A Unique Application of Railroad Preemption with Queue Mitigation at a Roundabout Interchange

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Roundabouts Near At-Grade RR Crossings

Two primary concerns:

• Safety - Queue extends from roundabout onto railroad tracks
• Efficiency - Queue extends from railroad tracks into roundabout

Use microsimulation tool to evaluate operations
Roundabouts Near At-Grade RR Crossings

Four Possible Solutions

• Sign the tracks with “Do Not Stop on Tracks” signage
• Provide drivers with a “refuge area” to escape rails when in a queue
• Railroad preempttion
• Gates/advance warning
Ohio River Bridges Project

Downtown Crossing:
Sections 1, 2, and 3

East End Crossing:
Sections 4, 5, and 6
East End Design Team
Indiana Approach (Section 6)

- Mainline (SR 265): 4.0 miles
- Two interchanges
- Structures: 5 rehab and 10 new bridges
East End Crossing Schedule

• Begin design – February 2013
• Begin construction – June 2013
• Section 6 open to traffic – fall 2015
• Section 4 open to traffic – summer 2016
• Section 5 open to traffic – late fall 2016
Technical Provisions (TP)

• Guidance document developed by the owner and its consultants to guide design development
• Allows for innovations that bring value to the overall project [Alternative Technical Concepts (ATC)]
• Defines operational objectives
• Can be more or less restrictive
Interchange TP Requirements

Modification to the existing interchange per the criteria below:

• Maintain all traffic movements, including uninterrupted traffic movements from Port Road to EB or WB SR 265
• Provide better than or equal LOS than TP
• Facilitate movement of 160’ trailer (windmill blade)
• No traffic back up onto SR 265
• At-grade railroad crossing on SR 62
Operational Challenges

• At grade railroad in close proximity
• Queuing impacts following a train crossing
• Proposed solutions
  • Railroad preemption
  • Queue mitigation concept to address queuing impact
TP Base Design – DCD/Trumpet
Proposed Roundabout Interchange

- CHANGED DDI TO MULTI-LANE ROUNDABOUT
- REDUCED BRIDGE WIDENING
- CHANGED LOOP RAMPS TO ROUNDABOUT
- ELIMINATED WEAVE ON SR 265
- REMOVED FLYOVER BRIDGE

Proposed Roundabout Interchange
Traffic Analysis Tools

- HCS2010 for Freeway Segments
  - Mainline, Merge, Diverge, Weave
- ARCADY 8
  - Roundabout Capacity
- VISSIM for Traffic Simulation
  - Roundabout Capacity and Operations
  - Merge/Diverge Behaviors
  - Railroad Pre-emption

Traffic analysis performed for 2030 design year volumes
Ramp Merges and Diverges - LOS
Roundabouts - LOS
## LOS Summary & Comparison

<table>
<thead>
<tr>
<th>Facility Direction</th>
<th>Ramp Junction</th>
<th>ATC</th>
<th>RFP Design</th>
<th>2030 Build LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diverge Ramp Junctions</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SR 265 EB</td>
<td>SR 62 off-ramp (Diverge)</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>SR 265 EB</td>
<td>Port Road off-ramp (Diverge)</td>
<td>N/A</td>
<td>N/A</td>
<td>A</td>
</tr>
<tr>
<td>SR 265 WB</td>
<td>SR 62/Port Road off-ramp (Diverge)</td>
<td>C</td>
<td>B</td>
<td>N/A</td>
</tr>
<tr>
<td>SR 265 WB</td>
<td>SR 62 off-ramp (Diverge)</td>
<td>N/A</td>
<td>N/A</td>
<td>C</td>
</tr>
<tr>
<td><strong>Merge Ramp Junctions</strong></td>
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<td></td>
</tr>
<tr>
<td>SR 265 EB</td>
<td>Port Road/SR 62 on-ramp (Merge)</td>
<td>B</td>
<td>D</td>
<td>B</td>
</tr>
<tr>
<td>SR 265 WB</td>
<td>SR 62 on-ramp (Merge)</td>
<td>D</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>SR 265 WB</td>
<td>Port Road on-ramp (Merge)*</td>
<td>B</td>
<td>B</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Weaving Segment</strong></td>
<td></td>
<td></td>
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<tr>
<td>SR 265 WB</td>
<td>Weave Between Port Road on/off-ramps*</td>
<td>N/A</td>
<td>N/A</td>
<td>C</td>
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<tr>
<td><strong>Intersection</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SR 62 &amp; SR 265 EB Ramp (South Terminal)</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>SR 62 &amp; SR 265 WB Ramp via WB C-D (North Terminal)</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Port Road &amp; SR 265 WB Ramp (North Terminal)</td>
<td>A</td>
<td>A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

ATC RFP Design

*The Weaving Segment in the RFP Design is replaced with a Merge section under ATC. This is a traffic operational and safety improvement.
Benefits of the Proposed ATC

Improved efficiency over DCD during a train event

- Less complex signal logic
- Less phases to clear
- Similar movements allowed with fewer bridges
- EB to SB queue has more storage distance

Improved safety over DCD

- More efficient signal logic
- Less opportunity for severe crashes
- Shorter track clearance interval

Cost savings of $8-10 million
RR Preemption and Queue Mitigation Concept
Proposed Signals for RR Preemption / Queue Mitigation

• Needed something that:
  • Could ideally rest in dark
  • Does not conflict with yield signs at the roundabout
  • Was contextual to the RR crossing
  • Was supported by Indiana State Code
  • HAWK-style signal
Stop Bar Locations

Distance to yield line: 165 ft.

Distance to entry: 90 ft.

EB to SB right turn remains free-flow

No conflict between signal and yield sign

Safety concern if too close

Longer track clearance time if too far back

Longer track clearance time if placed too far back
Logic for Railroad Preemption

1) Clear circulatory roadway
   - Stop both southbound SR 62 and eastbound SR 265 off ramp

2) Clear the tracks on northbound SR 62

3) Preemption Hold
   - Southbound SR 62 remains stopped
   - Eastbound SR 265 off ramp allowed to proceed

4) Release southbound SR 62 and return to normal operations
## Railroad Preemption Timing

**GUIDE FOR DETERMINING TIME REQUIREMENTS FOR TRAFFIC SIGNAL PREEMPTION AT HIGHWAY RAIL GRADE CROSSINGS**

**SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION**

<table>
<thead>
<tr>
<th>Preempt verification and response time</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preempt delay time (seconds)</td>
<td>Controller type:</td>
</tr>
<tr>
<td>2. Controller response time to preempt (seconds)</td>
<td></td>
</tr>
<tr>
<td>3. Preempt verification and response time (seconds): add lines 1 and 2</td>
<td>3. 0.0</td>
</tr>
</tbody>
</table>

**Worst-case conflicting vehicle time**
Logic for Railroad Preemption
Logic for Queue Mitigation

1) A critical queue is detected on the eastbound SR 265 off ramp
2) Stop southbound SR 62
3) Provide eastbound SR 265 off ramp ample time to clear the queue and not back up onto SR 265
4) Release southbound SR 62 and return to normal operations
Logic for Queue Mitigation
Plan B: Logic for RR Preemption During Queue Mitigation

1) Railroad preemption has priority over queue mitigation
2) Southbound SR 62 already stopped
3) Stop eastbound SR 265 off ramp
4) Clear circulatory roadway
5) Clear the tracks on northbound SR 62
6) Preemption Hold
   • Southbound SR 62 remains stopped
   • Eastbound SR 265 off ramp allowed to proceed
7) Release southbound SR 62 and return to normal operations
Plan B: Logic for RR Preemption During Queue Mitigation
VISSIM Simulation – Rail Event
Project Progress
Time-Lapse Video of Train Event
Contact Info

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