Roundabout Experience in Nevada after 20 years

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Abstract

Modern roundabouts are now considered an integral part of intersection controls in the US compared to the 1990s when they were first introduced. This partly is due to the increased number of as a result of roundabout's ability to improve safety at intersections and to operate efficiently under varying traffic conditions. The influence of roundabouts has also grown steadily because of its effectiveness in the reduction of crashes (rates and severities), fatalities and delays at intersections. Engineers and politicians thus continue to promote them, resulting in some states adopting the "Roundabout First Policy." More roundabouts are therefore expected to be constructed. Theoretically, with the increased number of roundabouts, driver maneuvering skills is also expected to improve accordingly. However, during a recent study involving roundabouts in Nevada, observations revealed mix results. The issues of concern center on driver behavior relating to safety and capacity. These observations are of concern since currently, any planned new intersection is a possible roundabout location and also some existing intersections are being converted to roundabouts. This paper discusses observations made during a recent data collection effort to measure "critical gap" and "follow-up time" at ten roundabouts in Northern and Southern Nevada. From the data collected, the observations suggest that a sizeable number of drivers still lack adequate understanding to maneuver roundabout thus increasing the potential for crashes. Another observation is the risk that pedestrians are exposed to since most drivers failed to stop though pedestrians were waiting at designated crosswalks. These observations lead to the recommendation of a need to carry out public education on the operations of roundabouts for every new roundabout installation and also for certain locations that have persistent issues. The expectation is to improve capacity and safety for vehicles and pedestrians (especially pedestrians with disabilities.)

Keywords: Modern roundabouts, safety, capacity, pedestrian

Introduction

Modern roundabouts after its introduction in 1990 have become a significant intersection control in the USA. Currently there are over 2000 roundabout in the US with more being added every year[1]. Las Vegas, Nevada was the first city to introduce roundabouts as an intersection control in Summerlin. There was a significant level of skepticism within transportation engineers and the public alike at the initial stages of installation concerning the suitability of roundabouts for US roads despite the overseas experience. Since the conception of roundabouts in 1966, there has been overwhelming success in safety and performance improvement reported in Britain, France, Germany and Australia etc. After the Nevada initiative, other States installed roundabouts and evidence suggest almost all those roundabouts have substantively improved safety and operation.. For the 20 years operating in the US, roundabouts experienced initial rejection (36 percent) through tolerance (59 percent) to acceptability and slowly becoming the preferred intersection control (over 70 percent) for several states[2] within one year of installation. The performance evaluations of roundabouts in the U.S. published to date are in line with the overseas experience[3], and have resulted in some agencies adopting the "Roundabout First Policy". One major advantage of roundabouts is safety. Roundabouts help in reduction of number of crashes and reduction of crash severities. Research in the US showed that converting intersections from traffic signals or stop controls to roundabouts reduced injury crashes by 80 percent and all crashes by 40 percent[4]. The severity of crashes for roundabouts is reduced because speeds are generally lower than for Traffic signals and also all vehicles travel in the same direction hence few conflict points, compared to traffic signals with lot of conflict points. In the US, roundabouts have operated successfully under urban, rural, residential and commercial areas and resulted in reduction in delays and crashes[5] generally..

Roundabouts are also able to operate efficiently at intersections where traffic volume varies drastically at different times of the day or year better than other intersection controls without any intervention. Roundabout generally experience lower delays since the "yield sign" allows drivers to merge into circulatory lanes when it is safe or no circulating vehicle without having to stop first[4]. This is a remarkable achievement within the relatively short period of introduction

During the early years of roundabout introduction in the US, most states preceded the opening of every roundabout with extensive public education to ensure maximum success. States like Kansas[6], Arizona[7] and Wisconsin[8] developed educational videos for each roundabout and sometimes used traffic wardens at the roundabout for several days to ensure drivers were able to maneuver around the roundabout adequately. The Nevada DOT like others also has useful information on the correct use of roundabout on their website. For Nevada, just like most of the other states, the initial enthusiasm with which drivers were educated on roundabout use has reduced considerably over the years. This partially may be attributed to the general idea that drivers are now sufficiently experienced with roundabouts.

Considering the good achievements reported with the introduction of roundabouts, the expectation is that drivers will also have gained more experience and relatively more skillful in maneuvering roundabouts[9]. Simply because drivers encounter roundabouts more frequently now than when first introduced. However, when observations were made in the field the results were inconsistent with expectations. This situation prompted further observations at different locations and the results is compiled and presented in this paper.

Methodology

This research was initiated based on observations of driver behavior observed during an ongoing research measuring critical gaps and follow-up times for selected roundabouts in Northern and Southern Nevada. The driver characteristics were observed during the video recording for main project hence the main method of data collection was video recording. The video recording for the original research involved at least 2 cameras. These cameras enable the capture of vehicles from a distance of about 450 ft when they approach the roundabout; while they negotiate the central island and during exit maneuvers. The recording hours were usually during the AM peak and the PM peak and lasted for a minimum of two hours each. The video recordings had the advantage of allowing replays.

Speed measurements were done using a handheld radar speed gun. The process involved selecting vehicles randomly and measuring the speeds before they entered the circulatory lanes (about 10-30 feet from the stop line) and sometimes when they negotiated the central island. The observer location was selected to prevent drivers from observing the speed gun pointed at them. This was necessary to eliminate the undesired effect of drivers decelerating suddenly in reaction to seeing the speed gun pointed at them. If it was perceived that a driver noticed the process and reacted, that recording was rejected.

The pedestrian observation involved two procedures. The first procedure was done by replaying video recording and estimating the number of vehicles passed before a driver was willing to stop for a pedestrian. The duration was estimated from the video recording time. The second approach involved the author making repeated crossings on all the legs of the study roundabout and observing the driver willingness to stop. The second procedure was subjective.

Observation

The video recording were played several times to observe the driver behavior and that resulted in the following discussion and the related conclusions. It must be stated that the selection of the roundabouts was solely based on the requirements necessary for measuring the critical headway and follow-up headway hence there was no previous knowledge of the observations made to prejudice the observation made. This section discusses the observations made from the video recording and in the field. Also discussed here is how these observations affect safety and capacity. The observations are generally driver related.

Speed

The field observations reveal a significant number of drivers do not reduce speed when approaching the yield line though there is a posted "speed limit" usually 25 mph and "yield" sign. Most roundabout also had a "roundabout ahead" notification sign posted in advance. The observation is prevalent on two lane roundabouts and also for roundabout with bigger inscribed circles (greater than 180 feet)[10]. These observations are commonly observed when a driver at about 200 feet from the yield line, observes no conflicting vehicle in the circulatory lane. Such drivers typically maintain speed or accelerate to merge unto the circulatory lane usually above the speed limit. The practice has safety concerns associated with it. Drivers occasionally lose control because of the circulatory lane curvature. Drivers while speeding to merge into the roundabouts are usually unable to yield to pedestrians at crosswalks (more at the exit legs). For two-lane roundabouts, while one driver may stop for a pedestrian, an adjacent driver is unable to stop because of speeding. Pedestrians are usually hesitant to cross upon observing such behavior at crosswalks. Blind pedestrians are at a greater risk because they depend on their hearing ability to cross[11].

Table 1 below shows speed data measured at some roundabouts. The maximum speeds recorded are all above the posted speed limits of 25 mph though the mean speeds are within limit.

Table 1 Speed Data for Selected Roundabouts in Southern Nevada

	Banbury/ N Town Center	Village Center/ N Town Center	Democracy/ Canyon Retreat	Havenwood/ Golden Willow	E Carey/ Hamilton	W Carey/ Revere
Mean	29	25	23	22	24	20
Mode	28	24	25	19	30	19
Minimum	15	19	12	14	11	14
Maximum	40	34	34	29	37	28

Hesitation at Yield Line

Driver hesitations at yield line even when there is no circulatory vehicle was present was surprisingly high despite the fact that "yield" signs were already in use the U.S. before the introduction of roundabouts . These observations are common to all types of roundabout. The main issue with this type of behavior is its capacity reducing effect. Whereas drivers familiar with roundabouts merge smoothly when the circulatory lane has an acceptable gap or no vehicle, other drivers will stop and sometimes hesitate for significantly long periods before merging onto the circulatory lane. This behavior introduces additional delays when there is a queue which sometimes results in intolerance with drivers following such vehicle. Arguments exist in favor of

hesitant driver behavior as being more safety inclined or generally accepting bigger gaps; but the capacity reduction and increased delays are undesirable effect for roundabout operations.

Pedestrian Safety

General observations suggest drivers were unwilling or unable to stop for pedestrians at designated crosswalks though pedestrians have priority. The situation is more critical for two lane roundabouts where one driver stops allowing a pedestrian to cross, but the driver in the adjacent lane is unable to react early enough before arriving at the crosswalk. The result is the pedestrian being faced with a dilemma of safety. It must be acknowledged this situation is not unique to Nevada or the USA; similar observations have been made elsewhere [12]. It is nevertheless worth noting since it can be very challenging for blind pedestrians hence the FHWA project researching safe crossing for persons living with disability[13]. For a State like Nevada where pedestrians have priority over vehicles, this situation needs urgent action, especially since most roundabouts are in location with few pedestrians hence not much is reported.

Illegal Maneuvers

The illegal maneuvers being referred to involve movements that are not allowed at roundabouts and can be likened to running of red light at a signalized intersection. The issue of illegal maneuvers at roundabout is its inherent ability to result in crashes. Though there aren't as many as before, they still take place and for the 30 hours of video recordings at various locations, the maneuvers mentioned below were captured. Drivers who drove opposite the traffic flow (clockwise) around the circulatory lane from a "north approach" to a "west exit" (As though making a left turn at a "stop control" intersection). This is illustrated in the Figure 1 below with the thick arrow line showing the vehicle path.

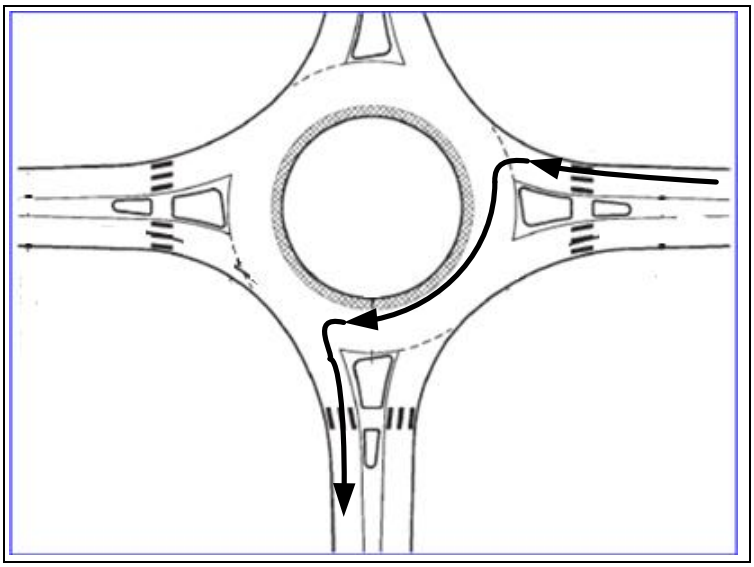

Figure 1 Diagram showing a vehicle making an illegal left-turn at a roundabout

Another common type is the making of U- turn from the approach lane into the exit lane on the same leg without going round the central island. An illustration in shown in the Figure 2 below with the thick arrow line showing the vehicle path

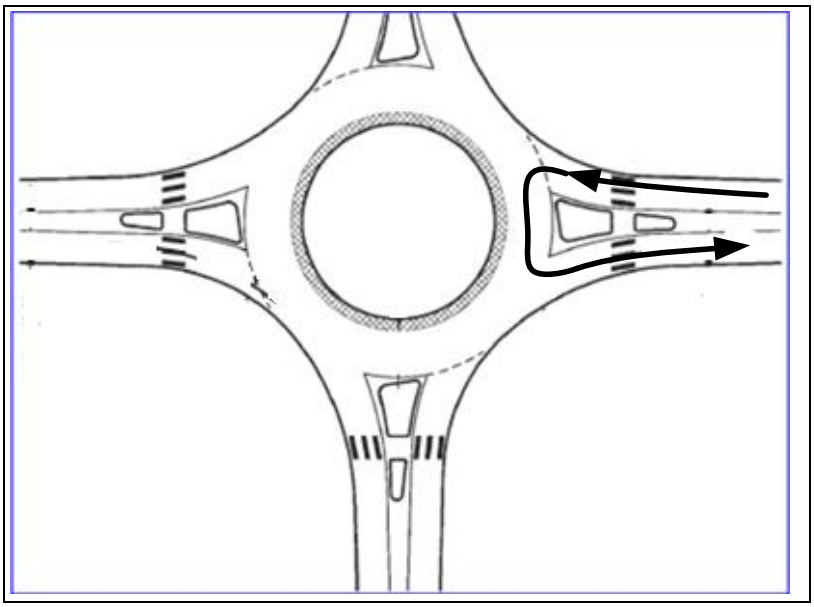

Figure 2 Diagram showing a vehicle making a U-turn at a roundabout

Another observation is circulatory vehicles stopping for entry vehicles. This results in the malfunction of the modern roundabouts. One of the major operational operation principles of roundabouts is vehicles in the circulatory lane have priority over entering vehicles. This could result in crashes since drivers following do not expect stops in the circulatory lanes.

Whereas the clockwise left-turn movement usually involves elderly drivers, the U-turning movements have been known to involve all categories of drivers. These movements raise safety concerns and give credence to the need for continuous driver education especially with every new roundabouts installation at intersections that had other control.

Inappropriate use of Entry lanes

This is unique only to multi-lane roundabouts. The phenomenon is observed when drivers approach from either the outer entry lane cut across to merge unto the inner circulatory lane rather than the prescribed outer circulatory lane, or a drivers coming from the inner entry lane and merges onto the outer circulatory lane though making a through movement or exiting at the third exit. This introduces a degree of uncertainty for drivers in the circulatory lane for two reasons. Drivers in the inner lane are not expecting cars from the outer entry lane to cut across the outer circulatory lane to merge unto the inner lane so maintain speed without watching out for such mergers. Also drivers in the outer circulatory lane are usually exiting so are not on the

look-out for driver from the inner lane merging into their lane. Figure 3 below illustrates these scenarios.

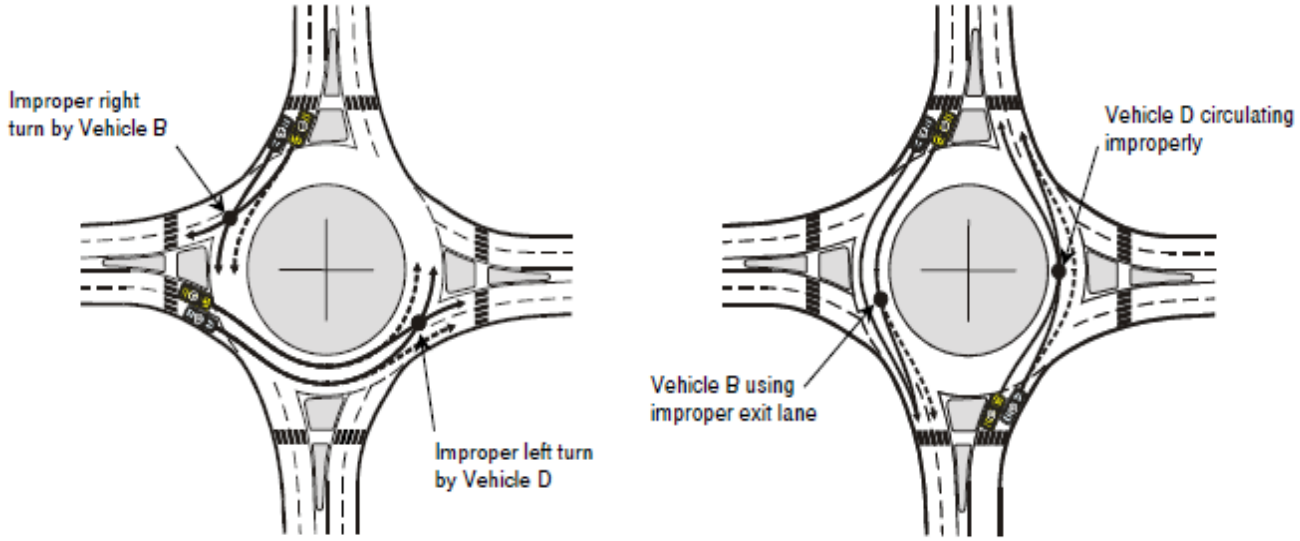

Figure 3 Diagram showing improper lane use at two lane roundabouts

Accident Data at Selected Roundabout

To justify the need for continuous public education for newly installed roundabouts Table 2 below shows accident data for selected roundabouts obtained from NDOT.

Table 2 Crash Data for Selected Roundabouts

	2-Lane Roundabouts						Single-Lane Roundabouts	
Year	**Banbury/ N Town Center**	**Village Center/ N Town Center**	**Democracy/ Canyon Retreat**	**Havenwood/ Golden Willow**	**E Carey/ Hamilton**	**W Carey/ Revere**	**5th St/ Fairview Ave**	**US95 Fernley**
2010	17	10	2	-	10	11	1	1
2009	25	18	1	-	14	17	7	-
2008	16	18	-	4	8	9	5	-
2007	31	12	-	1	8	6	5	1

From Table 2 it can be seen that, roundabout may experience an appreciable level of crashes when they are newly installed. A major advantage with crashes at roundabouts is that the severities are lower than experienced at other intersections. Using crash data from NDOT safety department, the major causes for the crashes as captured by the police reports were attributed to:

- Failure to yield right of way
- Failed to maintain lane
- Driving too fast
- Unsafe lane change
- Improper turn

Most of the above causes for accidents can be reduced or possibly eliminated if drivers have the requisite skill.

Conclusion and Recommendations:

Conclusions

Using field observations and studying the video recording the above discussions lead to the generally conclusion that a number of safety and capacity issues still exist at roundabouts and need to be addressed. They generally are related to driver skills and behavior characteristics. If addressed adequately the result is likely to lead to an increased efficiency and safety for roundabouts greater than previously reported.
Notable issues are;

- Speeding above the limit when approaching and negotiating the central island resulting in some avoidable crashes,
- Pedestrian safety when crossing at the crosswalks, especially for two lane roundabouts and
- Capacity reduction concerns related to driver hesitation at the yield lines.
- An issue of minor occurrence but with significant safety concern in illegal maneuvers

Recommendation

In order to address the concerns observed and further improve on the gains already reported for roundabouts, the following recommendations are suggested.

- Public education using television, radio and possibly internet media before opening any new roundabout to traffic flow.
- Also, the DMV can as part of their driver testing for new license seekers, test their skills at roundabouts to raise awareness.

NDOT could also consider occasional public education on the correct use of roundabout and upload simple demonstration videos on their website. For roundabouts with significantly high pedestrian population NDOT can consider experimenting the “press button” activated flashers so drivers are warn when a pedestrian is at the crosswalk.

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