Design & Construction of an Effective, Durable Concrete Pavement Jointing System

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Tech Center

Today’s Presentation

- Design & Layout
- Construction
- Durability

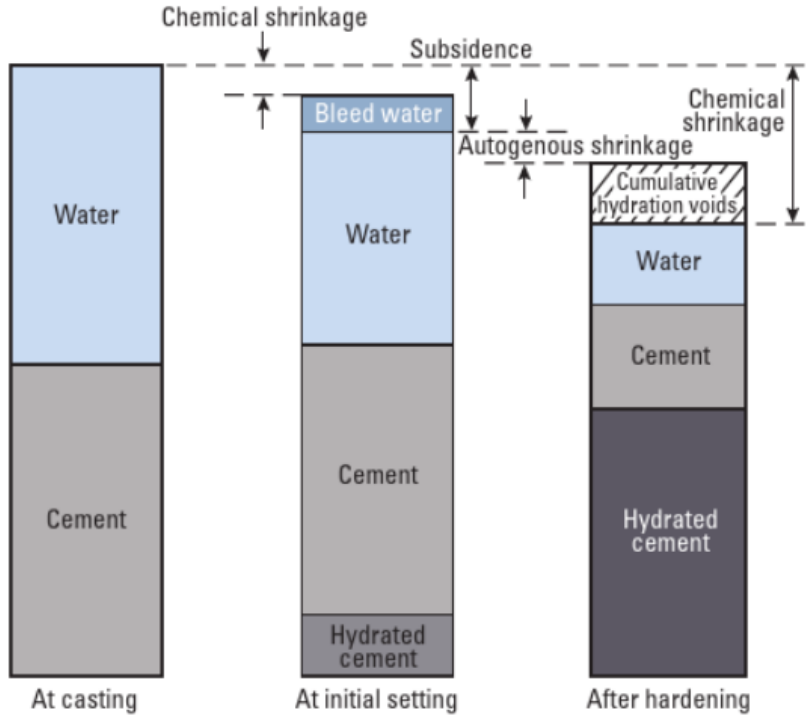
Acknowledgments

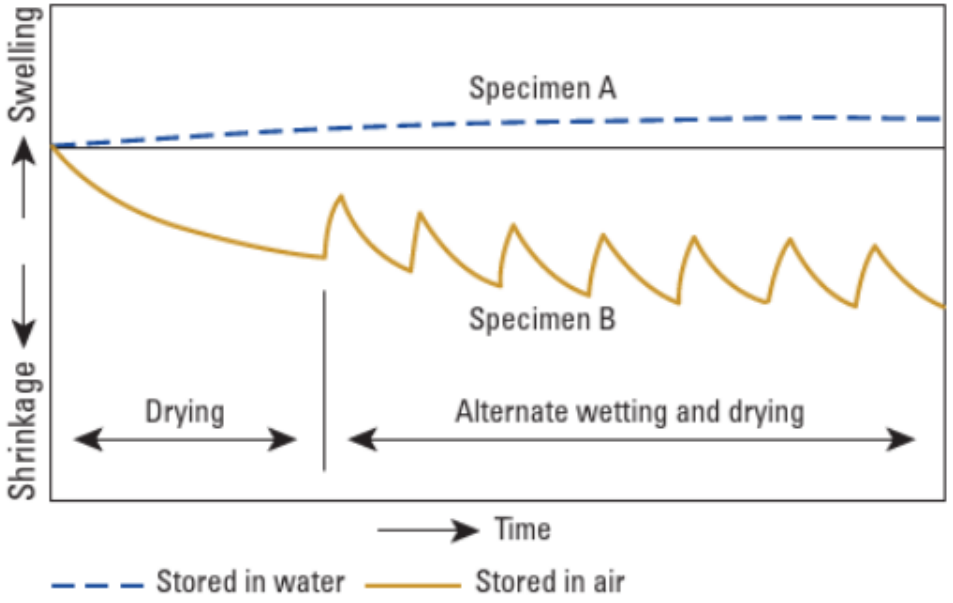
- Thanks to Iowa DOT & ICPA for their support of this program
- Special thanks to Eric Ferrebee, ACPA
  - ACPA is a great resource for jointing-related questions
  - Visit **https://wikipave.org** for additional resources

Design & Layout

Why Place Joints in Concrete Pavements?

- Concrete begins to shrink shortly after placement
  - Natural result of the hydration reaction, reduction in temperature, and loss of moisture from the system





Images: ACA

Why Place Joints in Concrete Pavements?

- If concrete slabs could expand and contract freely, shrinkage wouldn't cause any problems
- However, restraint from the underlying subgrade or subbase causes tensile stresses to develop in the slab as it contracts

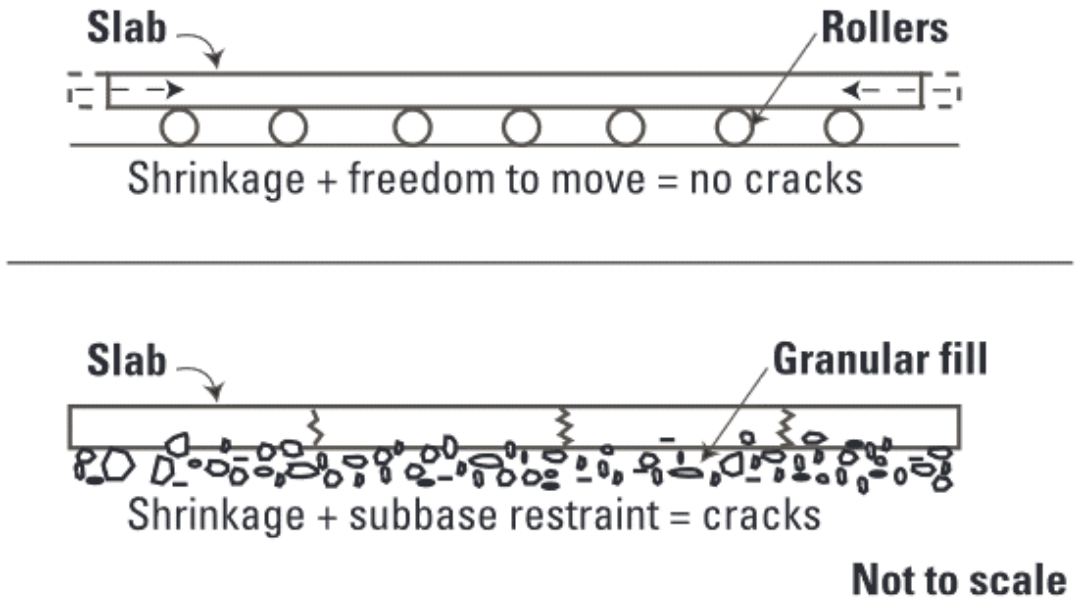
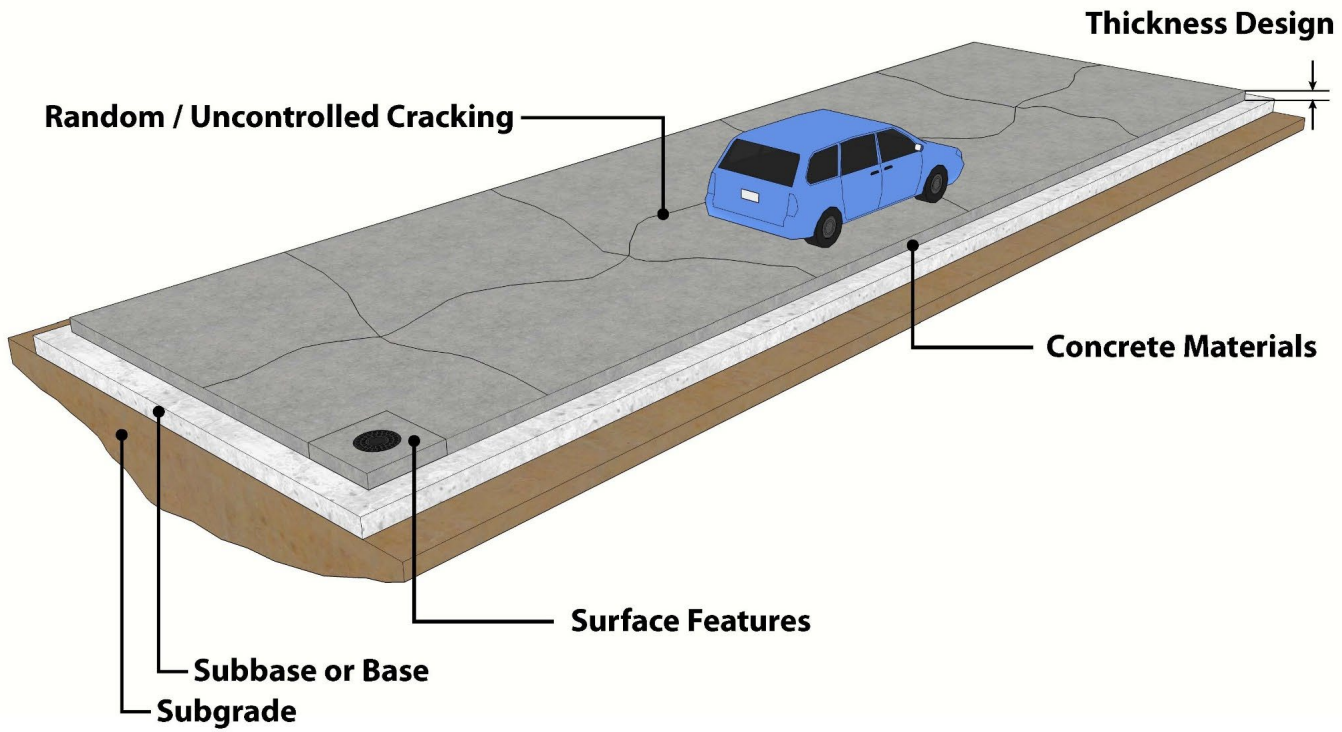


Image: ACPA

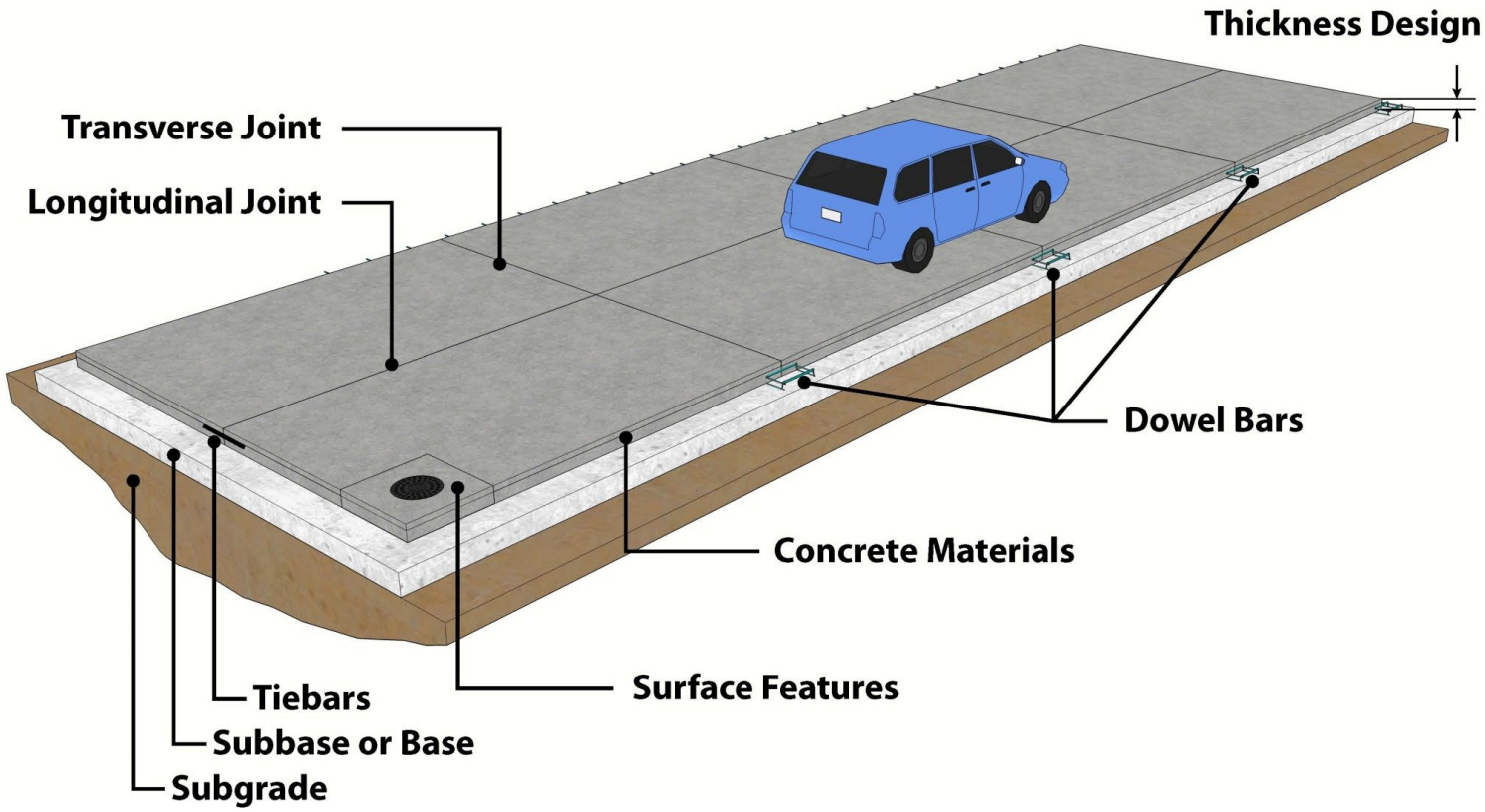
Why Place Joints in Concrete Pavements?

- Concrete gains strength as it hydrates, but eventually these tensile stresses will exceed the concrete strength, and random cracks will develop in the pavement



Why Place Joints in Concrete Pavements?

- We place joints in concrete pavements to direct the formation of cracks at planned locations and to control cracking behavior



Types of Joints

- Vehicles cross transverse joints
  - Load transfer across transverse joints is a key factor in concrete pavement performance
- Longitudinal joints are parallel to the direction of traffic
  - Frequently coincide with lane lines on streets and roads

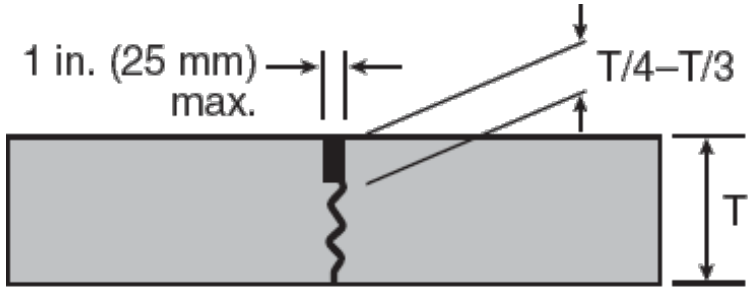
- In parking lots without channelized traffic, we may not distinguish between transverse and longitudinal joints

Types of Joints

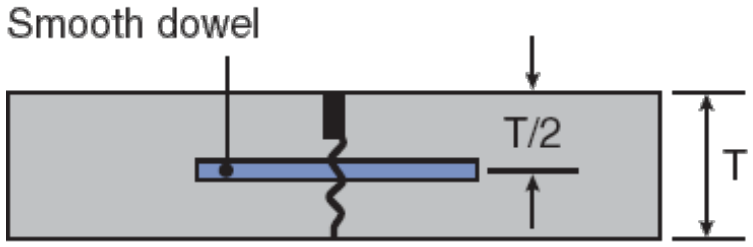
- Primary joint types:
  - Contraction
  - Construction
  - Isolation or Expansion
- Each of these joints can be transverse or longitudinal
- See Iowa DOT PV-101 / SUDAS 7010.01

Contraction Joints

- Transverse contraction joints
  - Formed by saw cuts that create a weakened plane to direct the formation of cracks at planned locations

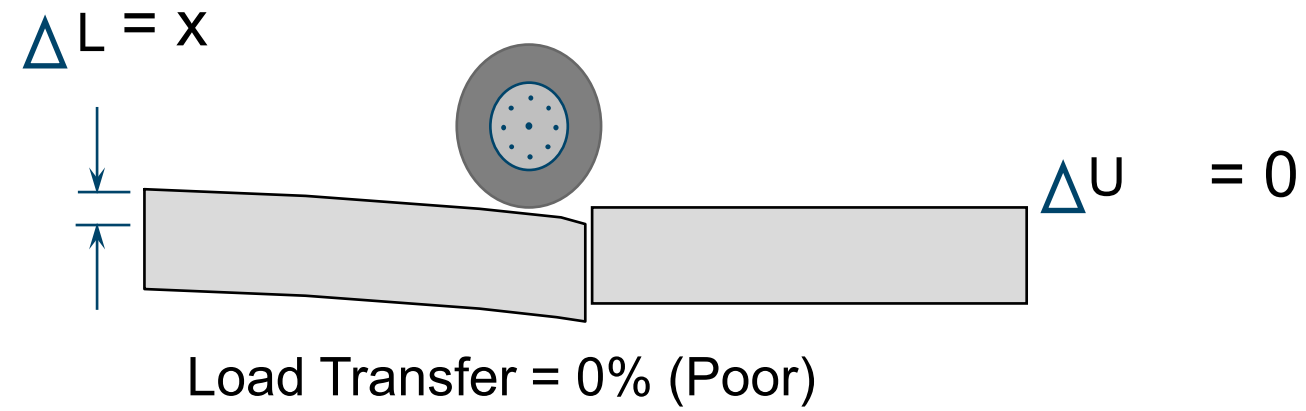


Undoweled – Transverse (Type A-1)

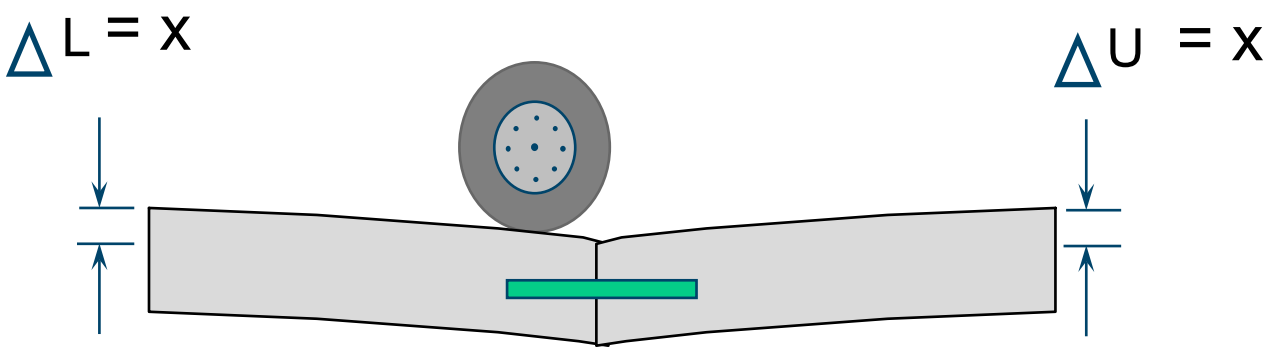


Doweled – Transverse (Type A-2)

Load Transfer



Load Transfer = 0% (Poor)



Load Transfer = 100% (Good)

Image: ACPA

Load Transfer

- In the absence of dowel bars, aggregate interlock provides shear load transfer across the joint
  - Function of aggregate properties (including size, shape, and hardness), mix properties, and joint opening

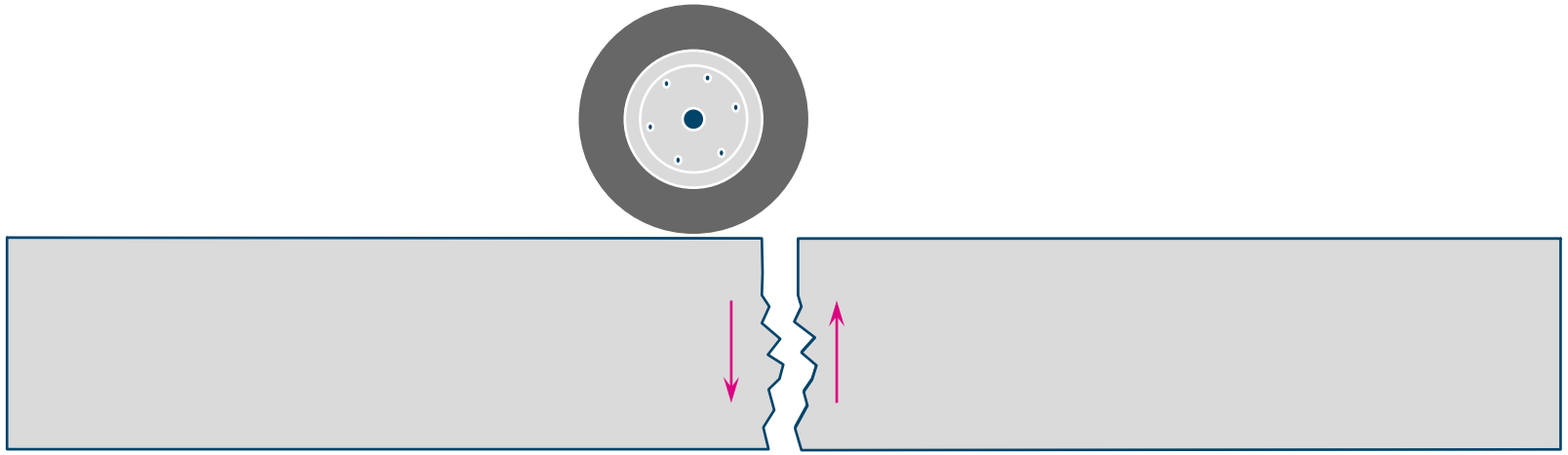


Image: ACPA

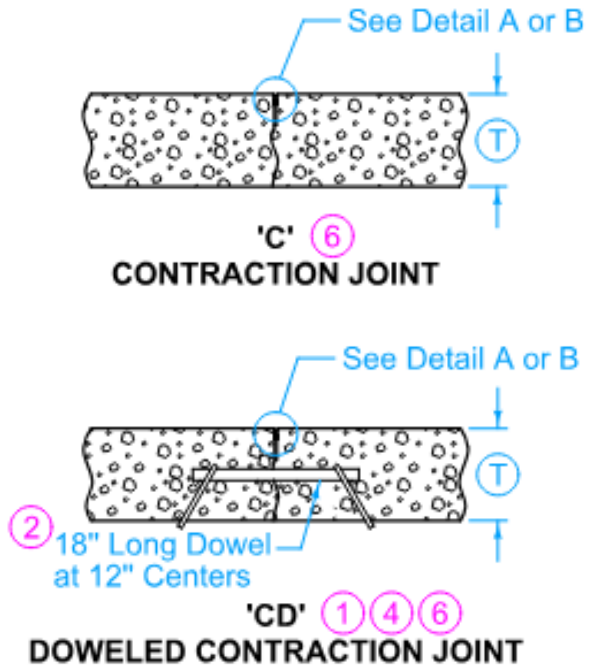
Load Transfer

- When a pavement carries a high volume of heavy traffic loads, aggregate interlock will not provide sufficient load transfer
- Upon reaching about 100 trucks/day, we reinforce transverse joints with dowel bars for additional load transfer

Image: FHWA

Contraction Joints

- Transverse contraction joints: ‘C’ and ‘CD’ (PV-101)
  - Dowels are generally used when pavement is ≥ 8 in. thick
  - Dowel diameter specified as a function of slab thickness



BAR SIZE TABLE FOR CONTRACTION JOINTS			
T	Solid Dowel Diameter	Tubular Dowel Diameter	Tie Bar Size
< 8"	$\frac{3}{4}$"	$\frac{7}{8}$"	#6
≥ 8" but < 10"	$1\frac{1}{4}$"	$1\frac{3}{8}$"	#10
≥ 10"	$1\frac{1}{2}$"	$1\frac{5}{8}$"	#11
Tubular Dowel Bars will not be allowed for RD joints.			

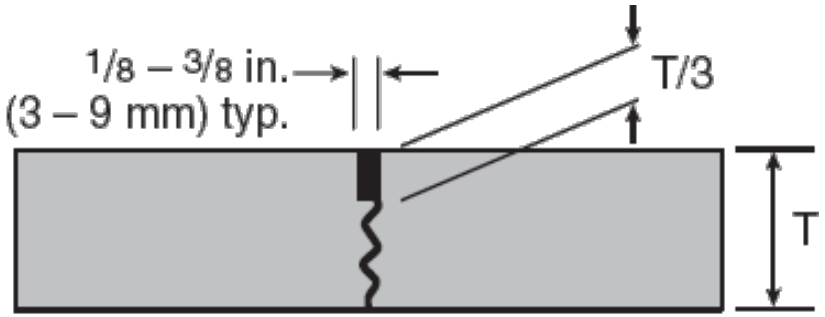
Types of Dowel Bars

- Epoxy-coated solid steel (round or elliptical)
- Galvanized tubular steel with end caps
- Glass fiber reinforced polymer (GFRP)

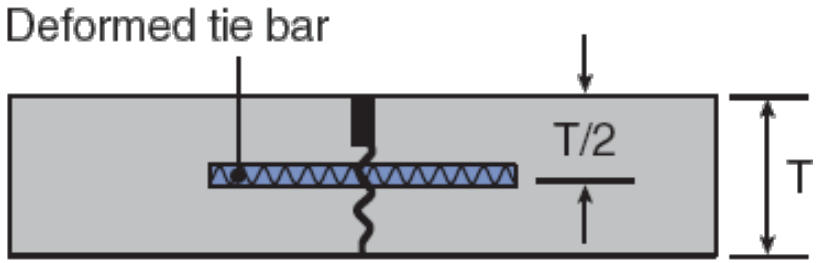
Images: Avient

Contraction Joints

- Longitudinal contraction joints
  - Tie bars are used to tie lanes together



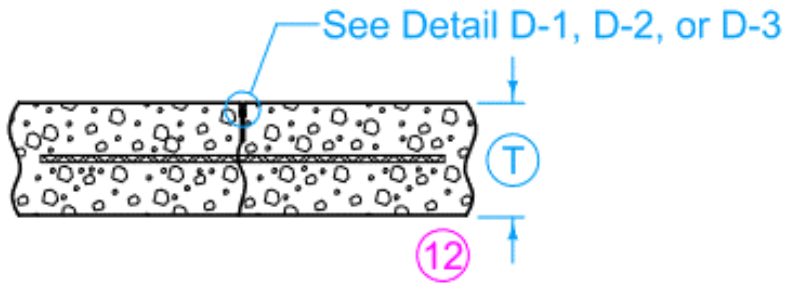
Untied – Longitudinal (Type A-3)



Tied – Longitudinal (Type A-4)

Contraction Joints

- Longitudinal contraction joints: ‘L’ (PV-101)
  - Tie bar diameter and spacing are specified as a function of slab thickness

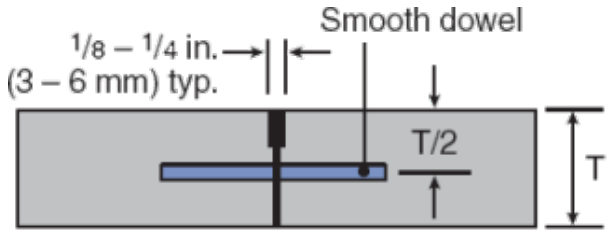


'L'
CONTRACTION JOINT

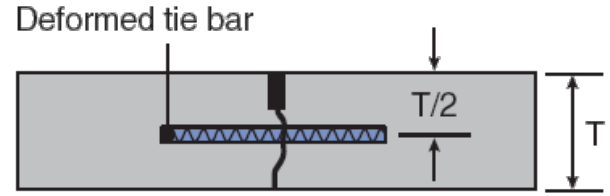
T	Joint	Bars	Bar Length and Spacing
< 8"	'L-1'	#4	36" Long at 30" Centers
≥ 8"	'L-2'	#5	36" Long at 30" Centers
	'L-3'		36" Long at 15" Centers

Construction Joints

- Transverse construction joints (headers)
  - Occur at ends of pavement sections
  - Locations are unplanned on mainline street & roadway pavements



Doweled butt – Transverse (Type B-1)

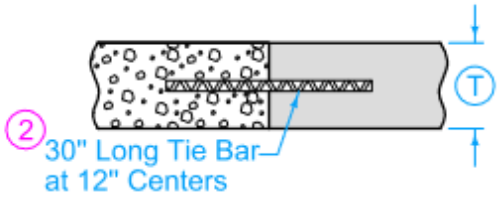


Tied – Transverse (Type C-1)
(Keyway optional)

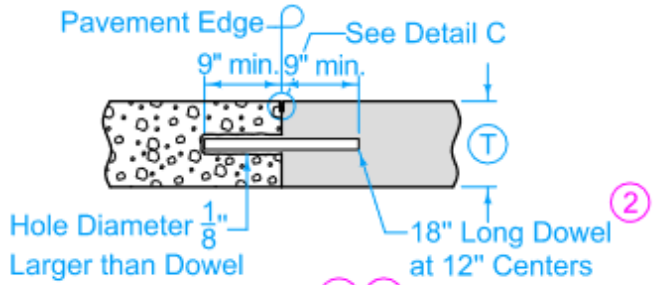
Images: ACPA

Construction Joints

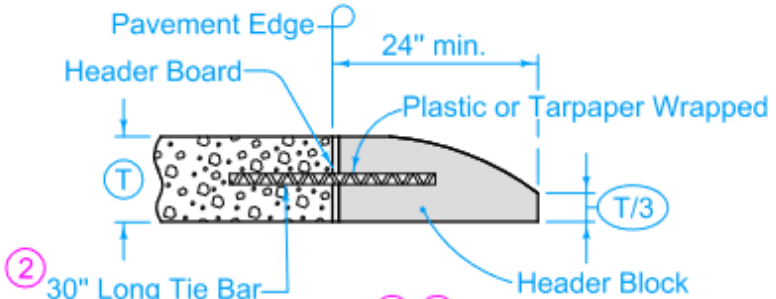
- Transverse construction joints: ‘DW’, ‘HT’, ‘RD’, and ‘RT’ (PV-101)



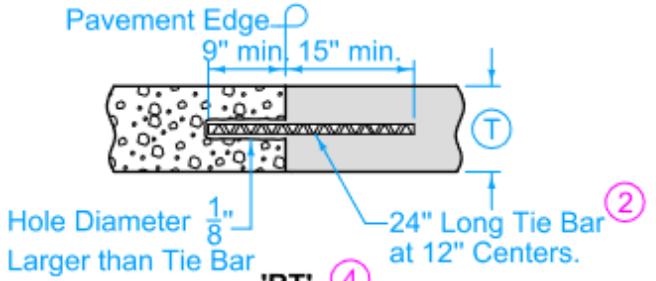
'DW' (3) (4) (7)
DAY'S WORK JOINT(Non-working)



'RD' (4) (5)
ABUTTING PAVEMENT JOINT



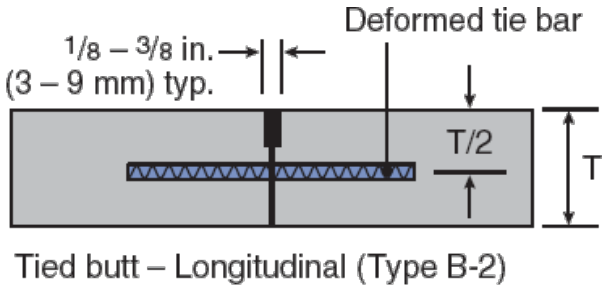
'HT' (4) (5)
HEADER JOINT
(End Rigid Pavement)



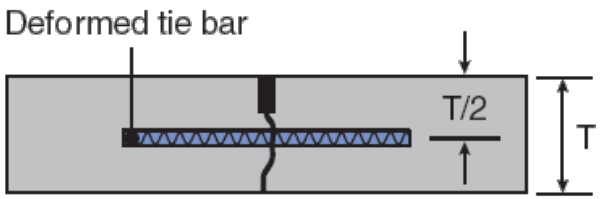
'RT' (4)
ABUTTING PAVEMENT JOINT
RIGID TIE

Construction Joints

- Longitudinal construction joints
  - Occur when paving lanes are placed in separate passes



Tied butt – Longitudinal (Type B-2)

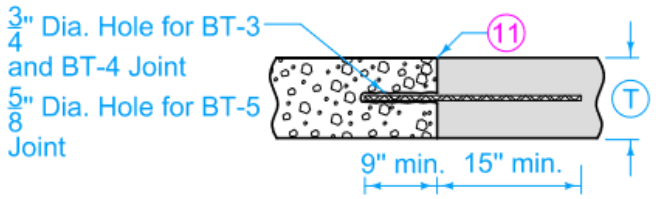


Keyed – Longitudinal (Type C-2)
(Deformed tie bar optional)

Images: ACPA

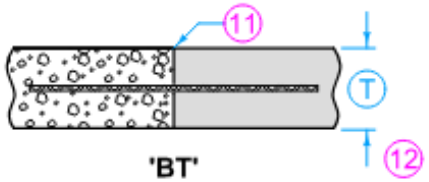
Construction Joints

- Longitudinal construction joints: ‘BT’ and ‘KT’ (PV-101)
  - Interchangeable with ‘L’ contraction joints subject to the construction sequence
  - ‘KT’ joints are no longer allowed on Iowa DOT projects



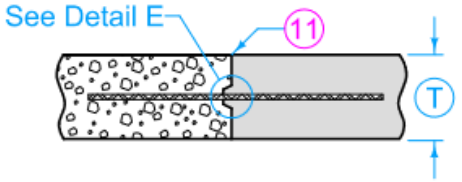
'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE (Drilled)

T	Joint	Bars	Bar Length and Spacing
< 8"	'BT-5'	#4	24" Long at 30" Centers
≥ 8"	'BT-3'	#5	24" Long at 30" Centers
	'BT-4'		24" Long at 15" Centers



'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE

T	Joint	Bars	Bar Length and Spacing
< 8"	'BT-1'	#4	36" Long at 30" Centers
		#5	30" Long at 30" Centers
≥ 8"	'BT-2'	#5	36" Long at 30" Centers

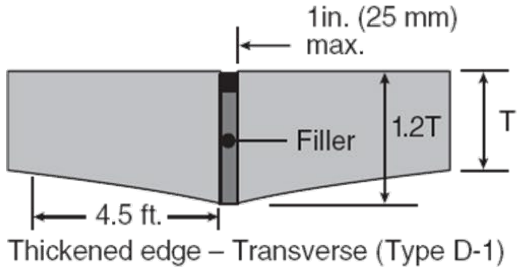


'KT' 10 12
ABUTTING PAVEMENT JOINT - KEYWAY TIE

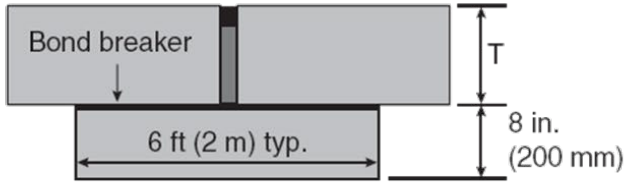
T	Joint	Bars	Bar Length and Spacing
< 8"	'KT-1'	#4	30" Long at 30" Centers
≥ 8"	'KT-2'	#5	30" Long at 30" Centers
	'KT-3'		30" Long at 15" Centers

Isolation or Expansion Joints

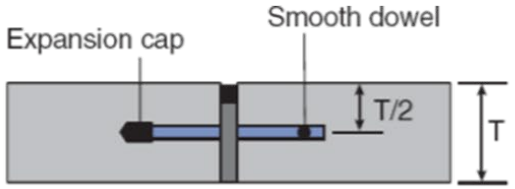
- Used to isolate structures within or adjacent to the pavement
- Also used to mitigate cracking potential when adjacent roadway sections come together at intersections and roundabouts



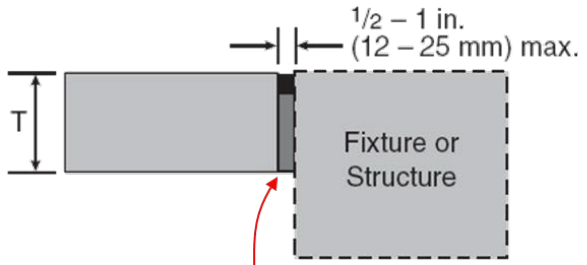
Thickened edge – Transverse (Type D-1)



Sleeper slab – Transverse (Type D-3)

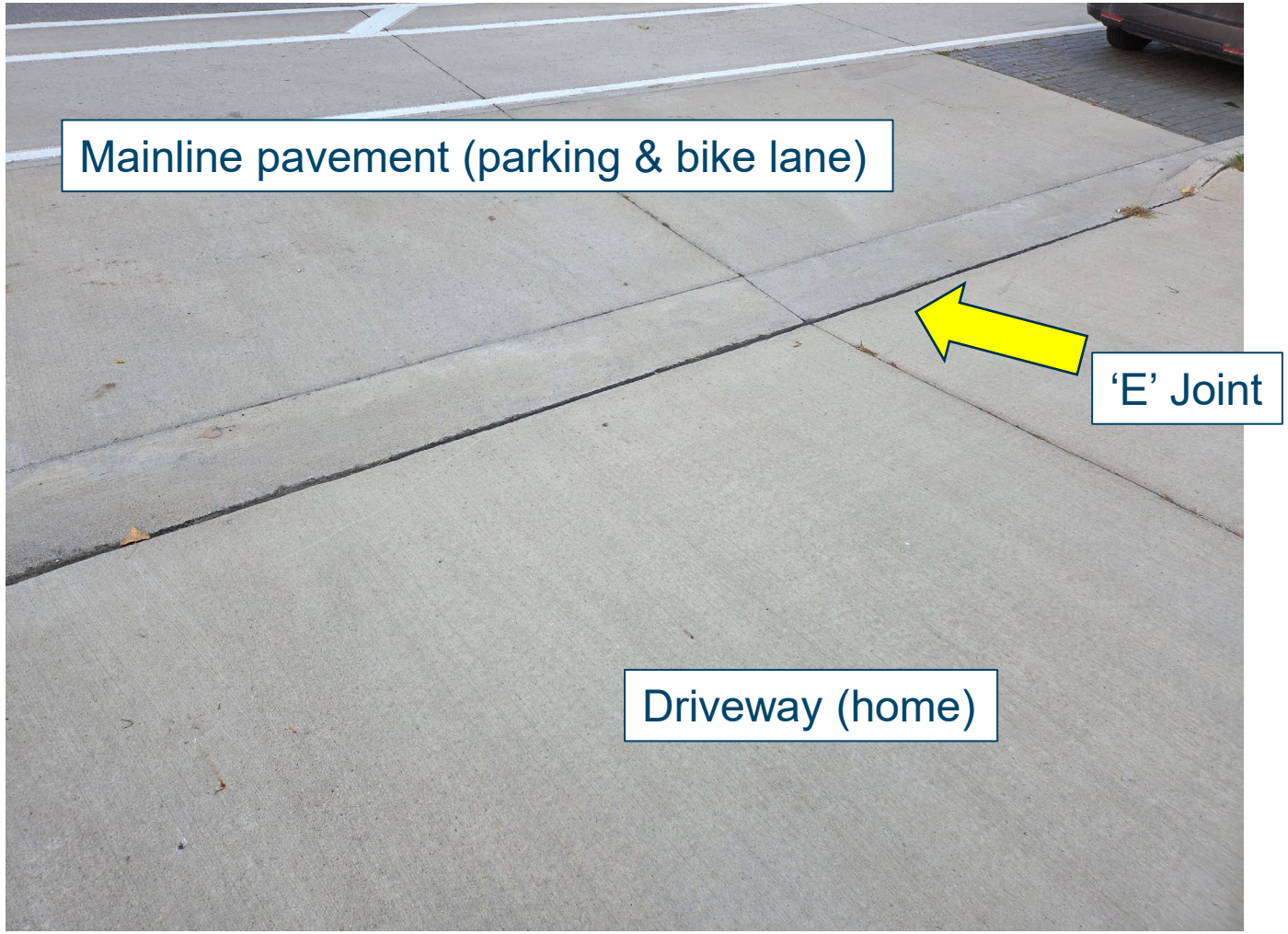


Doweled – Transverse (Type D-2)



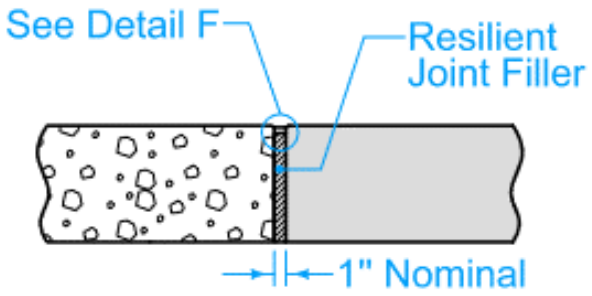
Undoweled – Longitudinal (Type D-4)

Isolation or Expansion Joints

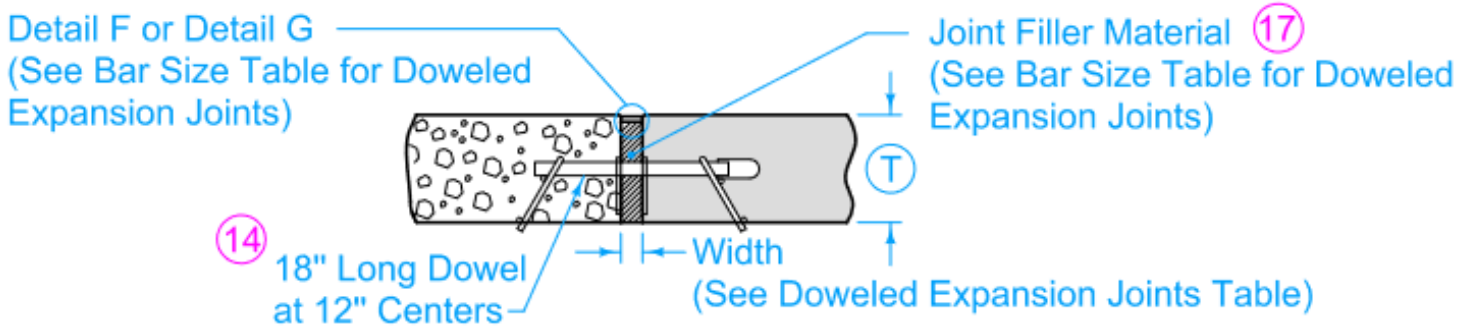


Isolation or Expansion Joints

- ‘E’, ‘ED’, ‘EE’, and ‘EF’ joints (PV-101)
  - These joints should only be used when isolation is needed, <u>not</u> at regular intervals



'E'
1" EXPANSION JOINT



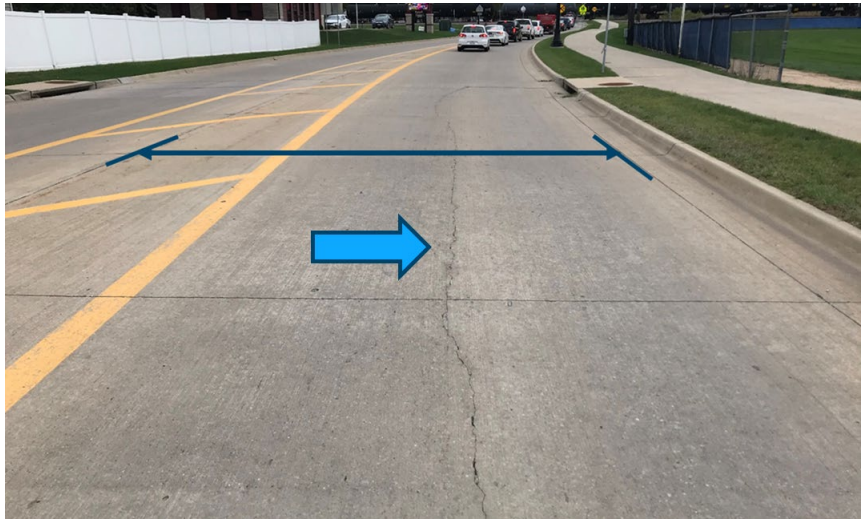
'ED', 'EE', 'EF' 16
DOWELED EXPANSION JOINT

Basic Joint Layout Principles

- To the best of our ability, our joint layout should be:
  - Short
  - Uniform
  - Perpendicular
  - Square
  - Simple
  - Practical
- Be flexible – joint locations can always be adjusted in the field!

Joint Layout Recommendations

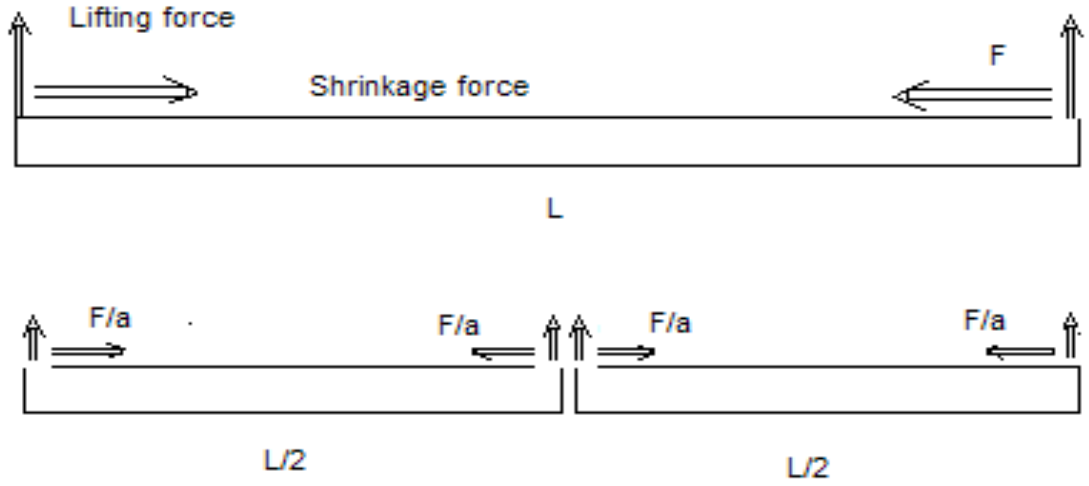
- Adhere to design limits for transverse joint spacing
- Limit slab width (longitudinal joint spacing) to 15 ft
- Keep slabs square or rectangular when possible (1.5 to 1)
- Avoid angles less than 60° at joint intersections
  - Use “dog-leg” joints through curve radius points

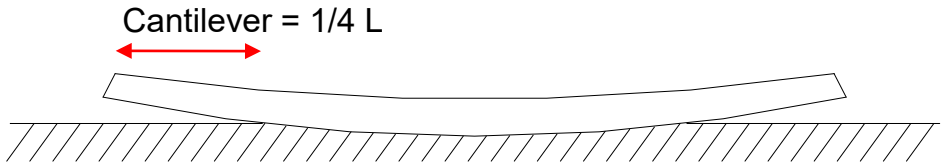


L Image: Jerod Gross; R Image: Michigan Concrete Association

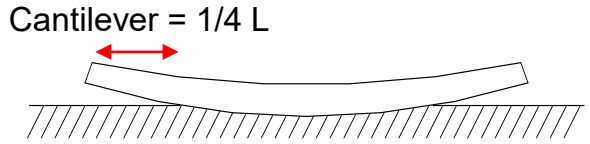
Transverse Joint Spacing

- Longer slabs can be susceptible to several issues:
  - Increased opening/closing of joints and loss of load transfer
  - Increased curling and warping stresses, which can combine with traffic loads to cause cracking





Length 12 to 15 ft., cantilever = 3 to 3.75 ft



Length 6 ft., cantilever = 1.5 ft

Images: ACPA

Transverse Joint Spacing

- A general rule of thumb is that maximum transverse joint spacing (in feet) should not exceed twice the thickness of the pavement (in inches)

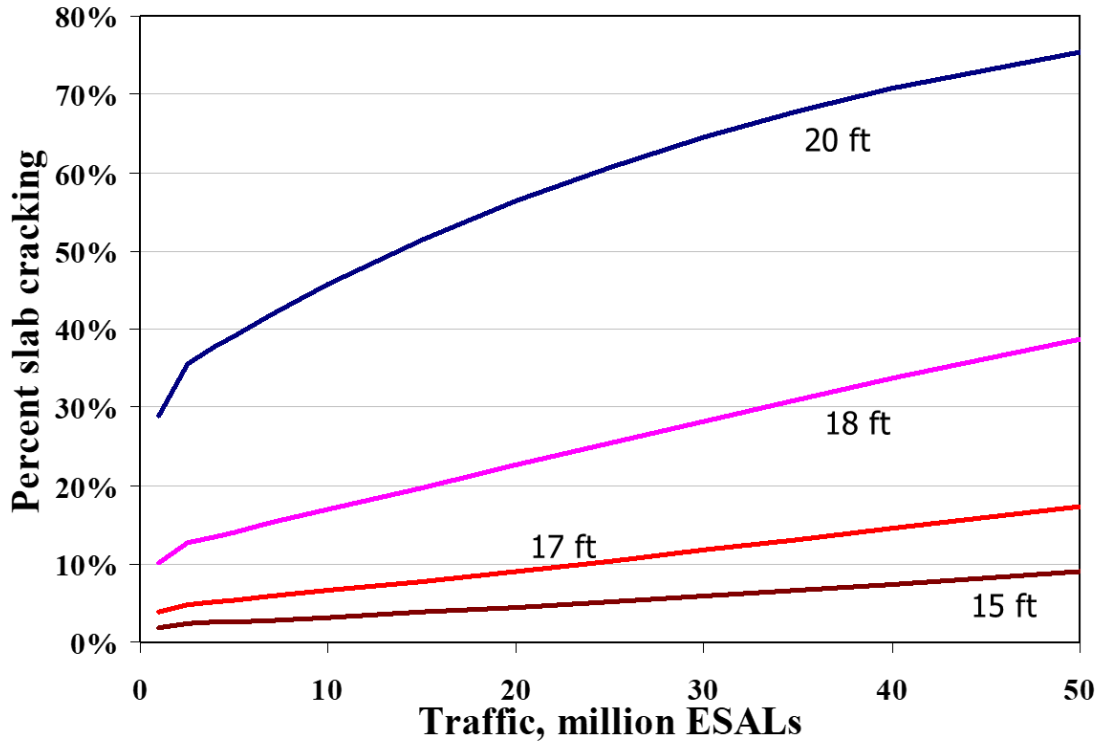
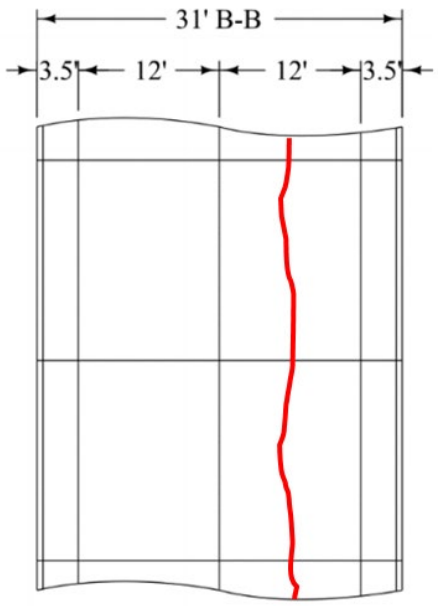


Image: Eric Ferrebee, ACPA

Longitudinal Joint Layout

- Depending on pavement width, longitudinal joints may not always coincide with lane lines or edges of the pavement
- Gutterline longitudinal joints sometimes fail to crack, especially in pavements less than 9 in. thick

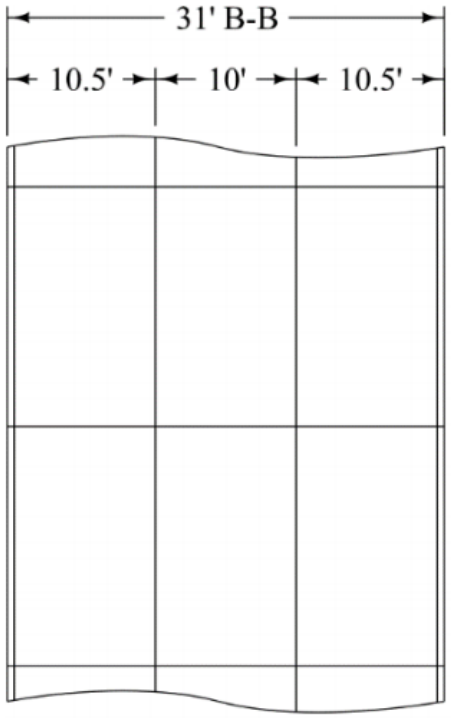


Gutterline Jointing

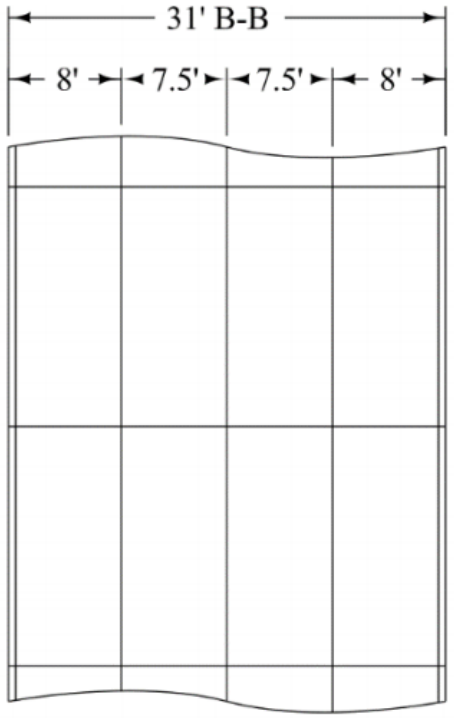
L Image: SUDAS; R Image: Steve Mallicoat

Longitudinal Joint Layout

- Consider using third- or quarter-point jointing in these types of situations (e.g. ≤ 9 in. slab thickness)



Third Point Jointing



Quarter Point Jointing

Images: SUDAS

Longitudinal Joint Layout

- Pavement width transitions – SUDAS Section 5G-3

Figure 5G-3.04: Quarter-Point Jointing - Concentric Widening (31 Foot to 41 Foot)

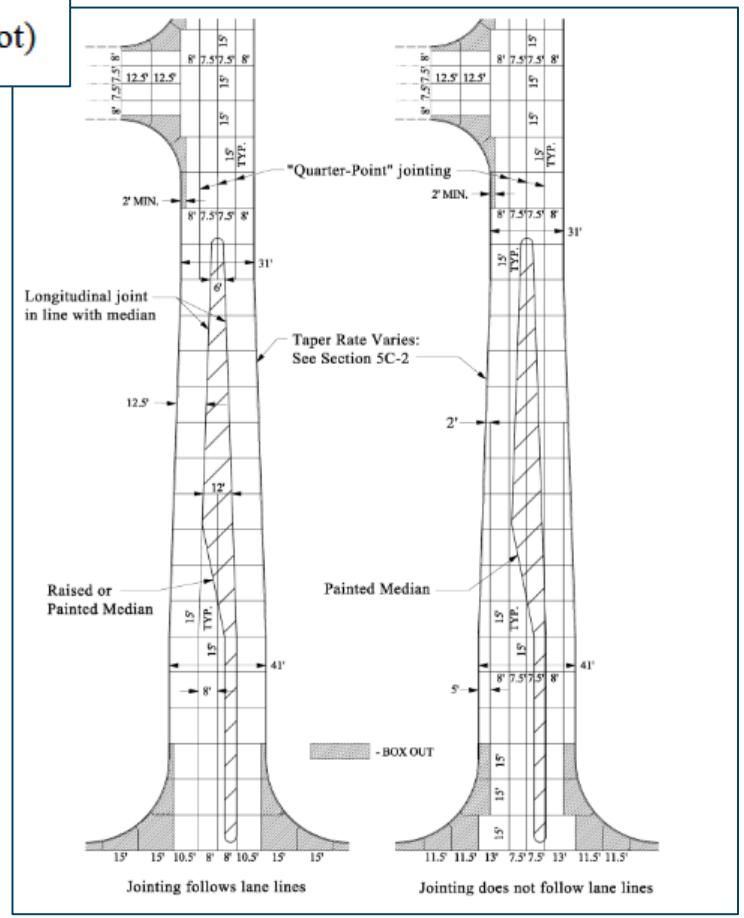


Image: SUDAS

Parking Lot Joint Layout

- ACI 330 Guide for Design of Concrete Parking Lots
- Features:
  - Isolate from buildings, planters, sidewalks
  - Tension ring around the outside with tie bars (unless there is curb)
  - Avoid acute angles
  - Dowels in areas with consistent one-way traffic

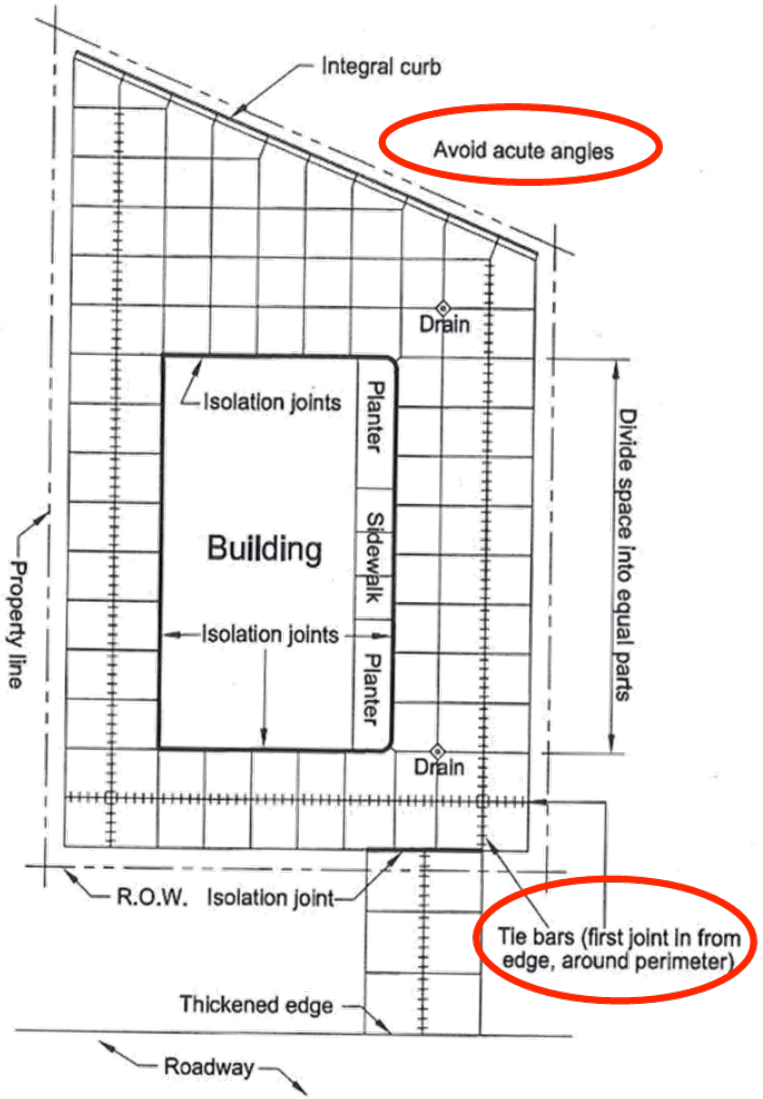
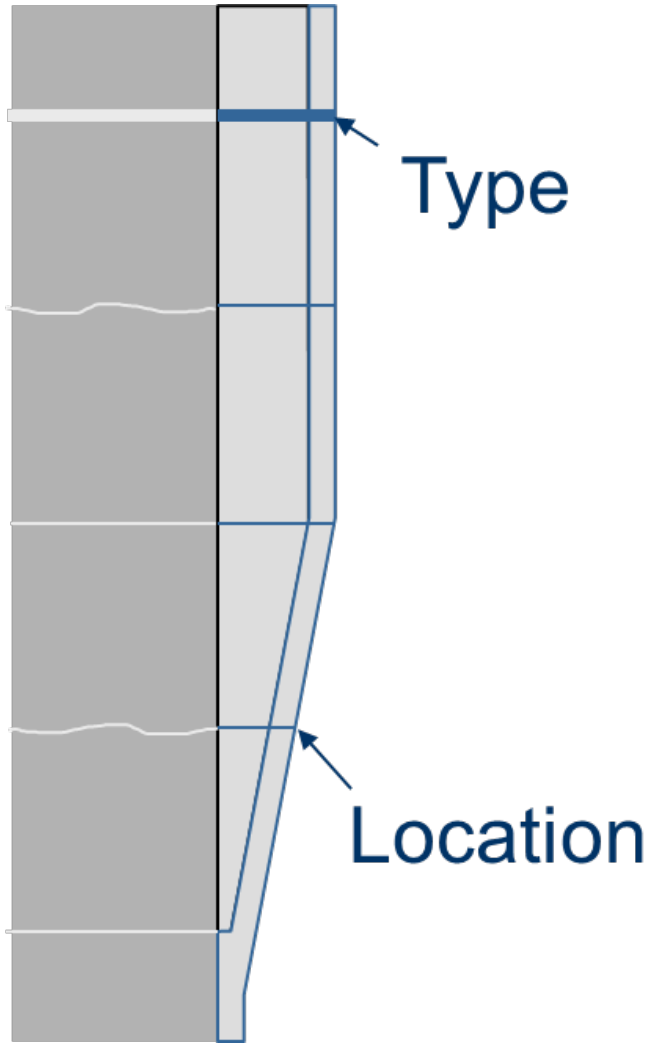


Image: ACI

Other Joint Layout Recommendations

- Match existing joints and cracks in adjacent pavement sections



Other Joint Layout Recommendations

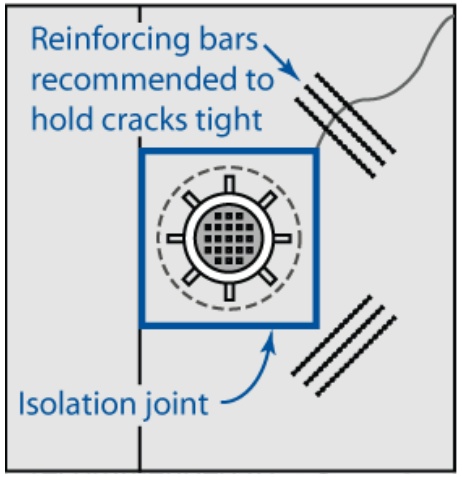
- Place joints to meet in-pavement structures such as manholes
- Use expansion joints as needed for manholes and boxouts

vs.

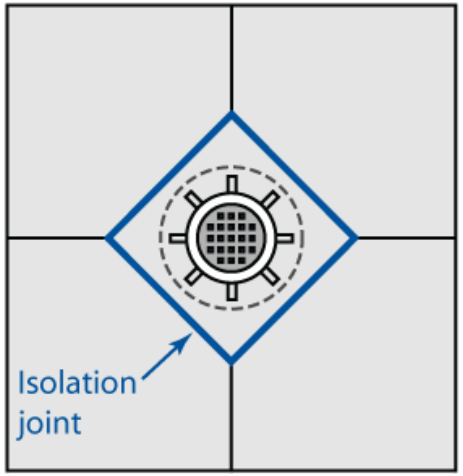
Image: ACPA

Boxout Fixture Details

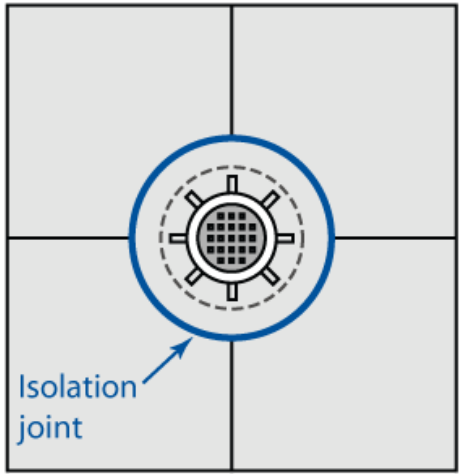
Square Manhole Boxout



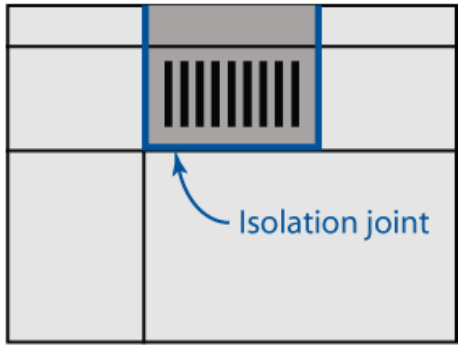
Diagonal Manhole Boxout



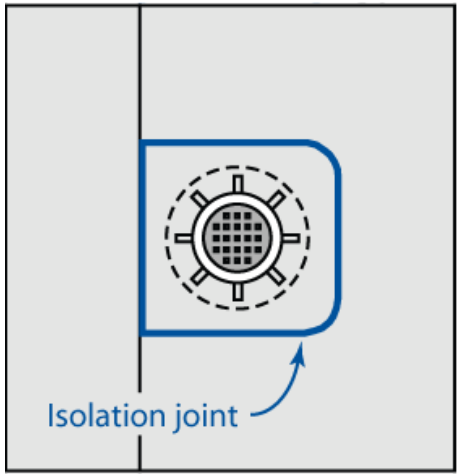
Circular Manhole Boxout



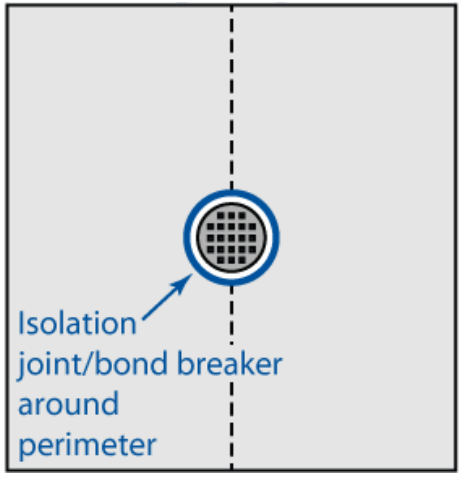
Square Inlet (no boxout)



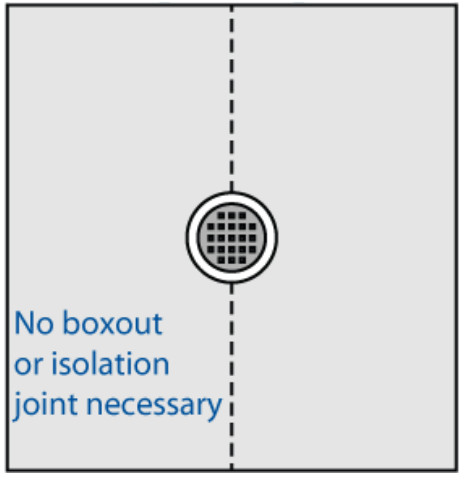
Square Boxout with Fillets



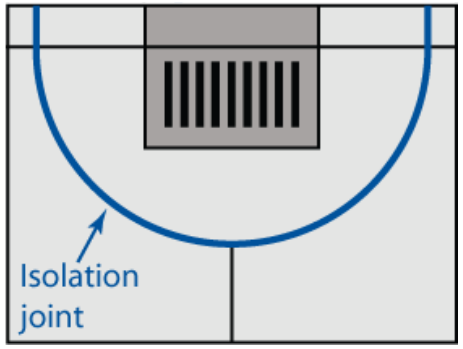
Manhole (No Boxout)



Telescoping Manhole



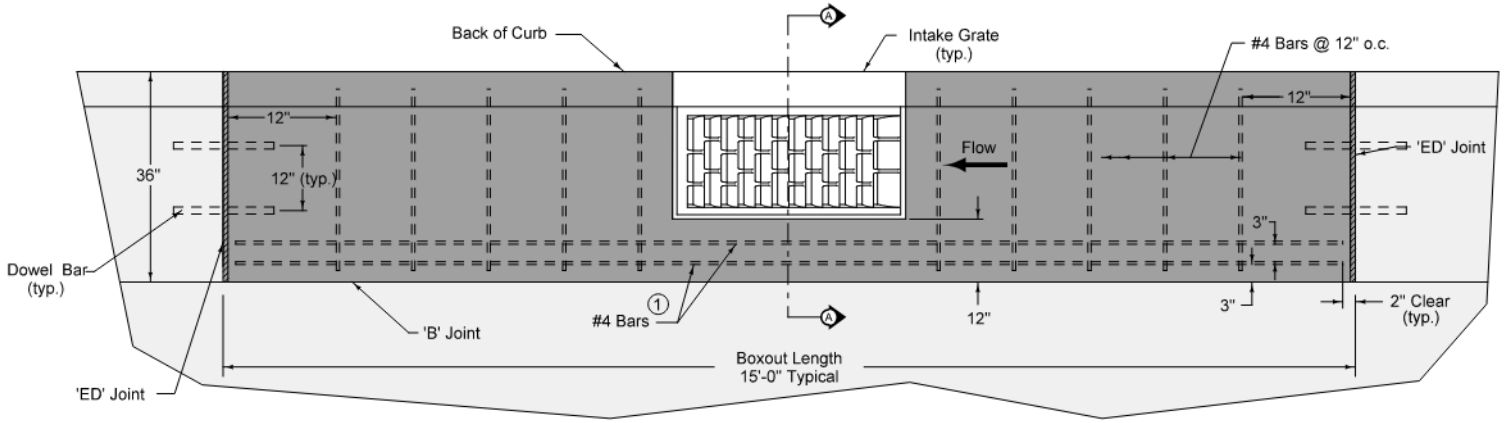
Round Inlet Boxout



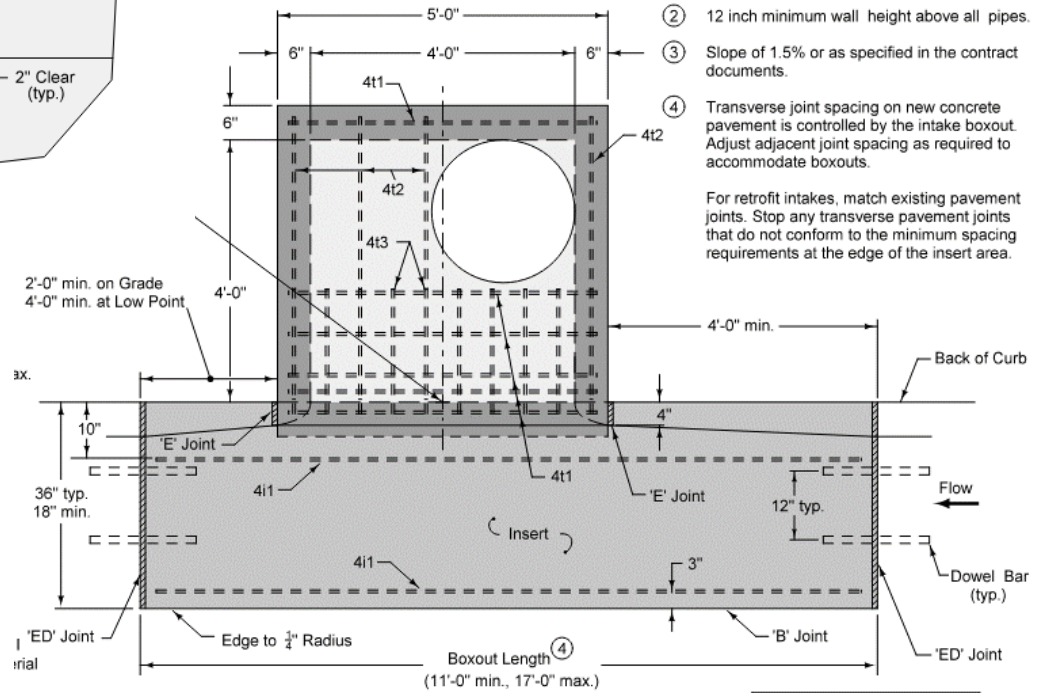
Images: ACPA

Box Out Fixture Details

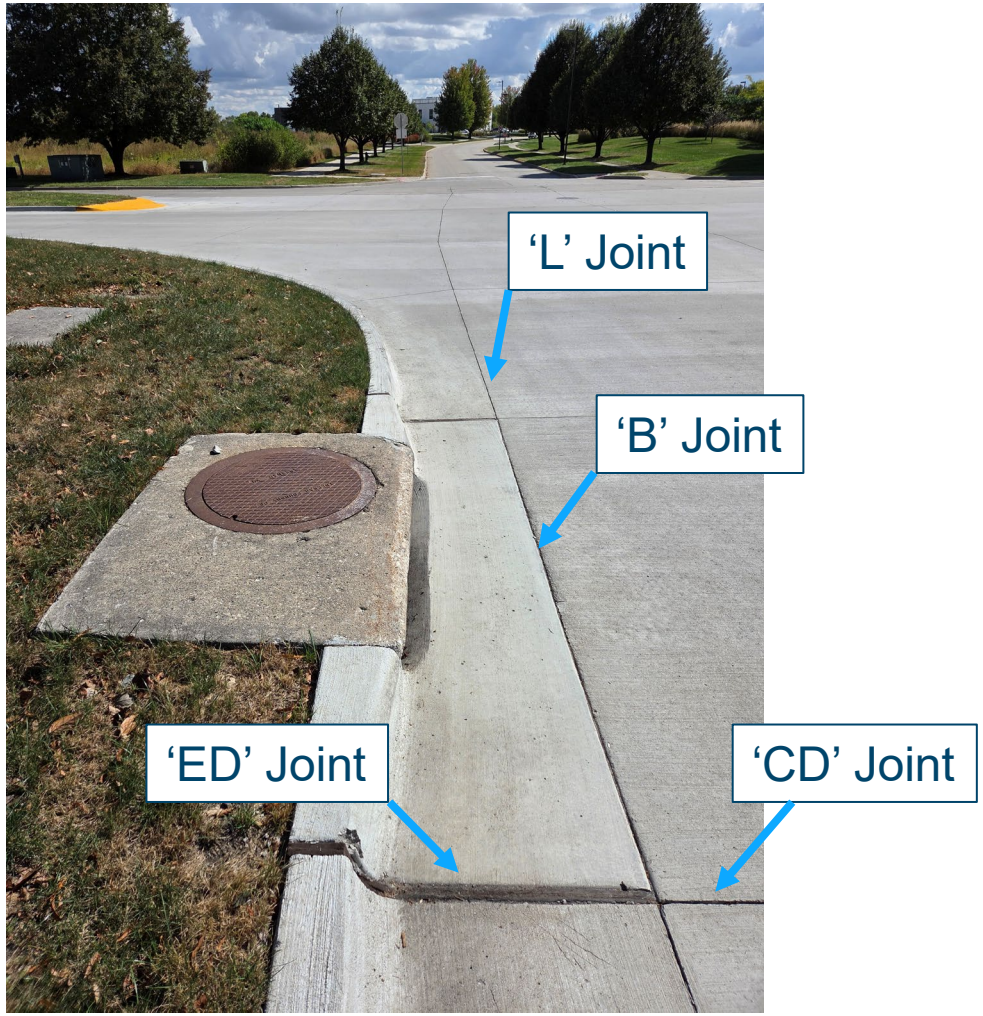
- SUDAS 6010:

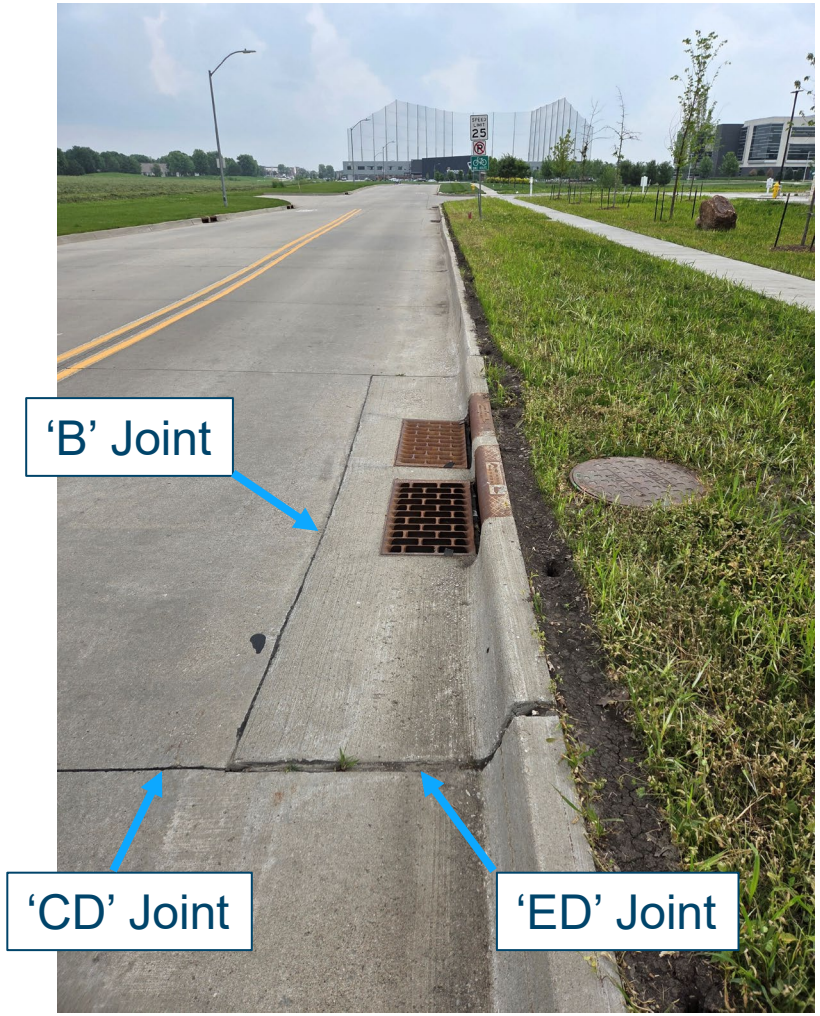


BOXOUT IN PCC PAVEMENT AND PCC BASE WITH HMA OVERLAY



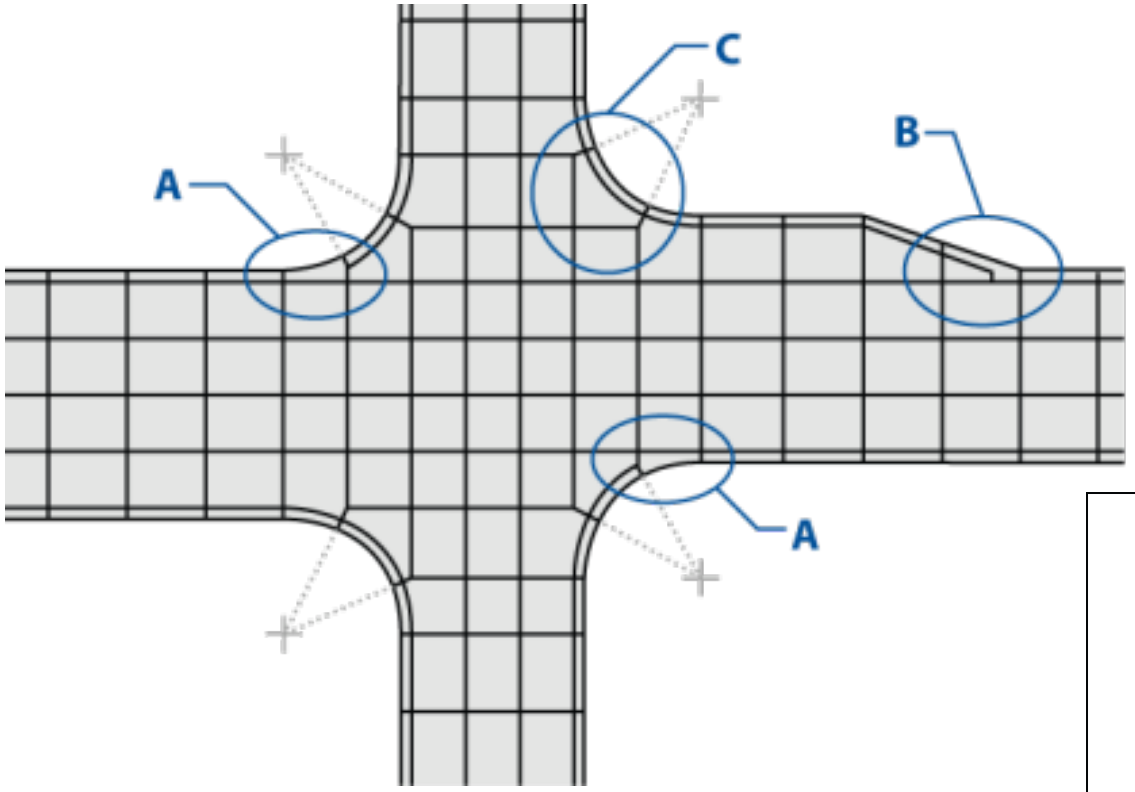
Box Out Fixture Details

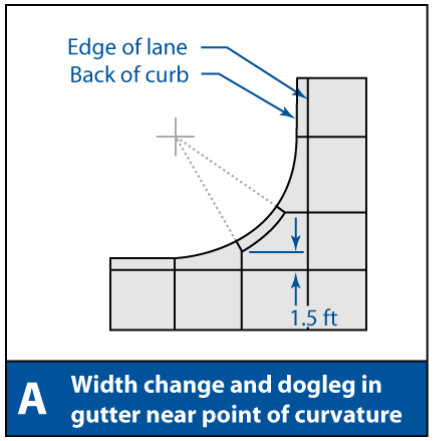


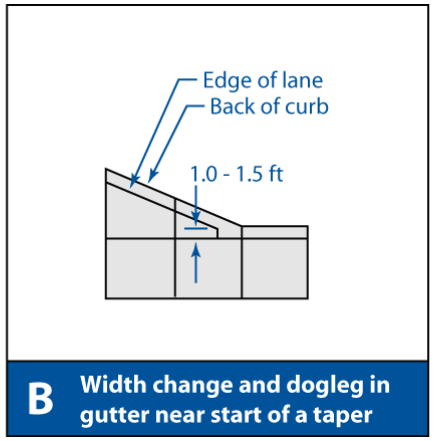


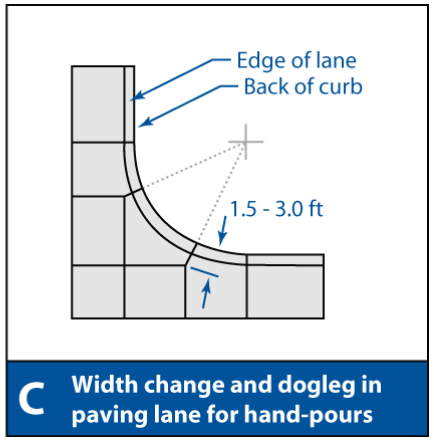
Jointing Intersections

- Intersections present a number of joint layout challenges:





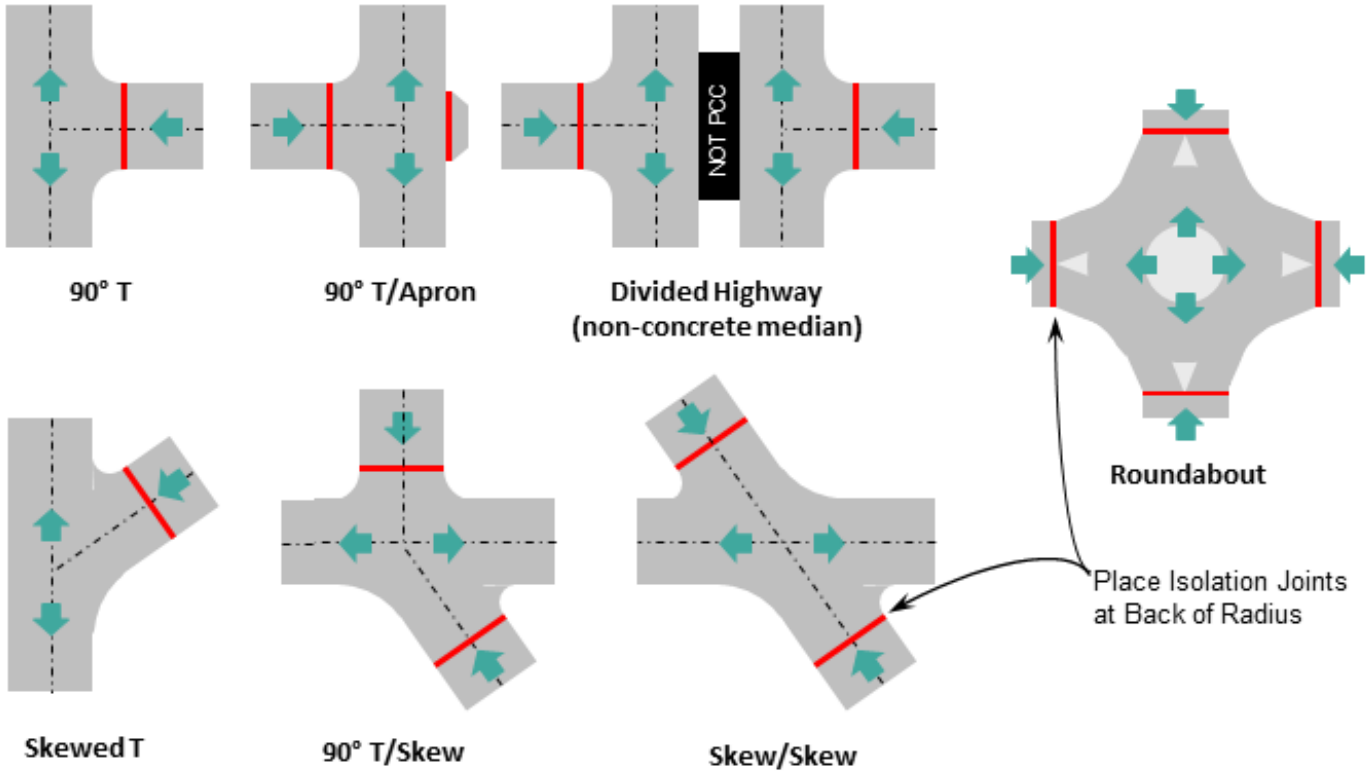




Images: ACPA

Jointing Intersections

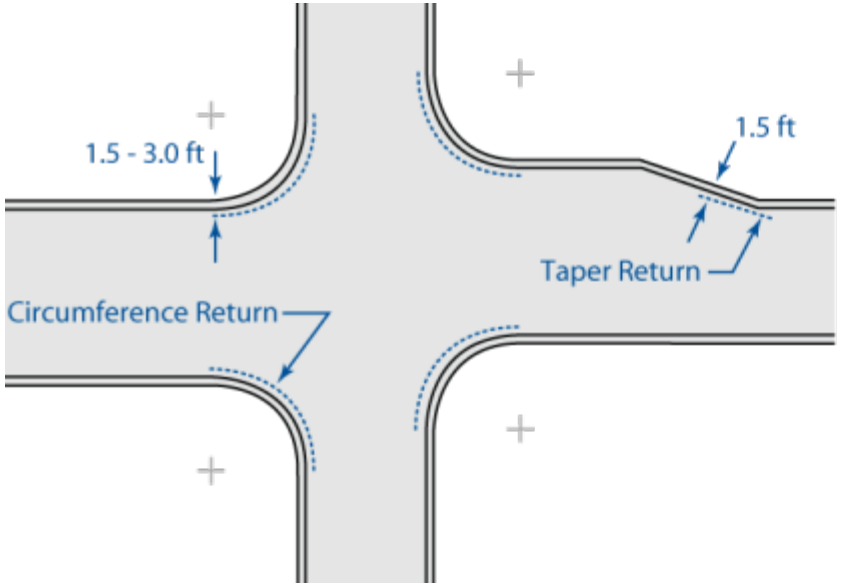
- Isolation joints may be used to separate side roads from through streets

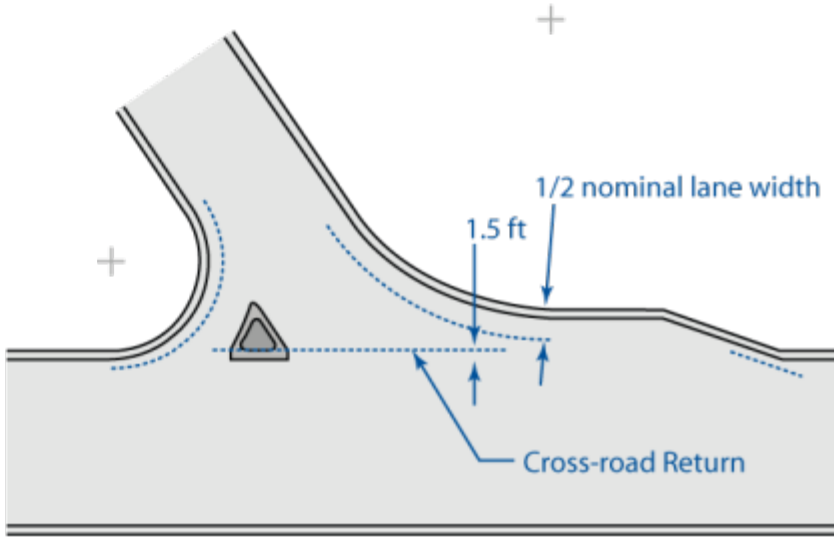


Images: ACPA

Jointing Intersections

- ACPA has a 10-step method for jointing intersections:
  - 1. Draw pavement edge and back of curb lines to scale
  - 2. Lightly draw circumference return, taper return, and crossroad-return lines

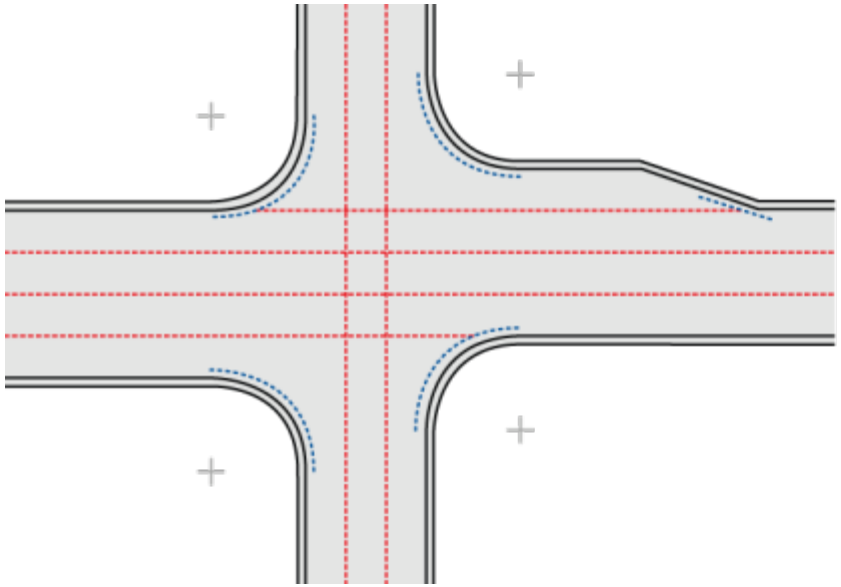


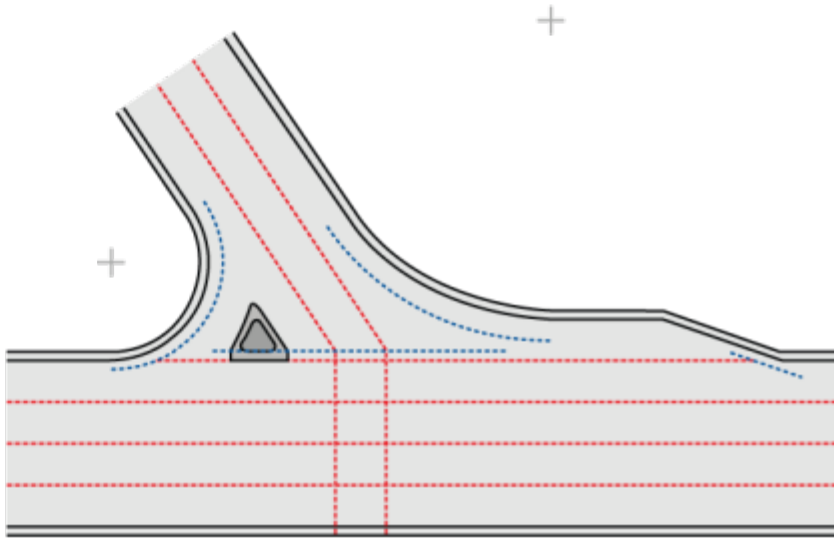


Images: ACPA

Jointing Intersections

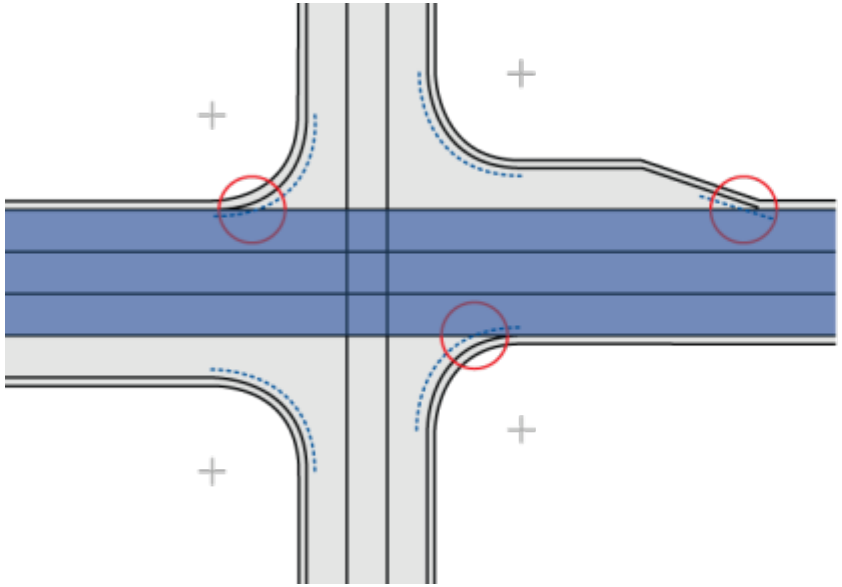
- 3. Draw all lane lines on mainline roadway and crossroad

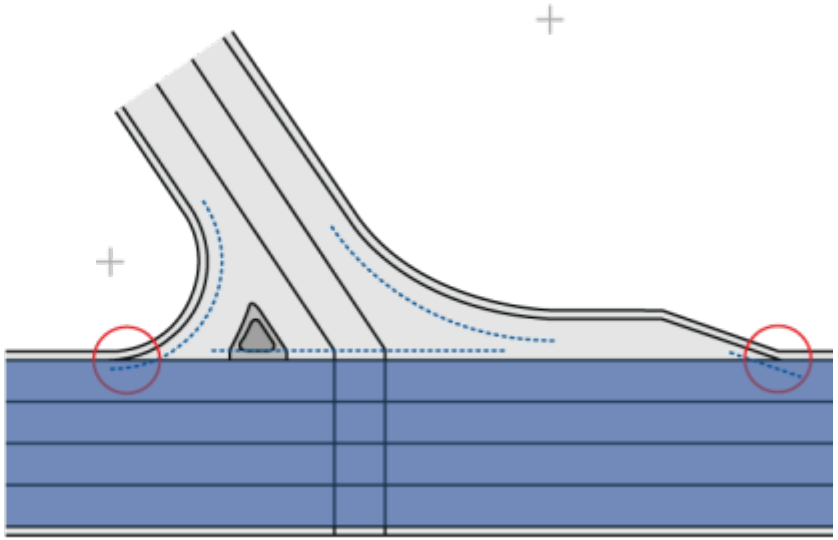




Jointing Intersections

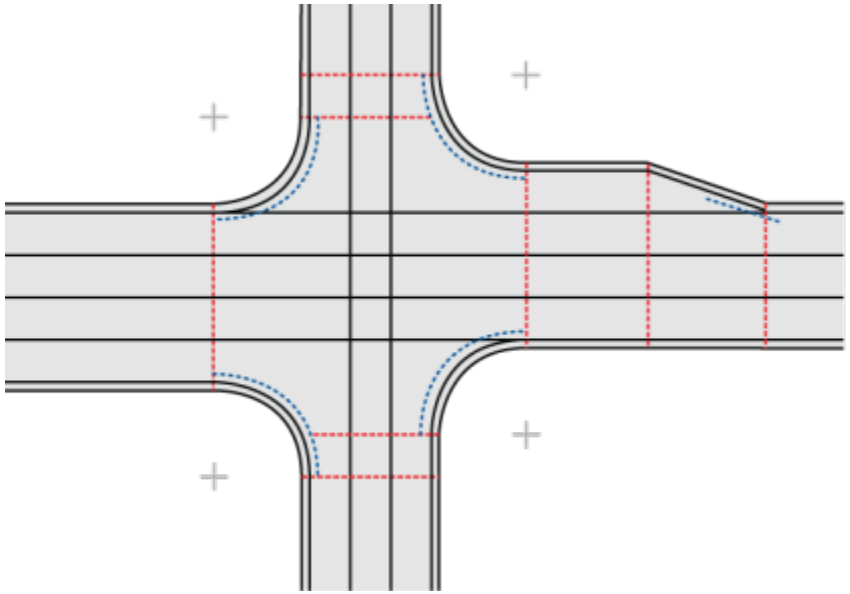
- 4. Define mainline lanes for paving. Extend *only* these lane lines through return lines (offsets) to allow for slipform paving
  - Blockouts and dog-legs will occur in the gutter pan at these locations

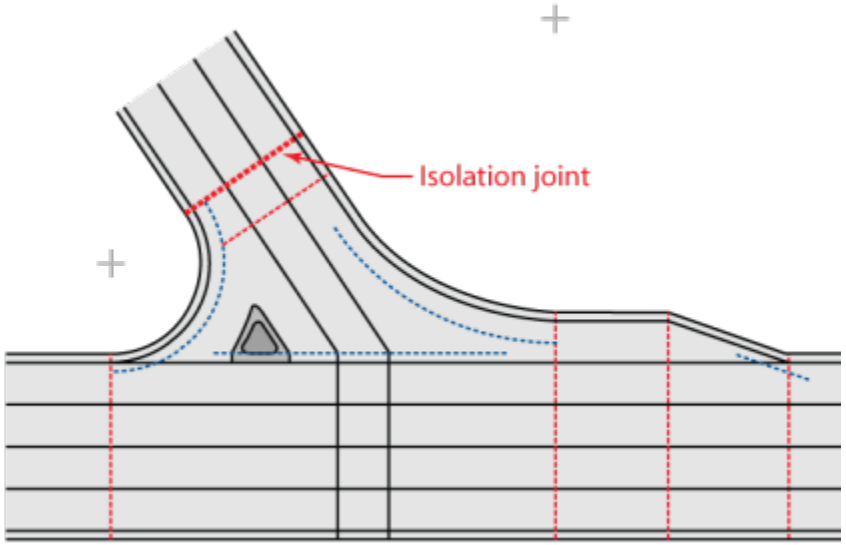




Jointing Intersections

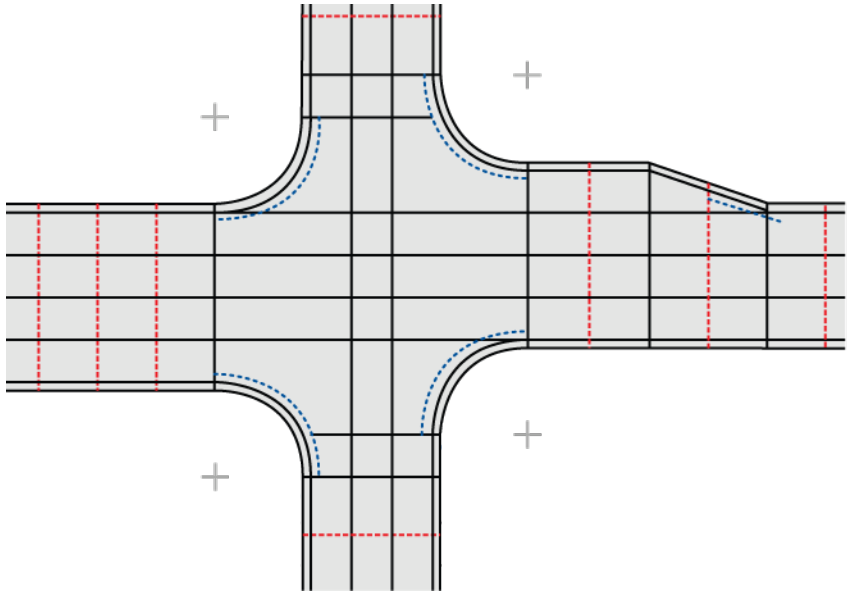
- 5. Add transverse joints where a width change occurs

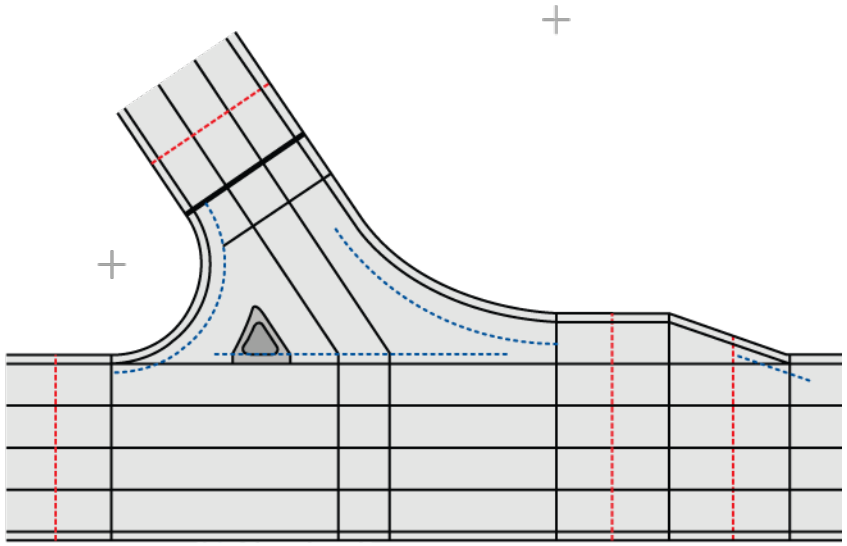




Jointing Intersections

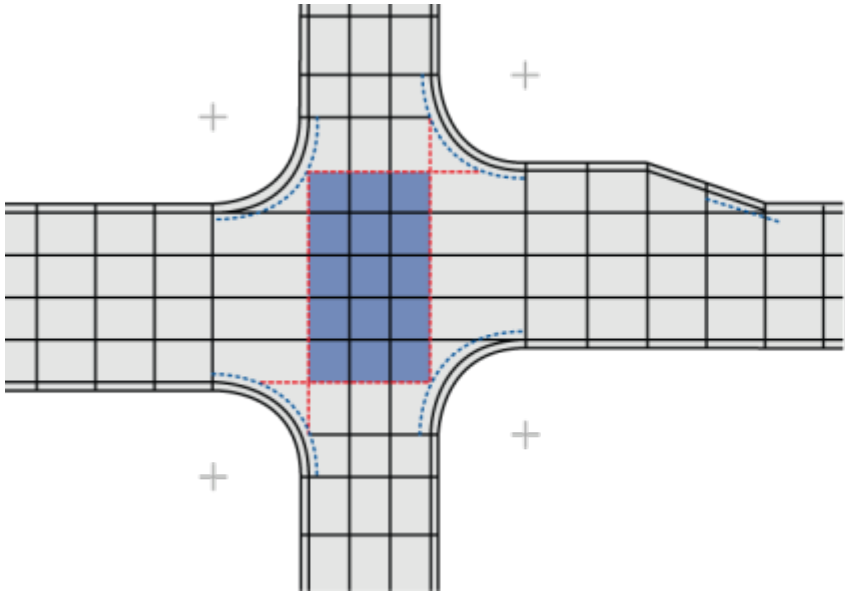
- 6. Add transverse joints between and beyond the joints in Step 5, but not to the center of the intersection

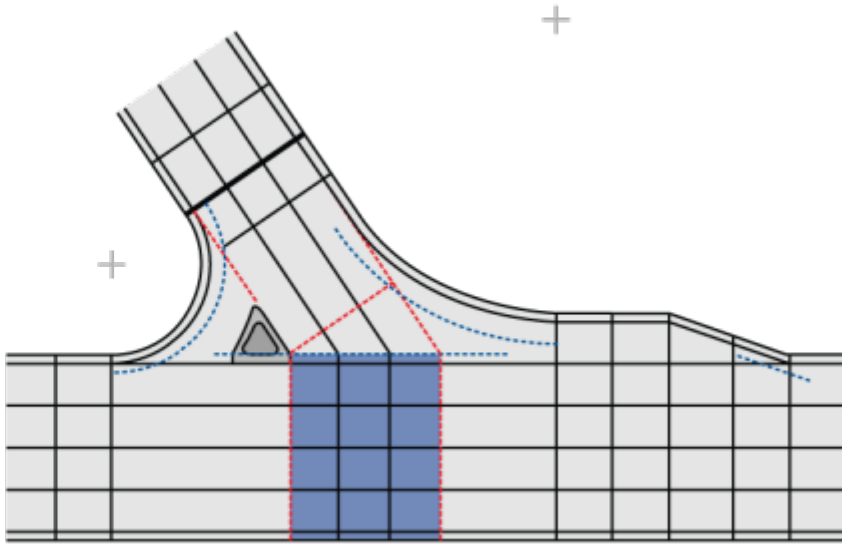




Jointing Intersections

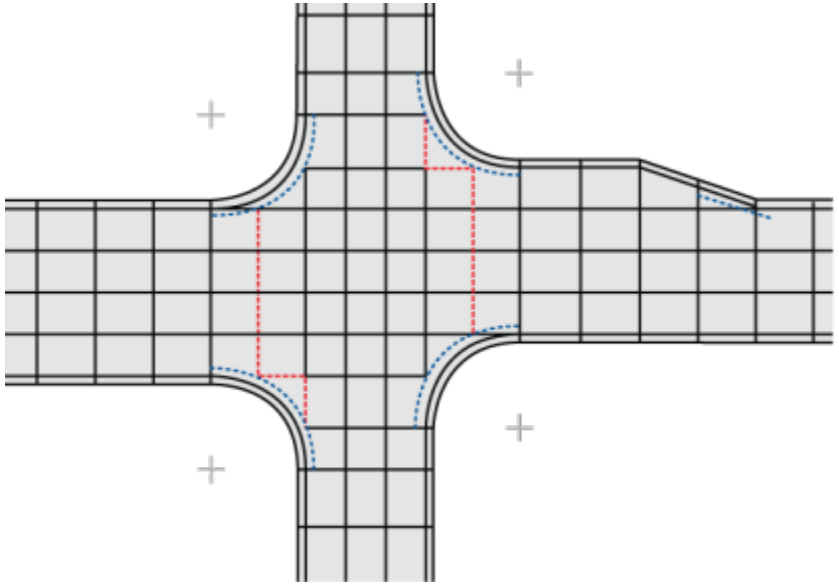
- 7. Define the intersection box by extending the edges of the pavement lines for the cross road and any turning lanes

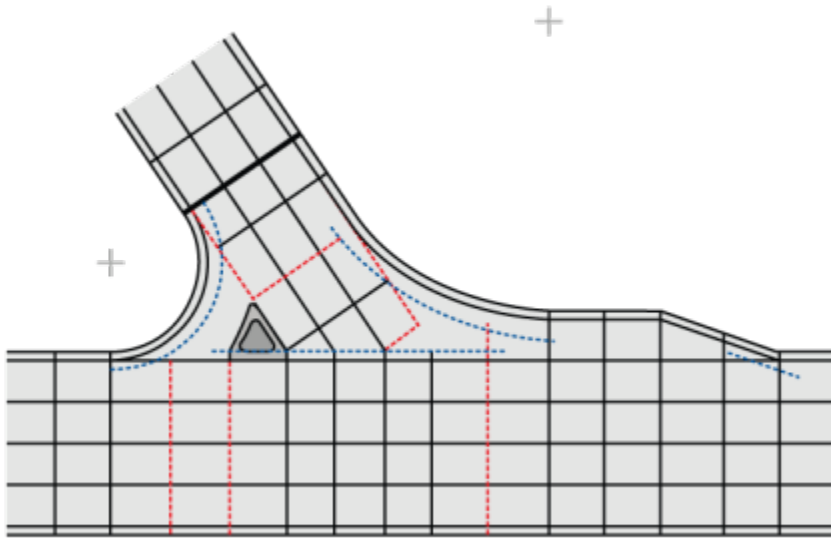




Jointing Intersections

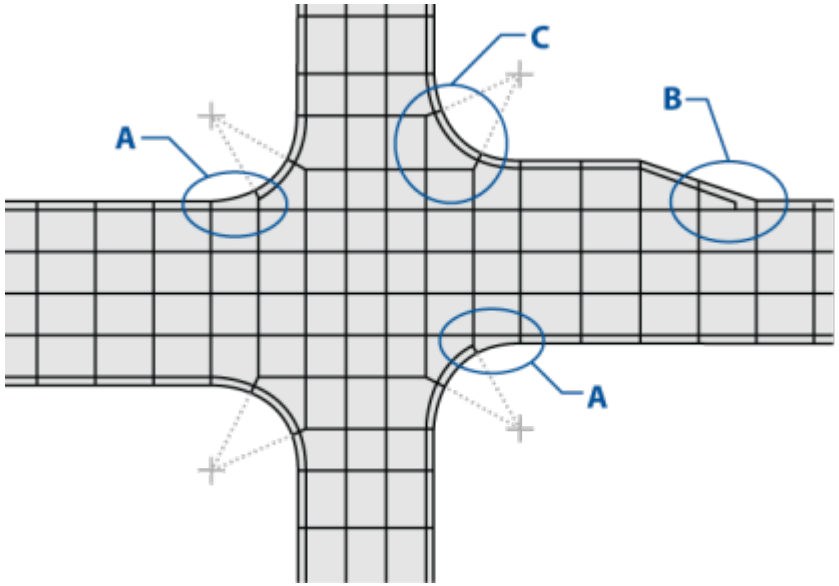
- 8. Check distances between the intersection box and surrounding joints (stay within maximum joint spacing)
- 9. If needed, add transverse joints at an equal spacing

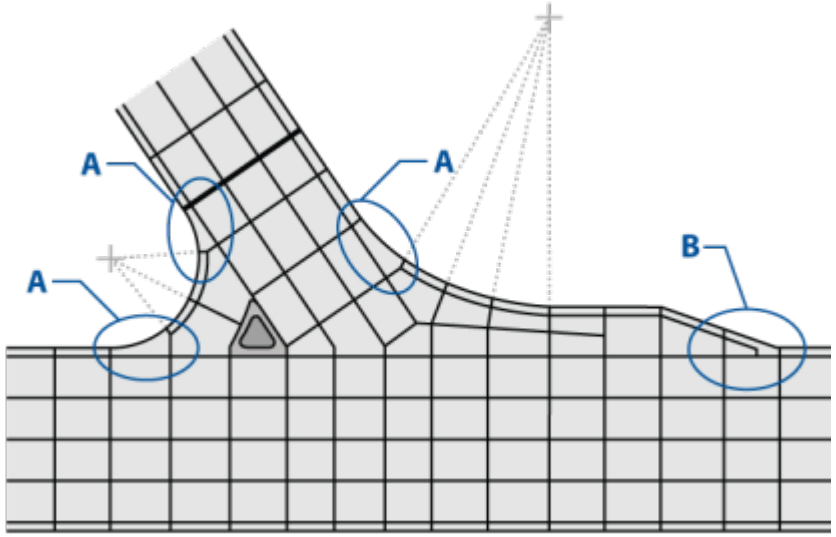




Jointing Intersections

- 10. Extend lines from center of curb return radii to corners of intersection box panels & draw joints along diagonal lines.





Jointing Intersections

- SUDAS Section 5G-3 contains additional intersection guidance

Figure 5G-3.01: Locating Predetermined and Difficult Joints

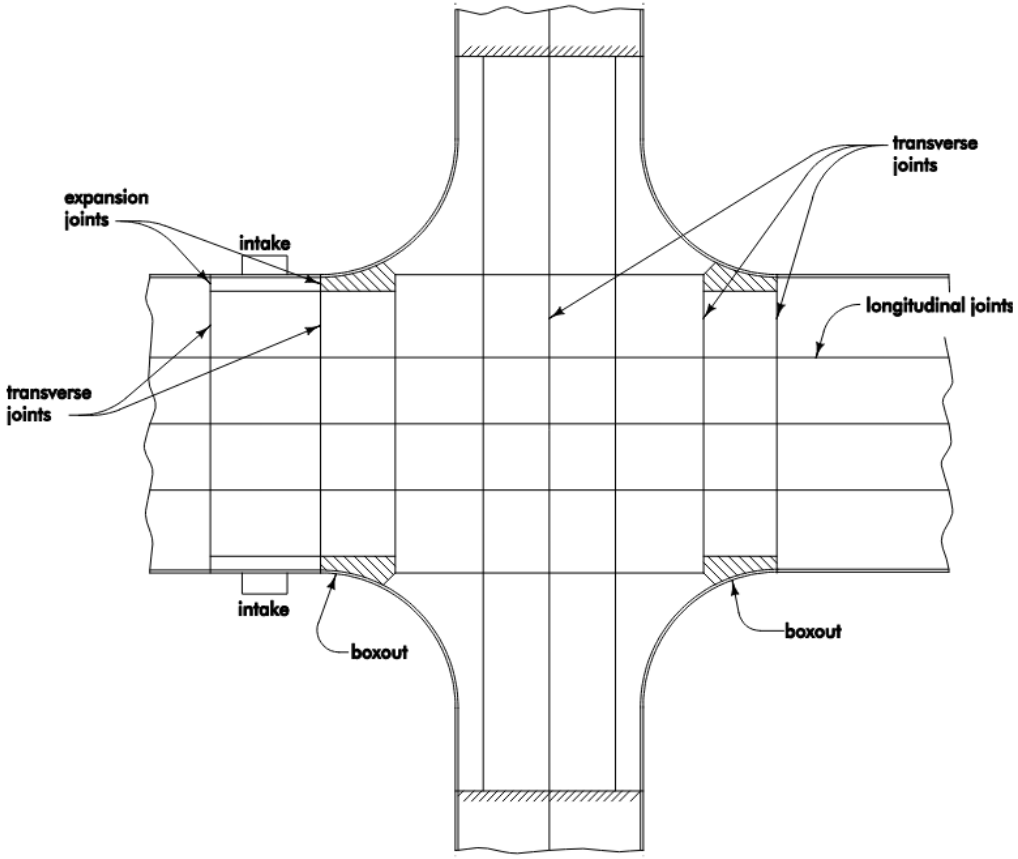
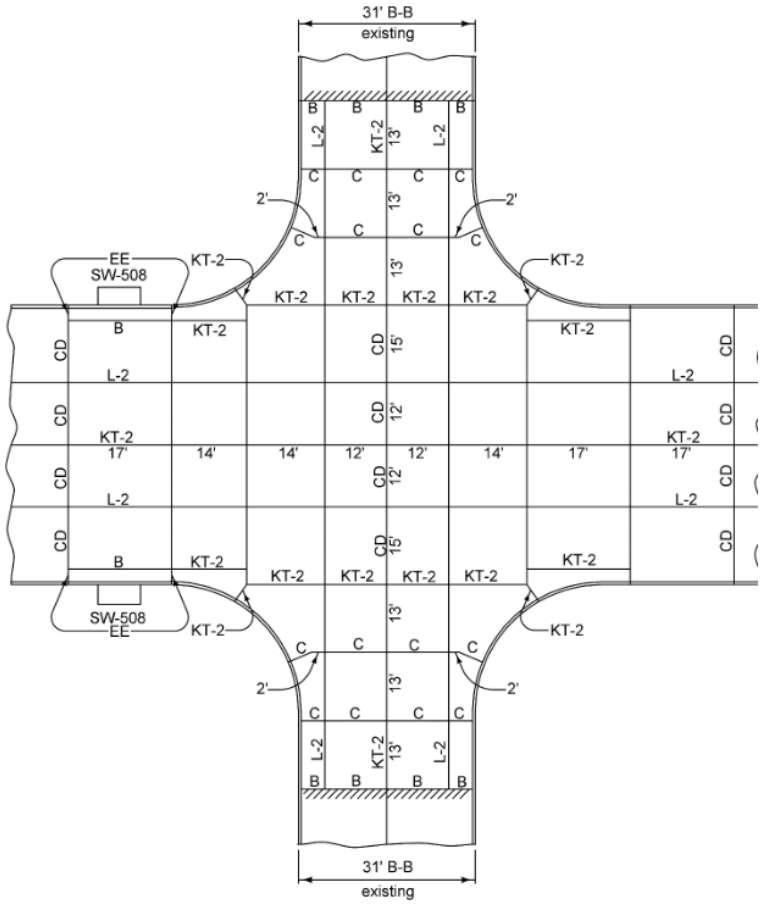


Figure 5G-3.02: Final Jointing Layout

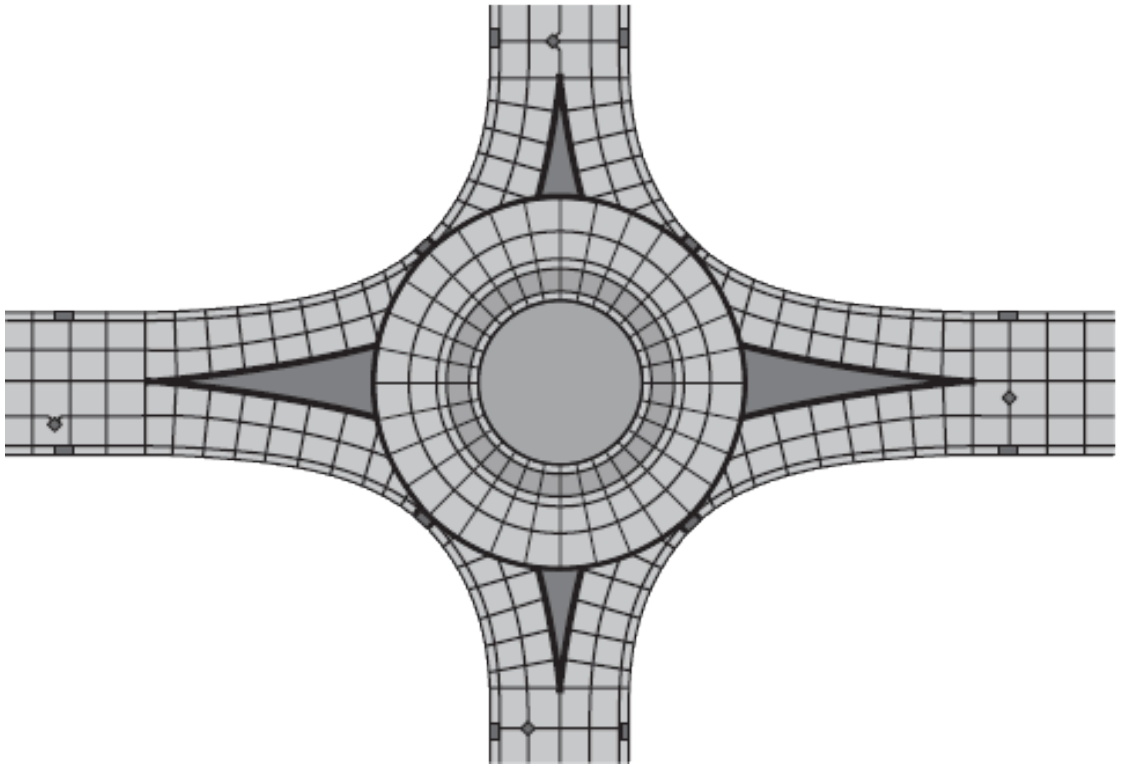


Images: SUDAS

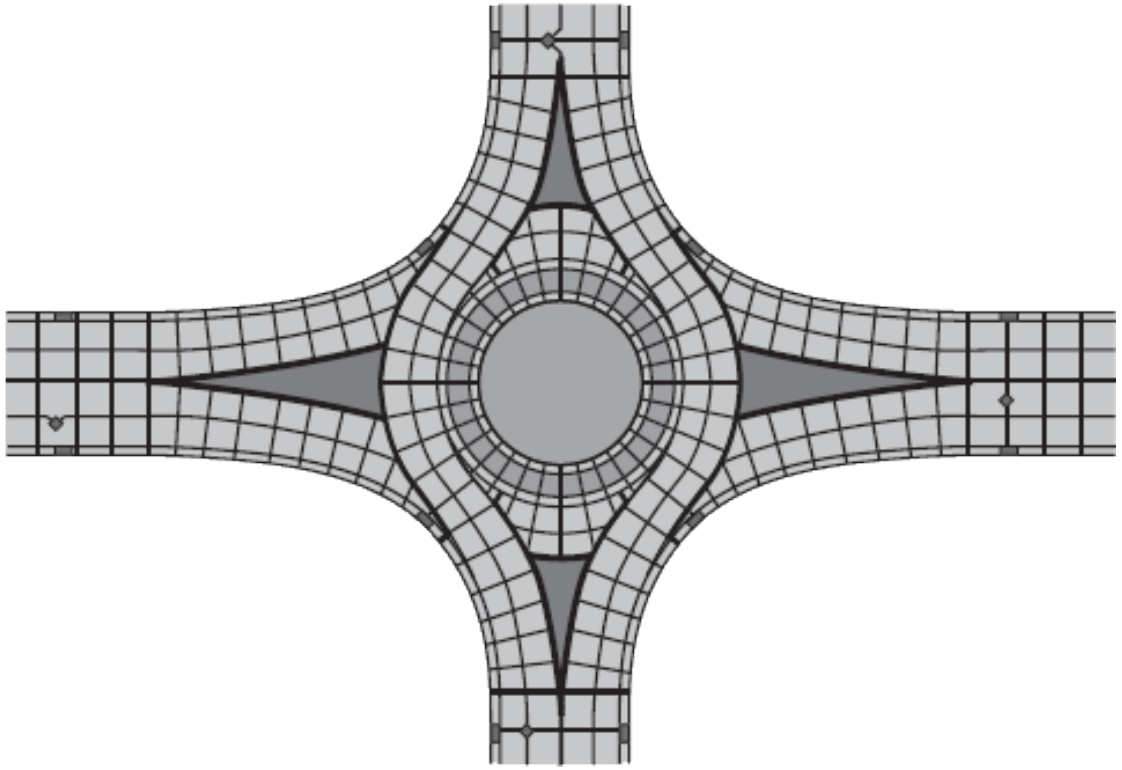
Jointing Roundabouts

- Roundabouts also present a number of joint layout challenges:

Isolated circle



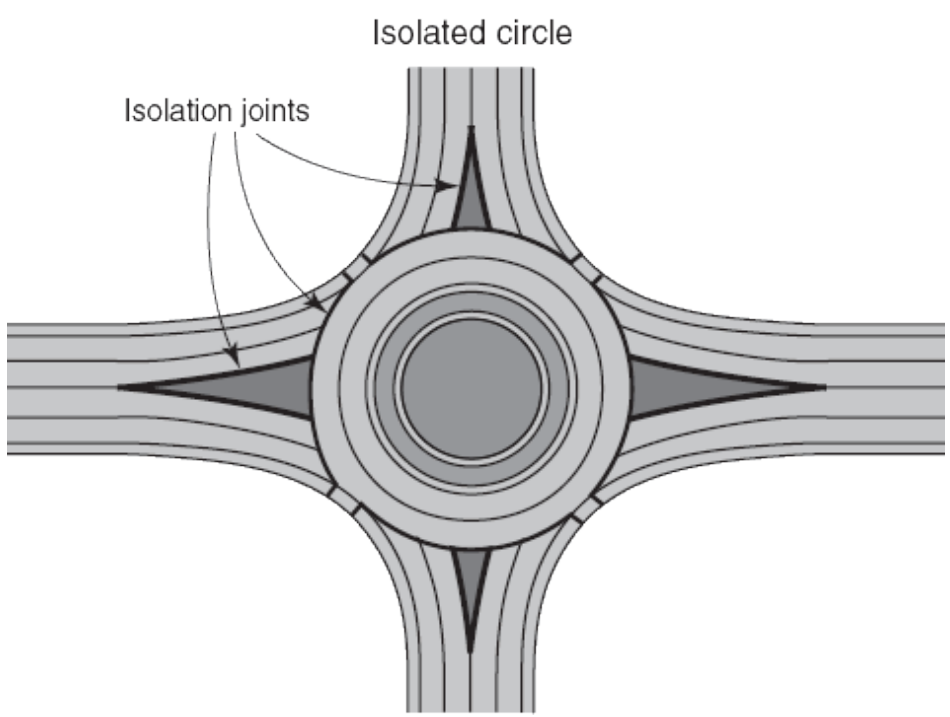
Pave-through

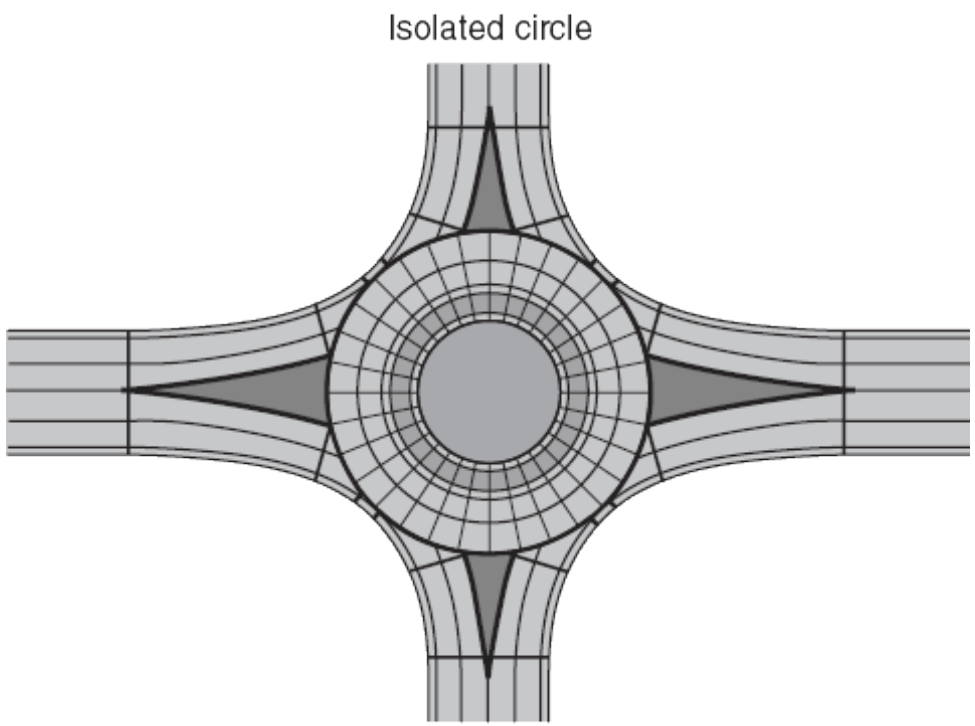


Images: ACPA

Jointing Roundabouts

- ACPA has a 6-step method for jointing roundabouts:





Images: ACPA

Jointing Interchanges

- ACPA has an 11-step method for diverging diamond interchanges:

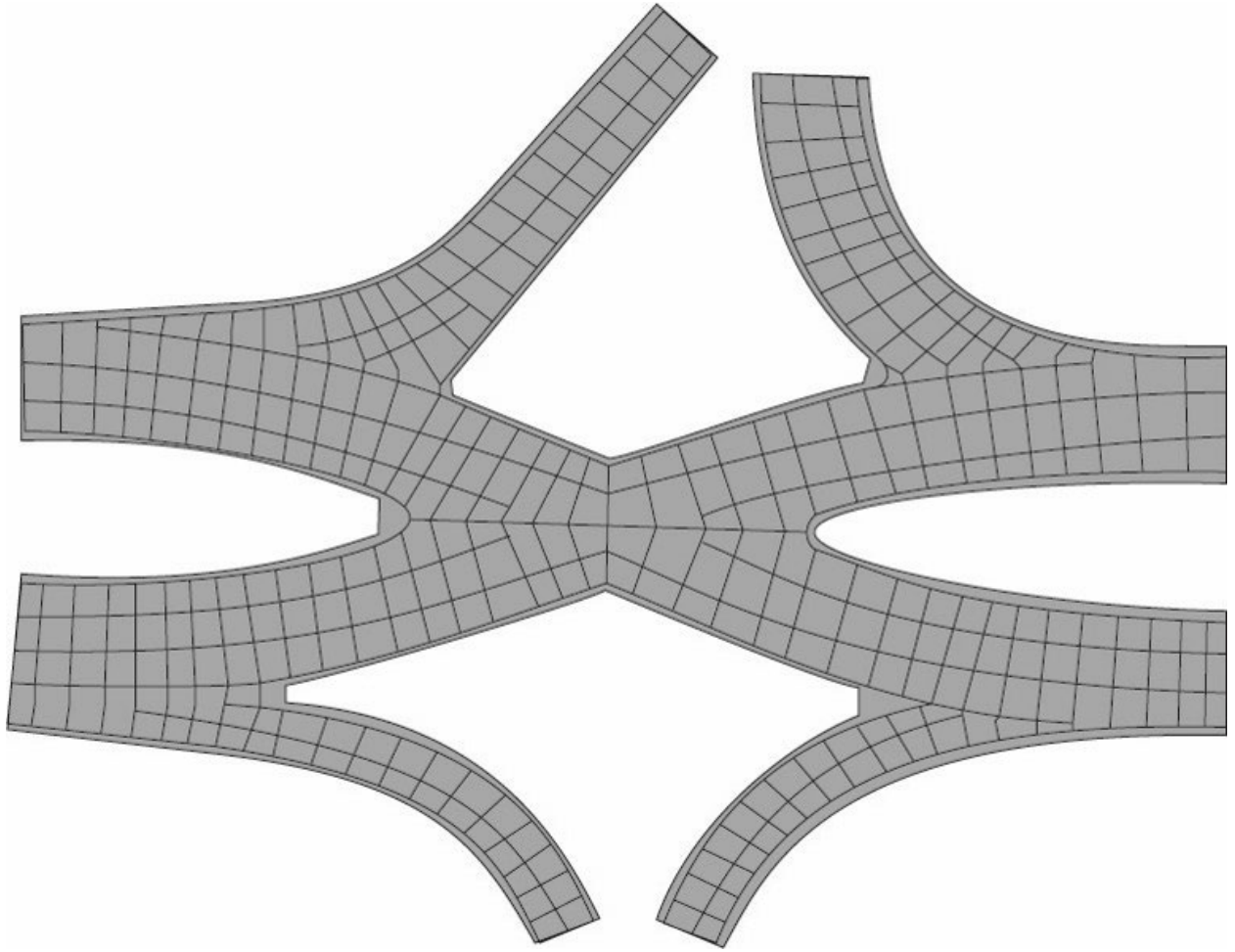
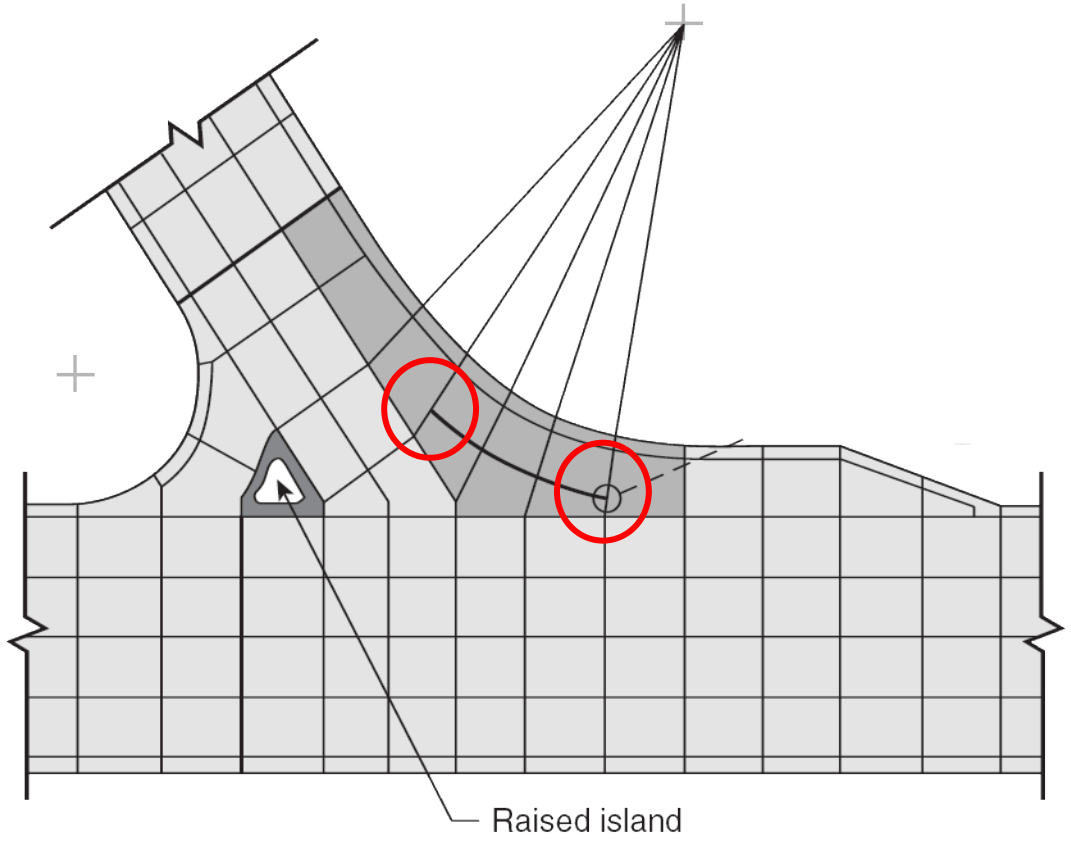
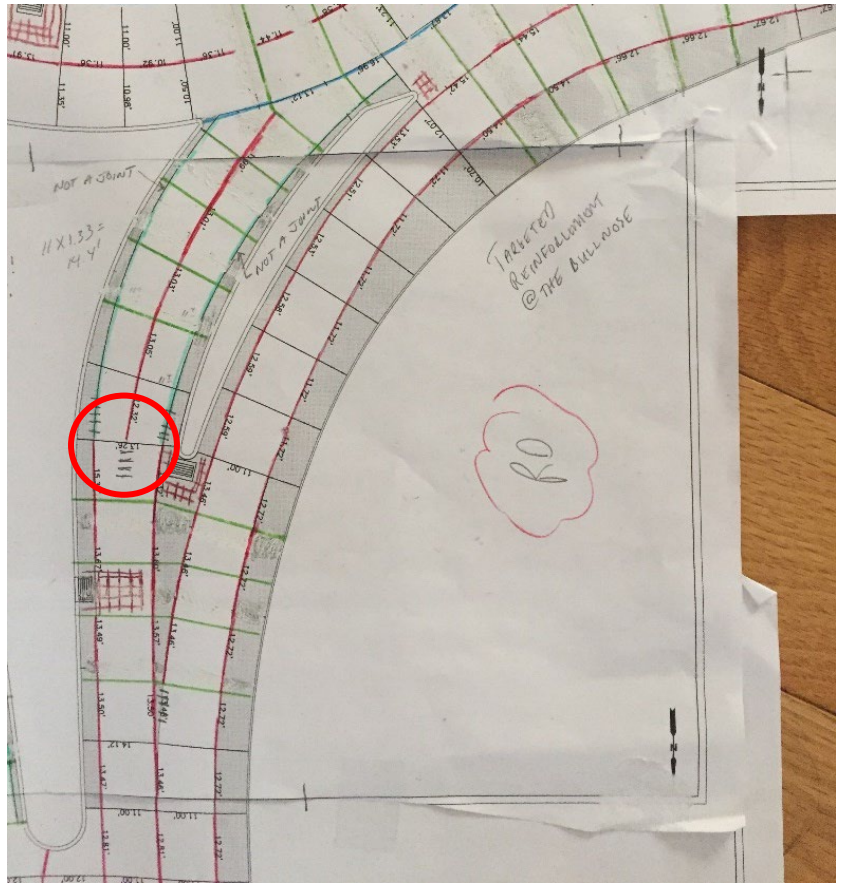


Image: ACPA

Troubleshooting Irregular Geometries

- Sometimes dead-end joints will be unavoidable:





Images: ACPA

Troubleshooting Irregular Geometries

- Using an isolation joint at a dead end is a good way to relieve stresses and prevent cracking
- Termination cores can also be used to relieve stresses at dead-end joints or T-intersections:

Images: ACPA

Troubleshooting Irregular Geometries

- Termination cores can be used to relieve stresses at dead-end joints or T-intersections:

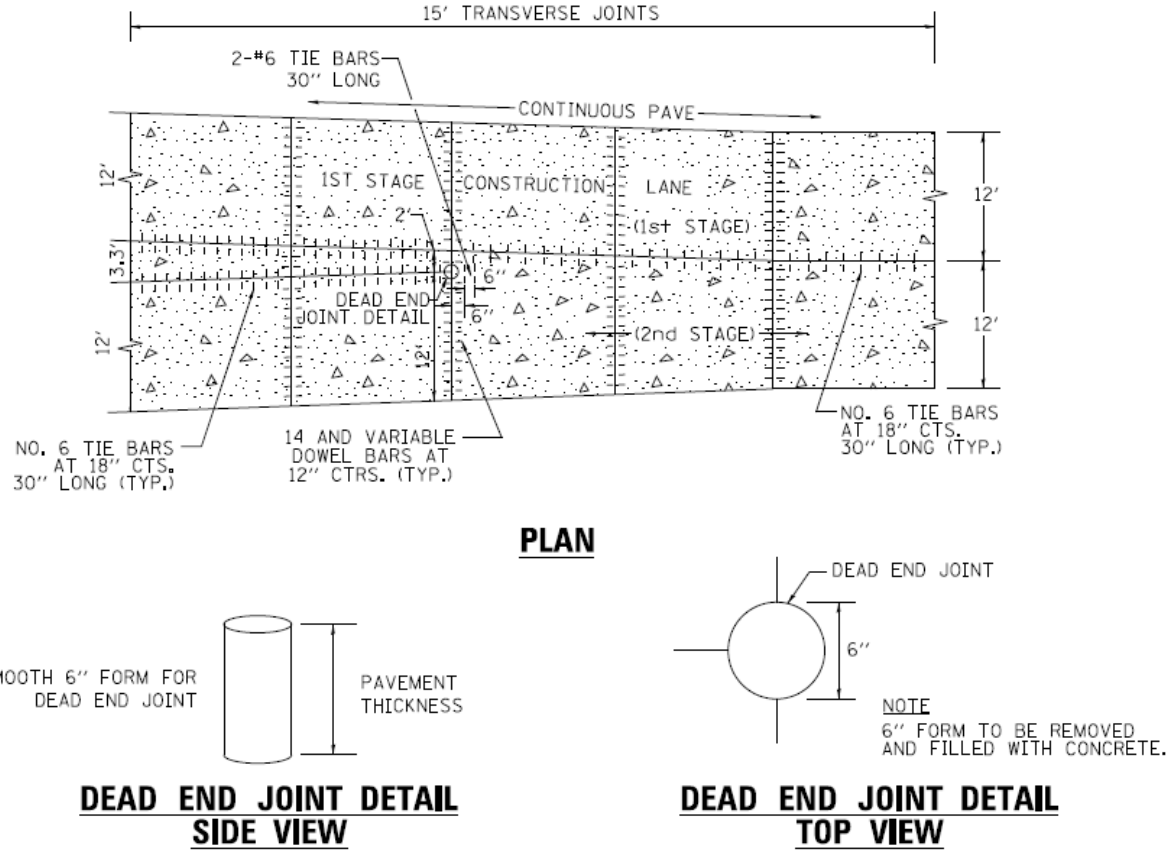


Image: Illinois DOT

Troubleshooting Irregular Geometries

- Reinforcement can also help mitigate potential for cracking at dead end joints and in irregularly-shaped slabs:

L Image: NCE; R Image: Rob Golish, MnDOT

Construction

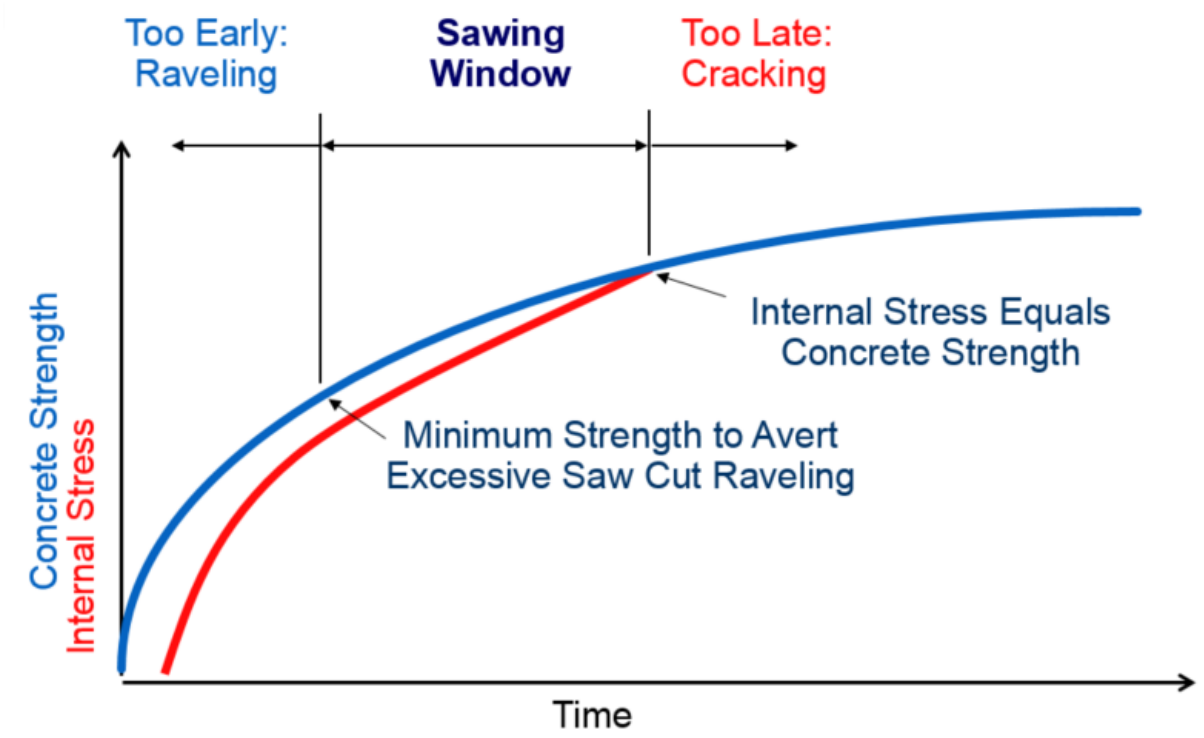
Joint Sawing

- To establish the jointing system to meet our requirements, we need to saw joints at the proper timing and depth

R Image: ACA

Timing of Joint Sawing

- Joint sawing must be done in the sawing window
  - Period where concrete is strong enough to saw without raveling or spalling, and before tensile stresses exceed strength

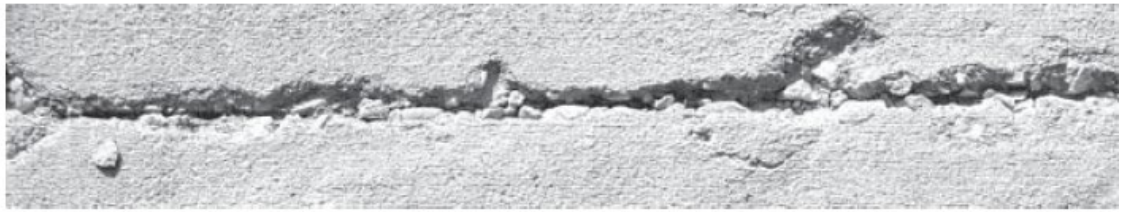


- Conventional saws
  - Window starts about 4 to 12 hours after placement
- Early-entry saws
  - Window starts from 1 to 4 hours after placement

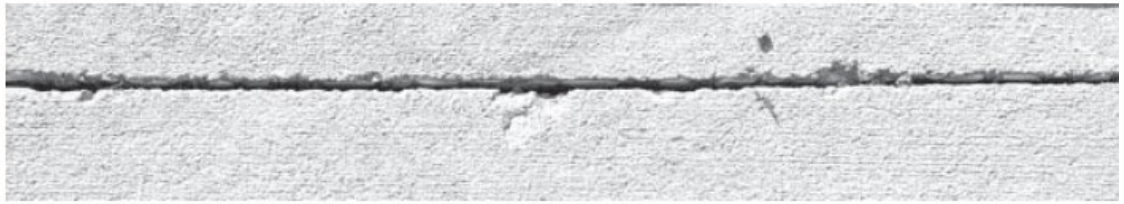
Image: ACPA

Timing of Joint Sawing

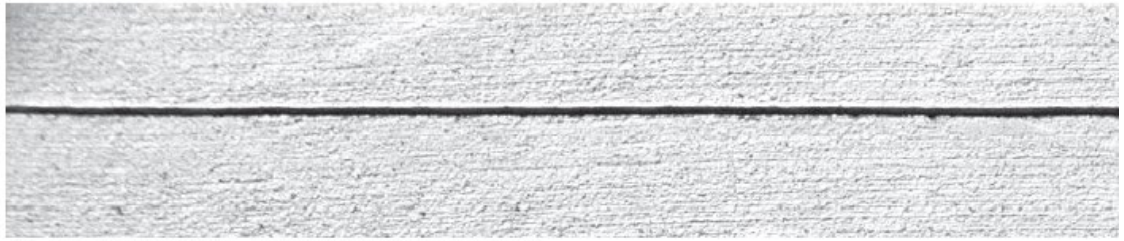
- Joint sawing must be done in the sawing window
  - Period where concrete is strong enough to saw without raveling or spalling, and before tensile stresses exceed strength



A. UNACCEPTABLE RAVELING - Sawed too early



B. MODERATE RAVELING - Sawed early in window



C. NO RAVELING - Sawed later in window

Depth of Joint Sawing

- Joints must be sawed deep enough to weaken the plane and ensure the cracks form at the saw cut locations
- Note differences in specifications for:
  - Transverse vs. longitudinal joints
  - Doweled vs. un-doweled transverse joints
  - Early-entry vs. conventional saws

Conventional saw

Early-entry saw

Images: Iowa DOT

Depth of Joint Sawing

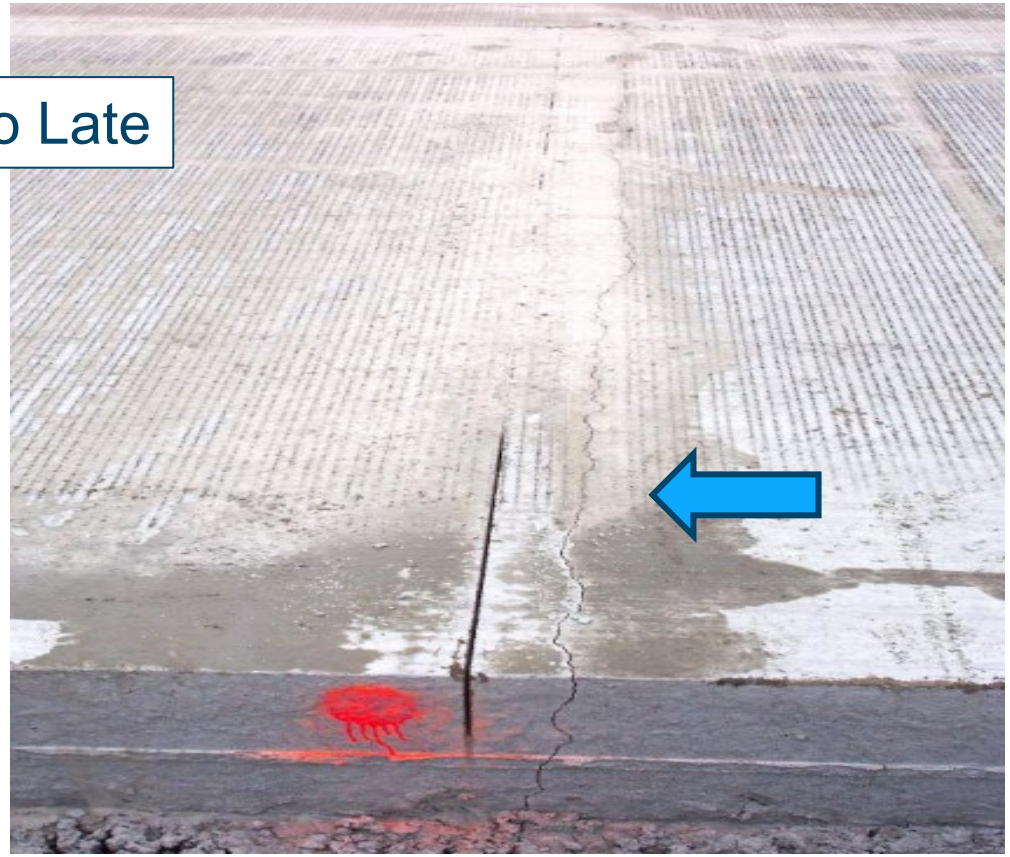
- Iowa DOT PV-101, SUDAS Figure 7010.101:

Joint Type	Saw Cut Depth		Saw Cut Width	
	Conventional	Early-Entry	Conventional	Early-Entry
Transverse	Undoweled: T/4 ± 1/4” Doweled: T/3 ± 0.25”	1-1/4” ± 1/4”	1/4” ± 1/16”	1/8” to 5/16”
Longitudinal	T/3 ± 0.25”		Not Filled: 1/8” ± 1/16” Filled: 1/4” ± 1/16”	

Troubleshooting Joint Sawing Issues

- Cracking due to joint sawing issues:

Too Late



Too Shallow

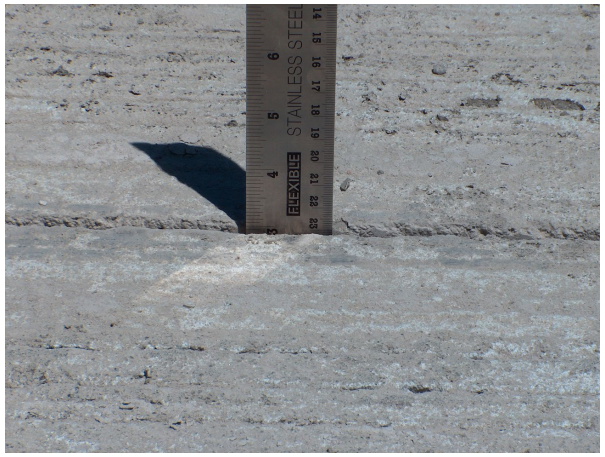
R Image: Jerod Gross

Troubleshooting Joint Sawing Issues

- The sawing window is sensitive to many factors:
  - Temperature changes can speed up or delay set time, shifting the window
  - A sharp temperature decrease late in the day or overnight can lead to more slab contraction, narrowing the window
  - Windy, sunny, or dry conditions can lead to a greater amount of evaporation, narrowing the window
  - Concrete mixtures with higher Portland cement contents and higher water contents (greater w/cm) experience more shrinkage, narrowing the window

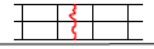
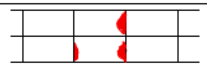
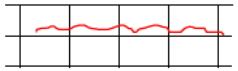
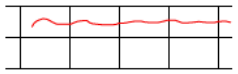
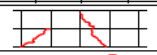
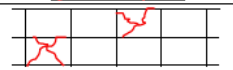
Troubleshooting Joint Sawing Issues

- Verify saw cut depth in the field!
  - If longitudinal joints are shallow, you may have time to re-saw
- Maintain blades and equipment
  - Select proper blade for aggregate type
  - Regularly check for wear and replace blades
  - Check the skid plate on early-entry saws



Recommended Repairs

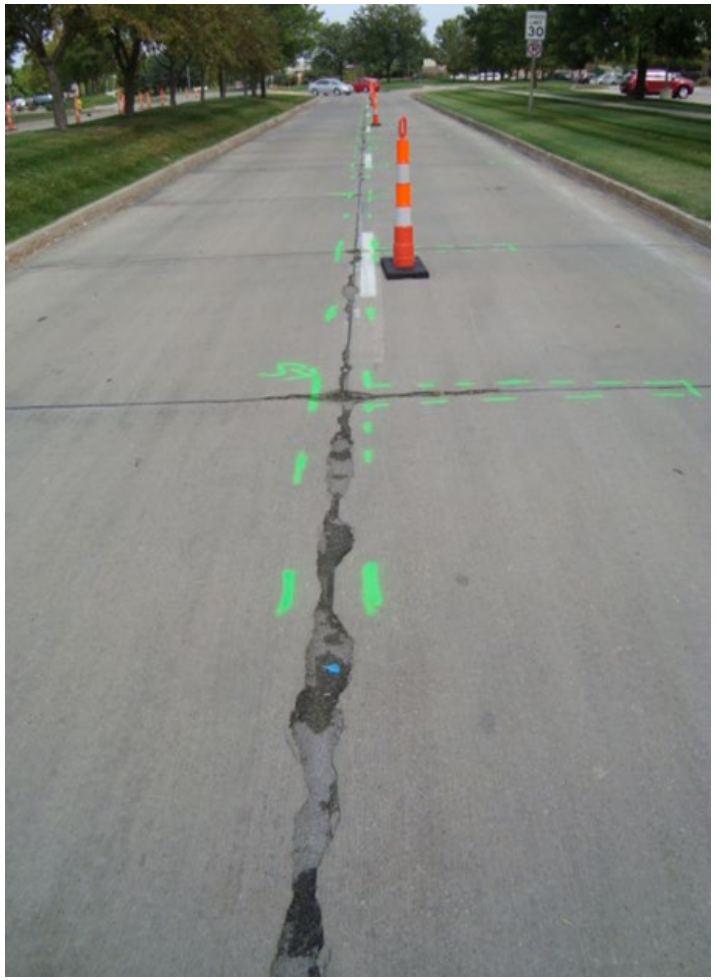
- Iowa DOT Construction Manual Appendix 9-6

Defect	Orientation	Location	Description	Dowelled/Undowelled Transverse Joints	Recommended Repair	
Plastic Shrinkage	Any	Anywhere	Partial-depth and more than 0.007 in. wide	Either	Do nothing	
Uncontrolled Crack	Transverse	Mid-Panel	Full-Depth	Undowelled	Saw/route and seal crack	
				Dowelled	Full-Depth Repair or LTR[a]	
Uncontrolled Crack	Transverse	Crosses or ends at transverse joint	Full-Depth	Undowelled	Saw & seal crack; Epoxy sawed joint if uncracked	
				Dowelled	Full-Depth Repair or If crack jumps from sawcut to edge of slab within 3 feet of edge of slab, stop sawcut, saw & seal crack	
Uncontrolled Crack	Transverse	Parallel to & within 5 ft. of joint	Full-Depth	Undowelled	Saw and seal crack Seal joint	
				Dowelled	Full-Depth repair to replace crack and joint	
Spalled sawcut or uncontrolled crack	Transverse	Anywhere	Spalling; more than 3.0 in.wide	Either	Partial-Depth Repair	
Uncontrolled Crack	Longitudinal	Relatively parallel to & within 1 ft. of joint; May cross or end at longitudinal joint	Full-Depth	Either	Saw/route & seal the crack or cross-stitch the crack Epoxy sawed joint if uncracked	
Uncontrolled Crack	Longitudinal	Relatively parallel to & within wheel path; 1 - 5 ft. from jcint	Full-Depth, hairline, or spalled	Either	Remove and replace panel or cross-stitch crack	
Uncontrolled Crack	Longitudinal	Relatively parallel to & further than 5 ft. from a longitudinal joint or edge	Full-Depth	Either	Cross-stitch crack	
Spalled sawcut or uncontrolled crack	Longitudinal	Anywhere	Spalled	Either	Partial-Depth Repair	
Uncontrolled Crack	Diagonal	Anywhere	Full-Depth	Either	Full-Depth Repair	
Uncontrolled Crack	Multiple per panel	Anywhere	Two or more full depth cracks dividing panel into 3 or more pieces	Either	Remove and replace panel	

Durability

Joint Durability

- Moisture and chloride ingress play a role in many concrete deterioration mechanisms
- Joints are the most common location of early deterioration and premature failure in concrete pavements



Joint Deterioration Mechanisms

- Saturated freeze-thaw damage
  - Poor quality air void system
  - Highly permeable paste
- Durability cracking (D-cracking)
  - Unsuitable, porous aggregates
- De-icing salt attack
  - Greater use of $MgCl_2$, $CaCl_2$
  - Mixes not optimized for resistance
- Incompressible materials

Preventing Joint Deterioration

- First things first: build good concrete pavements
  - Ensure sufficient drainage
  - Use a durable concrete mix with a good air void system
  - Follow best practices for sawing and filling joints

Durable Concrete Mixtures

- What do we need to target with our concrete mix?
  - Good air void system
  - Quality aggregates
  - Low w/cm (< 0.45 or lower)
  - SCMs (at least 20% replacement)

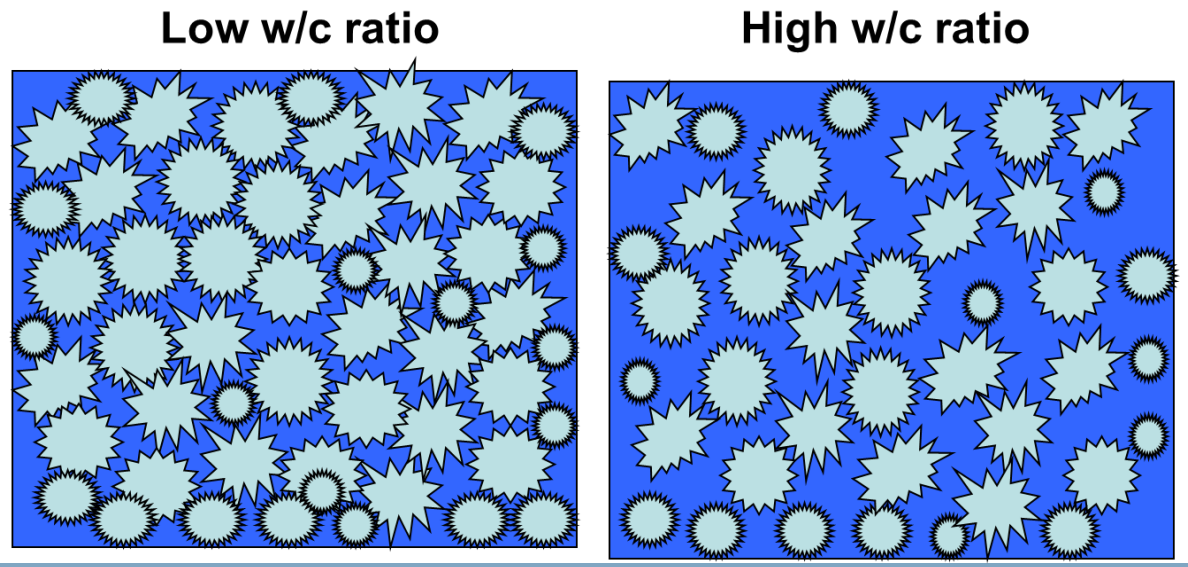


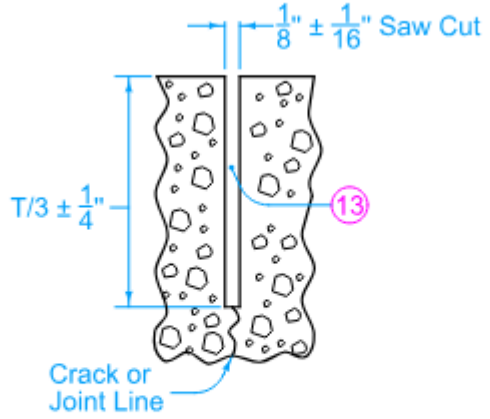
Image: Todd Hanson

Durable Concrete Mixtures

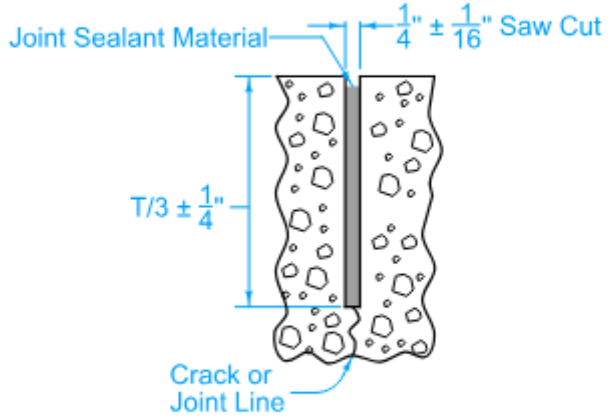
- Consider use of C-SUD and C-SUDHW mixes
  - Especially important for pavements that receive a significant amount of de-icing chemicals
  - C-SUDHW mixes are not yet in Iowa DOT or SUDAS specifications, but we began trials this summer

Joint Sealing / Filling

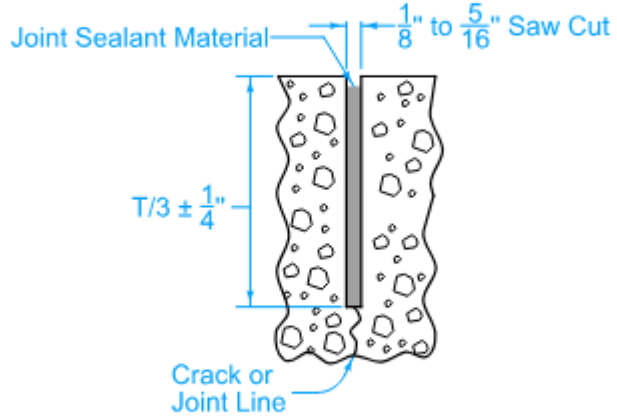
- Do we need to seal or fill our joints?
  - Filling helps keep fluids and incompressible materials out of the joint and out of the pavement system



DETAIL D-1
(Required when specified in the contract documents.)



DETAIL D-2
(Required when the Department of Transportation is not the Contracting Authority, or when specified in the contract documents)

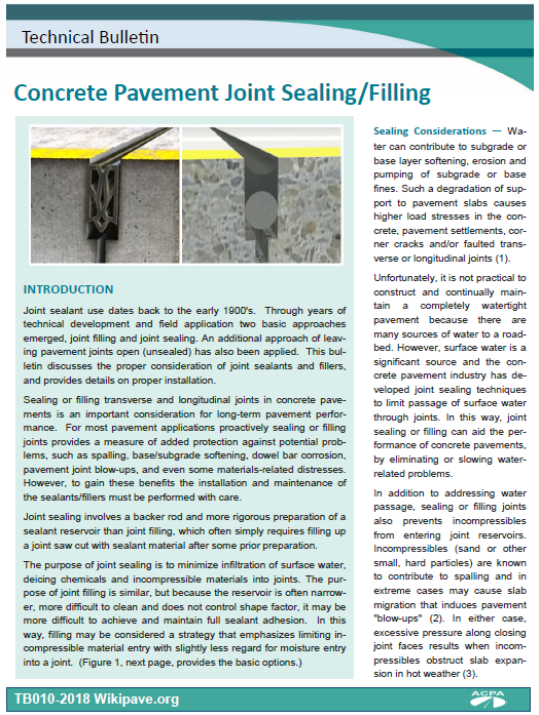


DETAIL D-3
(Required when the Department of Transportation is the Contracting Authority, or when specified in the contract documents)

Images: SUDAS

Joint Sealing / Filling

- Should I always seal or fill joints? Are there situations where it is not necessary?
  - ACPA Technical Bulletin TB010-2018:



Technical Bulletin

Concrete Pavement Joint Sealing/Filling

INTRODUCTION

Joint sealant use dates back to the early 1900's. Through years of technical development and field application two basic approaches emerged, joint filling and joint sealing. An additional approach of leaving pavement joints open (unsealed) has also been applied. This bulletin discusses the proper consideration of joint sealants and fillers, and provides details on proper installation.

Sealing or filling transverse and longitudinal joints in concrete pavements is an important consideration for long-term pavement performance. For most pavement applications proactively sealing or filling joints provides a measure of added protection against potential problems, such as spalling, base/subgrade softening, dowel bar corrosion, pavement joint blow-ups, and even some materials-related distresses. However, to gain these benefits the installation and maintenance of the sealants/fillers must be performed with care.

Joint sealing involves a backer rod and more rigorous preparation of a sealant reservoir than joint filling, which often simply requires filling up a joint saw cut with sealant material after some prior preparation.

The purpose of joint sealing is to minimize infiltration of surface water, deicing chemicals and incompressible materials into joints. The purpose of joint filling is similar, but because the reservoir is often narrower, more difficult to clean and does not control shape factor, it may be more difficult to achieve and maintain full sealant adhesion. In this way, filling may be considered a strategy that emphasizes limiting incompressible material entry with slightly less regard for moisture entry into a joint. (Figure 1, next page, provides the basic options.)

Sealing Considerations — Water can contribute to subgrade or base layer softening, erosion and pumping of subgrade or base fines. Such a degradation of support to pavement slabs causes higher load stresses in the concrete, pavement settlements, corner cracks and/or faulted transverse or longitudinal joints (1).

Unfortunately, it is not practical to construct and continually maintain a completely watertight pavement because there are many sources of water to a roadbed. However, surface water is a significant source and the concrete pavement industry has developed joint sealing techniques to limit passage of surface water through joints. In this way, joint sealing or filling can aid the performance of concrete pavements, by eliminating or slowing water-related problems.

In addition to addressing water passage, sealing or filling joints also prevents incompressibles from entering joint reservoirs. Incompressibles (sand or other small, hard particles) are known to contribute to spalling and in extreme cases may cause slab migration that induces pavement "blow-ups" (2). In either case, excessive pressure along closing joint faces results when incompressibles obstruct slab expansion in hot weather (3).

TB010-2018 Wikipave.org

Joint Sealing / Filling

KEY:

NR=Not recommended

Should perform adequately based on engineering judgment and limited experience (if sealed/filled then also with correct installation/maintenance procedures)

Will perform adequately based on engineering judgment and limited experience (if sealed/filled then also with correct installation/maintenance procedures)

	STREETS / ROADS / HIGHWAYS							
	Any Posted Speed Limit (Unless Indicated by Note)							
Layer Below Slab	Dense-Graded Base or Subgrade Soil				Non-Erodible (2) or Free-Draining Layer (3)			
Climatic Zone	Dry No-Freeze		Other		Dry No-Freeze		Other	
Joint Spacing	≤ 6 ft (2 m)	> 6 ft (2 m)	≤ 6 ft (2 m)	> 6 ft (2 m)	≤ 6 ft (2 m)	> 6 ft (2 m)	≤ 6 ft (2 m)	> 6 ft (2 m)
Open Reservoir Cut	NR	NR	NR	NR	NR	NR	NR	NR
Open Narrow Saw Cut	■	■	■	NR	■	■	■ (4,5)	■ (5)
Filled Saw Cut or Reservoir	■	■	■ (6)	■ (6)	■	■	■ (6)	■ (6)
Sealed Saw Cut or Reservoir	■	■	■	■	■	■	■	■

[4]Sealing recommended in freezing climates

[5]Sealing recommended when speed limit <45 mph

Penetrating Surface Sealers

- May be used to reduce the permeability of concrete at the surface or at the joints
- Provide additional protection from water and de-icing chemicals
- Enhance the performance of good concrete in challenging environments
- Improve existing pavements that may be susceptible to joint deterioration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