“AN EVALUATION OF CHARACTERISTICS THAT IMPACT VIOLATION RATES AT RIGHT-IN / RIGHT-OUT DRIVEWAYS”
Steve Thieken, PE, PTOE
Bachelor of Civil Engineering from University of Dayton
MS in Transportation Engineering from The Ohio State University
Transportation Engineer for Burgess & Niple, Inc., Columbus, Ohio
11-years of experience
Overview

- Define Right-in/Right-out Driveway and Issues
- Motivation and Objectives
- Surveys and Literature Review
- Data Collected and Violation Rates
- Case Studies and Analysis
- Conclusions
What is a Right-in/Right-out Driveway?

[Diagram showing a Right-in/Right-out Driveway with a raised concrete island, yellow delineators, and a stop sign.]

YELLOW DELINEATORS e 5' C-C

DOUBLE YELLOW CENTERLINE

RAISED CONCRETE ISLAND

ONLY

STOP
What is a Right-in/Right-out Driveway?
Focus of this Research

- No continuous center median on the mainline to physically prohibit movement
- On arterial streets
Why install one?

To dissuade or prohibit left-turns
Why dissuade or prohibit left turns?

To reduce vehicular conflicts

Full Access Drive

RIRO

Source: National Highway Institute
Why reduce vehicular conflicts?

Reduces accident potential (and delay)

Source: National Highway Institute
So what’s the problem?

Compliance!
Motivation

- Popular design concept
- Very little formal research on topic
- Master’s Thesis
Co-Author

Dr. Frank Croft, PE, The Ohio State University
Surveys

State Departments of Transportation
- Twenty responses received
- Most use on case-by-case basis
- Five states had design guidelines
- Three state DOT representatives expressed skepticism about effectiveness without a center median.
Surveys (continued)

Institute of Transportation Engineers
– Nearly all respondents were skeptical about their effectiveness in preventing left turns
– Other thoughts
  ▪ “If the mainline traffic volume is high enough then most drivers will not even bother to try the left turn”
  ▪ Could possibly increase safety concerns
Literature Review

- Aksan and Layton Oregon State University/Oregon Department of Transportation Study
- NHI Course No. 15255 Access Management, Location and Design
- FHWA-RD-76-86 Technical Guidelines for the Control of Direct Access to Arterial Highways
Aksan / Layton Conclusions

• The rate of violation depends primarily on the “setting” of the island.
Setting

- Setting A
- Setting B
- Setting C
Aksan / Layton Conclusions (continued)

• A continuous raised median is the only solution for preventing left turns to and from a right-in right-out island.

• Larger island sizes have been found helpful but are not sufficient to prevent violations.
Where there is a two-way left turn lane or left turn lane for an adjacent intersection between through traffic lanes, the violation rate is higher.
Aksan / Layton Conclusions (continued)

- No correlation between the accident rate and the violation rate could be found.
Channelized RIRO driveways discourage left turn maneuvers, reducing the conflict points at the driveway from nine to two.

Left turns are involved in a high proportion of crashes.

Use AASHTO guidelines for island design.

Use turn prohibition regulatory signs per the MUTCD.
Discusses benefits – accident reduction

States: “…violations will be common in absence of a non-traversable median.”

Conclusions and recommendations based on assumptions not on research of RIRO driveway locations.

Considers the method “cost effective”
Recommended Design

Figure C-3.3 - Driveway Channelizing Island to Prevent Left-Turn Egress and Ingress Maneuvers
Research Objectives
Research Objectives

- Develop a better measure of effectiveness than used in previous research
- Evaluate compliance/violation rates at RIRO driveways
- Relate the violation rates to driveway and site characteristics that are generally available to designers at time of site design
Objectives (continued)

- Develop a mathematical model(s) that predicts violation rates based on design characteristics of a RIRO driveway
- Gain insight into the appropriate application of RIRO driveways
- Develop warrants
Case Studies
Case Studies

- Collected Field Data at 7 RIRO Sites
Site Data Collected
Site Data Collected (continued)

- Existence of adequate “no left-in, left-out” regulatory signage
- Availability of storage on mainline
- Setting
- Distance to closest legal alternate left-in/left-out access
- Visibility of alternate access
Site Data Collected (continued)

- Average Daily Traffic (ADT) on arterial
- Number of lanes on the arterial
- ADT divided by the number of through lanes on mainline roadway in vehicles per day
Traffic Field Data Collected

PM Peak Hour (2 hours)

- Number of violations at RIRO driveway
- Total volume at RIRO driveway
- Total alternate legal LI and LO volume
Legal Alternate Left

Right-in / Right-out Driveway

Morse Road

220'

Cleveland Avenue

Signalized Intersection

Walgreen's

Alternate Legal Left-in / Left-out
Violation Rates

*Total Rate*
Total Rate = \( \frac{\text{LI Violations} + \text{LO Violations}}{\text{RI Volume} + \text{RO Volume}} \times 1000 \)

*LIRI Rate & LORO Rate (Aksan/Layton)*
LI/RI Rate = \( \frac{\text{LI Violations}}{\text{RI Volume}} \times 1000 \)
LO/RO Rate = \( \frac{\text{LO Violations}}{\text{RO Volume}} \times 1000 \)

*LI Alternate Rate & LO Alternate Rate*
LI Alternate Rate = \( \frac{\text{LI Violations}}{\text{LI Legal Alternate Volume}} \times 1000 \)
LO Alternate Rate = \( \frac{\text{LO Violations}}{\text{LO Legal Alternate Volume}} \times 1000 \)

Better Measure!
Frantz Road @ Shopping Center

- Low total rate
- Average LO rate
- Long Island Length
Wilson Bridge Road @ Worthington Mall

- High violation rates
- Small Island
- 2-lanes in/out

- Site and Parking Layout
- Poor visibility of alternate LILO
Sawmill Road just South of Bethel Road CVS

- Unexpectedly high LI rates
- Low LO Alternate Rate

- Small Island
- No signage
- Site layout
SR 161 @ Shopping Center

- No Violations
- Large Island

- High ADT per lane on SR 161
- RI deceleration, RO acceleration lanes
Morse Road @ Walgreen's

- No violations
- High ADT per lane
- Large # of lanes
- Backup of adjacent intersection traffic
Sawmill @ Max & Erma's/CVS

- High LI rates
- Long Alternate LI
Cleveland Avenue @ Meijer

- No Violations
- Excellent visibility of legal alternate
- High ADT per lane
Violation Rate Finding

- Most RIRO driveways served numerous RIRO movements with only a few violations
  - 3% of total traffic using RIRO were violators
- Not conclusive that low % due to driveway design
Violation Rate Findings

- Setting A violations confirm Aksan conclusions for Setting A

<table>
<thead>
<tr>
<th>Violation Rate</th>
<th>Setting A</th>
<th>Setting B*</th>
<th>Setting C*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>36.82</td>
<td>0.0</td>
<td>14.08</td>
</tr>
<tr>
<td>LI</td>
<td>8.96</td>
<td>0.0</td>
<td>27.03</td>
</tr>
<tr>
<td>LO</td>
<td>165.29</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>LI Alternate</td>
<td>17.79</td>
<td>0.0</td>
<td>60.61</td>
</tr>
<tr>
<td>LO Alternate</td>
<td>39.53</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Only one site.
Linear Regression Analysis

- To evaluate nature of relationships between violations and RIRO driveway and site features
- Multiple variable regression analysis
Regression Models

LOLA Model 1
Adjusted R Square = 0.996

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>264.636</td>
<td>31.632</td>
<td>0.000</td>
</tr>
<tr>
<td>RO Corner Radius</td>
<td>-4.319</td>
<td>-25.057</td>
<td>0.000</td>
</tr>
<tr>
<td>Total Island Area</td>
<td>-0.04331</td>
<td>-24.936</td>
<td>0.000</td>
</tr>
<tr>
<td>Delineators Used?</td>
<td>-32.607</td>
<td>-21.279</td>
<td>0.000</td>
</tr>
<tr>
<td>(Yes = 1, No = 0)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Regression Models

### LOLA Model 2

Adjusted $R^2 = 0.999$

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>269.381</td>
<td>62.019</td>
<td>0.000</td>
</tr>
<tr>
<td>RO Corner Radius</td>
<td>-4.575</td>
<td>-39.903</td>
<td>0.001</td>
</tr>
<tr>
<td>Total Island Area</td>
<td>-0.0449</td>
<td>-46.078</td>
<td>0.000</td>
</tr>
<tr>
<td>Delineators Used?</td>
<td>-32.862</td>
<td>-43.68</td>
<td>0.001</td>
</tr>
<tr>
<td>(Yes = 1, No = 0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO Lane Width</td>
<td>0.455</td>
<td>3.27</td>
<td>0.082</td>
</tr>
</tbody>
</table>
Findings

- A procedure and methodology was established to evaluate the impact of various characteristics on violation rates
Findings

Though not conclusive, regression analysis points to the following characteristics influencing violation rates:

- Shape and size of the raised island
- Width of RO lane
- Existence of vehicle storage on the arterial
- Volume of traffic on the arterial
- Existence of delineators
Unofficial Findings

- The Legal Alternate rate is a good measure of effectiveness
Characteristics to consider that may impact violation rates:

- Setting
- Driveway lane width
- ADT per lane on adjacent arterial
- Visibility of alternate legal LILO
- Signage
- Site and parking layout
- Number of lanes on adjacent arterial
- RI deceleration lane and RO acceleration lane
- Vehicle storage on adjacent arterial
- Distance to legal alternate
Additional Research Needs

Additional research is needed

– More sites with a wide variety of characteristics
  ▪ Geometry
  ▪ Site design
– Compare to full access driveways in similar locations
– Analyze additional hours
– Additional measures of effectiveness
  ▪ Accidents
  ▪ Delay
– Cost/Benefit analysis for warrants
Thank You

Steve Thieken, PE, PTOE
Burgess & Niple, Inc.
5085 Reed Road
Columbus, Ohio 43220
614-459-2050
sthieken@burnip.com