Experimental Analysis of a Direct Access Driveway at a Roundabout: Performance with One or More Slip Lanes

Presented by
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Access Management

• Roundabouts can be used as an intersection design to facilitate major traffic turning movements and to enhance operational and safety performance.
• Should Access Management support direct driveway access to a roundabout?
• If a slip lane is present, how does the proposed driveway impact traffic delay?
Roundabout: Shanghai, China- with Four Slip Lanes

A Roundabout with a Driveway

Hillborough Street and W. Morgan Street, Raleigh, NC, USA
**Objective**

- To explore overall roundabout and driveways’ operational performance in a simulated environment by quantifying average delay with and without slip lanes options.

**Approach**

- Development of Experimental Scenarios
- Analytical Framework (Flow charts)
- Literature Review
- Inputs
- VISSIM
- Conflicting Flow Analysis
- Sensitivity
- Process
- Output
- Roundabout and Driveway Operational Performance
### Scenarios

<table>
<thead>
<tr>
<th>Variable Symbols</th>
<th>Variable Description</th>
<th>Level of Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vₕt</td>
<td>Right-Turn volume as dominant turn at Northbound Approach</td>
<td>50, 100, 150, 200, 250, 300, 350, 400, 450, and 500 vehicles per hour.</td>
</tr>
<tr>
<td>DRW</td>
<td>Driveway Volumes</td>
<td>DRW50: Low driveway’s volumes (50 vehicles/hour).</td>
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<tr>
<td></td>
<td></td>
<td>DRW100: Moderate driveway’s volumes (100 vehicles/hour).</td>
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<tr>
<td></td>
<td></td>
<td>DRW300: High driveway’s volumes (300 vehicles/hour).</td>
</tr>
<tr>
<td>S₁</td>
<td>No Driveway</td>
<td>Balanced scenarios:</td>
</tr>
<tr>
<td>S₂</td>
<td>With a Driveway</td>
<td>Balanced flow with 75 percent flow for all turns.</td>
</tr>
<tr>
<td>S₃</td>
<td>Slip Lane and No Driveway</td>
<td></td>
</tr>
<tr>
<td>S₄</td>
<td>Slip Lane and a Driveway</td>
<td></td>
</tr>
<tr>
<td>S₅</td>
<td>Two Slip Lanes and No Driveway</td>
<td></td>
</tr>
<tr>
<td>S₆</td>
<td>Two Slip Lanes and a Driveway</td>
<td></td>
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</tbody>
</table>

### Assumptions

- A single-lane roundabout.

- Traffic percentage distribution flow matrices were assumed as balanced (traffic flow into and out of every roundabout approach is the same).

- A dominate right-turn was assumed to be placed at the northbound (NB) entry to the roundabout.

- A direct driveway access road, one lane driveway right-out movements only, to allow facility (land parcel) driveway volumes to access directly at a roundabout.
Scenario S1 (No Driveway)

Scenario S2 (With a Driveway)
Scenario S3 (Slip Lane and No Driveway)

Scenario S4 (Slip Lane and a Driveway)
Scenario S5 (Two Slip Lanes No Driveway)

Scenario S6 (Two Slip Lanes and a Driveway)
### Analysis

Sample of VISSIM Driveway Average Delay – Balanced Scenarios (S2 and S4).

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>( V_{nt} ) Right-Turn Volume at Northbound (NB) Approach (Vehicle/hour)</th>
<th>Average Driveway Delay (seconds) (Standard Deviation(s) Errors for 20 Runs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Driveway Volumes (DRW50)</td>
<td>Driveway Volumes (DRW100)</td>
</tr>
<tr>
<td>S2</td>
<td>50 (Low)</td>
<td>0.5 (1.2)</td>
</tr>
<tr>
<td></td>
<td>250 (Med)</td>
<td>3.6 (4.7)</td>
</tr>
<tr>
<td></td>
<td>500 (High)</td>
<td>11.6 (10.7)</td>
</tr>
<tr>
<td>S4</td>
<td>50 (Low)</td>
<td>0.5 (1.7)</td>
</tr>
<tr>
<td></td>
<td>250 (Med)</td>
<td>2.0 (3.2)</td>
</tr>
<tr>
<td></td>
<td>500 (High)</td>
<td>3.7 (4.8)</td>
</tr>
</tbody>
</table>

Source: Al-Ghandour, et. al. 2011.

At high driveway's volumes level, the total average roundabout traffic delay was increased by 50% at a moderate vehicle traffic level, before oversaturation.

Sample of Outputs from VISSIM: Comparison between Roundabout Average Delay, Scenarios S1-S6.
High Volume Driveway (DRW300) 300 vehicles per hour

Sample of Outputs from VISSIM: Comparison between Roundabout Average Delay, Scenarios S1-S6.

Moderate Volume Driveway (DRW100) 100 vehicles per hour

Sample of Outputs from VISSIM: Comparison between Driveway Average Delay, Scenarios S2, S4, and S6.
High Volume Driveway (DRW300) 300 vehicles per hour

The total average driveway traffic delay was increased by 12% at a high traffic level, before oversaturation.

The total average driveway traffic delay was increased by 7% at a high traffic level, before oversaturation.

Conclusions & Recommendations

- Experiment results indicate that average delay of a roundabout is sensitive to changing driveway’s volumes.

- As expected, results indicate a direct access driveway increases the roundabout vehicle average delay.

- At high driveway’s volumes level, the total average roundabout traffic delay was increased by 50% at a moderate vehicle traffic level and by 71% at a high vehicle traffic level, before oversaturation.
Conclusions & Recommendations

- The total average driveway traffic delay also was increased by 8% at a moderate traffic level and by 12% at a high traffic level, before oversaturation.

- Finally, this study also suggests that having more than one slip lane, at different roundabout approaches, reliefs total roundabout average delay, provides an efficient direct roadway driveway access, and enhances access management.

Future Research

- Future research should include investigating the performance of access point driveways with full movement (right-in and right-out) access near a roundabout, including the capacity of the access point, left-turn storage needs, including access spacing criteria and sight-distance.

- Finally, future analysis should be conducted to consider more variations in percentages of trucks in and out from the driveways.
Contact Information & Questions

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THANK YOU