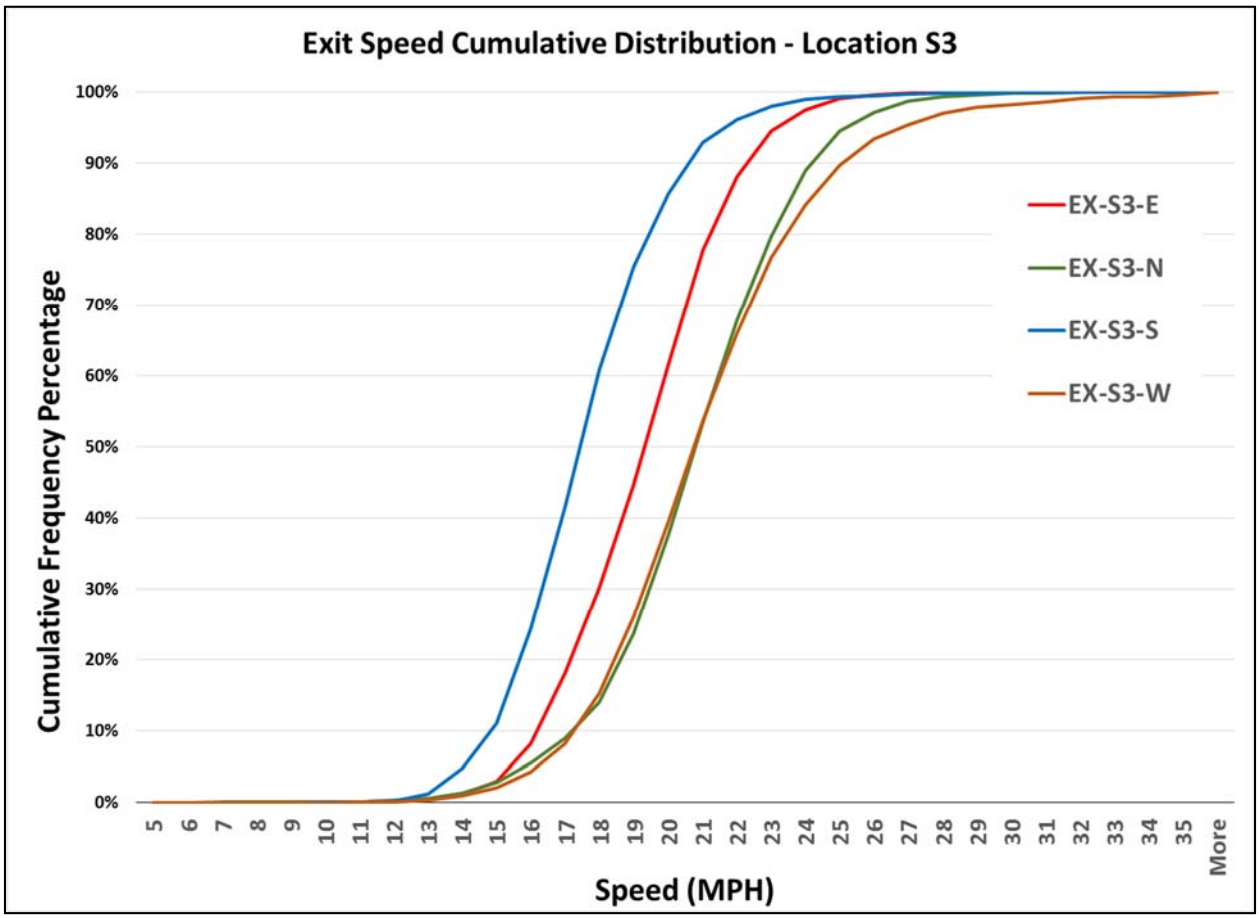

Figure 10. Exit Speed Cumulative Distribution – Location S3

The large speed data sample allows for the operation of each roundabout to be checked and assessed. Reviewing the speed distributions can also confirm that speeds are slower on entry and faster on exit. In Figure 11, the northbound through movement at location M2, the multilane roundabout in Addison, is represented as an entry speed and exit speed distribution. The entry is clearly shifted to the left indicating slower entry speeds than exit speeds in this instance.

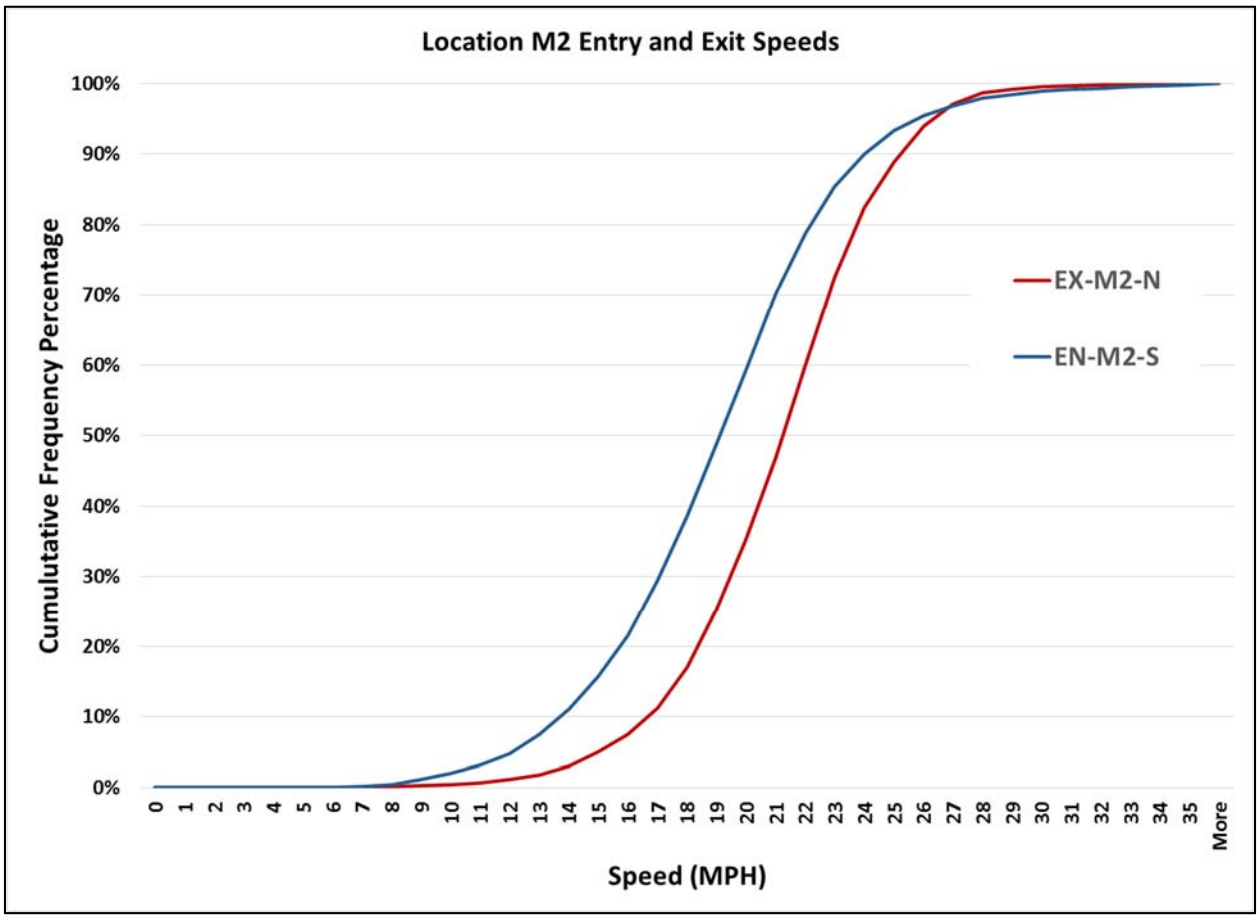

Figure 11. Entry and Exit Speed Cumulative Distribution – Location M2

CONCLUSION

Compared to traditional intersection types, generally low speeds appear to be the norm at the sampled single and multilane roundabouts in north Texas. Average entry speeds ranged from approximately 11 to 19 miles per hour at the study locations. Average exit speeds ranged from 14 to 24 miles per hour.

Based on this review of the available data, the general perception held by some local public officials and local engineers that operating speeds are related to inscribed circular diameter does not appear supported. The perceptions of a location as “fast” or “slow” may not necessarily reflect the actual speeds in the various intersections.

Future study should evaluate the relationship between the entry geometry, entry angle and calculated fastest paths with the collected speed data. Additionally, future study may investigate the relationship that congestion and delay at these intersections may have on their perceived operating speed.

The most important point to take away from this data is the continued reinforcement that roundabouts of a variety of sizes and lane configurations can all be successful in creating a low speed driving environment that is safer for the motoring public.