Roundabout Prequalification Training

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- Craig Parks, PE
Why Roundabouts?

- Everybody else is building them?
- They look cool?
- Circles are better than squares?
- We want to be like the Europeans?
SAFETY!

According to Insurance Institute for Highway Safety (IIHS):

- In 2012, 683 people were killed and approximately 133,000 were injured in the U.S. in crashes that involved red light running

- Roundabouts have 79% fewer accidents with injuries than ordinary intersections and 90% fewer fatalities

- Since 2000, IIHS has issued a total of five reports promoting the use of roundabouts
Safety - Type of Crashes

Typical 4-leg intersection

- Angle
- Left turn

Roundabout

- Sideswipe
Safety - Vehicular Conflict Points

Total Conflict Points:  32

Crossing (16)
Diverging (8)
Converging (8)

Total Conflict Points:  8

Crossing (0)
Diverging (4)
Converging (4)
Why Roundabouts?

- INDOT desires roundabouts to be considered for any intersection improvement project
- Another tool in the toolbox
- Not always the answer, but often you’ll be surprised!
Why Prequalification?

- Proven safety measure
- INDOT desires roundabouts to be considered in your planning process
- Sound design plays a major role in the function of a roundabout
- Understanding the important parameters of roundabouts is crucial to sound design
Definitions

- **Splitter Island**
- **Circulatory Roadway**
- **Central Island**
- **Approach**
- **Exit**
What makes a Modern Roundabout?

- Diameter 100’-220’
- No Pedestrians in Center
- Yield on Entry
- Smooth Exit
- Deflected Entry
INDOT Roundabout Design Policy

- FHWA Guide (NCHRP 672)
- 2009 MUTCD (pavement markings and signage)
- HCM 2010 (operations)
- IDM Chapter 51-12.0 (written prior to NCHRP 672)
- To be replaced by IDM 305-5.0 (supplement to NCHRP 672)
- Meantime: Design Memo 13-10
Purpose: To provide guidance to designers and reviewers on many of the major items to be considered during the design of roundabouts.
Roundabout Design Checklist

- Not a comprehensive list nor a set of hard and fast rules
- Documentation is critical for reviewers to understand the designer’s intentions
- Diverging from the ranges outside of the desirable ranges shown is acceptable but needs to be justified with design documentation
Roundabout Design Checklist

- Divided into four major categories
  - Planning
  - Design Documentation
  - Roundabout Design
  - Design Plans

- Designers should submit completed checklist and documentation with all roundabout submittals
“A comparison of roundabout practicality/feasibility vs. other intersection types should be conducted, taking into consideration safety, traffic operations, capacity, ROW impacts, and cost.”
Roundabout Planning
Evaluation Criteria

- Operations
- Safety
- R/W impacts
- Construction cost
- User costs
- Constructability
- Public input
- Maintenance of traffic
- Noise and environmental impacts
Roundabout Planning
Locations Where Roundabouts Can Be Beneficial

- High-speed rural intersections
- Locations with mediocre/poor crash history
- Locations with traffic operational problems
- Closely spaced intersections
- Near structures, including freeway interchange ramps
- Access management
- Gateway or transition locations
- Where community enhancement is desired
- Near schools
- Corridors
NCHRP Report 772 recently completed. Provides framework for analyzing a roundabout corridor vs. a signal or stop controlled corridor.

Our experience: work very well when all roundabouts are operating under capacity.

No need to coordinate timings.

Every vehicle on every approach must slow down to enter the roundabout.

Slower speeds increase motorist and pedestrian safety.
Roundabout Planning
Location - Proceed with Caution

- Within a system of coordinated signals
- On a steep grade
- Where stopping sight distance cannot be achieved
- Near rail crossings
- Near a signalized intersection
Roundabout Planning

Documentation

Memo or report with the following, where applicable:

- Traffic volumes and crash history
- 20-year traffic projections
- Capacity analysis
- Conceptual geometric design
- Public involvement
- Comparison to other intersection types, including “Do Nothing”
- Crash analysis
- Selection of preferred option

Use INDOT “Intersection Decision Guide”
Roundabout Planning

Traffic Data

- 20-year forecasts
- Consider staged construction
  - Interim year analysis required
- Turning movements critical
  - Roundabout capacity dependent on approach and conflicting circulating traffic
# Roundabout Planning

## Traffic Data - Calculating Volumes

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Mason Road and Hickory Woods Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Hour</td>
<td>AM Peak</td>
</tr>
<tr>
<td>Analyst</td>
<td>TVW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>South Leg</th>
<th>North Leg</th>
<th>West Leg</th>
<th>East Leg</th>
<th>Hour Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LEFT</td>
<td>THRU</td>
<td>RIGHT</td>
<td>LEFT</td>
<td>THRU</td>
</tr>
<tr>
<td>Year</td>
<td>LEFT</td>
<td>THRU</td>
<td>RIGHT</td>
<td>LEFT</td>
<td>THRU</td>
</tr>
<tr>
<td>2009</td>
<td>140</td>
<td>51</td>
<td>12</td>
<td>2</td>
<td>119</td>
</tr>
<tr>
<td>2030</td>
<td>200</td>
<td>70</td>
<td>20</td>
<td>0</td>
<td>170</td>
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<tr>
<td>Excluded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Year 2030 Traffic Volumes

Mason Road and Hickory Woods Drive

AM Peak

#### Approach-Based Totals For Peak Hour

<table>
<thead>
<tr>
<th>Leg</th>
<th>Direction</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Leg</td>
<td>Leaving</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Approaching</td>
<td>370</td>
</tr>
<tr>
<td>East Leg</td>
<td>Leaving</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Approaching</td>
<td>110</td>
</tr>
<tr>
<td>South Leg</td>
<td>Leaving</td>
<td>440</td>
</tr>
<tr>
<td></td>
<td>Approaching</td>
<td>290</td>
</tr>
<tr>
<td>West Leg</td>
<td>Leaving</td>
<td>460</td>
</tr>
<tr>
<td></td>
<td>Approaching</td>
<td>290</td>
</tr>
</tbody>
</table>
Roundabout Planning
Capacity Analysis - Tools

Capacity Analysis (Macroscopic):

- RODEL / ARCADY
- SIDRA Intersection
- Equations from FHWA Roundabout Guide
- Equations from NCHRP Report 572 “Roundabouts in the United States” (published in 2007)
- HCM 2010 (HCS 2010, Synchro, SIDRA, etc.)

Simulations (Microscopic):

- Vissim
- Paramics
- Others
- Roundabout geometric features used in design should match those in the capacity analysis if a capacity model with geometry inputs is being used (ARCADY, RODEL, SIDRA)

- Learn the theory, limitations, and strengths of the software that you are using!
Figure 4-6 NCHRP 672
(Based on HCM 2010)
Roundabout Planning
Capacity - Rules of Thumb

- Single-lane roundabouts – up to 25,000 vpd
- Two-lane roundabouts – up to 40,000 vpd
- Three-lane roundabouts – in excess of 55,000 vpd
- Highly dependent upon turning movement percentages
- Rule of Thumb: Single lane approach volume = 1,100 – 1,200 vph
Roundabout level of service is similar to that of an unsignalized intersection.

<table>
<thead>
<tr>
<th>Control Delay (s/veh)</th>
<th>Level of Service by Volume-to-Capacity Ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v/c ≤ 1.0</td>
</tr>
<tr>
<td>0–10</td>
<td>A</td>
</tr>
<tr>
<td>&gt;10–15</td>
<td>B</td>
</tr>
<tr>
<td>&gt;15–25</td>
<td>C</td>
</tr>
<tr>
<td>&gt;25–35</td>
<td>D</td>
</tr>
<tr>
<td>&gt;35–50</td>
<td>E</td>
</tr>
<tr>
<td>&gt;50</td>
<td>F</td>
</tr>
</tbody>
</table>

* For approaches and intersection-wide assessment, LOS is defined solely by control delay.

NCHRP Report 672 - Exhibit 4-9
(based on HCM)

Level of service should meet the IDM thresholds for different facility types.
(Currently Chapters 53-56)
# Roundabout Planning

## Capacity – LOS Requirements

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Manual Section</th>
<th>2 Lanes</th>
<th>4 or More Lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Year Traffic, AADT</td>
<td>40-2.01</td>
<td>&lt; 400</td>
<td>400 ≤ AADT &lt; 2000</td>
</tr>
<tr>
<td>Design Forecast Period</td>
<td>40-2.02</td>
<td>20 Years</td>
<td>20 Years</td>
</tr>
<tr>
<td>*Design Speed, mph (1)</td>
<td>40-3.0</td>
<td>Level: 60 – 70; Rolling: 50 – 60</td>
<td>60</td>
</tr>
<tr>
<td>Access Control</td>
<td>40-5.0</td>
<td>Partial Control / None</td>
<td>Partial Control / None</td>
</tr>
<tr>
<td><strong>Level of Service</strong></td>
<td>40-2.0</td>
<td>Desirable: B; Minimum: C</td>
<td>Desirable: B; Minimum: C</td>
</tr>
</tbody>
</table>

### Design Controls

<table>
<thead>
<tr>
<th>Travel Lane <strong>Width</strong></th>
<th>Manual Section</th>
<th>Typical Surface Type (2)</th>
<th>Chp. 52</th>
<th>12 ft</th>
<th>12 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Width Usable</td>
<td>45-1.01</td>
<td>Asphalt / Concrete</td>
<td>Chp. 52</td>
<td>6 ft</td>
<td>8 ft</td>
</tr>
<tr>
<td>Shoulder (3) <strong>Width Paved</strong></td>
<td>45-1.02</td>
<td>4 ft</td>
<td>6 ft</td>
<td>10 ft (3b)</td>
<td></td>
</tr>
<tr>
<td>Typical Surface Type (2)</td>
<td>Chp. 52</td>
<td>Asphalt / Concrete</td>
<td>Chp. 52</td>
<td>11 ft (3b)</td>
<td>Right: 11 ft (3b)</td>
</tr>
<tr>
<td>Cross Slope <strong>Travel Lane (4)</strong></td>
<td>45-1.01</td>
<td>2%</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder (4A) <strong>Width Usable</strong></td>
<td>45-1.02</td>
<td>Paved Width ≤ 4 ft: 2%; Paved Width &gt; 4 ft: 4%</td>
<td>Paved Width ≤ 4 ft: 2%; Paved Width &gt; 4 ft: 4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Lane <strong>Lane Width (5)</strong></td>
<td>45-1.03</td>
<td>Desirable: 12 ft; Minimum: 11 ft</td>
<td>Desirable: 12 ft; Minimum: 11 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder Width (6)</td>
<td>Same as Next to Travel Lane</td>
<td>Same as Next to Travel Lane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Width</td>
<td>45-2.0</td>
<td>N/A</td>
<td>0.0 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear-Zone Width</td>
<td>49-2.0</td>
<td>(8)</td>
<td>8 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side Slopes (9) <strong>Cut</strong></td>
<td>45-3.0</td>
<td>Foreslope</td>
<td>6.1 (10)</td>
<td>6.1 (10)</td>
<td></td>
</tr>
<tr>
<td>Ditch Width</td>
<td>4 ft (11)</td>
<td>4 ft (11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backslope</td>
<td>4:1 for 20 ft; 3:1 Max. to Top (12)</td>
<td>4:1 for 20 ft; 3:1 Max. to Top (12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill</td>
<td>45-3.0</td>
<td>6:1 to Clear Zone; 3:1 Max. to Toe</td>
<td>6:1 to Clear Zone; 3:1 Max. to Toe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Slopes</td>
<td>45-2.02</td>
<td>N/A</td>
<td>Desirable: 8:1; Maximum: 5:1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Cross-Section Elements **

### Bridges

<table>
<thead>
<tr>
<th>New or Reconstructed Bridge <strong>Clear-Roadway Width</strong></th>
<th>Manual Section</th>
<th>Chp. 60</th>
<th>HL-93 (13)</th>
<th>Full Paved Approach Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Bridge to Remain in Place <strong>Clear-Roadway Width</strong></td>
<td>45-4.01</td>
<td>HS-20</td>
<td>Travelway Plus 2 ft on Each Side</td>
<td></td>
</tr>
<tr>
<td><em>Vertical Clearance, Arterial Under</em>*</td>
<td>44-4.0</td>
<td>16.5 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New or Replaced Overpassing Bridge (15)</td>
<td>14 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Overpassing Bridge</td>
<td>14 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign Truss / Pedestrian Bridge (15)</td>
<td>New: 17.5 ft; Existing: 17 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Clearance, Arterial Over Railroad (16)</td>
<td>Chp. 69</td>
<td>23 ft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Controlling design criterion. ** An arterial of 4 or more lanes on a new location should be designed as Divided. *** Selection of the cross section and bridge elements is based on the design-year traffic volume irrespective of the design speed.

GEOMETRIC DESIGN CRITERIA FOR RURAL ARTERIAL (New Construction or Reconstruction)

Figure 53-2
Calculated queue lengths should not cause blocking of nearby drives or intersections (95th percentile queue length)
Definitions of paths per FHWA Guide

Refer to NCHRP 672 Sections 6.7.1 and 6.7.2

R1-R2-R3 movement is typically fastest path
NCHRP 672 provides illustrations of how to create these paths...

Exhibit 6-48

Exhibit 6-49
...and how to measure the radii...

See text for typical offsets.

Begin drawing entry path at least 165 ft (50 m) prior to the entrance line.

R1 should be measured over a distance of 65 to 80 ft (20 to 25 m). It is the minimum radius that occurs along the approach entry path near the entrance line but not more than 165 ft (50 m) in advance of it.

Exhibit 6-51
...and how to determine the speeds from the radii.
Use Eqn 6-4 to check $R_3$ speed.

$$V_3 = \min \left\{ \frac{V_{3\text{phase}}}{\frac{1}{1.47} \sqrt{(1.47V_2)^2 + 2a_{23}d_{23}}} \right\}$$

where

- $V_3 =$ exit speed, mph;
- $V_{3\text{phase}} = V_3$ speed predicted based on path radius, mph;
- $V_2 =$ circulatory speed for through vehicles predicted based on path radius, mph;
- $a_{23} =$ acceleration between the midpoint of $V_2$ path and the point of interest along $V_3$ path $= 6.9$ ft/s$^2$; and
- $d_{23} =$ distance along the vehicle path between midpoint of $V_2$ path and point of interest along $V_3$ path, ft.
## Design Documentation

### Speeds Appropriate / Fastest Paths

<table>
<thead>
<tr>
<th>Roundabout Type</th>
<th>Recommended Fastest Path Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Roundabout</td>
<td>20 mph</td>
</tr>
<tr>
<td>Single Lane Roundabout</td>
<td>25 mph</td>
</tr>
<tr>
<td>Multi Lane Roundabout</td>
<td>25 - 30 mph</td>
</tr>
</tbody>
</table>

- Speeds can exceed these recommendations
- Engineering judgment must be used
- Documentation must be provided
Desirable to have all speeds in roundabout within 10mph – 15mph of one another

Refer to NCHRP 6.7.3.1

Should be balanced with other roundabout needs. All variances should be explained in documentation
All SSD calculations must be shown graphically

Refer to NCHRP 6.7.3.1

SSD is a level 1 criteria
Three locations should be checked:

- Approach sight distance
- Sight distance on circulatory roadway
- Sight distance to crosswalk on exit
All ISD calculations must be shown graphically

Refer to NCHRP 6.7.3.2

ISD is soon to be a level 1 criteria

Too much ISD can increase roundabout speeds

Use equations found in NCHRP 672
- Eye location set 50’ from yield line
- Use NCHRP 672 equation 6-6 and 6-7 with $t_c = 5.0s$
- $d_1$ can be minimized to 50’ behind yield line (documentation required)

Eqn 6-6 \[ d_1 = (1.468)(V_{\text{major, entering}})(t_c) \]

Eqn 6-7 \[ d_2 = (1.468)(V_{\text{major, circulating}})(t_c) \]
Design Documentation
Allowable Landscaping Areas

- Include an overlay of all graphical checks of ISD and SSD on a single sheet.
- Overlays will reveal areas where landscaping height is and is not restricted.
- Must perform checks even if landscaping is not part of original plans.
Splitter Island maximum landscaping height will be 1.5’ from top of curb

Refer to NCHRP 672 Chapter 9 for additional guidance
FHWA Roundabout Guide:

“For a roundabout to operate satisfactorily, a driver must be able to enter the roundabout, move through the circulating traffic, and separate from the circulating stream in a safe and efficient manner. To accomplish this, a driver must be able to perceive the general layout and operation of the intersection in time to make the appropriate maneuvers. Adequate lighting should therefore be provided at all roundabouts.”
Present guidance and resources

- NCHRP 672, Chapter 8
- IESNA Publication DG-19-08
- AASHTO
- Proprietary methods and vendor assistance
Several studies have been completed to determine the best lighting practices at roundabouts.

- Approaches
- Circulatory Roadway
- Exits

Light placement in advance of pedestrian facilities is critical – try not to “backlight” pedestrians

Pavement markings, signs, and lighting designs go hand-in-hand
Light poles can be placed in central island if necessary but should not be placed in splitter islands.
Design Documentation
Lighting Design - Conflict Points and Luminaire Placement

- Important locations
  - Crosswalks
  - 45°, 135°, 225°, 315° quadrant points

- Consider clear zone

- Evaluate arm lengths
All roundabouts need to be lit
Place one light in advance of each approach crosswalk
Additional lighting at roundabouts should be considered to better illuminate the roundabouts and eliminate dark spots
Light pollution to neighboring residents can be a concern
Center island landscaping can incorporate uplighting for additional visibility
Roundabout Design

Geometry

- Roundabout geometry plays a major role in the capacity and safety of the roundabout.
- Geometry of roundabout design needs to match geometry in capacity analysis.
- If geometry is different than engineer’s report, designer should re-run capacity analysis.
Roundabout Design
Inscribed Circle Diameter
Roundabout Design
Inscribed Circle Diameter

<table>
<thead>
<tr>
<th>Roundabout Type</th>
<th>Low End</th>
<th>High End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Lane</td>
<td>90’</td>
<td>180’</td>
</tr>
<tr>
<td>Two Lane</td>
<td>150’</td>
<td>220’</td>
</tr>
<tr>
<td>Three Lane</td>
<td>200’</td>
<td>300’</td>
</tr>
</tbody>
</table>

- Refer to NCHRP 6.3.1
- Exhibit 6-9 provides better detail of inscribed diameters
- Document rationale if larger or smaller sizes are used
Roundabout Design

Approach Alignment

- Right offset should be avoided.
- Left offset is preferred because it typically improves deflection.
- Justification of right offset should be provided with documentation.
- Refer to NCHRP 6.3.2
Why is left offset preferred?

- Desired deflection is easier to achieve
- Can utilize a smaller circle without reducing deflection
- Results in slower entry speeds
Roundabout Design
Circulatory Roadway Width
### Roundabout Design

**Circulatory Roadway Width**

<table>
<thead>
<tr>
<th>Roundabout Type</th>
<th>Low End</th>
<th>High End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Lane</td>
<td>16’</td>
<td>20’</td>
</tr>
<tr>
<td>Two Lane</td>
<td>28’</td>
<td>32’</td>
</tr>
<tr>
<td>Three Lane</td>
<td>42’</td>
<td>48’</td>
</tr>
</tbody>
</table>

- Refer to NCHRP 6.4.3 and 6.5.3
- “Rule of Thumb” is that circulatory roadway is 100% to 120% of entry width
Roundabout Design

Approach Radii
Roundabout Design
Approach Radii

- Design should match the geometry used in the capacity analysis
- A wide range may be appropriate depending upon the components of the design
- Refer to NCHRP 6.4.5 and 6.5.4

<table>
<thead>
<tr>
<th>Roundabout Type</th>
<th>Low End</th>
<th>High End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Lane</td>
<td>50’</td>
<td>100’</td>
</tr>
<tr>
<td>Multi-Lane</td>
<td>65’</td>
<td>120’</td>
</tr>
</tbody>
</table>
Roundabout Design

Entry Width
# Roundabout Design

## Entry Width

<table>
<thead>
<tr>
<th>Roundabout Type</th>
<th>Low End</th>
<th>High End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Lane</td>
<td>14’</td>
<td>18’</td>
</tr>
<tr>
<td>Two Lane</td>
<td>24’</td>
<td>30’</td>
</tr>
<tr>
<td>Three Lane</td>
<td>36’</td>
<td>45’</td>
</tr>
</tbody>
</table>

- Measured perpendicular to left and right curb lines
- Refer to NCHRP 6.4.2 and 6.5.2
Roundabout Design

Exit Radii
Roundabout Design
Exit Radii

- Typically 100’ to 800’
- 300’ to 600’ is desirable
- Refer to NCHRP 6.4.6 and 6.5.6
- Exit radii as small as 50’ can be used if necessary to control speeds at crosswalk
- Smaller exit radii can affect natural flow of traffic through roundabout and reduce capacity
Roundabout Design

Entry Path or Exit Overlap

- Only affects multi-lane roundabouts
- Refer to NCHRP 6.2.3
- Figure 51-22NN in current IDM illustrates how to avoid overlap
Roundabout Design
Entry Path or Exit Overlap

Desired Path of Vehicles

Entry Path Overlap

Speed & Trajectory of vehicle at yield point determines natural path

Striping and proper geometric design is crucial to achieving proper lane use!
Case Study - Entry Path Overlap
Truck apron allows large vehicles to track to the inside of the roundabout

Minimum effective/constructible width is 3’, minimum width of 5’ is desirable

No maximum width – based on turning templates

Refer to NCHRP 6.4.7.1 and 6.8.7.4

Documentation for proper design vehicle and illustrating adequate width should be included with design submittals
Roundabout Design
Pedestrian Crossing

- Crosswalk should be placed 20’-40’ behind Yield Line (one to two car lengths)
- Refer to NCHRP 6.4.1 and 6.8.1.2
- Ample length and width of splitter island should be designed to provide a safe refuge for pedestrians
- Placement should coincide with a vehicle’s slowest speed on approach
- Pay attention to cross-slope
Pavement markings and signs are critical to the function of roundabouts.

Pavement marking schematics should be submitted with Stage 1 plans to illustrate design intent.

Pavement markings should be designed in accordance with MUTCD 3C and NCHRP 7.3.

Signs should be designed in accordance with MUTCD 2B.43-45 and NCHRP 7.4.
Roundabout Design

Entry Grade Profile
Entry grade profile should be leveled out so as not exceed 3%.

Entry grade profile is defined as the area approximately two car lengths from the outer edge of the circle.

Refer to NCHRP 6.8.7.5.
Roundabout Design

Drainage Structures

- Avoid drainage structures within circulatory roadway
- Desirable location is between circulatory roadway and curb ramps
- Primary reason for concern is maintenance difficulties
- Refer to NCHRP 6.8.7.6
- In some situations, this cannot be avoided to meet spread/encroachment requirements
Design Plans

- Spot elevations and/or grading plans should be clear and concise
- Sign types and locations should be clearly defined
- Specialty pavement markings must be clearly detailed
Design Plans

- Radii should be clearly labeled

- For early plan submittals – Provide the reviewer ample information to identify the critical elements (ICD, Approach & Exit Radii, etc.)

- For Stage 3 plans - Can a contractor build the roundabout with the information provided?
Future Policy Updates

- Indiana Design Manual Updates - Upcoming!
  - Significantly reduced
  - Largely relies on NCHRP 672
  - Incorporated into intersections chapter 305
  - May be organized per checklist
Future Policy Updates

- Checklist modifications
- All roundabouts will now be considered 4R
- Adding lane drop taper requirements
- High speed approach detail modifications
Future Policy Updates

- Clear zone definition
  - Curb offset + 4’ for interior
  - Curb offset + 6’ for perimeter
  - Clear zone transition zone on approach
- Pedestrian signal recommendations
Common Questions

- How important is public education?
- How do you maintain traffic during construction?
- What about visually impaired pedestrians?
- Are roundabouts safe on high speed facilities?
- What about bicyclists?
Single Lane Roundabout Layout
Single Lane Roundabout Layout

Getting Started

- 5 step process with a foundation of designing pavement marking alignments
- Multiple iterations of these 5 steps will need to be completed to achieve the optimum geometric design
- Curbs and edges of pavement are derived by the pavement markings in accordance with the FHWA Roundabout Guide.

Disclaimer: There are many approaches to achieve a sound geometric roundabout design. This approach is just one relatively simple method we have found to work.
Geometric Basics

- Inscribed diameter
  - Typically start with 130’ and adjust based on existing conditions
  - Dependent on your design vehicle

- Circulatory roadway width
  - Dependent on your design vehicle
  - Typically start with 15’-16’ for a single lane roundabout

- Truck apron width
  - Dependent on your design vehicle tracking
  - Typically start with 5’
Single Lane Roundabout Layout

Geometric Basics

- **Approach Radius**
  - Typically start with 100’
  - Affects roundabout capacity and speeds

- **Exit Radius**
  - Typically start with 600’
  - Affects roundabout capacity and speeds
Single Lane Roundabout Layout

**Situation**
- Simple 90 degree intersection
- Both roadways are 2 lane roads
Single Lane Roundabout Layout

**Step 1**

- Draw center circle
- Offset for circulatory roadway width
- Draw exits
**Step 2**

Fillet centerline to inside of circulatory roadway for exits
Step 3
Fillet inside of exit lane with inside circle to create inside approach lane
**Step 4**

Offset inside of exit lane to match approaching lane width
Step 5

Fillet with outside edge of circulatory roadway
Single Lane Roundabout Layout

**Step 6**
Trim & review your geometrics
**Deflection Check**

Tangent to outside edge of approach should line up close to point where inside edge of approach intersects circulatory roadway.
Example 2
Single Lane

Scale 1” = 30’
**Situation 2**

- Offset intersection
- Higher speed on east-west road
Step 1

- Draw center circle to maximize deflection on higher speed approach
- Offset for circulatory roadway width
- Draw exits
Step 2
Fillet centerline to inside of circulatory roadway for exits
Step 3
Fillet inside of exit lane with inside circle to create inside approach lane
**Step 4**

Offset inside of exit lane to match approaching lane width.
Step 5

Fillet with outside edge of circulatory roadway
Step 6
Trim & review your geometrics
Splitter Islands

Once layout is complete, create splitter islands as illustrated in Exhibit 6-13 of NCHRP 672.
**Splitter Islands**

- Where pedestrian facilities exist, the splitter island should be at least 50’
- Additional modifications to geometry may be necessary to develop required splitter island length
Single Lane Roundabout Layout

**Alterations to Geometric Layout**

- Can decrease exit radii to avoid R/W impacts or slow exiting traffic due to crosswalk
- Be careful not to reduce exit radii too much
- Can offset centerline in Step 4 additionally to create a longer splitter island
- When a median is involved, in Step 4 you can offset the line to match the inside approach edge of the existing median
Multi-Lane Roundabout Layout
Multi-Lane Roundabout Layout

Geometric Basics

- Inscribed diameter
  - Typically start with 160’ and adjust based on existing conditions
  - Dependent on your design vehicle

- Circulatory roadway width
  - Dependent on your design vehicle
  - Typically start with 30’-31’ for a 2 lane roundabout

- Truck apron width
  - Dependent on your design vehicle tracking
  - Typically start with 5’
Multi-Lane Roundabout Layout

**Situation**

- Skewed intersection
- East-west roadway is a 4 lane facility
- North-south roadway is a 2 lane facility
Multi-Lane Roundabout Layout

**Step 1**
- Draw Center Circle
- Offset for Circulatory Roadway Width
- Draw Exits
Step 2
Fillet inside of exit Lanes to inside of circulatory roadway
Step 3

- Fillet inside of exit lane with inside circle to create inside approach lane.
- Only do this for single lane entries!
Multi-Lane Roundabout Layout

**Step 4**
- Offset inside of exit lane to match approaching lane width
- Only do this for the single lane entries!
Step 5

- Fillet with outside edge of circulatory roadway
- Only do this for the single lane entries!
Multi-Lane Roundabout Layout

Desired Path of Vehicles

Entry Path Overlap

Speed & Trajectory of vehicle at yield point determines natural path

Striping and proper geometric design is crucial to achieving proper lane use!
Multi-Lane Roundabout Layout

**Step 6**

Create tangents on two-lane approaches to prevent entry path overlap
Step 7
Trim and review geometry