

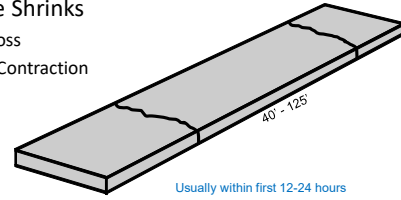
# Jointing Concrete Pavements



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## Why Joint Concrete Pavements?

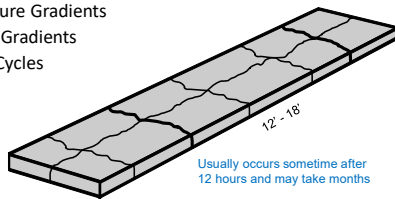
- Concrete Shrinks
- Volume loss
- Thermal Contraction



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## Natural Crack Development

- Temperature Gradients
- Moisture Gradients
- Thermal Cycles
- Loading



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Hot then Cold

**HOT AT SET**

**COOLED OFF**

$\Delta L = \alpha \cdot \Delta T \cdot L$

**Thermal Shrinkage**

Hydration Uses Water

**Drying Shrinkage**

**Chemical Shrinkage**

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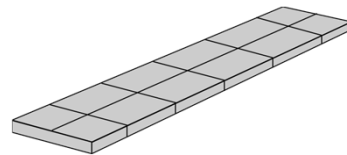
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## Why Joint Concrete Pavements?

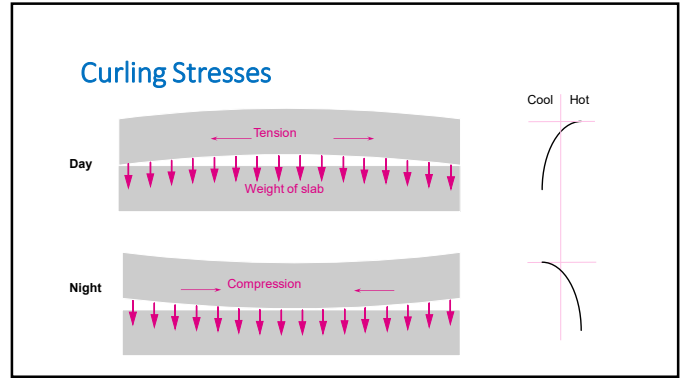
Natural cracking can be mitigated through jointing



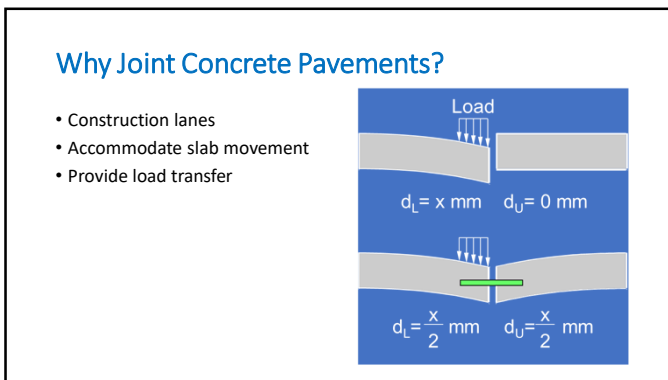
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### Joint Spacing - Mechanistic

$l = \text{radius of relative stiffness (in.)}$   
 $E = \text{modulus of elasticity (psi)}$   
 $h = \text{slab thickness (in.)}$   
 $k = \text{modulus of subgrade reaction (psi/in.)}$   
 $\mu = \text{Poisson's ratio for concrete (typically 0.15)}$   
*\*ratio of joint spacing to  $l$  should be limited to 4-5*

$$l = \sqrt[4]{\frac{Eh^3}{12(1-\mu^2)k}}$$

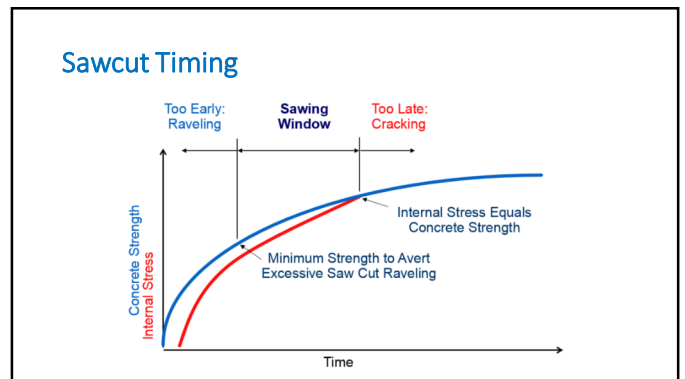
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### Joint Spacing - Empirical

Based on thickness of slab and subbase/ subgrade support layer immediately beneath concrete


- Thickness x Support Constant
  - Support constant = 24 for subgrades and unstabilized subbases
  - Support constant = 12-15 for thin bonded overlays on asphalt
- App: Maximum Joint Spacing Calculator

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### Sawcut Timing



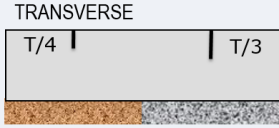
High Performance Concrete PAVing software  
www.hiperpav.com

- Determine how weather affects pavement performance
- Predict & prevent uncontrolled cracking at early ages
- Determine optimum sawcutting window during construction
- Determine how early pavement can be opened to traffic

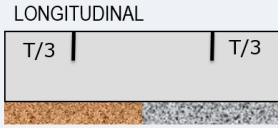
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### Sawcut Depth

TRANSVERSE



LONGITUDINAL



Frictional resistance between the slab and the stabilized subbase is greater -> deeper cut necessary to present a weakened plane that reliably controls crack formation using conventional sawing equipment

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### Types of Joints

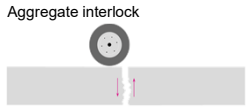
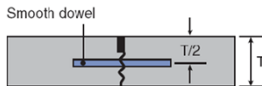
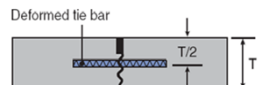
- Contraction
- Construction
- Isolation

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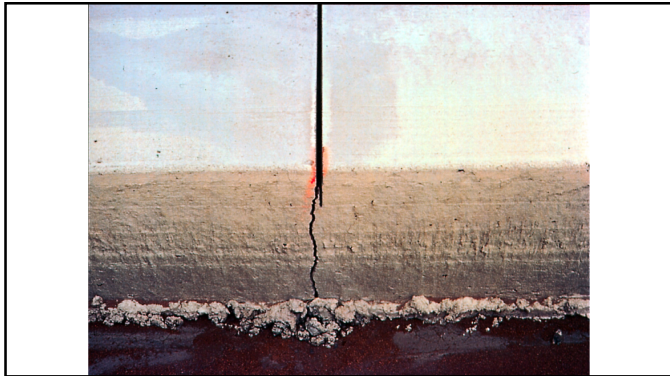
### Contraction Joints

Control formation of cracks

- Transverse
  - Typically 15' spacing
  - Utilize aggregate interlock or dowels for load transfer
- Longitudinal
  - Typically 12' spacing
  - Typically tied together with a tie bar


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### Construction Joints

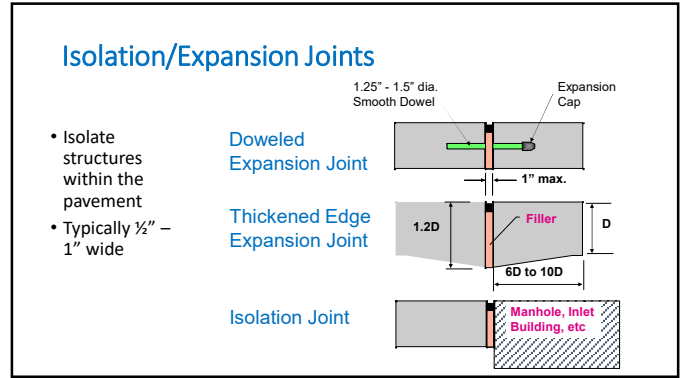
- Transverse
  - End of a paving run or interruption
  - Formed or sawed
- Longitudinal
  - Joining lanes paved in separate passes
  - Tie bars typically used to prevent separation



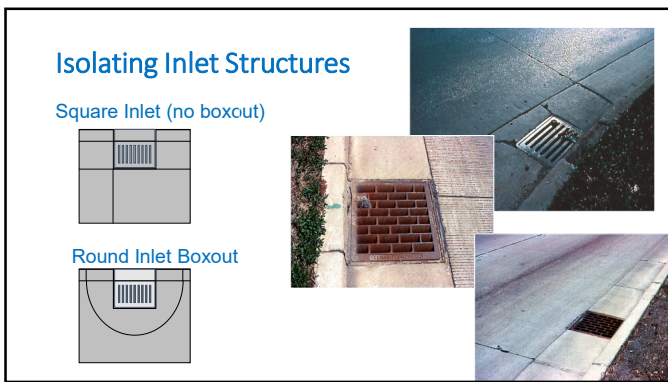
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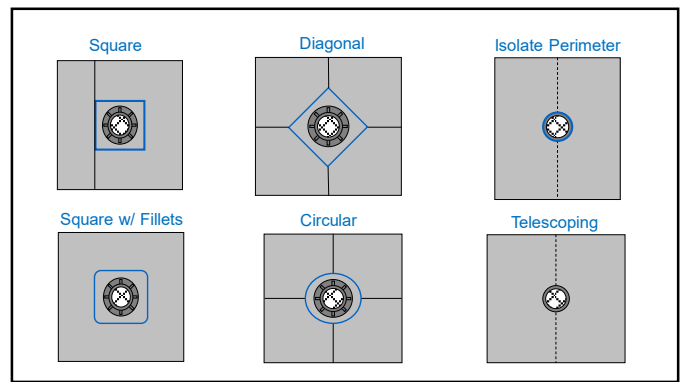
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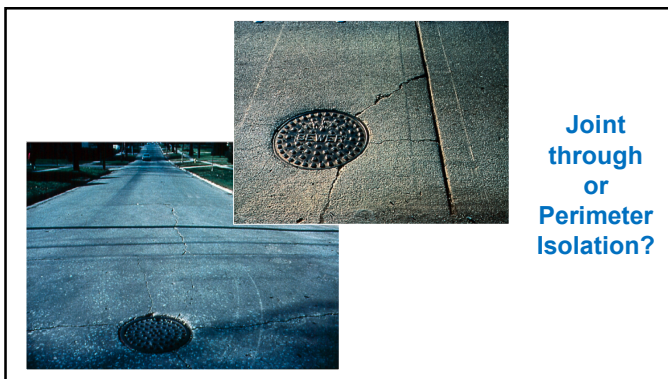
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### Sawing



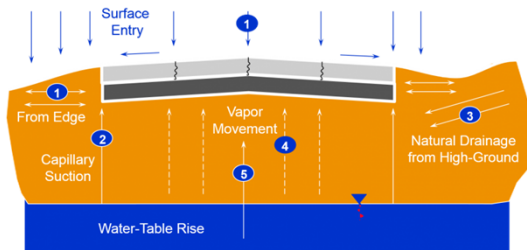
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### Sealing Joints

- Water infiltration can lead to:
  - Subgrade or subbase softening
  - Erosion
  - Pumping
  - Loss of support
- Watertight pavement not practical to construct
- Joint seal minimizes the passage of water & incompressibles

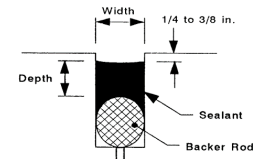
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### Water Infiltration



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### Joint Sealant



$$\text{Shape Factor} = \frac{\text{Depth}}{\text{Width}}$$

Liquid Sealant Type	Typical Shape Factor
Hot-Pour	1.0
Silicone	0.5

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### Joint Sealing



- Protects the pavement
- Keeps incompressible materials out
- Reduces deicer penetration
- Reduces water infiltration

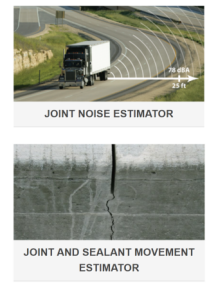
#### Timing

- Based on mix design and manufacturer recommendation
- 3-7 days following placement of pavement

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### Web Apps: [apps.acpa.org/applibary](https://apps.acpa.org/applibary)

- Maximum Joint Spacing Calculator
- Joint Noise Estimator
- Joint and Sealant Movement Estimator
- Compression Seal Joint Width Calculator
- Evaporation Rate Calculator
- HIPERPAV



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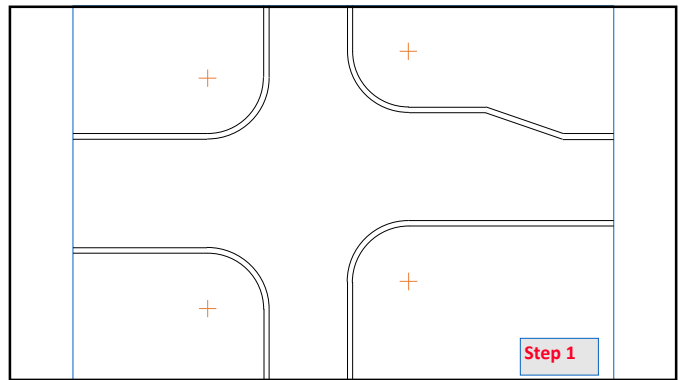
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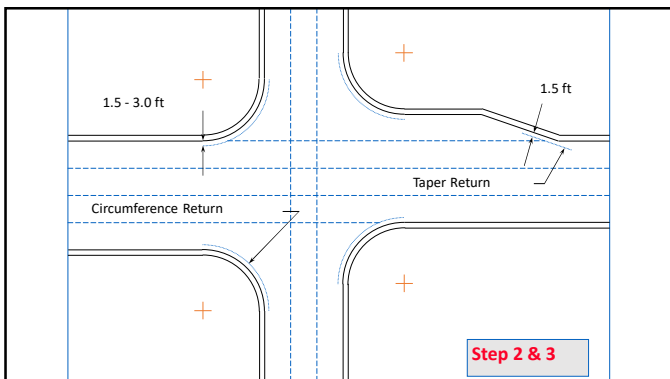
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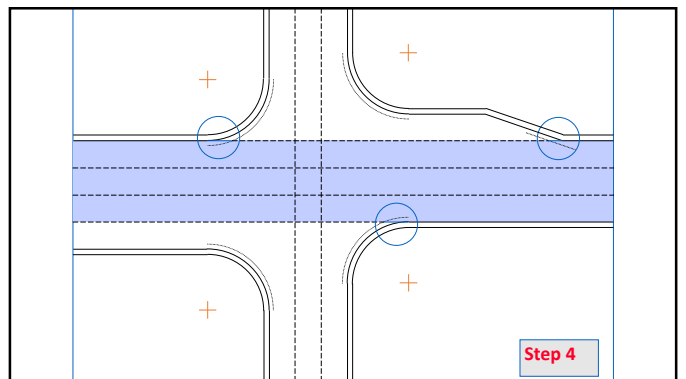
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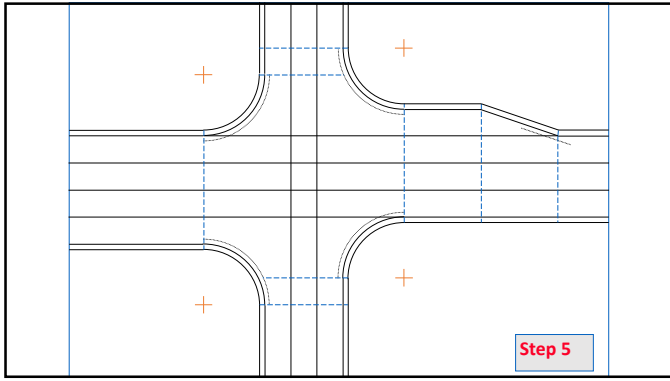
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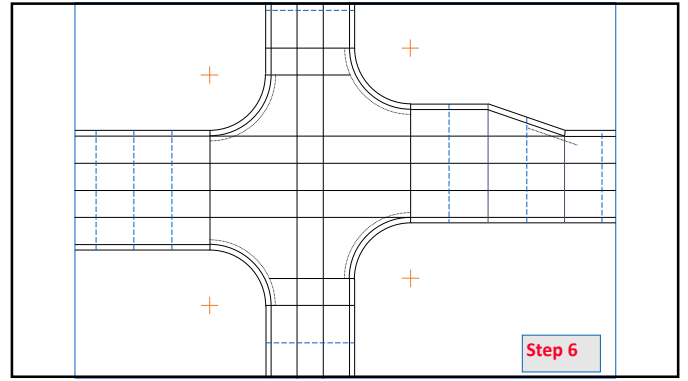
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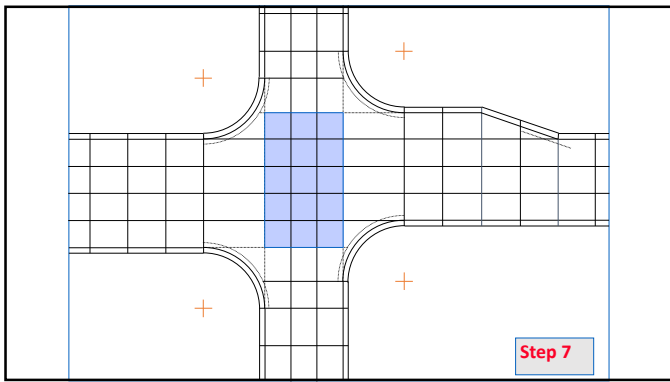
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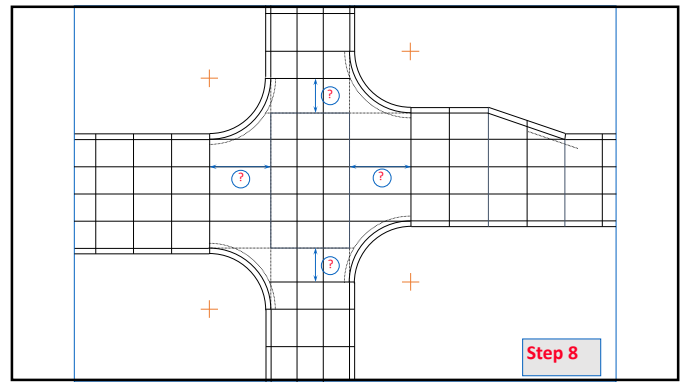
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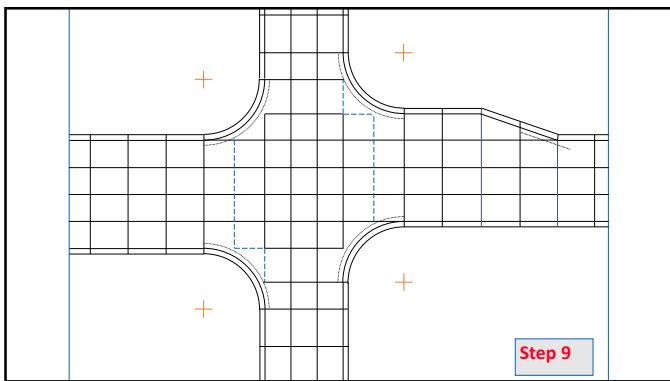
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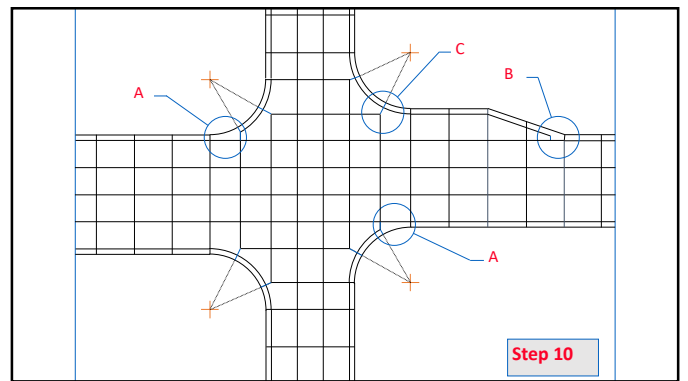
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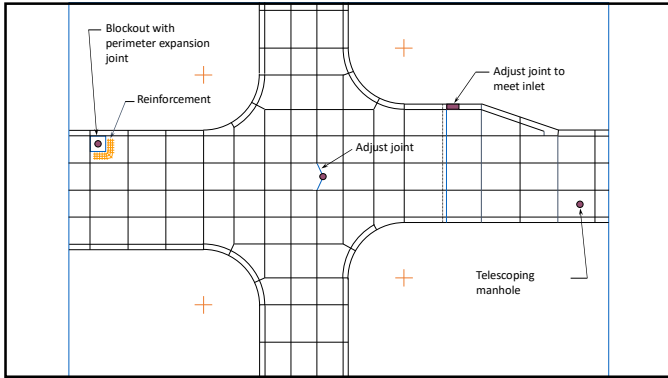
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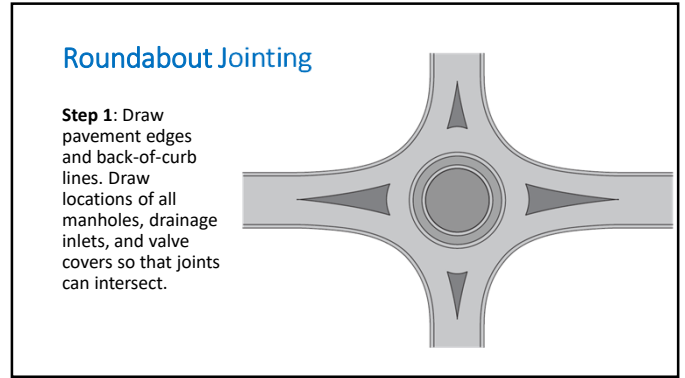
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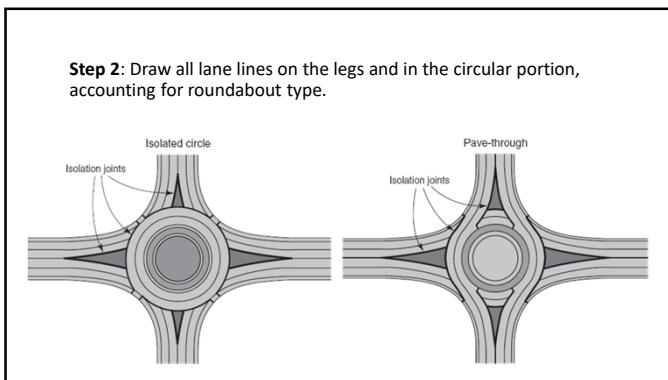
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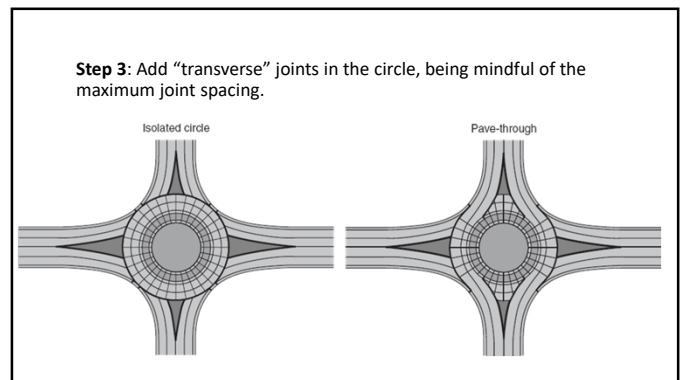
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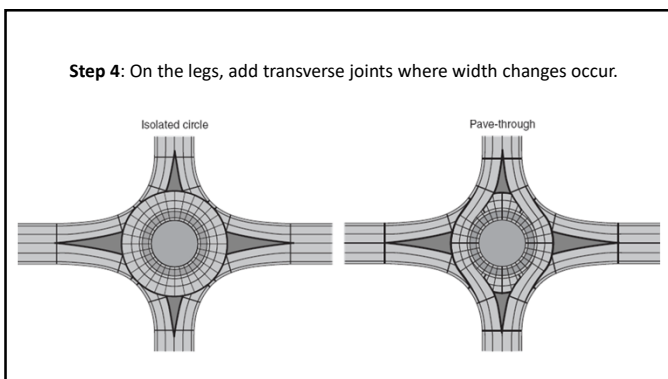
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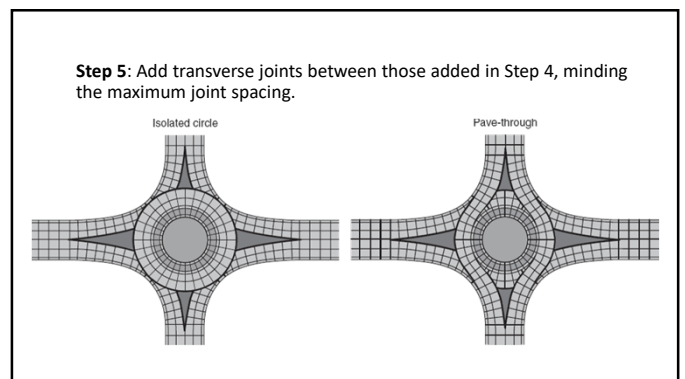
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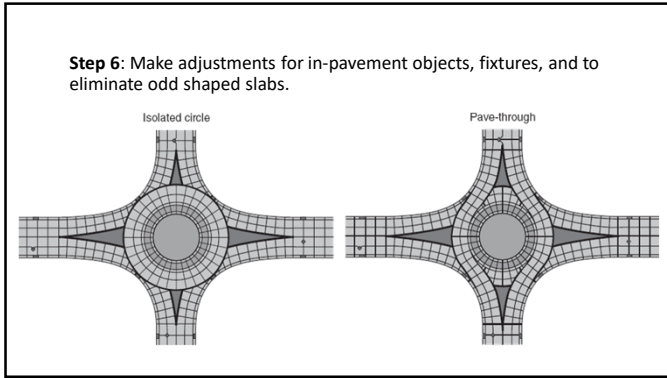
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### Diverging Diamond Jointing

1. Draw all pavement edges and back-of-curb lines in plan view.
2. Divide the interchange into four quadrants.
3. Place a joint in each quadrant when the pavement width changes as you work your way out from the center. Make sure the joint is perpendicular to the direction of travel.
4. Lightly draw the circumference-return and taper-return line(s) outside of the central portion defined in Step 3.

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5. Lightly draw cross road return lines on each side of the central bisecting joint.
6. Define paving lanes on the mainline approaches. Do not cross the cross road return lines defined in Step 5.
7. Place transverse joints on the mainline approaches.
8. Lightly draw cross road return lines for each of the on/off ramps.

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9. Add longitudinal joints to the on/off ramps.
10. Add transverse joints to the on/off ramps.
11. Address doglegs and odd shaped panels as possible.

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Resources [www.wikipave.org](http://www.wikipave.org)

[www.cptechcenter.org](http://www.cptechcenter.org)

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