Roundabout Design and Construction

IOWA STATE UNIVERSITY
Institute for Transportation

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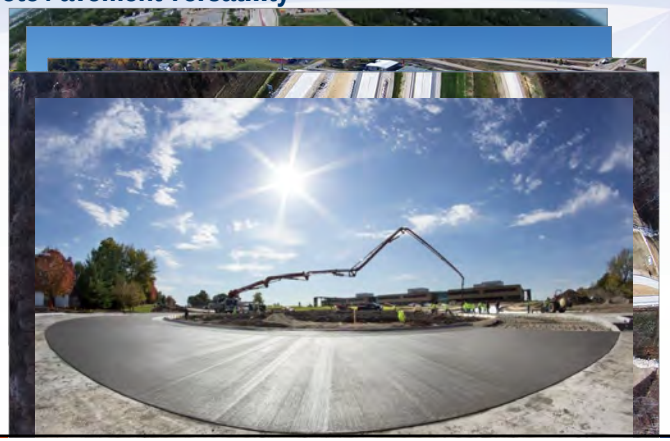
National Concrete Pavement Technology Center
Tech Center

Concrete Pavement Versatility



Why Roundabouts Anyway?

- According to FHWA:
  - Up to 90% reduction in fatalities
  - 76% reduction in injury crashes
  - 30-40% reduction in pedestrian crashes
  - 75% fewer conflict points than 4-way intersections
  - 30-50% increase in traffic capacity
  - No signal equipment to install/maintain
  - No left-turn lane and reduced need for storage lanes

Where are Concrete Pavements Historically Used?

Answers:

- High traffic areas
- Areas with lots of turning movements
- Situations where we need a “long-term fix”
- Situations where future maintenance must be kept to an absolute minimum
- Areas where future disruption to traffic must be kept to a minimum
- Economical over long-term – Life-Cycle Cost (LCC)
- Areas where safety is a priority – surface characteristics

Things to Consider for all Intersections and Roundabouts

- Thickness
- Jointing
  - Spacing
  - Type
  - Layout
- Constructability and MOT
- Other:
  - Drainage
  - Reconstruction versus inlay
  - Subgrade and subbase requirements

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Thickness Design for Intersections and Roundabouts

Pavement Thickness Design

- AASHTO
  - 1993 Pavement Design Guide
  - Pavement ME Design (MEPDG)
    - Implemented in many states
    - Under calibration in many other states
- Concrete Pavement Industry Method
  - PavementDesigner.org
    - Developed for Street & Local Road Design
- REGARDLESS OF METHOD MUST CONSIDER CUMULATIVE TRAFFIC!!

PvD AASHTOWare Pavement ME Design AASHTO

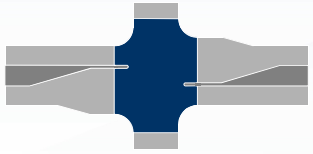
PavementDesigner.org

Thickness Impacts Jointing!

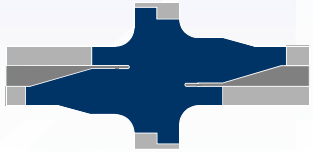
Design may be based on AASHTO, PavementDesigner, etc.

Class	ADT	ADTT	Thickness
Light residential	< 200	2-4	4.0-5.0 in.
Residential	200-1,000	10-50	5.0-6.0 in.
Collector	1,000-8,000	50-500	5.5-8.0 in.
Business	11,000-17,000	400-700	6.0-8.0 in.
Industrial	2,000-4,000	300-800	6.5-9.5 in.
Arterial (minor)	4,000-15,000	300-600	6.5-9.5 in.
Arterial (major)	4,000-30,000	700-1,500	7.0-10.0 in.

Concrete Intersections and Roundabouts: Thickness

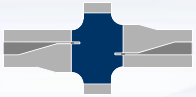


Physical Area



Functional Area

Concrete Intersections and Roundabouts: Thickness



Physical Area

Functional Area

Roadway 1	Roadway 2	Physical Area Thickness
Low ADTT (T1)	Low ADTT (T2)	T2
Low ADTT (T1)	High ADTT (T3)	T3
High ADTT (T3)	High ADTT (T3)	T3 + 0.5 to 1 in.

T3>T2>T1

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Basic Principles for Jointing and Joint Layout

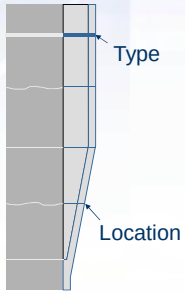
Joint Spacing "Best Practices" Summary

- Keep it Short!
- Keep it Uniform!
- Keep it Perpendicular!
- Keep it Simple!
- Keep it Practical!

Rules for Joint Layout

Things to Do

- Match existing joints or cracks – location AND type!
- Cut joints at the proper time and to the proper depth
- Place joints to meet in-pavement structures
- Remember maximum joint spacing
- Place isolation joints where needed
- Understand that joint locations can be adjusted in the field!
- Be Practical



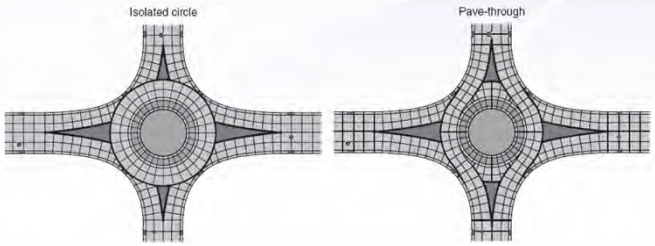
Rules for Joint Layout

Things to Avoid:

- Slabs < 2 ft wide
- Slabs > 15 ft wide
- Angles < 60º (90º is best)
  - Use "dog-leg" joints through curve radius points
- Creating interior corners
- "Odd" shapes
  - Keep slabs nearly square or rectangular, when possible

Additional Step by Step Guidance

- 6 Step Method for Roundabouts



http://wikipave.org/index.php?title=Joint_Layout

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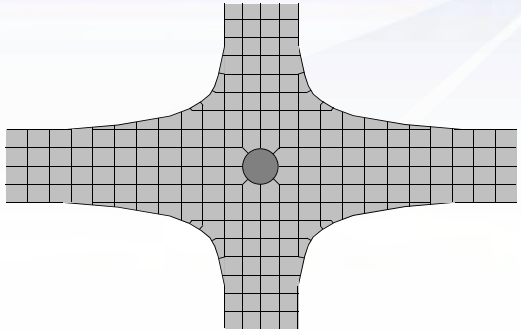
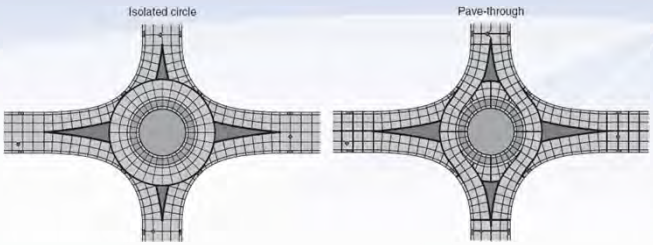
Joint Layout for Roundabouts

Layout Joints as Normal Intersection



Jointing

- Decide on joint layout philosophy
  - ~~Like normal intersection~~
  - Isolate circle from legs
  - Pave-through, isolate two legs
  - Other philosophy, based on experience
- Follow 6-step method
- Joints in circular portion radiate from center
- Joints in legs are normal (perpendicular)



Concrete Roundabout Design And Construction

6-STEP METHOD FOR JOINTING ROUNDABOUTS

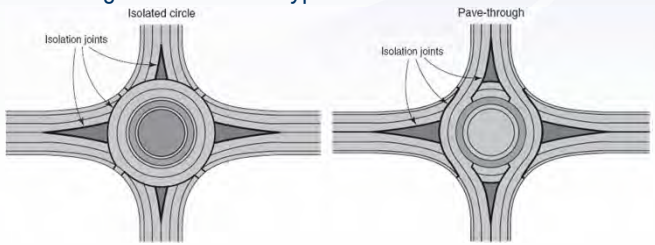
http://wikipave.org/index.php?title=Joint_Layout

Jointing a Roundabout

Step 1: Draw all pavement edges and back-of-curb lines in plan view.

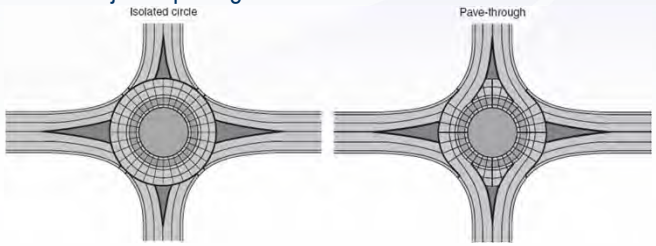
Jointing a Roundabout

Step 2: Draw all lane lines on the legs and in the circular portion, accounting for roundabout type.

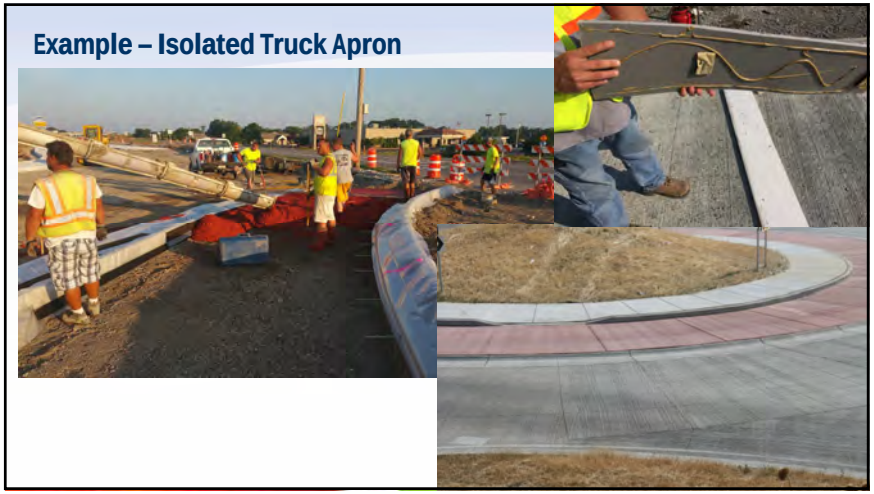


Jointing a Roundabout

Step 3: Add "transverse" joints in the circle, being mindful of the maximum joint spacing.

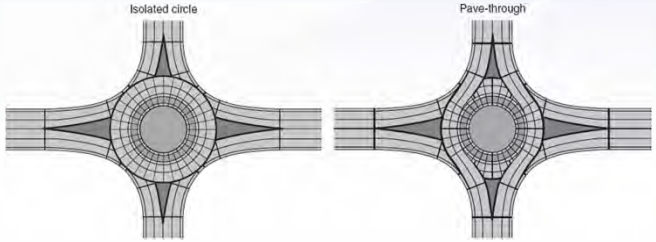


Example – Isolated Truck Apron



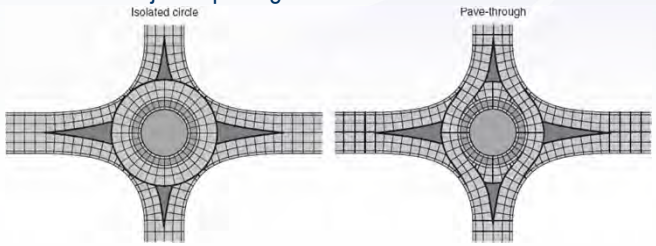
Jointing a Roundabout

Step 4: On the legs, add transverse joints where width changes occur.

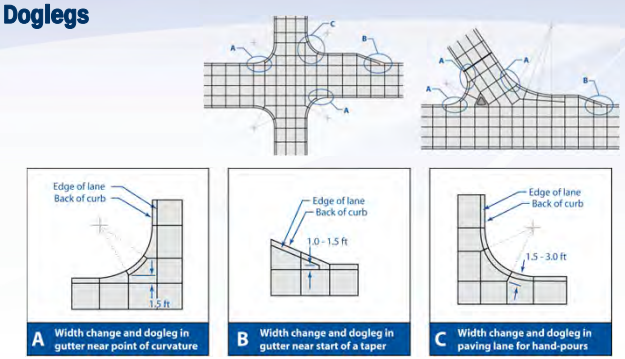


Jointing a Roundabout

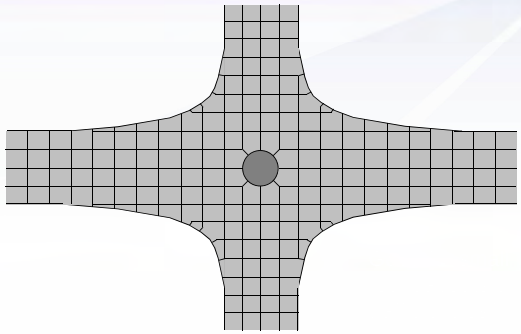
Step 5: Add transverse joints between those added in Step 4, minding the maximum joint spacing.



Doglegs



Layout Joints as Normal



Jointing a Roundabout

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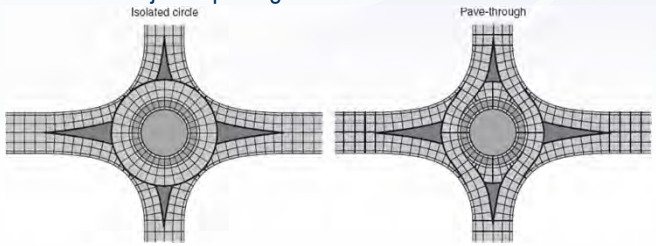
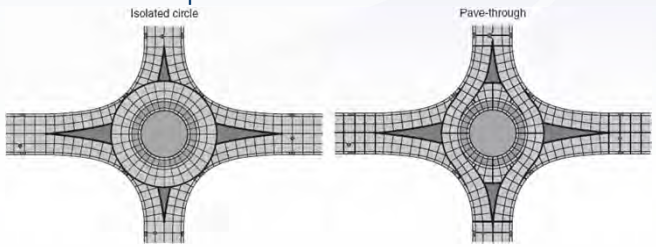


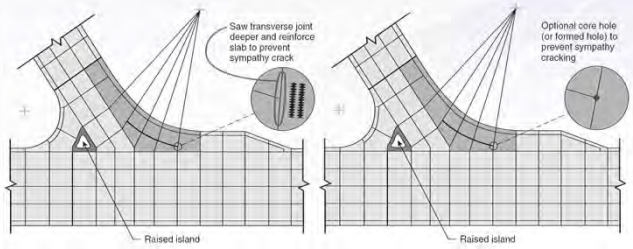
Jointing a Roundabout

Step 6: Make adjustments for in-pavement objects, fixtures, and to eliminate odd shaped slabs.

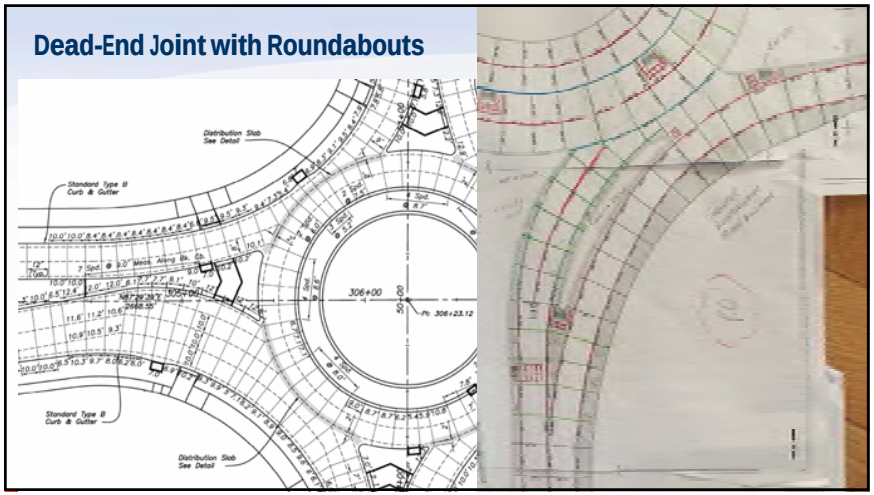


Properly Jointed Roundabout

What If I Have to Dead-end a Joint?



Dead-End Joint with Roundabouts



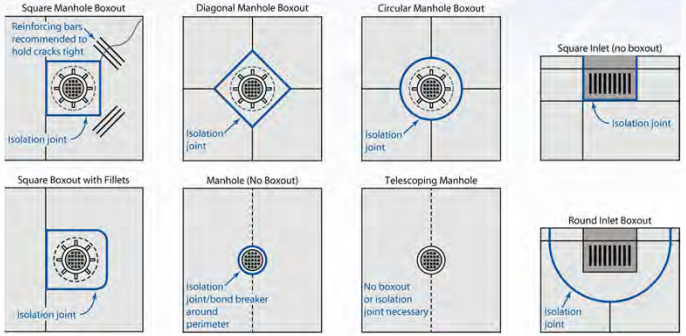
What If I Have to Dead-end a Joint?

What If I Have to Dead-end a Joint?

What If I Have an Odd Shaped Slab?

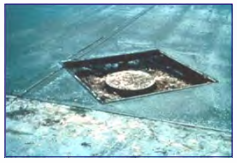
Concrete Intersections: Jointing

Box Out Fixture Details



If You DO Box Out Properly…Good Results Happen!

If You DON'T Box Out Properly…Bad Things Happen!



Where There's a Will, There's a Way…

Old…BUT NO CRACKS!

Good Practice…

Lining joints perpendicular to pavement edge!

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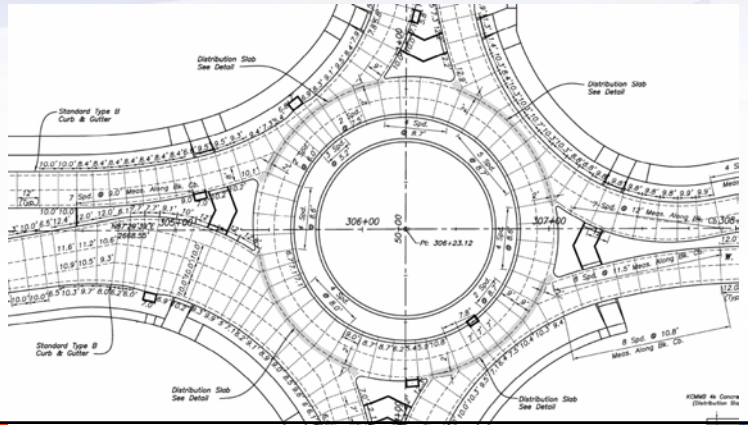
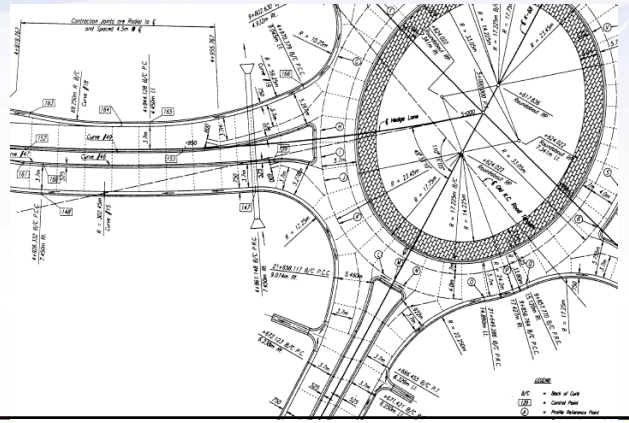
Alternate Design Examples for Roundabouts

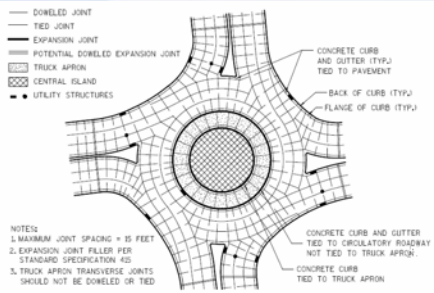
Dealing With Traffic Calming and Flare Outs

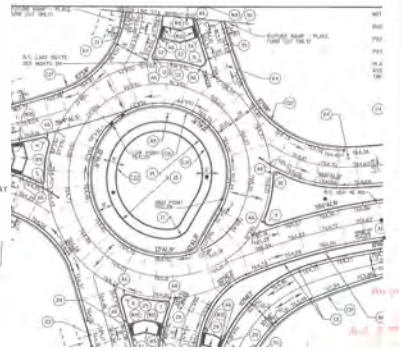


Kansas – Oval Shaped



Wisconsin – Pinwheel Method





https://wisconsindot.gov/rdwy/sdd/sd-13c18.pdf#page=1

Minnesota – Fiber Reinforced Jointless

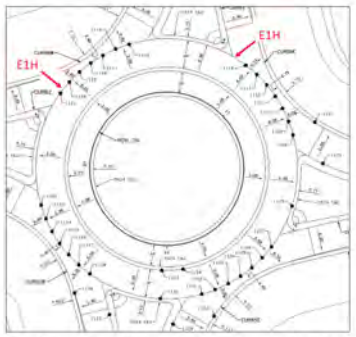


Figure 3- Construction joint E1H (un-doweled) at the outer perimeters of the FRC ring

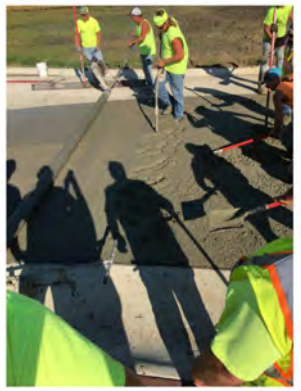
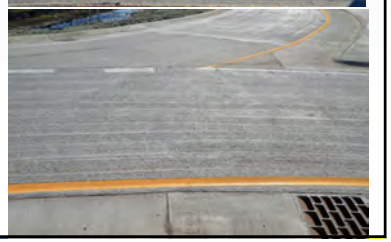


Figure 16- Using a portable vibrator and the roller screed for concrete placement

Report: http://dot.state.mn.us/mnroad/nrra/structure-teams/rigid/files/frc-roundabout-task-1-construction-report-final.pdf

Minnesota – Fiber Reinforced Jointless

Figure 20- Location of the cores taken from the joint-less FRC roundabout in late September 2018 indicated by red "x" marks



Netherlands – Continuously Reinforced

Guidelines for Concrete Roundabouts in The Netherlands

W.A. Kramer, *Cement&BetonCentrum*
G. Jurriaans, *ECCRA*

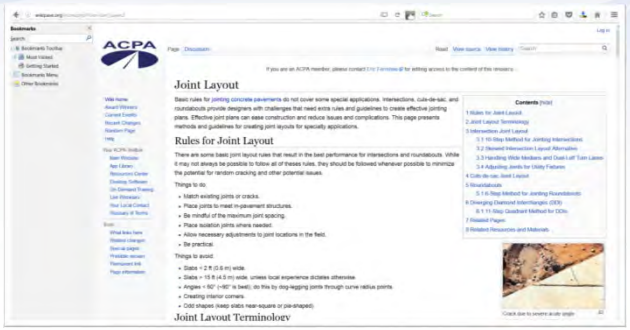
More Information?

- "Concrete Pavement Field Reference: Prepaving," EB237P, ACPA, 2007.
- "Concrete Roundabouts: Rigid Pavement Well-Suited to Increasingly Popular Intersection Type, " R&T Update #6.03, ACPA, June 2005.
- "Roundabouts: An Informational Guide," FHWA-RD-00-068, FHWA, March 2000.
- "Kansas Roundabout Guide": http://www.ksdot.org/burTrafficEng/Roundabouts/Roundabout_Guide/RoundaboutGuide.asp
- Various agency standards…KS, WI, IA, OH, etc…

Acknowledgements:

- Thanks to all ACPA Chapter / State Paving Associations and CPAM and MCA for various slides and photos throughout
- Thanks to Bill Cuerdon, Todd LaTorella, Kevin McMullen, and Matt Zeller

Resources



http://wikipave.org

Thank You!

Next Up: Roundabout Construction

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