Florida Department of Transportation (FDOT) will be hosting a webinar series focused on design and analysis of Diverging Diamond Interchanges (DDI). This series will present guidance on the major elements of DDI project development, including Geometric Design, Signing and Pavement Markings, Traffic Operations, Signalization, Plan Detailing, and Public Involvement.

FDOT Developmental Design Criteria, D217 Diverging Diamond Interchanges, will be covered as well as national design guidance and industry best practices.

Intended Audience: The intended audience for this training includes transportation professionals involved in the planning, design, and review of Diverging Diamond Interchanges.

Schedule:
- DDI Overview: June 15, 2021, 2p-5p
- DDI Geometric Design: June 29, 2021, 2p-3p
- DDI Signing & Marking and Signals: July 16, 2021, 2p-3p
- DDI Traffic Operations: August 10, 2021, 2p-3p
- DDI Multimodal Accommodations: August 24, 2021, 2p-3p
- DDI Plans Detailing & Public Involvement: September 7, 2021, 2p-3p
DDI Signals, Signs and Pavt. Markings – Webinar Logistics

- You are MUTED upon entry
- Please ask questions via *Questions* dialogue box

![Webinar UI with questions and mute icon]
DDI Signals, Signs and Pavt. Markings - AGENDA

- Signs & Pavement Markings
- Signalization
- Lighting
- Pedestrian and Bicycle Accommodations
DDI Signing and Pavement Markings
## Signing and Pavement Markings

### Signs
- MUTCD does not explicitly address DDI signing details
- Practices are still evolving
- A lot of options
- Minimize confusion

<table>
<thead>
<tr>
<th>One Way Signs</th>
<th>Keep Right/Left Signs</th>
<th>No Turn Signs</th>
<th>Do Not Enter</th>
<th>Lane Split Signs</th>
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<tbody>
<tr>
<td><img src="image1" alt="One Way Signs Diagram" /></td>
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Signing and Pavement Markings

- **Signs**
  - MUTCD does not explicitly address DDI signing details
  - Practices are still evolving
  - A lot of options
  - Minimize confusion

Source: Utah DOT DDI Guidelines
Guide Signs

- Master Signing Plan
  - Initial guide sign layout
  - Follows MUTCD sign sequence criteria
  - Early guidance for motorists approaching the DDI
Guide Signs

- Arrow per lane sign
  - Shared lanes have left & thru arrow
  - Could the left turn arrows cause a wrong way movement?
Guide signs

- Arrow per lane sign
  - Could the left turn arrows cause a wrong way movement?
Guide signs

- **Arrow per lane sign**
  - Could the left turn arrows cause a wrong way movement?

- **Benefit**
  - Advance notification of on-ramp drop lane
Guide Signs

- Multiple overhead advance signs consideration
  - Approaches with unique or congested adjacent intersections
  - Shared on-ramp entrance lanes
  - Larger interchanges

- Previous Interchange
  - How different is the DDI from the old interchange?
Guide Signs

- **Advance Signs Example**
  - Old loop on-ramp replaced with a DDI
  - Left vs right side of the road
Guide Signs

- Single overhead with multi-post advance signs
- Best for:
  - Fewer lanes
  - Less congestion
  - Easier to make a last minute lane change
- No bridge mount when arterial goes over the interstate
DDI Signing

- At crossover intersections
  - Thru arrows & lane prohibition
Signing and Pavement Markings

- **Pavement Markings**
  - Identify the appropriate design vehicles, especially for dual lane turning movements
  - Place excess pavement between lanes in the middle for use by trucks from both turn lanes

*Design Vehicle Accommodation at Multi-Lane Ramp Terminals*
Pavement Markings

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Signing and Pavement Markings

- **Pavement Markings**
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Wrong Way Driving

- FDM Exhibit 230-2
- Pavement Markings
  - Interstate route shields and thru arrows before & after crossovers
  - 2-4 dotted stripes through the crossovers
- Signs
  - Turn prohibitions
  - Do not enter
  - Wrong Way
Wrong Way Driving

- Wrong Way Driving Detection System
  - Detection, Red RRFB, CCTV, Communication
  - Detection zones
  - Detail from District 5’s Smart Roads website
  - Wireless or fiber communication
DDI Signalization
Mast Arm Layout

- **Strategy 1**
  - Mast arms on the far side of the crossover
  - Don’t block signal visibility with the opposing mast arm
Mast Arm Layout

- **Strategy 1**
  - Mast arms on the far side of the crossover
  - Don’t block signal visibility with the opposing mast arm
Mast Arm Layout

- **Strategy 1 Modified**
  - Near-side of the crossover in one direction to avoid sight distance conflict
Mast Arm Layout

- Near-side
  - Consider a driver’s view upstream of the stop bar
Mast Arm Layout

- Single mast arm for both directions
  - Signals back to back
  - 7 signal heads
  - 6 signs
- Visual clutter
- Supplemental signal heads
Mast Arm Layout

- Single mast arm for both directions
  - Signals back to back
- Visual clutter
Mast Arm Layout

- Avoid placement of the mast arms in the existing pavement for ease of constructability and testing
Mast Arm Layout

- Poles placed outside the existing roadway
Traffic Signals

- Signal Head Placement
  - Supplemental head usage
Traffic Signals

- Signal Head Placement
  - Supplemental head usage
  - Seeing the signal head along the ramp when approaching
Traffic Signals

- **Signal Head Placement**
  - Supplemental head usage
  - Seeing the signal head along the ramp when approaching
  - Avoid confusion
Signal Head Layout
Signal Head Layout
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Signal Head Layout
Traffic Signals

- Signal Head Placement
  - Crossover Intersection
  - Basic green ball
Traffic Signals

- Signal Head Placement
  - Crossover Intersection
    - Basic green ball
    - Straight up arrow
Traffic Signals

- **Signal Head Placement**
  - Crossover Intersection
    - Basic green ball
    - Straight up arrow
    - Diagonal arrow (up)
Traffic Signals

- **Signalized Right Turns**
  - Poor sight lines can lead to driver error
  - Dual turn lanes can cause sight line obstructions
Signal Head Layout

- Signalized Right Turns
  - No Turn on Red
Traffic Signals

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Traffic Signals

- Signalized Right Turns
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  - Dual turn lanes can cause sight line obstructions
  - No turns on red
Traffic Signals

- **Pedestrian Signals**
  - Ped signals all on the wider side of the median
  - Ped signals separated diagonally with push buttons consistently on the same side

Traffic Signals

- **Pedestrian Signals**
  - Meeting 10’ separation between pedestrian push buttons is difficult in the narrow median
  - Consider moving stop bar back where median is wider
  - Increases clearance distance
Traffic Signals

- Pedestrian Signals
  - Single pole can be confusing
  - Narrow median
  - Insufficient pedestrian storage

Signal Cabinet Options

- Number of signal cabinets
  - One or two cabinets can be used.
  - Use two if there’s concern of connection loss to the controller.
    - If the controller is on one side of a bridge and controlling the signal on the other side.
  - GPS clocks alleviate some of the two cabinet concerns.
Traffic Signals

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**Source:** DDI Information Guide, Second Edition (2021)
Multimodal Accommodations
Multimodal Accommodations

- Pedestrian Accommodations
  - Inside (center) of the interchange
  - Outside of the interchange
Multimodal Accommodations

- Refuge in center median island

Source: Ohio DOT
Multimodal Accommodations

- Signalizing the right turns provides pedestrian signal heads so they know when to cross.

Source: Ohio DOT
Multimodal Accommodations

- Pedestrian Accommodations
  - Center walkway is preferred in Florida
  - Avoids free-flow left turning movement
Multimodal Accommodations

- Pedestrian Accommodations
  - *Center walkway is preferred in Florida*
    - Avoids free-flow left turning movement
    - Improve line of sight for between pedestrians and drivers
Multimodal Accommodations

- **Pedestrian Accommodations**
  - *Center walkway is preferred in Florida*
    - Avoids free-flow left turning movement
    - Improve line of sight for between pedestrians and drivers
    - Cross at signalized crossover intersection consistent with expectations
      - pedestrians looking left first
Multimodal Accommodations

- **Pedestrians – Outside**
  - Provide clear line of sight at all crossings, especially free-flow crossings
Multimodal Accommodations

- Provide adequate sight distance of the pedestrian crossings

Source: Ohio DOT
Multimodal Accommodations

- Signalizing the right turns provides pedestrian signal heads so they know when to cross

Source: Ohio DOT
Multimodal Accommodations

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- **Pedestrians – Outside**
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  - Perpendicular crossings
Multimodal Accommodations

- **Pedestrians – Outside**
  - Provide clear line of sight at all crossings, especially free-flow crossings
  - Perpendicular crossings
  - Position the crossings close to the arterial to reduce high-speed conflicts
Multimodal Accommodations

- **Bicyclists**
  - 3 possible treatments at a DDI
    - Separated bicycle lanes or shared use paths
    - Marked bicycle lanes
    - Bicyclists share the driving lanes with vehicular traffic
      - This treatment should be used only in very low-speed conditions
Multimodal Accommodations

- **Bicyclists**
  - Keep to the right of the right-most travel lane
  - Will position the bicyclist on the “inside of the roadway” across the freeway but still are to the right of the driver
Multimodal Accommodations

- **Bicyclists**
  - Avoid lengthy “key holed” bicyclists if possible
Multimodal Accommodations

- **Bicyclists**
  - Or option lanes where bicyclists are unclear where drivers are going

What if an Option Lane?
Multimodal Accommodations

- **Bicyclists**
  - If the “key hole” occurs, one option is to shift them to a wider sidewalk along the outside.
  - Cross the free-flow ramp with the pedestrians.
  - Then re-enter the bike lane prior to the crossover.
Multimodal Accommodations

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Multimodal Accommodations
DDI Lighting
DDI Lighting – Complete Interchange

- High mast, conventional poles, or combination
- Primary focus on conflict areas, merge/diverge areas, and raised objects
- Give uniformity and reduction of glare additional attention

Source: Ohio DOT
DDI Lighting – Pedestrian Lighting

- Position of light poles to front light pedestrians
- Consider fixture with forward throw for median pedestrian path