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ABSTRACT

The design of mini-roundabouts has been around and practiced in Europe for decades. It has been a successful and low-cost intersection configuration. Nevertheless, accessible traffic capacity models for mini-roundabouts do not exist.

This study provides design recommendations and a simulation approach for capacity models of mini-roundabouts from USA data. Two typical geometries are selected that have a 24’ or 36’ approach widths typical of conventional intersections. The mini-roundabouts are best defined by the Inscribed Circle Diameter of 50’ and 75’. Mini-roundabouts are low-cost treatments using existing external boundaries of intersections. Field data are collected on Critical Gap and Headway acceptance for a similar design located in Stevensville, MD in order to calibrate a simulation. VISSIM Microsimulation software is used to model the selected prototype designs for capacity estimations. The defining feature for mini-roundabouts is the traversable central and splitter islands for large vehicles that make through or left turn movements.

The linear capacity models presented, estimate the capacity of the mini-roundabouts to be lower than that of the single-lane roundabout. However the mini-roundabout has a higher capacity per square foot of land which would be an innovative solution for urban areas for increasing capacity at existing AWSC intersections at lower cost than single-lane roundabouts.
INTRODUCTION

Over the past decade in the USA, single-lane and dual-lane roundabouts are becoming the preferred choice of intersection design for States, cities and towns. They have proven benefits in safety and traffic flow improvements when properly designed. One of the designs that may capture the attention of engineers in the US is the mini-roundabout. However this design is not new to the roundabout community outside the US. The mini-roundabout is an innovative intersection design in the US that can improve safety, reduce delays and facilitate slower speeds.

According to the NCHRP, of the Federal Highway Administration’s (FHWA) “Roundabouts: An Informational Guide,” mini-roundabouts are small roundabouts with fully traversable central islands used in low speed urban environments (1)(5). Mini roundabouts are described by their traversable inscribed circle diameter (ICD) which is the distance between the outer edges of the circular roadway. The design of a mini-roundabout should fit within existing boundaries whether they are curb returns or edge of pavements with shoulder.

Much of the literature about mini-roundabouts focuses on the design criteria from other countries and how they can be applied in the USA. One of the advantages in designing a mini-roundabout is that the diameter can range from 45 feet to 80 feet to stay within current boundaries of a typical intersection (1). The mini-roundabout is designed such that trucks and busses are allowed to traverse over the central island. Experience in Germany with trucks and busses traversing over the center island developed a limit of the height for the central island to not exceed 4.7 inches (2). Clive Sawers provides recommendations that in the USA the height of the center island should not be lower than 2 inches, a slight cross slope from the center and a the curbing to be 1:4 (3). This is to provide a safe height measure for trucks and busses to go over the island, ensures proper drainage and guides passenger cars safely though the mini-roundabout.

One of the concerns with constructing a new design such as the mini-roundabout in an area unfamiliar with the design is the impact on operational performance. This was investigated in Germany with a study that looked at the impact of converting 13 unsignalized intersections to mini-roundabouts. This study concluded no significant delay impacts with the mini-roundabout at volumes of approximately 17,000 vehicles per day (2).

The only capacity model that is available for analyzing mini-roundabouts is a empirical based model from a study by the United Kingdom in a program called ARCADY executed by Transport Research Laboratory (4). One of the equations from ARCADY/3 used in Europe for calculation of 4-way mini roundabouts is shown in equation 1 (7).

\[
Q_E = 1200 - Q_C
\]

where

\[
Q_E = \text{entry flow (Veh/h)}
\]
\[
Q_C = \text{circulating flow (Veh/h)}
\]

The NCHRP Report 572, “Roundabouts in the United States,” provides capacity equations for single and multilane roundabouts (5). The equation provided in NCHRP-572 for a single lane roundabout, is show in equations 2. This is the same model used in the HCM 2010 (6).
\[ c = 1130 \cdot \exp(-0.0010 \cdot V_c) \] (2)

where

\[ c = d_{e, \text{max}} = \text{entry capacity (Veh/h)} \]

\[ v_c = q_c = \text{conflicting circulating traffic (Veh/h)} \]

METHODOLOGY

To model the capacity of a mini-roundabout, three steps are undertaken. First, data on driver behaviors and travel characteristics at mini-roundabouts are observed from a similar mini-roundabout located in Stevensville, MD. Second, a microscopic traffic simulation model is developed to emulate drivers’ behavior and to simulate for different traffic flow scenarios in over saturated conditions. Finally, a regression model is developed and fitted to the simulated data to estimate the capacity of mini-roundabouts.

PERFORMANCE OF SIMILAR DESIGNS IN THE UNITED STATES

There are very few mini-roundabouts constructed in the United States that have all the desirable design recommendations. More importantly, no mini-roundabouts in the US operate at or near capacity. One site constructed in Stevensville, Maryland conforms closely to the basic design of a mini roundabout with an ICD of 80°. Nevertheless, the central and splitter islands are not raised and have no passenger car deterrent except for flex-posts located around the central island. This site was selected to evaluate the driver behavior with regard to gap and headway decisions. Video recordings were collected using cameras that captured data from 3:45 pm to 5:45 pm. The volume for this intersection is listed in Table 1. The cameras were set 30’ high on a telescopic pole shown in Figure 1.

The video data were used to collect time gaps (both accepted and rejected gaps) and follow-up time. An accepted gap is where a driver on the approach decides to move into the circulating stream as the (time) gap between vehicles is perceived sufficiently long. Rejected gaps are where a driver chooses not to move into the circulating stream as the gap is insufficient. Follow-up time is the (time) gap between the second vehicle and lead vehicle when entering the circulating stream. The driver behavior for cars and heavy vehicles were analyzed separately.

Figure 1: Data collection (left) and Google aerial photo (right) Stevensville, MD
TABLE 1: Traffic Characteristics Stevensville, MD

<table>
<thead>
<tr>
<th>Measures</th>
<th>Intersection Approaches</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>West Leg (Left)</td>
<td>North Leg (Off-ramp)</td>
</tr>
<tr>
<td>Entry flow, peak (veh/h)</td>
<td>290</td>
<td>320</td>
</tr>
<tr>
<td>Entry flow, off-peak (veh/h)</td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>Peak-hour factor</td>
<td>0.6</td>
<td>0.65</td>
</tr>
<tr>
<td>Vehicle composition (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Passenger cars</td>
<td>47%</td>
<td>48%</td>
</tr>
<tr>
<td>- Pickup trucks/SUV’s</td>
<td>51%</td>
<td>49%</td>
</tr>
<tr>
<td>- Trucks</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Turning movement (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Left-turn</td>
<td>82%</td>
<td>61%</td>
</tr>
<tr>
<td>- Right-turn</td>
<td>18%</td>
<td>39%</td>
</tr>
</tbody>
</table>

Note: *Calculate from the maximum 5-minute peak entry flow.*

TABLE 2: Field Data Results Stevensville, MD

<table>
<thead>
<tr>
<th>Approach</th>
<th>Decision</th>
<th>Critical Lag</th>
<th>Critical Gap</th>
<th>Follow-up Headway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>West Leg</td>
<td>Accepted</td>
<td>2.6-4.9</td>
<td>3.6</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Rejected</td>
<td>&lt; 4.3</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>North Leg</td>
<td>Accepted</td>
<td>1.7-6.7</td>
<td>3.4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Rejected</td>
<td>&lt; 3.5</td>
<td>1.8</td>
<td>1.2</td>
</tr>
<tr>
<td>South Leg</td>
<td>Accepted</td>
<td>2.1-4.7</td>
<td>3.5</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Rejected</td>
<td>&lt; 4.3</td>
<td>2.4</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Note: *S.D. = standard deviation, N = sample size.*

One observation in Table 2 are that the vehicles on the west leg have shorter critical gap because the distance between the entry of the north leg and west leg is shorter. As a result, vehicles on the west leg entering the roundabout were more aggressive with the gap from the vehicles approaching from the north leg. These critical gap values and follow up headway will be used in the calibration of the microsimulation model.

DRIVER BEHAVIORS AT MINI-ROUNDABOUTS

By the design of a mini-roundabout, heavy vehicles (HV) need to climb over the traversable circular island because their tracking surface requires a wider swept path. Hence, heavy vehicles and cars traverse along different paths through a mini-roundabout and the drivers of these two vehicles behave in a different way. The cars’ drivers yield to the vehicles in the circulating stream similar to those at a modern roundabout. On the other hand, trucks’ drivers at a mini-roundabout are more likely to behave as those at an all-way stop-controlled (AWSC) intersection. Heavy vehicles not only yield to the circulating vehicles but also verify that there is no other vehicle entering the intersection; in other words, when the trucks enter the mini-roundabout, vehicles from other approaches are stopping.

There are two factors influencing the drivers’ yield decision, drivers’ yielding behavior and the other is the drivers’ gap acceptance.
Drivers’ Yielding Behavior

Based on field observations, when vehicles arrive at a mini-roundabout, they yield to other vehicles. Yielding behaviors of drivers at a four-legged mini-roundabout can be classified into four rules based on types of vehicle conflicts (Car vs. Car, Car vs. HV, HV vs. Car, and HV vs. HV.) Consider vehicles from the eastbound (EB) approach.

Rule 1: Entering cars yield to other cars in the circulating stream, if the gap time and headway are sufficiently safe.

Rule 2: Entering cars yield to (i) left-turn and through heavy vehicles from the southbound (SB) approach; (ii) left-turn heavy vehicles from the westbound (WB) approach; and (iii) left-turn and through heavy vehicles from the northbound (NB) approach, if the gap time and headway are sufficiently safe.

Rule 3: Entering heavy vehicles yield to other cars in the circulating flow or from the SB approach, if the gap time and headway are sufficiently safe.

Rule 4: Entering heavy vehicles yield to (i) left-turn and through heavy vehicles from the SB approach; (ii) left-turn and through heavy vehicles from the WB approach; and (iii) left-turn and through heavy vehicles from the NB approach, if the gap time and headway are sufficiently safe.

Figure 2 shows that conflict areas that the drivers of cars and heavy vehicles approaching a mini-roundabout that are taken into account in simulation. When a car arrives, it yields to the vehicles in the circulating stream and to those on his/her left approach. If four cars arrive (one on each approach) at a mini-roundabout, then the total of four cars can be served at the same time. When a heavy vehicle arrives, the mini-roundabout is operated as first-come-first-serve. When the heavy vehicle enters, all other vehicles stop until the heavy vehicle leaves the intersection. The only difference between the yielding rules between cars and heavy vehicles is that a car may enter when there is a through heavy vehicle from the opposite direction. However, this is not the case for a heavy vehicle. A heavy vehicle will stop and wait until no other vehicles occupy the intersection box.

Figure 2: Clearance Zones for Cars and Heavy Vehicles
Setting the reasonable gap times and headways for each conflict in the simulation is challenging and these values affect the capacity estimate of the mini-roundabout.

Drivers’ Gap Acceptance

Once the data were collected and collated, curves representing the frequency of rejected and acceptance gaps were developed, and critical gap and lag are calculated. Gap acceptance parameters form a crucial part of many analytical and simulation models to evaluate the capacity of roundabouts. Critical gap is defined as the threshold by which drivers approach at a roundabout judge whether to reject or accept the available gap (yield or not yield to vehicles circulating). Critical lag happens when the number of accepted shorter lags is equal to the number of rejected longer lags (14).

MIRCOSIMULATION

VISSIM simulation software is used to model the capacity of 50’ and 75’ ICD mini-roundabouts. VISSIM is a microscopic, time-step and behavior-based traffic flow simulation model that includes urban traffic operations. (10) The design templates of the 50’ and 75’ ICD mini-roundabouts designed from a CAD are imported as background to the VISSIM software. The links in VISSIM are created for all vehicle movements and the vehicle characteristics are specified. For both 50’ and 75’ ICD mini-roundabouts, desired speeds of vehicles are set between 22 and 28 mph, and entry speeds of vehicles are 15 to 20 mph for both cars and heavy vehicles. Circulating speeds of all vehicle types are 8 to 12 mph in a 50’ ICD mini-roundabout, and they are between 13 to 17 mph in a 75’ ICD mini-roundabout. These speeds are based on field measurements at the Stevensville, MD site.

In the simulation, the eastbound (EB) approach of a four-legged mini-roundabout intersection was selected to measure estimated capacity, or maximum throughput. The concept for estimating capacity on the EB approach is to flood vehicles from this approach while varying the combination of traffic volumes at the other approaches. The volumes are designed to represent different traffic conditions with each approach simulating different intersection demands. The design for the input volumes simulated 343 different traffic scenarios (7 traffic volumes—0, 200, 400, 600, 800, 1000, 1200 veh/h on three approaches). The calculation is repeated for every 2 percent increase in heavy vehicles (from 0 to 10%). The proportions of left-turn and right-turn movement on each approach are selected randomly between 0-20%.

Vehicle Paths in VISSIM

One of the main differences between the mini-roundabout and the single-lane roundabout is the route for heavy vehicle (HV) movements. Given the complexity of heavy vehicle movements and their permutations (Car vs. Car, Car vs. HV, HV vs. Car, HV vs. HV) heavy vehicles and cars were designated to have separate VISSIM links/connectors and specific routing assignments, as shown in Figure 3. The priority rules for heavy vehicles to traverse the island require all other approaches to be clear as a heavy vehicle enters into the roundabout.
Priority Rules in VISSIM

In a VISSIM simulation, priority rules are used to simulate vehicle movements at conflict locations. The two parameters that are used to control priority rules are; (1) gap time and (2) headway spacing. Gap times are defined as the minimum gap in time that a merging vehicle needs to enter a circulating traffic stream. The headway is defined as a distance that identifies a space that will need to be clear for the merging vehicle to enter the traffic stream under the congested condition. The priority rules for the mini-roundabout design are more complicated than a typical single-lane roundabout. This part of the design is most critical as a result of the interaction between cars and heavy vehicles that requires different headways and gap time calibrations between different layers. Figure 4 shows the clearance zones for single-lane, AWSC and Mini-roundabout. The clearance zone shows the different priority rules for each of the three designs and how the mini-roundabout is a combination of the single-lane and AWSC.
In VISSIM, priority rules are set by two markers. One is a red stop line marker, and the other is a set of green conflict markers. Figure 4 shows examples of priority rules used for left-turn entering car. The red stop marker on the entry link indicates entering vehicle boundary and the green conflicting markers represent the circulating flow boundaries. The space between the downstream green dashed line and the upstream green dashed line represents the headway spacing. The priority rules for a single lane roundabout are much simpler than that of a mini-roundabout design with only the merge conflict being the only location for priority rules. For example, for left-turn entering cars, nine priority rules are considered as shown in Figure 5. Based on drivers’ yielding behaviors, four stop lines are used at the entry of each approach for different types of vehicle conflicts. These four stop lines are all set at the same location on each approach (just before entering the mini-roundabout.) For each stop line, the conflict markers are defined according to different movements of entering vehicles and conflicting vehicles.

The critical gap values from field observations were used to create the clearance zones (as demonstrated in Figure 5), although the observation site has different intersection configuration from the proposed mini-roundabouts. These conflicting zones are then defined by the gap (time) during uncongested condition and headway (distance) during congested condition in VISSIM.

These conflicting zones are then defined by the gap (time) during uncongested condition and headway (distance) during congested condition in VISSIM. The conflicting zones for Car vs. Car (M1-M2) in Table 3(c) are defined by both gap (time) and headway (distance) to ensure that the entering cars will yield to the conflicting cars from the left approach and circulating cars. The values were derived from the mean accepted gaps obtained from field data; however, the values were refined in order to match with the typical 2-lane and 3-lane 4-legged intersections.

The conflicting zones for Car vs. HV, HV vs. Car, and HV vs. HV are defined by headway (distance). These clearance zones are defined from the departure point to the 10-ft downstream of the stop markers of the conflicting approaches. By locating these conflicting markers (from the departure points to the 10-ft downstream), it will ensure that the vehicles will operate as first-come first-serve at the intersection and when a truck is in the mini, no other vehicles will enter the intersection. The gap and headway values for each clearance zone are varied based on the inscribed diameter of a mini-roundabout and intersection configurations.
Table 3 compares the priority rules used in VISSIM for controlling vehicles at a single-lane roundabout, an all-way stop-controlled (AWC) intersection, and a mini-roundabout. For a single-lane roundabout, only three priority rules are defined: (i) left-turn or through entry vehicles conflicting with circulating vehicles from left or opposite approach; (ii) right-turn entry vehicles with leading left-turn or through; and (iii) left-turn or through entry vehicles with leading right-turn for a total of 9 rules. For an AWSC intersection, 13 priority rules are defined, five rules for entry vehicles conflicting with vehicles from left or opposite approach, four rules for opposing approach, and four rules with vehicles from right approach, for a total of 52 rules. For a mini-roundabout, 30 priority rules are defined for different combinations of vehicle conflicts on one approach (12 for entry cars and 18 for entry HVs.) These priority rules are set similarly for all approaches; hence, there is a total of 120 rules for a four-legged mini-roundabout. The priority rules for Car vs. Car at a mini-roundabout (M1-M3) are similar to those for a single-lane roundabout (R1-R3), and the priority rules for HV vs. HV at a mini-roundabout (M18-M30) are

Figure 5: Example of priority rules for a left-turn entering car

Circulating cars from the left and opposite approach
Leading right-turn car on the same approach
Left-turn heavy vehicles from the left approach
Through heavy vehicles from the left approach
Left-turn heavy vehicles from the opposite approach
Left-turn heavy vehicles from the right approach
Through heavy vehicles from the right approach
Left-turn heavy vehicles on the same approach
Leading right-turn heavy vehicle on the same approach
The capacity models of mini-roundabouts in this study are developed using a calibrated micro-simulation model, that use gap-acceptance modeling to emulate drivers’ yielding behavior to circulating vehicles before entering a mini-roundabout. The parameters for the functional form of the capacity of a mini-roundabout are estimated using a linear regression model. It is assumed that the capacity (entry flow rate) is a function of circulating cars and conflicting truck movements HVs, shown in Figure 6(a).

TABLE 3: Comparison of Priority Rules for Different Intersection Controls in VISSIM

(a) Priority Rules for a Single-Lane Modern Roundabout

(b) Priority Rules for an All-Way Stop-Controlled Intersection

(c) Priority Rules for a Mini-Roundabout
Determination of Entering and Circulating Flows

To model the capacity of the mini roundabout, multiple data evaluation points are created in a VISSIM simulation model in the roundabout to record the entering and circulating flow rates, see Figure 6(b). The first evaluation point is set on the eastbound approach and counts cars for maximum throughput or estimated capacity. This approach is flooded in the simulation (with 2400 veh/hr) to make assure that there is always a queue. To calculate the entering volume passenger car equivalence (PCE) for trucks, the AWSC PCE for level terrain is weighted by a $(E_T)$ default value of 1.7 (6). According to HCM 2010, a factor 2.0 is applied to trucks to convert to passenger car equivalents for a single lane roundabout (11). Based on the turning movements of heavy vehicles for the mini-roundabout which relate similar to AWSC, the default value was set to 1.7, see Eq. (2).

\[
\text{Entry Flow Rate (\(V_e\))} \\
\text{Entering Volume} = V_{e,\text{Car}} + E_T \ast V_{e,\text{HV}} \quad (2)
\]

where:
\[
V_{e,\text{Car}} = \text{Volume of entering passenger cars} \\
V_{e,\text{HV}} = \text{Volume of entering heavy vehicles} \\
E_T = \text{Passenger Car Equivalent for Heavy Vehicle (default = 1.7)}
\]

Only one evaluation point is needed to capture passenger cars that are circulating and are located north of the entering volume and are in conflict with the eastbound approach. In Figure 6(a), three evaluation points are needed to capture the heavy vehicle movements; NB Left ($V_{C,\text{HV,NBL}}$), WB Left ($V_{C,\text{HV,WBL}}$) and SB Thru ($V_{C,\text{HV,SBT}}$). The circulating volume is calculated by the weighted sum of circulating vehicles and heavy vehicles as shown in Eq. (3).

\[
\text{Circulating Flow Rate (\(V_c\))} \\
\text{Circulating Volume} = V_{c,\text{Car}} + E_T \ast (V_{C,\text{HV,NBL}} + V_{C,\text{HV,WBL}} + V_{C,\text{HV,SBT}}) \quad (3)
\]

where:
\[
V_{c,\text{Car}} = \text{Volume of circulating and conflicting passenger cars} \\
V_{C,\text{HV,NBL}} = \text{Volume of heavy vehicles, northbound left} \\
V_{C,\text{HV,WBL}} = \text{Volume of heavy vehicles, westbound left} \\
V_{C,\text{HV,SBT}} = \text{Volume of heavy vehicles, south bound thru} \\
E_T = \text{Passenger Car Equivalent for Heavy Vehicle (default = 1.7)}
\]

For the circulating volumes conflicting with the eastbound approach, the west, north and south bound approaches are set to provide combinations of volumes were the sum did not exceed 1400 veh/hr.
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Figure 6: Entering and Circulating Flow for a Mini-Roundabout

Estimation of Capacity Models
The equations developed for 50’ and 75’ ICD are shown in Equation 4 and 5. The approach capacities are estimated using various ranges of circulating volumes (which is a result of different combination of approach volumes from conflicting approaches, % HV’s, % Left turns and % Right-turns) that are derived from hypothetical flows on adjacent approaches. The simulation results indicated that the capacity of 50’ mini-roundabout is smaller than that of 75’ mini-roundabout. An increase in conflicting vehicles causes a reduction in the mini-roundabout capacity for the 50’ versus the 75’ mini-roundabout results (see coefficient values: -1.025 for the 50’ and -0.944 for the 75’).

\[
C_{50ICD} = 1009 - 1.025 \times V_C ; \quad R^2 = 0.978 \tag{4}
\]

\[
C_{75ICD} = 1020 - 0.944 \times V_C ; \quad R^2 = 0.967 \tag{5}
\]

where \( V_C \) is the conflicting vehicles in passenger car equivalent per hour.

Figures 7(a) and 7(b) illustrate capacity estimates from VISSIM for mini-roundabouts with 50’ and 75’ ICD, respectively. In these figures, the simulated data points are plotted and the best fitting curve based on a linear regression is presented.
Figure 7: Mini-Roundabout Entry Capacity as a Function of Conflicting Flow

**Effect of Heavy Vehicles**

Heavy vehicles used in this simulation are appropriate for light trucks, school busses, fire trucks, delivery trucks, tow trucks etc. Trucks are shown to have an effect on capacity as shown in Figure 8. Simulations where run with 50% and 100% trucks that show significant impacts on capacity but these situations are not typical at roadway performance and were not included in the model design. The vehicles with trailers such as WB-50 trucks were not modeled in this simulation. The WB-50 truck will still be able to traverse the 50’ and 75’ ICD mini-roundabout tested using AUTO turn. The study estimates the capacity model for 0-10% heavy vehicles only which more realistically represents typical conditions in the field.
The capacity estimates of mini-roundabouts when compared to other intersection alternatives, including an all-way stop-controlled (AWSC) intersection and a single-lane modern roundabout, show that the capacity of a mini-roundabout is higher than that of an all-way stop-controlled intersection, but lower than that of a single-lane modern roundabout. This is because there are more complex interactions among vehicles at mini-roundabouts than modern roundabouts. For example, the simulation suggests that the NCHRP-572 equation for single lane roundabout predicts higher values for capacity than the mini roundabout model presented in this paper, see Figure 9.

**Figure 8: Effect of heavy vehicles on the mini-roundabout capacity**
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Figure 9: Comparison of Capacity Estimates of Different Intersection Designs

Capacity to Area
One of the advantages of the mini-roundabout is the amount of land required to build or convert to this intersection. When building a single-lane roundabout additional right-of-way is usually required based on the size of the ICD compared to an AWSC. In Figure 10, the entry capacity per foot-print area is shown as a function of circulating flow. The 50’ and 75’ ICD mini-roundabouts have a larger entry capacity per area than that of the single lane roundabout. This means that the mini-roundabout uses the area more efficiently based on the demand of the entering capacity. This would be applicable for converting an AWSC intersection to a Mini-roundabout resulting in an increase in capacity. For example; if 200 vehicles are circulating, the entry capacity for the 50’, 75’and single lane roundabout is about 400, 200 and 100 vph / 1,000sf respectively. Thus, the 50’ mini-roundabout has higher capacity per square foot up to a circulating volume greater than 800vph, where the single-lane roundabout surpasses the mini-roundabout.
CONCLUSION

This research has presented a methodology to estimate parameters of an analytical capacity model for the 50’ and 75’ ICD mini-roundabouts. The linear models presented are based on VISSIM simulation results where VISSIM has been calibrated from field data. The models presented include parameters for the 50’ and 75’ ICD mini-roundabout designs. The simulation results suggest that linear models provide useful estimates of capacity for the two selected prototype designs. Estimated capacity for the 50’ICD mini-roundabout is smaller than the 75’ ICD where heavy vehicles are shown to affect the capacity at high heavy vehicle presence. When comparing the land required to construct or convert from an AWSC to a mini-roundabout or single-lane roundabout, the mini-roundabout has higher entering capacity per square foot. This would be a useful design when optimizing existing land in urban areas to increase capacity at lower cost.

Figure 10: Entry capacity per area
REFERENCES