Jointing Concrete Pavements

Why Joint Concrete Pavements?
Concrete Shrinks
- Volume loss
- Thermal Contraction

Usually within first 12-24 hours

Natural Crack Development
- Temperature Gradients
- Moisture Gradients
- Thermal Cycles
- Loading

Usually occurs sometime after 12 hours and may take months

Natural cracking can be mitigated through jointing
Why Joint Concrete Pavements?
- Construction lanes
- Accommodate slab movement
- Provide load transfer

Joint Spacing - Mechanistic

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

- \( l \) = radius of relative stiffness (in.)
- \( E \) = modulus of elasticity (psi)
- \( h \) = slab thickness (in.)
- \( k \) = modulus of subgrade reaction (psi/in.)
- \( \mu \) = Poisson’s ratio for concrete (typically 0.15)

*Ratio of joint spacing to \( l \) should be limited to 4-5

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

Sawcut Timing

Too Early: Raveling
Sawing Window
Too Late: Cracking

Minimum Strength to Avert Excessive Saw Cut Raveling
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

Sawcut Depth

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

Types of Joints

• Contraction
• Construction
• Isolation

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

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
Joint Construction

Isolation/Expansion Joints
- Isolate structures within the pavement
- Typically ½” – 1” wide

Doweled Expansion Joint

Thickened Edge Expansion Joint

Isolation Joint

Joint through or Perimeter Isolation?

Good Practice!
Sawing

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

Water Infiltration

- 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

Joint Sealant

Web Apps: apps.acpa.org/applibrary

- Maximum Joint Spacing Calculator
- Joint Noise Estimator
- Joint and Sealant Movement Estimator
- Compression Seal Joint Width Calculator
- Evaporation Rate Calculator
- HIPERPAV
Step 1

1.5 ft

Circumference Return

1.5 - 3.0 ft

Taper Return

Step 2 & 3

Step 4
Adjust joint to meet inlet
Blockout with perimeter expansion joint
Adjust joint to meet inlet
Reinforcement
Telescoping manhole

Roundabout Jointing

Step 1: Draw pavement edges and back-of-curb lines. Draw locations of all manholes, drainage inlets, and valve covers so that joints can intersect.

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

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

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

Step 5: Add transverse joints between those added in Step 4, minding the maximum joint spacing.
**Step 6: Make adjustments for in-pavement objects, fixtures, and to eliminate odd shaped slabs.**

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.
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.
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.

**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.
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.
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.