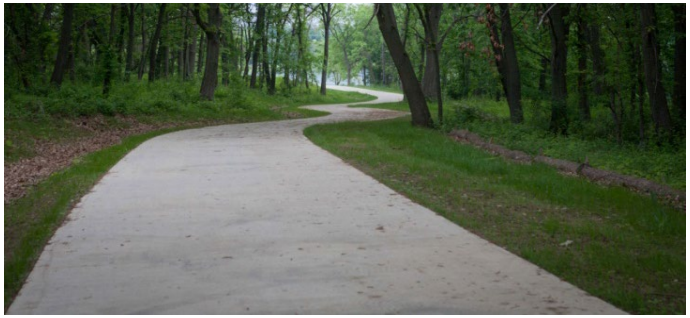
Best Practices for Jointing of Concrete Pavements



National Concrete Pavement Technology Center
Iowa's Lunch–Hour Workshop
In cooperation with the Iowa DOT
and the Iowa Concrete Paving Association

CP Tech Center

Agenda

Background

- Why Jointing?

  Controls cracking
  Accommodates movement
  Load transfer

- Load Transfer
- Joint Types & Layout
- Sawing Window

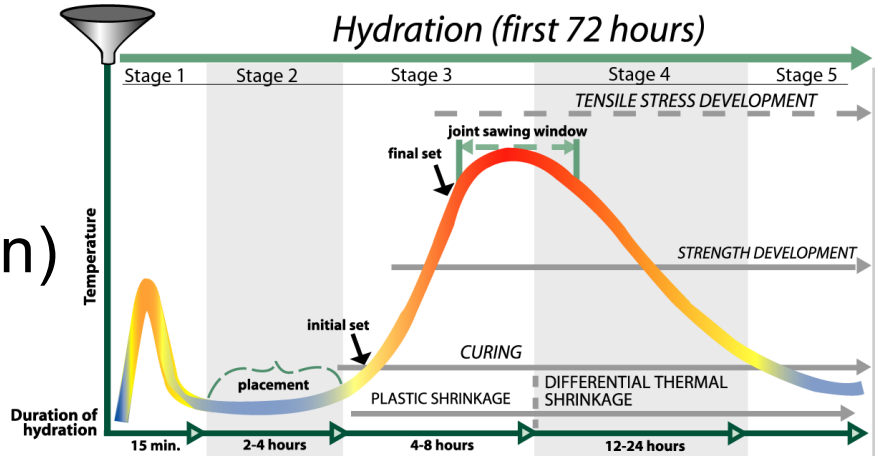
PCC Jointing Applications

- Roundabouts, Airports, Parking Lots, Trails

Tech Center

Early Cracking

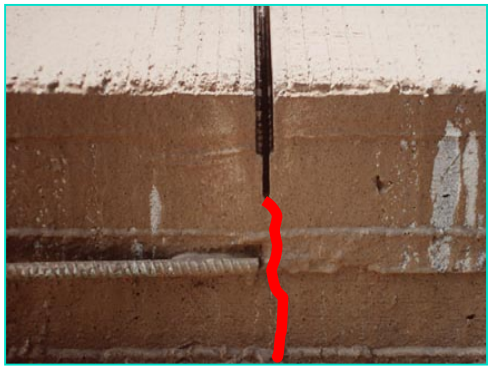
- Few hours to few months after construction
- Early cracking from:
  1. Shrinkage (volume loss) during hydration
     - ➢Temp change (contraction)
     - ➢Loss of water (drying shrinkage)
  2. Subgrade/subbase restraint
  3. Curling and Warping
     - * Mature cracking can occur with improper joint layout or construction



Source: SUDAS Design Manual Ch. 5G

Why Jointing?

- Joints minimize cracking by:
  1. Providing load transfer & ability to accommodate movement
  2. Proper timing of sawing
  3. Proper location of joints
  4. Proper curing
  5. Constructing a quality foundation
     - ➢Uniform subgrade & drainable subbase system



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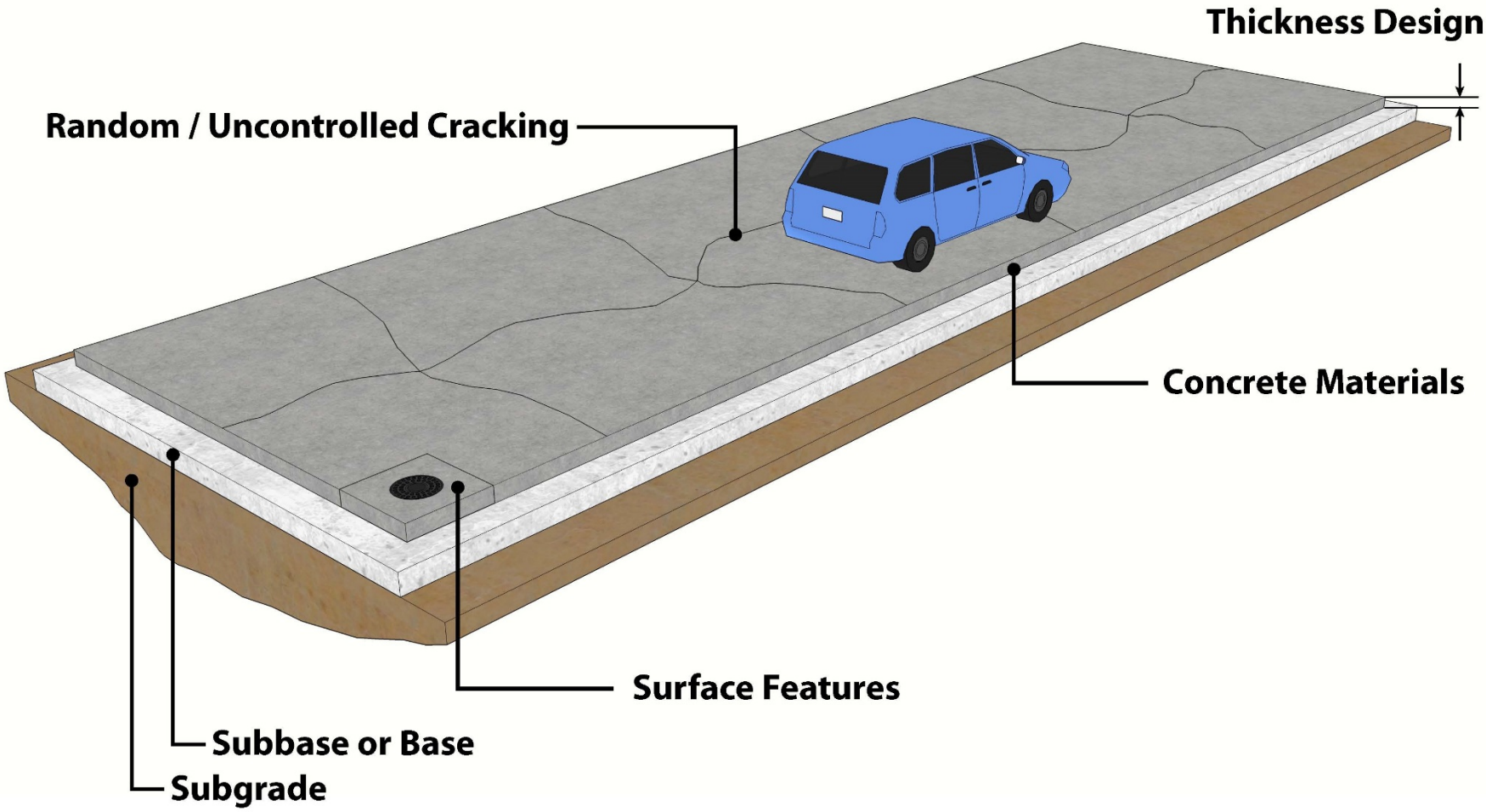
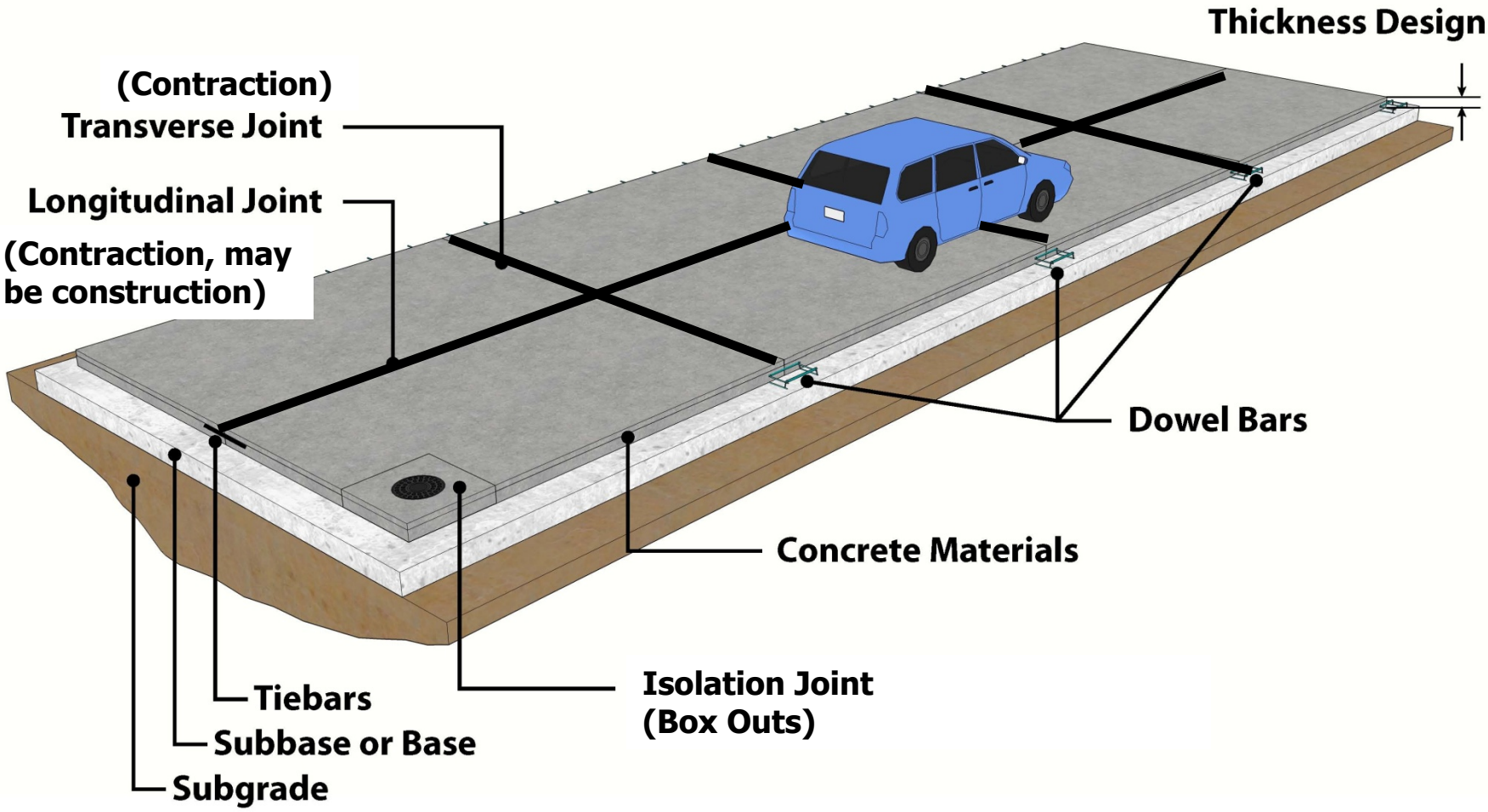
Source: SUDAS Design Manual Ch. 5G

Random Cracking without Joints



Types of Joints



US 20 – Moville, Iowa

1921 Pavement (97 Years Old)

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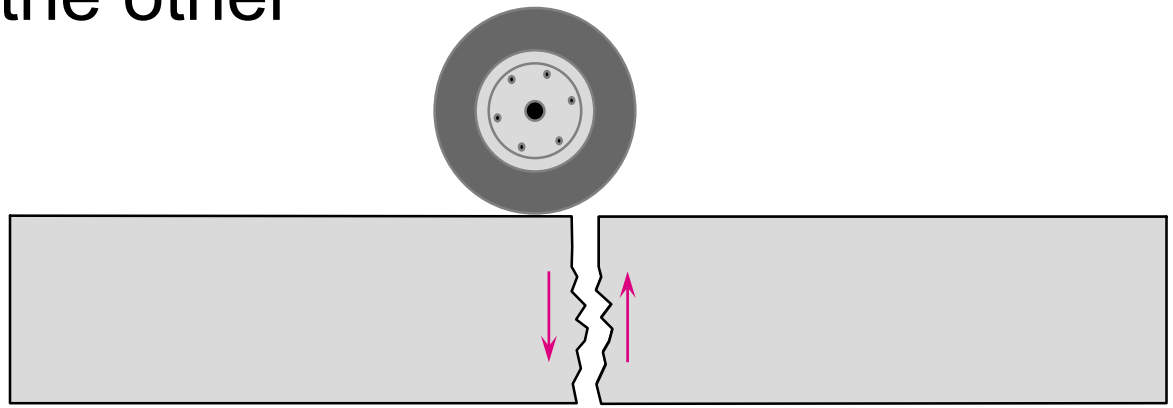
Load Transfer - Aggregate Interlock

- Traffic loadings must transfer from one side of the joint to the other

Joint Opening Below Saw Cut	Joint Efficiency
1/16”	>50%
1/8”	<50%
1/4"	0%



To Increase Aggregate Interlock:

Longitudinal tiebars

Stiff & uniform subgrades

Improved subgrade drainage

Crushed stone (angular creates rough joint space)

Suitable for less than 100 trucks per lane per day (4 million ESALs design traffic)

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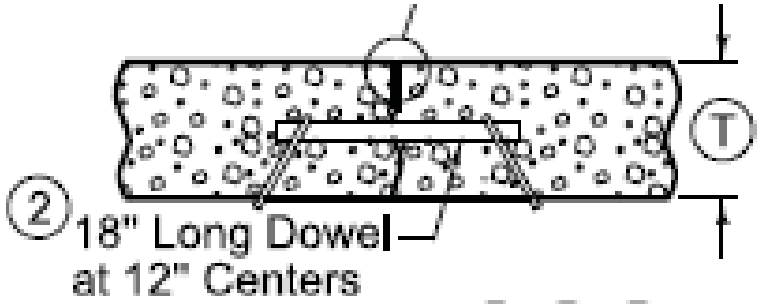
Load Transfer - Mechanical

- Dowel bars
  - Keeps slabs in horizontal and vertical alignment
  - Daily and seasonal joint openings have less affect on load transfer
  - Lowers deflection and stress in slabs

Source: Glen Eder



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Joint Types

Three Types of Joints

1. Contraction (L& T)
2. Construction (L & T)
3. Isolation (L & T)

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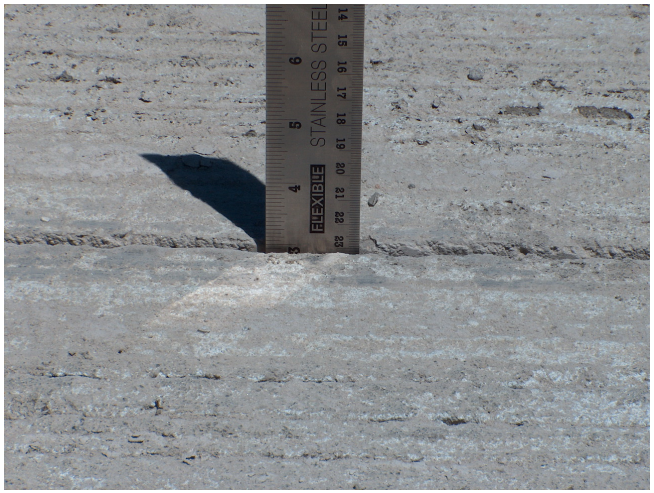
Transverse Contraction

Transverse contraction joints

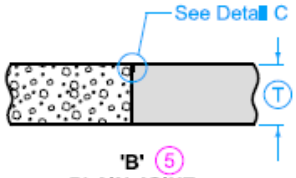
- "C" joint for pavements typically less than 8" and less than 100 trucks per day per lane
- "CD" joint for pavements typically 8" or greater and more than 100 trucks per day per lane



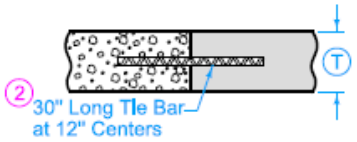
Conventional saw
Width = 1/4" ± 1/16"
Depth = T/4 ± ¼" (C joint)
Depth = T/3 ± ¼" (CD joint)

Early-entry saw
Width = 1/8" to 5/16"
Depth = 1 ¼" ± ¼"

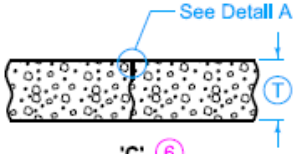
Transverse Contraction



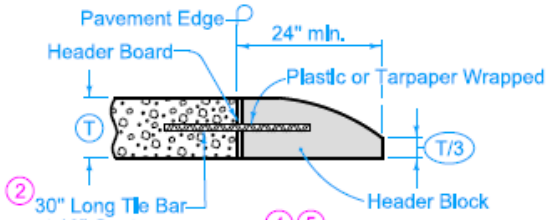
'B' (5)
PLAIN JOINT
(Abutting Pavement Slabs)



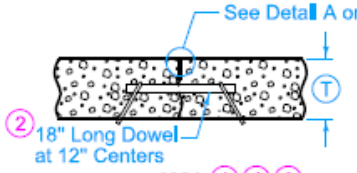
'DW' (3)(4)(7)
DAY'S WORK JOINT(Non-working)



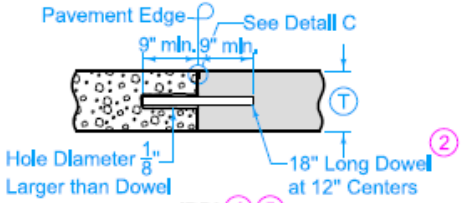
'C' (6)
CONTRACTION JOINT



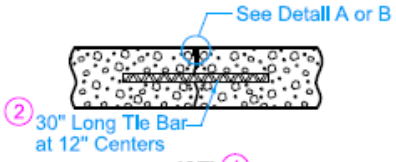
'HT' (4)(5)
HEADER JOINT
(End Rigid Pavement)



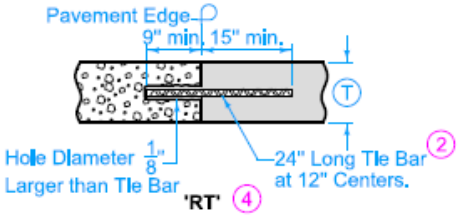
'CD' (1)(4)(6)
DOWELED CONTRACTION JOINT



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

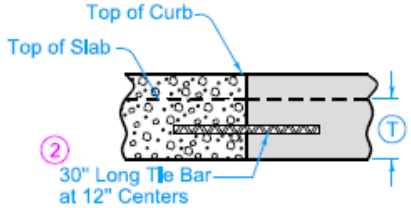


'CT' (4)
TIED CONTRACTION JOINT



'RT' (4)
ABUTTING PAVEMENT JOINT
RIGID TIE

1. See dowel assemblies for fabrication details.
2. See Bar Size Table.
3. Locate 'DW' joint at a mid-panel location between future 'C' or 'CD' joints. Place no closer than 5 feet to a 'C' or 'CD' joint.
4. Place bars within the limits shown under dowel assemblies.
5. Edge with 1/8 inch tool for length of joint. For HT joint, remove header block and board when second slab is placed.
6. Unless otherwise specified, use 'CD' transverse contraction joints in mainline pavement when (T) is greater or equal to 8 inches. Use 'C' joints when (T) is less than 8 inches.
7. 'RT' joint may be used in lieu of 'DW' joint at the end of the days work. Remove any pavement damaged due to the drilling at no additional cost to the Contracting Authority.



'DW - CG' (3)(4)
DAY'S WORK JOINT
CURB AND GUTTER UNIT

LEGEND
Existing Pavement
Proposed Pavement

SUDAS | IOWA DOT

REVISION	
8	10-16-18

FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101

SHEET 1 of 8

REVISIONS: Revised "RT-1" joint on sheet 3 to allow contractors to substitute 30" long, #5 bars at 30" spacing.

Ryan D. Wiegand
SUDAS DIRECTOR

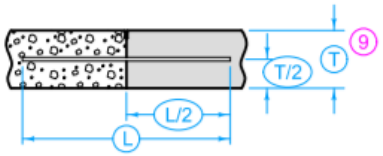
Deron Nelson
DESIGN METHODS ENGINEER

JOINTS

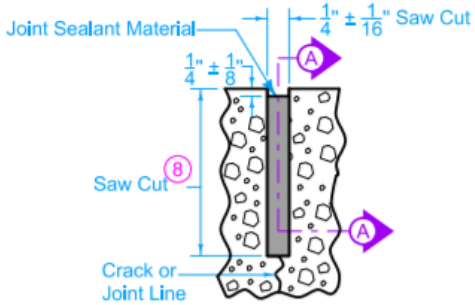
FIGURE 7010.101 SHEET 1 OF 8

TRANSVERSE CONTRACTION

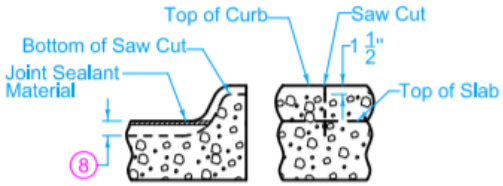
Transverse Contraction



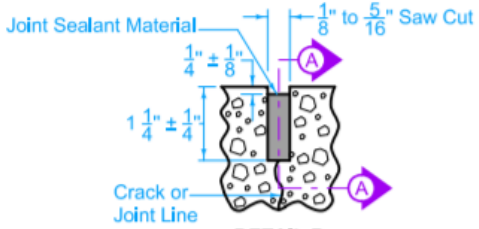
BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)



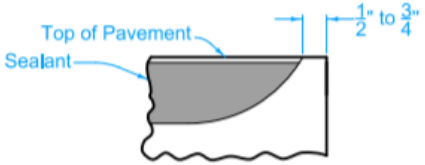
DETAIL A
(Saw cut formed by conventional concrete sawing equipment.)



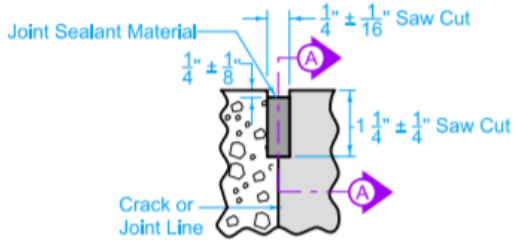
'C' JOINT IN CURB
(Match 'CT', 'CD', or 'C' joint in pavement.)



DETAIL B
(Saw cut formed by approved early concrete sawing equipment.)



SECTION A-A
(Detail at Edge of Pavement)



DETAIL C

8 Saw 'CD' joint to a depth of T/3 ± 1/4"; saw 'C' joint to a depth of T/4 ± 1/4".

9 When tying into old pavement, (T) represents the depth of sound PCC.

BAR SIZE TABLE		
(T)	Dowel Diameter	Tie Bar Size
< 8"	3/4"	#6
≥ 8" but < 10"	1 1/4"	#10
≥ 10"	1 1/2"	#11

LEGEND
Existing Pavement
Proposed Pavement

SUDAS | IOWA DOT | REVISION 8 10-16-18
FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101
SHEET 2 of 8

REVISIONS: Revised '8T-1' joint on sheet 3 to allow contractors to substitute 30" long, #5 bars at 30" spacing.

Russ D. Wigand
SUDAS DIRECTOR

DESIGN METHODS ENGINEER

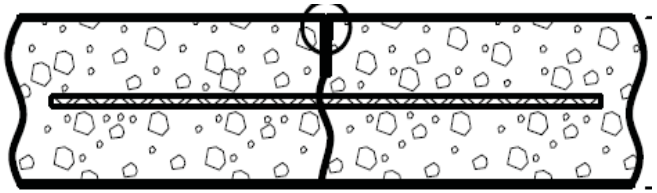
TRANSVERSE CONTRACTION

JOINTS

FIGURE 7010.101 | SHEET 2 OF 8

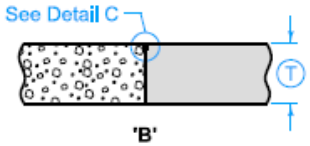
Longitudinal Contraction

- Hold aggregate interlock between slabs & allows “hinge”
- Delineates traffic lanes
- Depth is T/3 (may or may not be sealed)
- Early sawing is NOT recommended (unless T/3 is achieved)
- Width: 1/4” ± 1/16” (non DOT)
- Width: 1/8” to 5/16” (DOT)

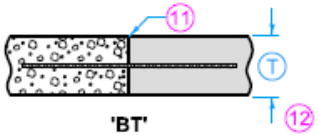


(T)	Joint	Bars	Bar Length and Spacing
< 8"	'L-1'	#4	36" Long at 30" Centers
≥ 8"	'L-2'	#5	36" Long at 30" Centers
	'L-3'		36" Long at 15" Centers

Longitudinal Contraction

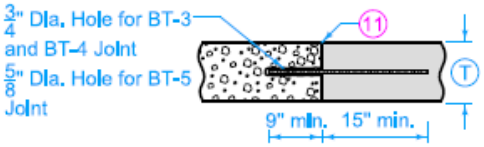


'B'
PLAIN JOINT
(Abutting Pavement Slabs)



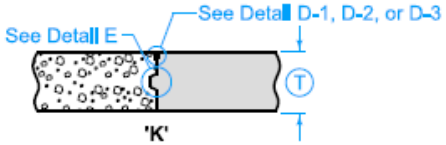
'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE

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

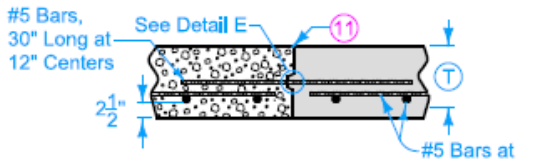


'BT'
ABUTTING PAVEMENT JOINT - RIGID TIE (Drilled)

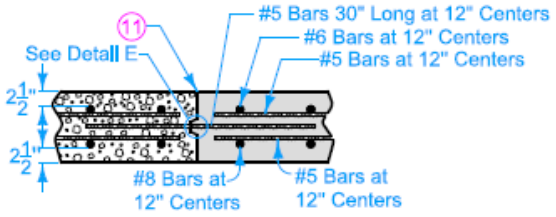
T	Joint	Bars	Bar Length and Spacing
< 8"	'BT-5'	#4	24" Long at 30" Centers
≥ 8"	'BT-3'	#5	24" Long at 30" Centers
	'BT-4'		24" Long at 15" Centers



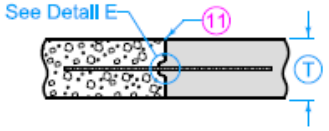
'K'
KEYED JOINT FOR ADJACENT SLABS
(Where T Is 8" or more)



'KS-1'
[Single Reinforced Pavement (Bridge Approach)]



'KS-2'
[Double Reinforced Pavement (Bridge Approach)]



'KT'
ABUTTING PAVEMENT JOINT - KEYWAY TIE (10) (12)

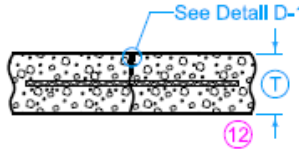
T	Joint	Bars	Bar Length and Spacing
< 8"	'KT-1'	#4	30" Long at 30" Centers
≥ 8"	'KT-2'	#5	30" Long at 30" Centers
	'KT-3'		30" Long at 15" Centers

LONGITUDINAL CONTRACTION

(10) Bar supports may be necessary for fixed form paving to ensure the bar remains in a horizontal position in the plastic concrete.

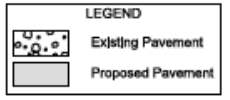
(11) Sawing or sealing of joint not required.

(12) The following joints are interchangeable, subject to the pouring sequence;
'BT-1', 'L-1', and 'KT-1'
'KT-2' and 'L-2'
'KT-3' and 'L-3'



'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



SUDAS | IOWA DOT | REVISION 8 10-16-18
FIGURE 7010.101 | STANDARD ROAD PLAN | PV-101 | SHEET 3 of 8

REVISIONS: Revised 'BT-1' Joint on sheet 3 to allow contractors to substitute 30" long #5 bars at 30" spacing.

Bureau Director | Design Methods Engineer

JOINTS

FIGURE 7010.101 SHEET 3 OF 8

Contraction Joint Spacing

$ML = T \times C_s$
ML = Maximum length between joints (in.)
T = Slab thickness (in.)
C_s = Support constant
(24 for subgrades or unstabilized subbases)
(21 for ATB, CTB or existing concrete or asphalt)

Roadways (Transverse):

6” - 7” = 2 x thickness in feet

8” - 9” = 15’

≥10” = 20’ (“CD” max.)

< 6” (concrete overlays) = 1.5 thickness in feet
(Not same ML formula)

Roadways (Longitudinal)

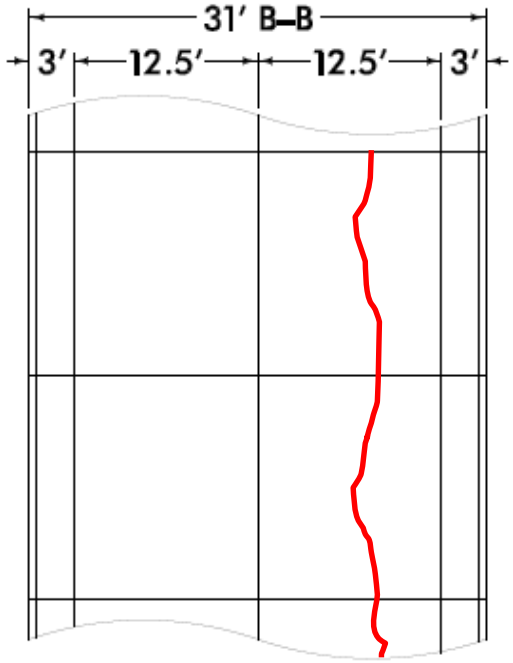
6” - 9” = 6.5’ min. to 12.5’ max.

>9” = 14.5’ max (SUDAS 10’-13’ max)

‘C’ Joint
For T < 8” & Trucks (<120 /lane/day)
‘CD’ Joint (dowels)
For T ≥ 8” and Heavy Trucks (>120 /lane/day)

Longitudinal Contraction Joints (Not Sawing Deep Enough)

- Use of gutter joints not recommended for thicknesses less than 9”
- Thinner pavements may not crack through at gutter joint, causing longitudinal cracks at mid-panel
- Saw depth must be T/3



Gutterline Jointing

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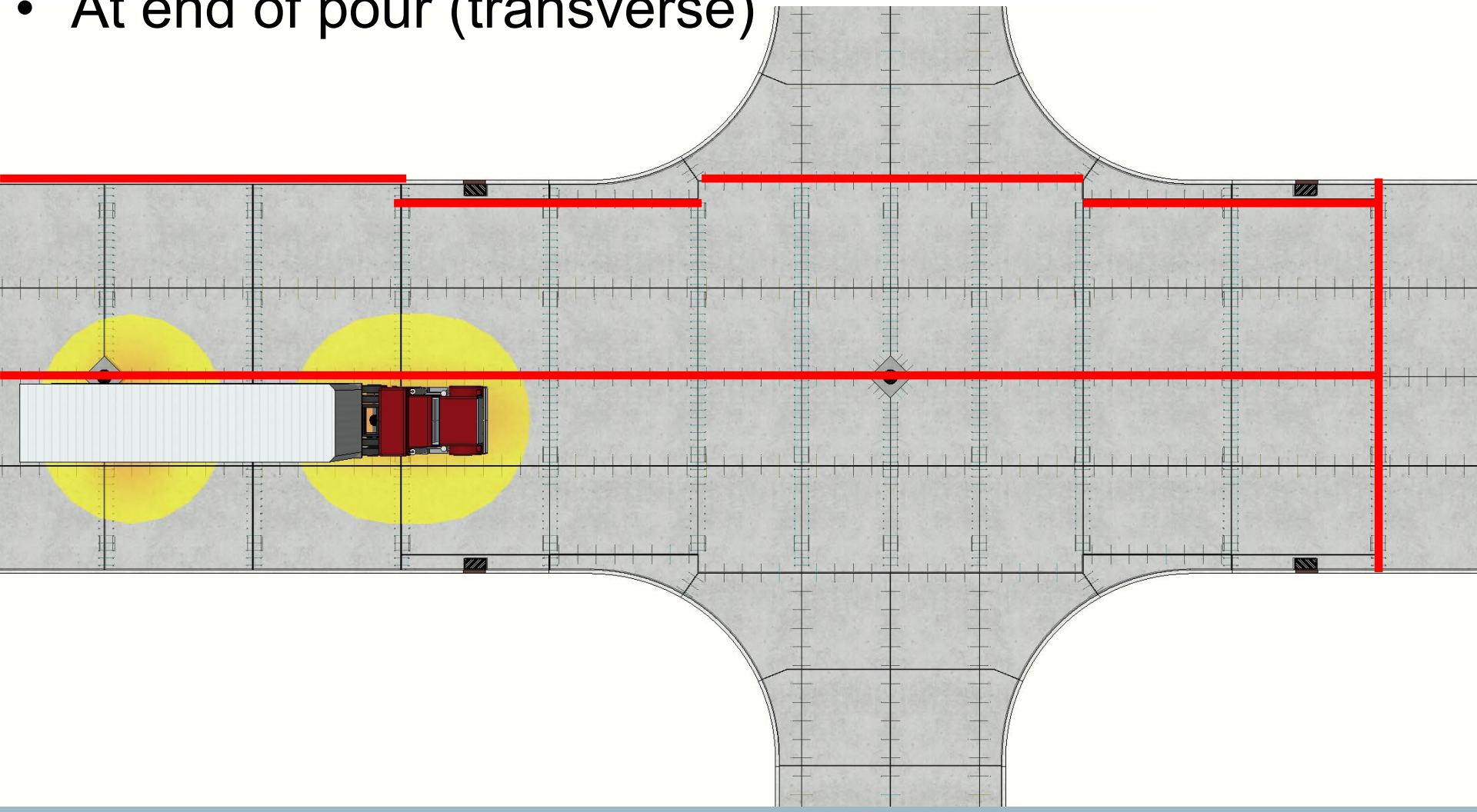
Construction Joints

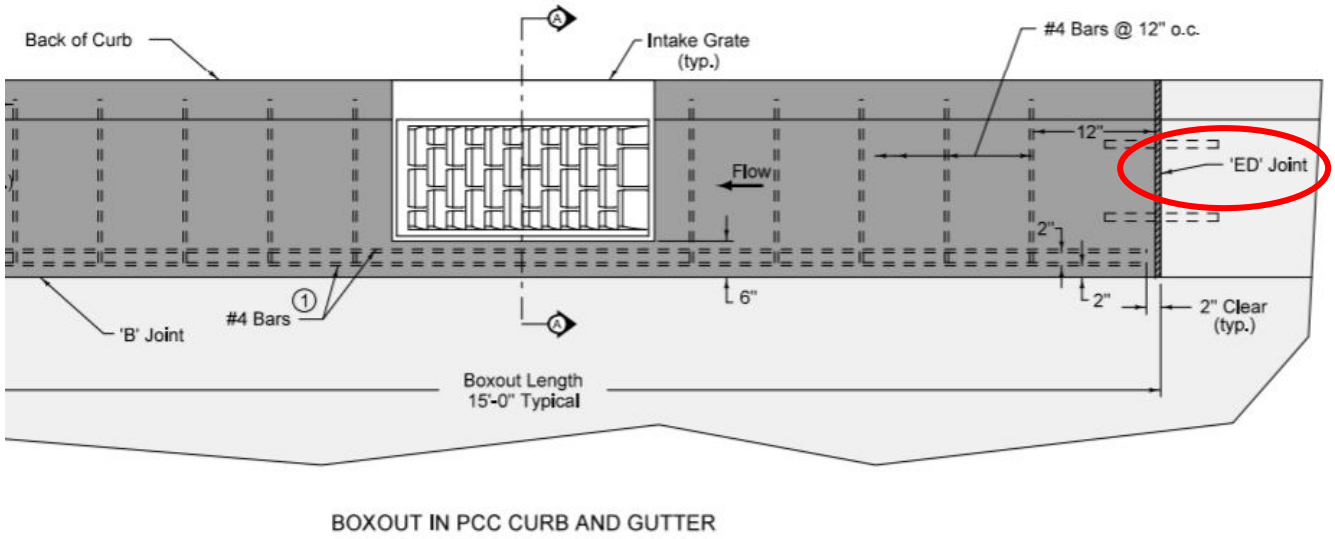
- At edge of pour (longitudinal)
- At end of pour (transverse)



Isolation/Expansion Joints

Isolation joints around structures

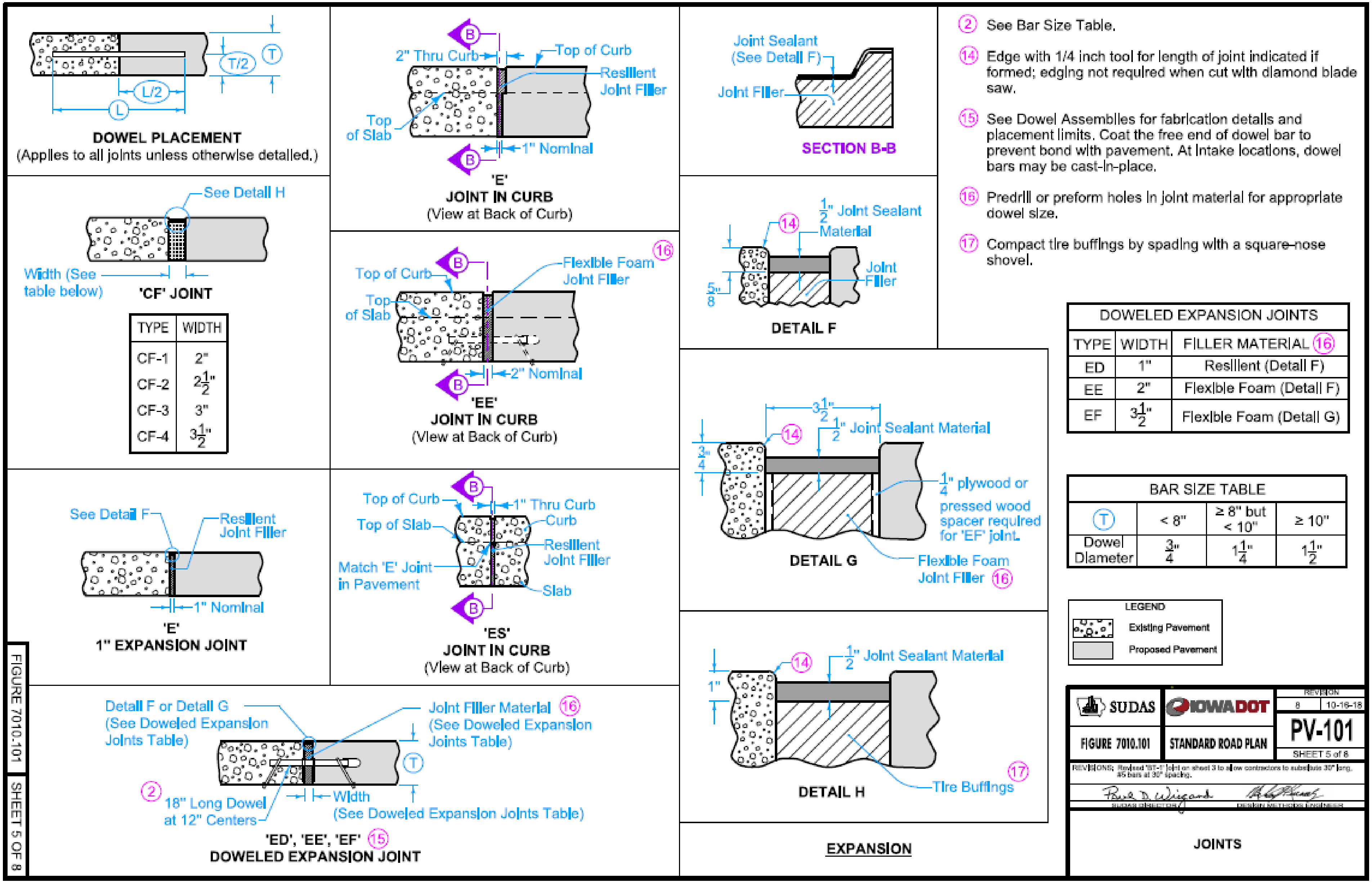
- Allows horizontal pavement movement without damaging adjacent structures
- Full-depth, full-width joints
- Isolates fixed structures from pavement



BOXOUT IN PCC CURB AND GUTTER

Use of Isolation/Expansion Joints to mitigate expansion (bridge approaches)

Isolation/Expansion Joints



(2) See Bar Size Table.

(14) Edge with 1/4 inch tool for length of joint indicated if formed; edging not required when cut with diamond blade saw.

(15) See Dowel Assemblies for fabrication details and placement limits. Coat the free end of dowel bar to prevent bond with pavement. At intake locations, dowel bars may be cast-in-place.

(16) Predrill or preform holes in joint material for appropriate dowel size.

(17) Compact tire buffings by spading with a square-nose shovel.

TYPE	WIDTH
CF-1	2"
CF-2	$2\frac{1}{2}$"
CF-3	3"
CF-4	$3\frac{1}{2}$"

DOWELED EXPANSION JOINTS

TYPE	WIDTH	FILLER MATERIAL (16)
ED	1"	Resilient (Detail F)
EE	2"	Flexible Foam (Detail F)
EF	$3\frac{1}{2}$"	Flexible Foam (Detail G)

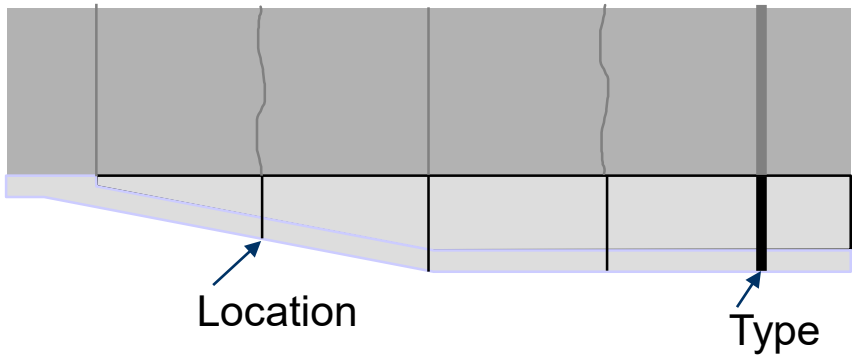
BAR SIZE TABLE

(T)	< 8"	≥ 8" but < 10"	≥ 10"
Dowel Diameter	$\frac{3}{4}$"	$1\frac{1}{4}$"	$1\frac{1}{2}$"

General Layout Rules

Things to Do

- Match existing joints or cracks – location AND type!
- Place joints to meet in-pavement structures
- Remember maximum joint spacing
- Place isolation joints where needed
- Locations can be adjusted in the field!



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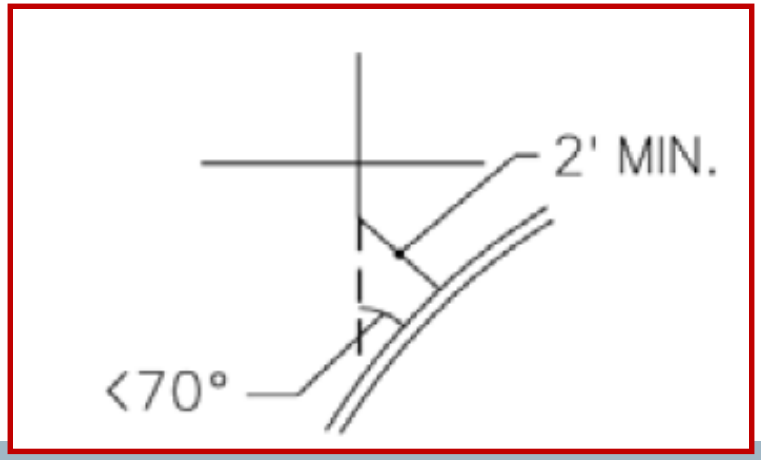
General Layout Rules

- Slabs ≤ 12.5 ft wide (for roadways T≤9”)
- Angles > 70º (90º is best)
- Avoid creating interior corners
- Keep slabs near-square (L = no more than 1.5 W)



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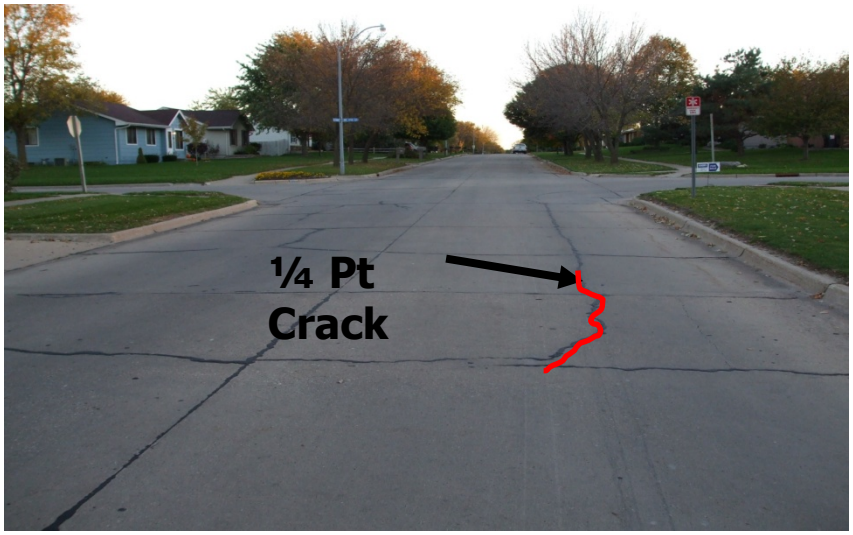
What happens if jointing isn't done correctly?



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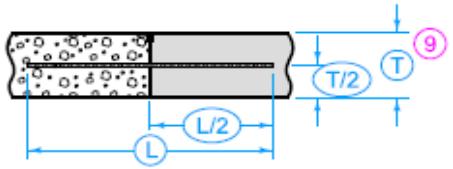
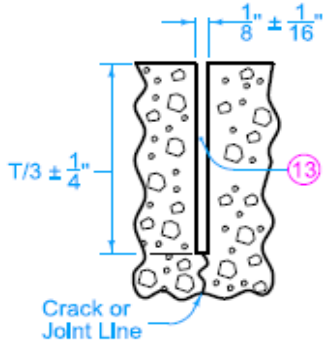
Seal (Filling) vs. No Seal



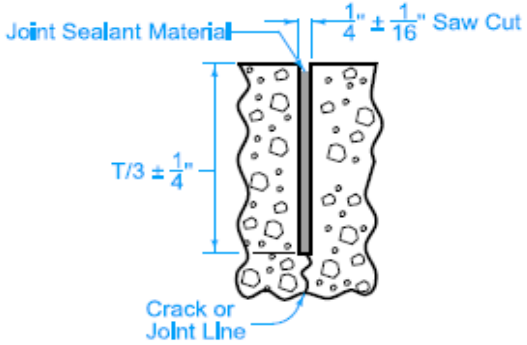
TIE BAR PLACEMENT
(Applies to all joints unless otherwise detailed.)



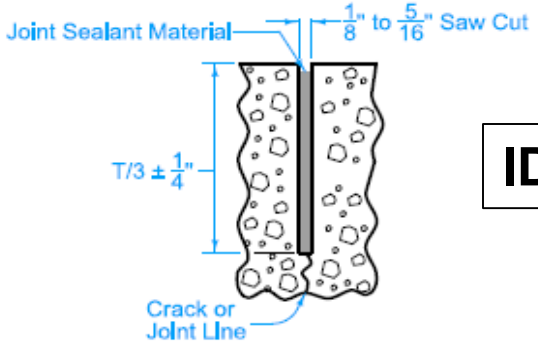
DETAIL D-1
(Required when specified in the contract documents.)

When Specified

Non-IDOT or when specified



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)

IDOT

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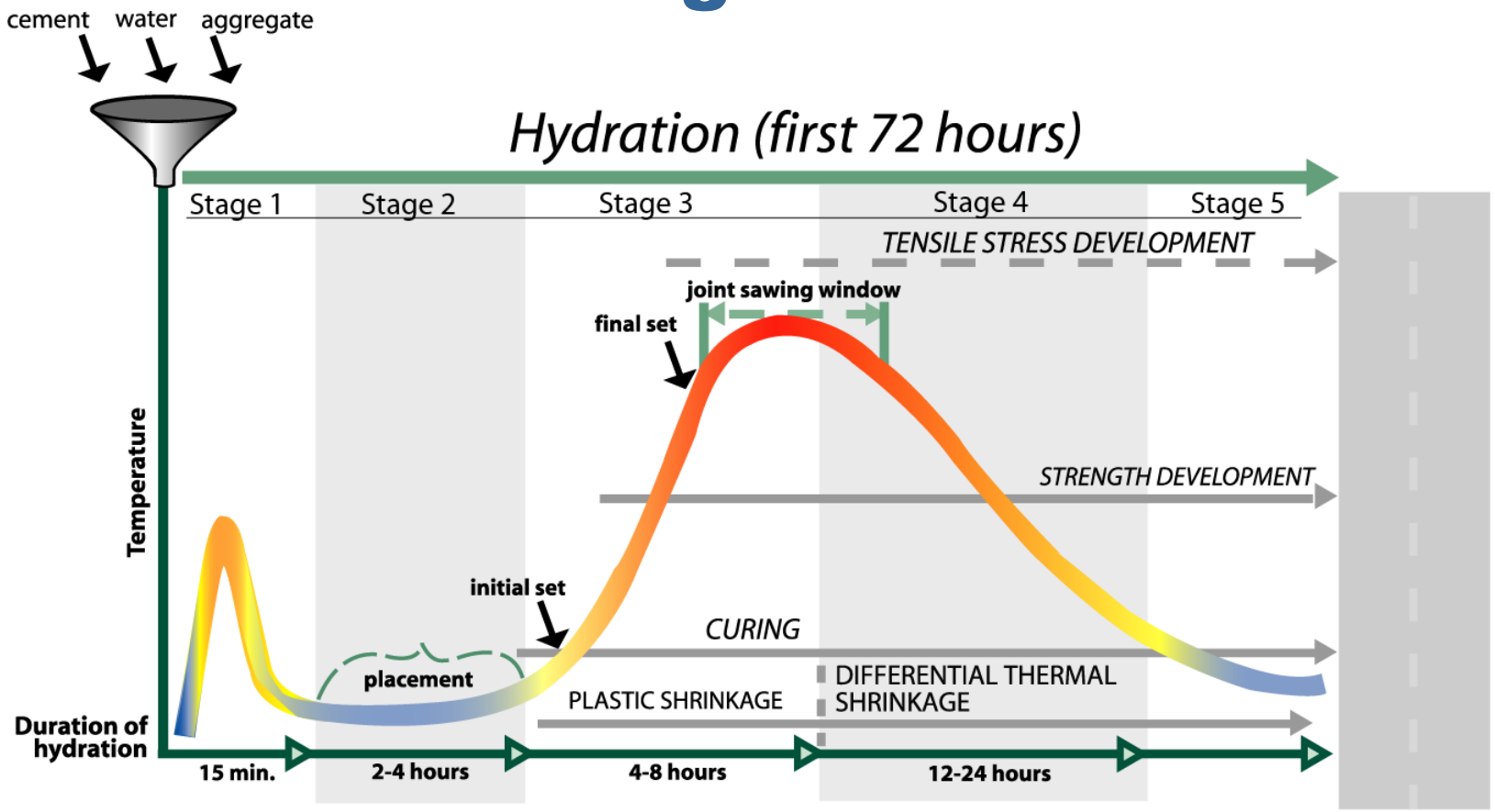
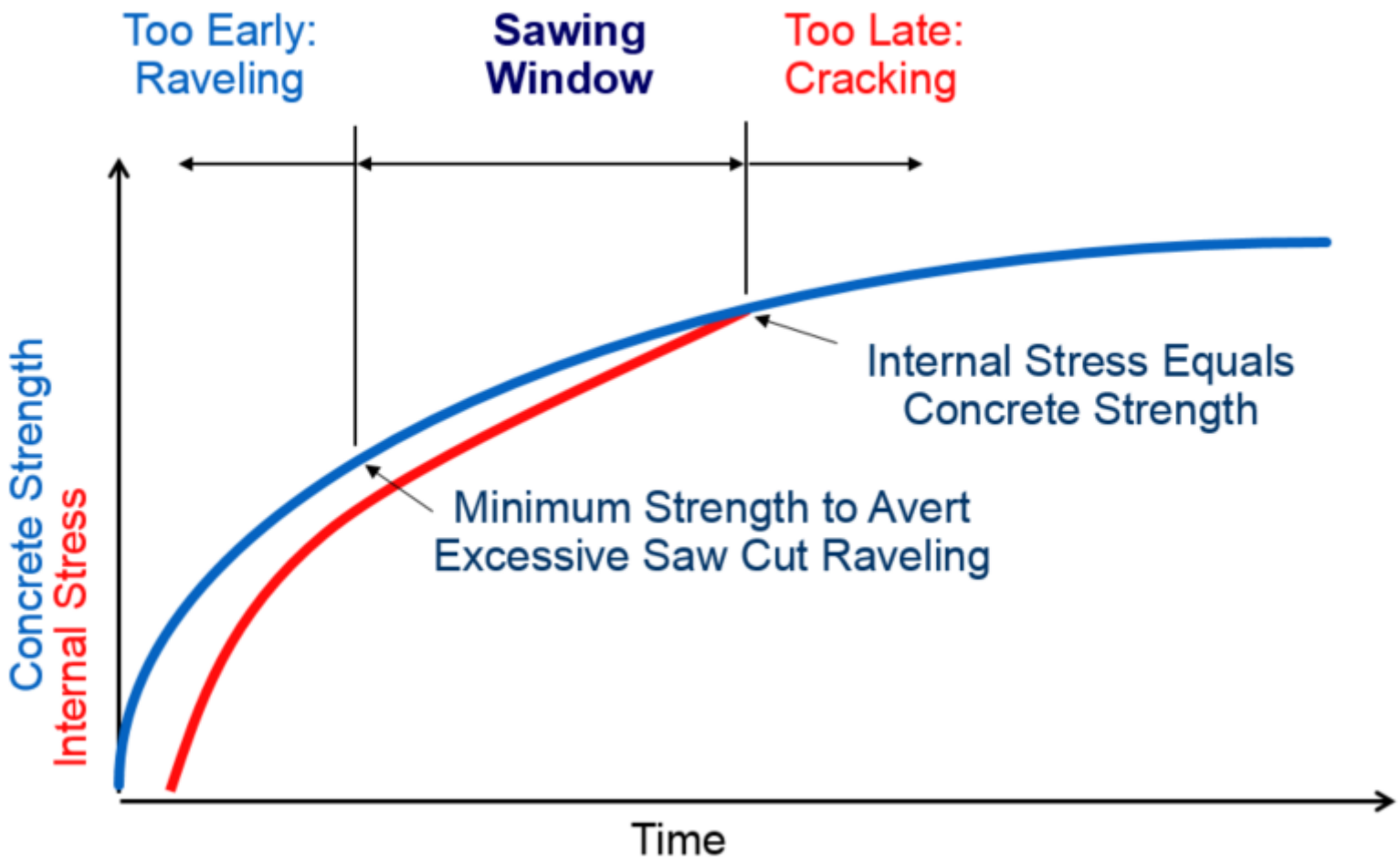
Longitudinal Joint Detail

Sawing Window



Initial Mix *(15 minutes)*	**Dormancy** *(24 hours)*	**Acceleration** *(4-8 hours)*	**Deceleration** *-24 hours)*	**Slow Hydration** *(Indefinitely)*
High heat followed by rapid cooling	Cool, plastic, workable	Significant heat, less workable, begins to harden	Becomes hard and dense	70 – 75%hydrated after 28 days
	Transport and Place	Begin curing Cut joints	Continue curing	Can continue indefinitely, as long as water can reach un-hydrated particles

Sawing Window



Source: ACPA Wikipave

Factors Affecting Sawing Window

- Weather:
  - Sudden temperature drop or rainshower
  - Sudden temperature rise
  - High winds & low humidity
  - Cool temperatures & cloudy
  - Hot temperatures & sunny
- Subbase:
  - High friction between the subbase & concrete slab
  - Bond between the subbase & concrete slab
  - Dry surface
  - Porous aggregate subbase materials
- Concrete Mixture:
  - High water demand
  - Rapid early strength
  - Retarded set
  - Cementitious content & composition
  - Supplementary cementing materials
  - Fine aggregate (fineness and grading)
  - Coarse aggregate (maximum size and/or percentage)

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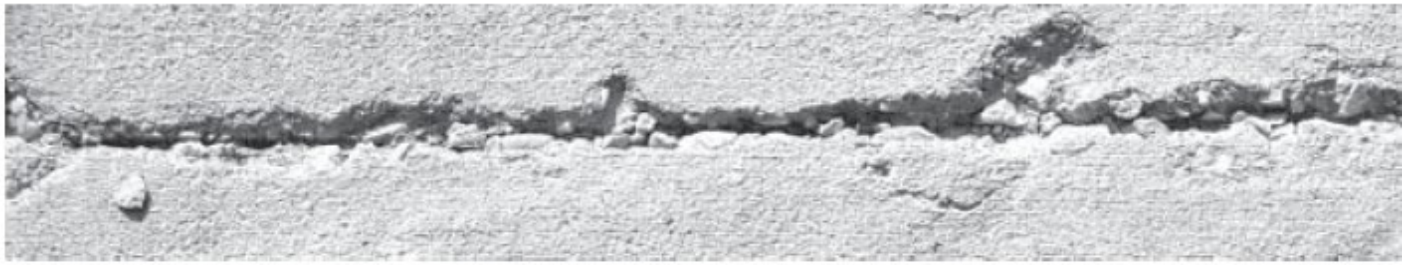
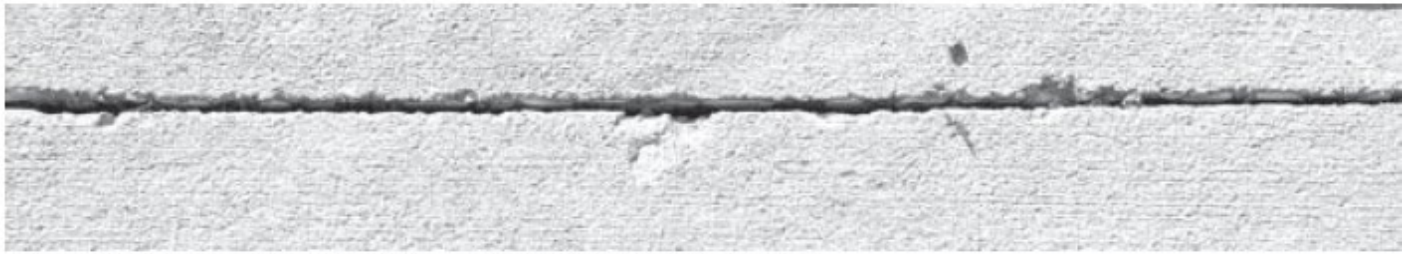
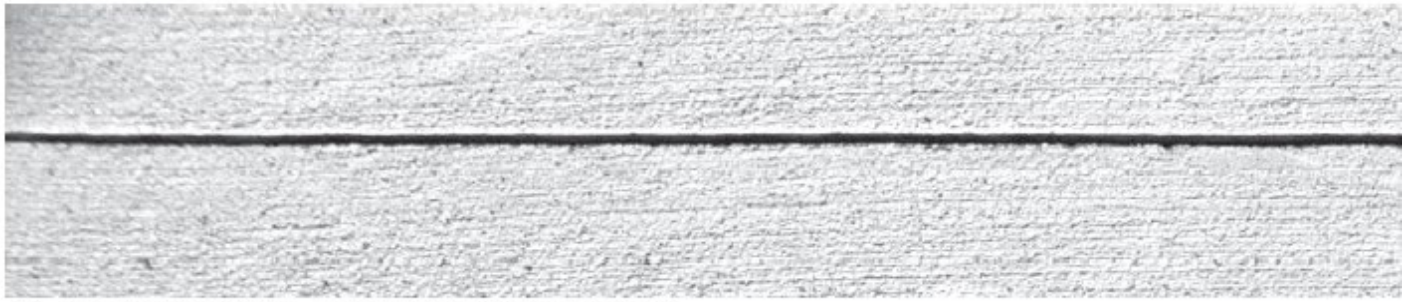
Sawing Window



A. UNACCEPTABLE RAVELING - Sawed too early



B. MODERATE RAVELING - Sawed early in window



C. NO RAVELING - Sawed later in window

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Late Saw Cut

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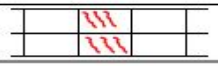
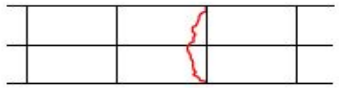
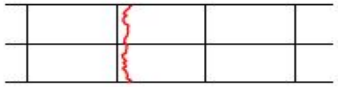
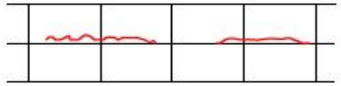
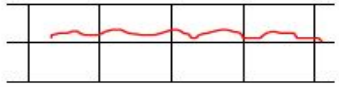
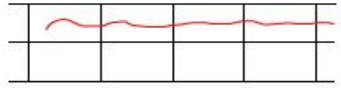
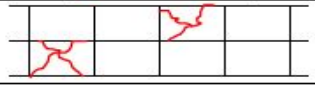
Iowa DOT Construction Manual Appendix 9-6

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 joint	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	

Full-Depth repair per Specification 2529
Partial-Depth repair per Specification 2530
Cross-stitch repair per Construction Manual 9.27
Repairs should be made without use of Calcium Chloride unless early opening to traffic is necessary.

a LTR = load-transfer restoration (if faulted less than 1/2"); 3 dowel bars per wheel path grouted into slots sawed across the crack. Slots must be parallel to each other and the longitudinal joint. Backfill with non-shrink, cement-based grout. Diamond grind if faulting is severe.

Sawing Practices

Early Entry Saws

- Transverse and Longitudinal
- 10” diameter blade (typical), 350 lbs, 11 hp, $15.9k
- Upward blade rotation
- Skid plate is critical
- Stop short on pavement edge & curb

Other

- L sheets are critical
- Sawing window
- ‘Leap frog’ operation
  (return with T/4)

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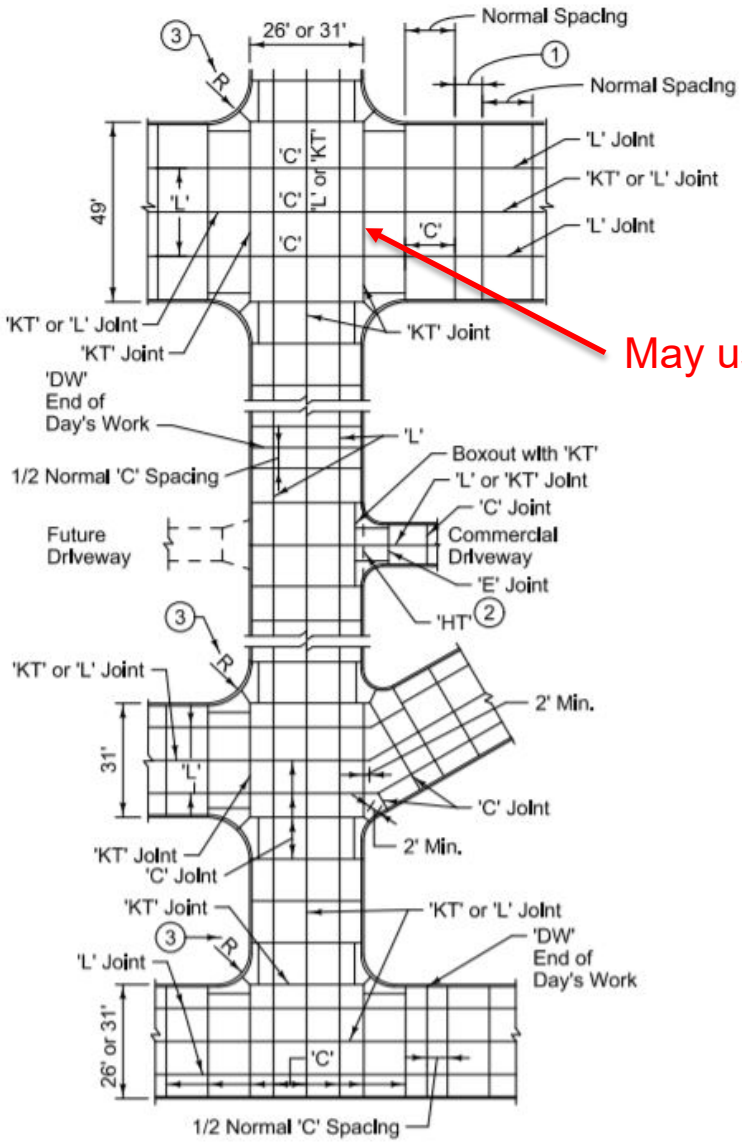
Image Source – Husqvarna

Intersections



PLAN VIEW

May use L Joint

Refer to Figure 7010.901 for maximum transverse joint spacing.

Where new and existing pavements meet, and no existing dowels, tie bars, or keyed joints are present, provide a 'BT', 'RT', or 'RD' joint.

(1) Shorten jointing pattern on either side of openings to allow joints to intersect round castings and fall at the edges of intake boxouts.

(2) Where pavement abuts an unimproved street, terminate with a type 'HT' joint.

(3) When radius exceed 20 feet, add one additional 'C' joint at radius intersections.

ACPA Wikipave "Joint Layout"
10 Step process

FIGURE 7010.904 SHEET 1 OF 1

SUDAS

REVISION New 10-19-10

7010.904

SHEET 1 of 1

SUDAS Standard Specifications

TYPICAL JOINTING LAYOUT

Roundabouts

- Three common types
  - Isolated circle
  - Pinwheel
  - Pave-through
- Follow 6-step method for joint layout

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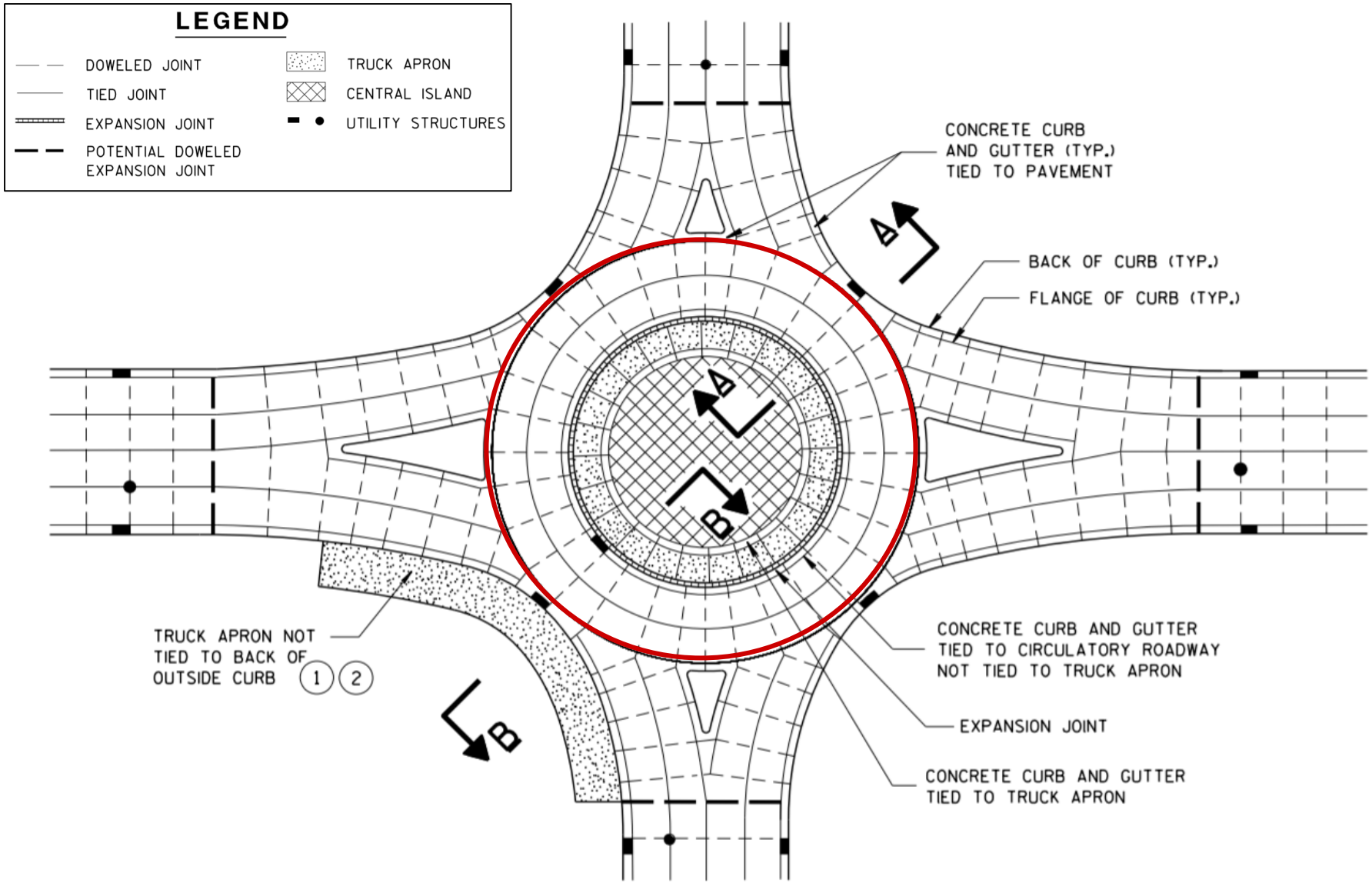
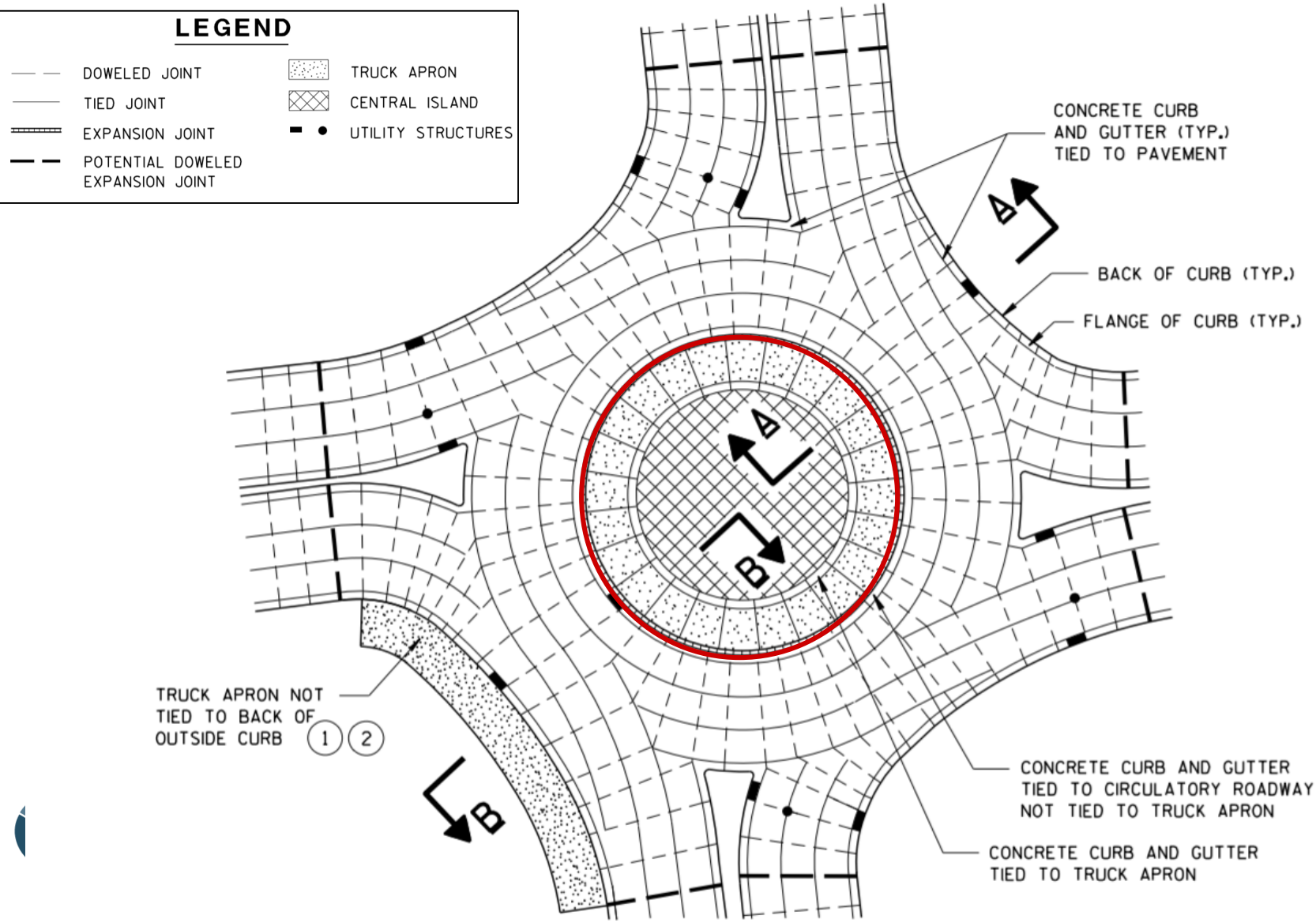
Isolated Circle



Source – Wisconsin DOT

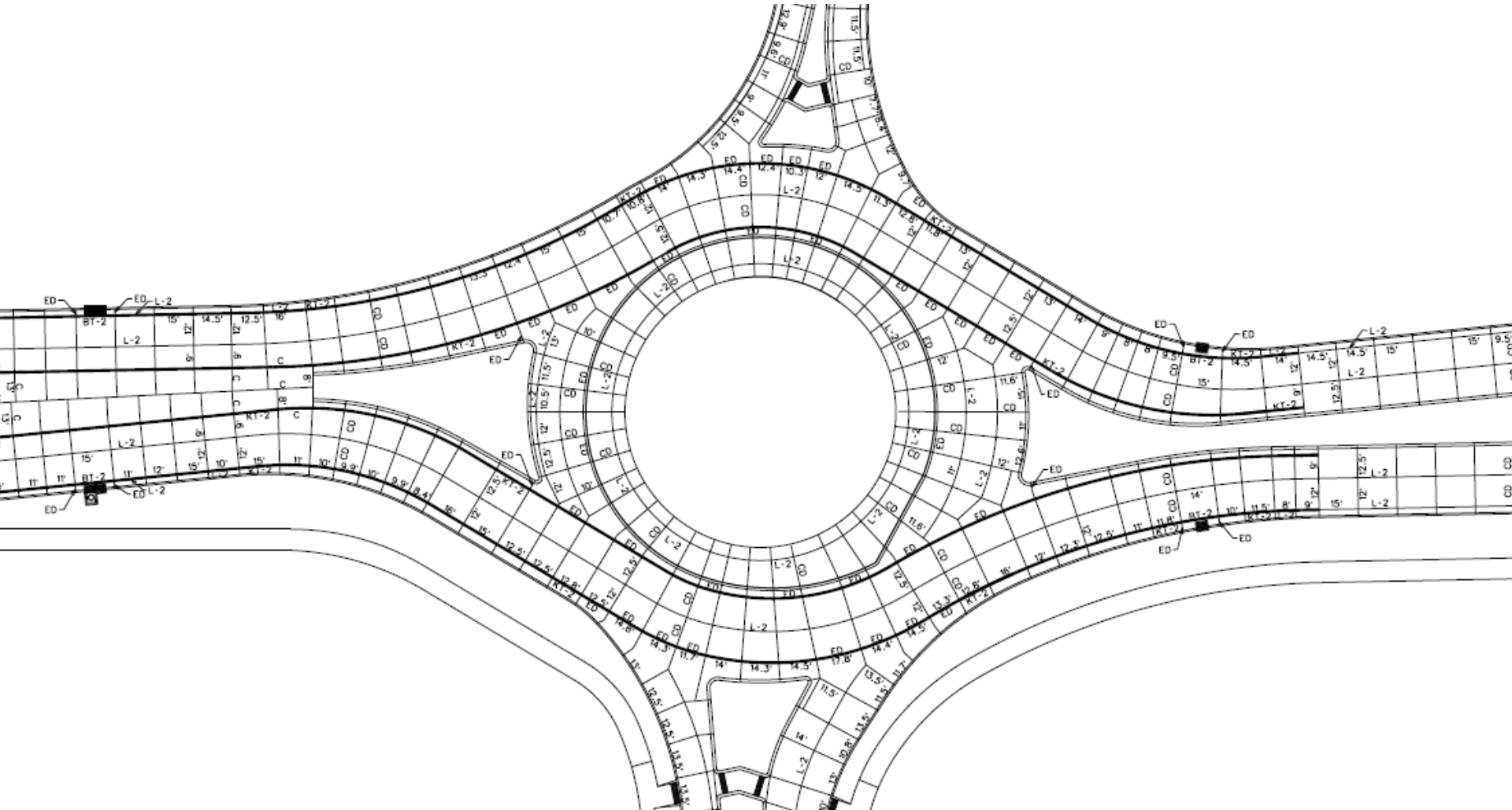
Pinwheel



Source – Wisconsin DOT

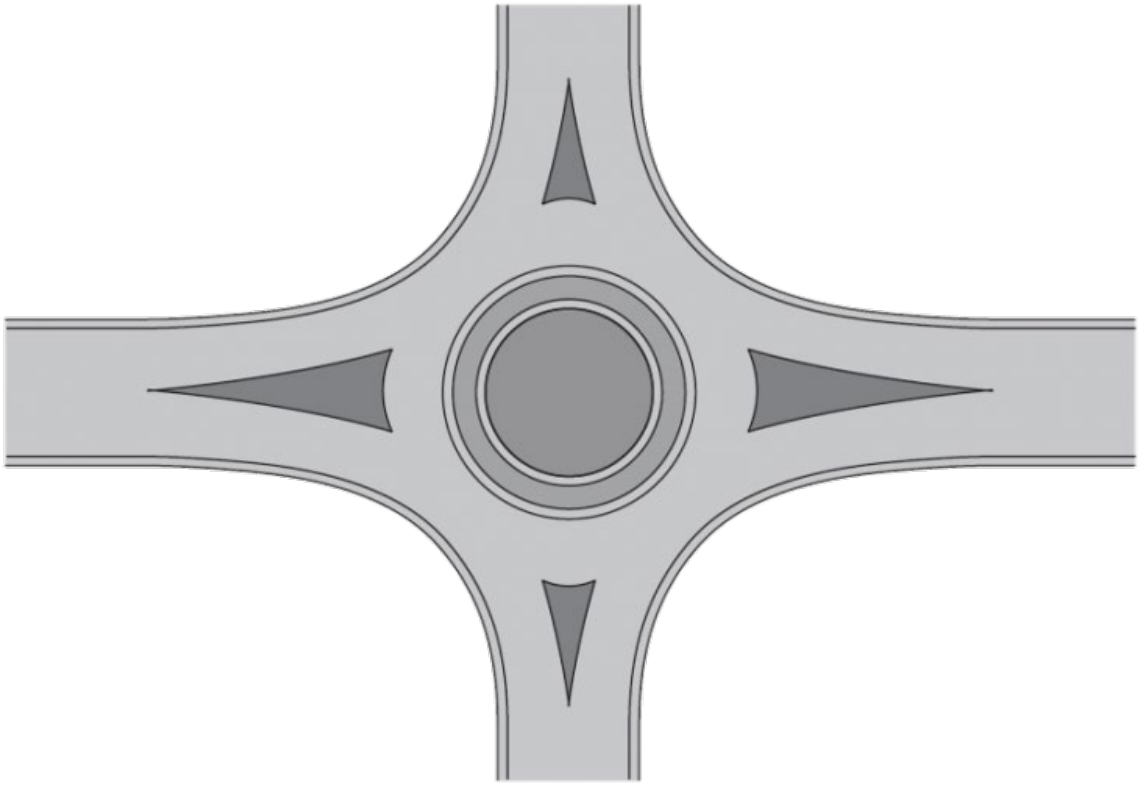
Pavethrough

- Allows paver to move through
- Remaining paving is hand pours



Jointing a Roundabout

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



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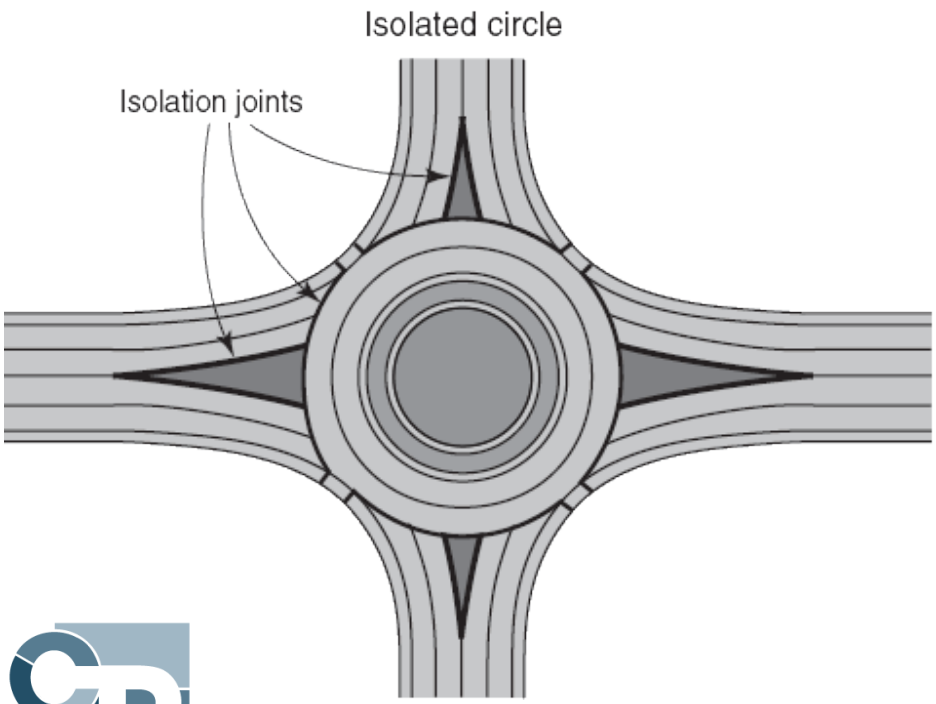
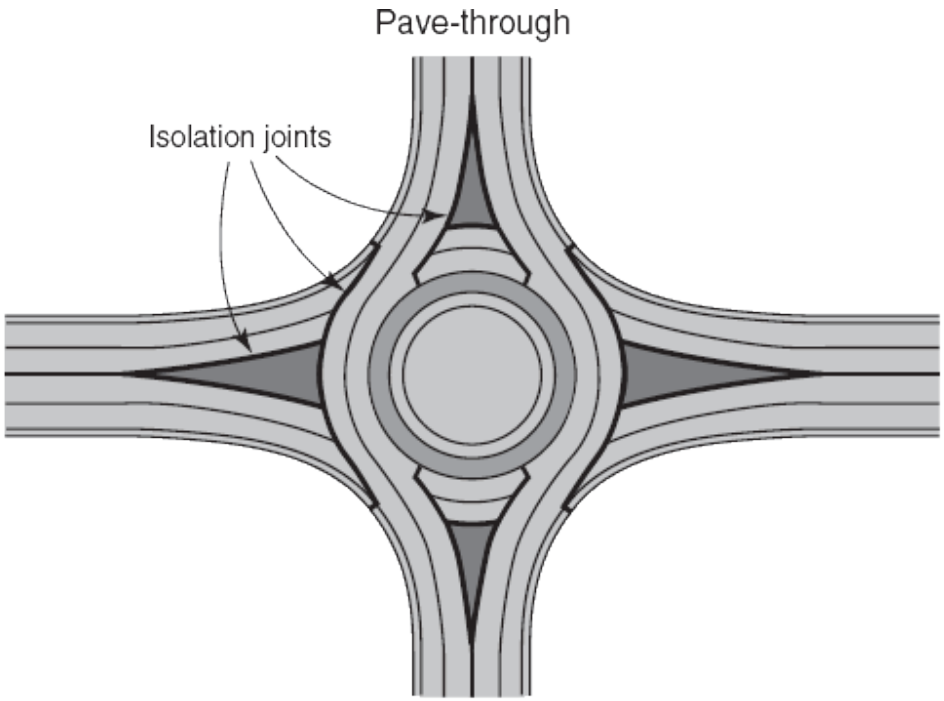
Source – ACPA Wikipave “Joint Layout”

Jointing a Roundabout

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





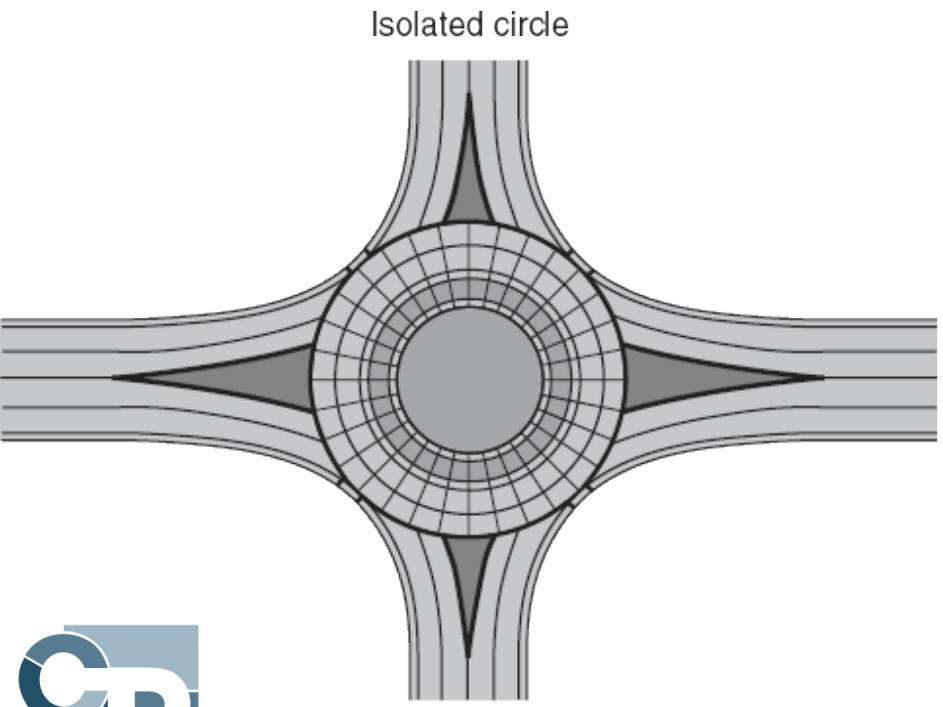
Make sure no distance is greater than the recommended lane width ~~(typ.15ft - 16ft.)~~

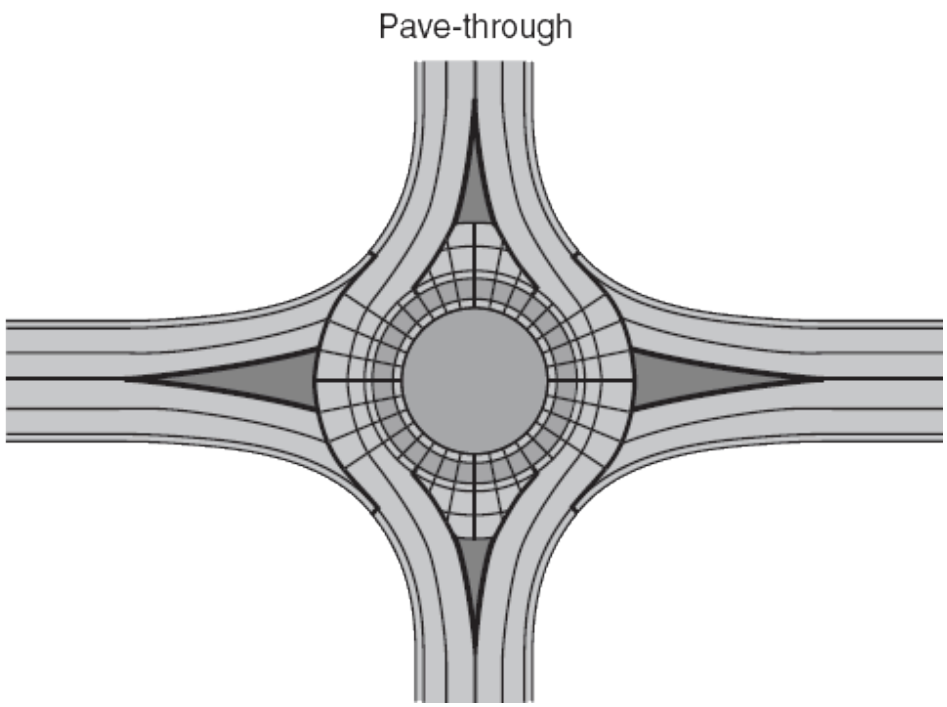
SUDAS 12.5’ – 13’ max

Source – ACPA Wikipave “Joint Layout”

Jointing a Roundabout

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



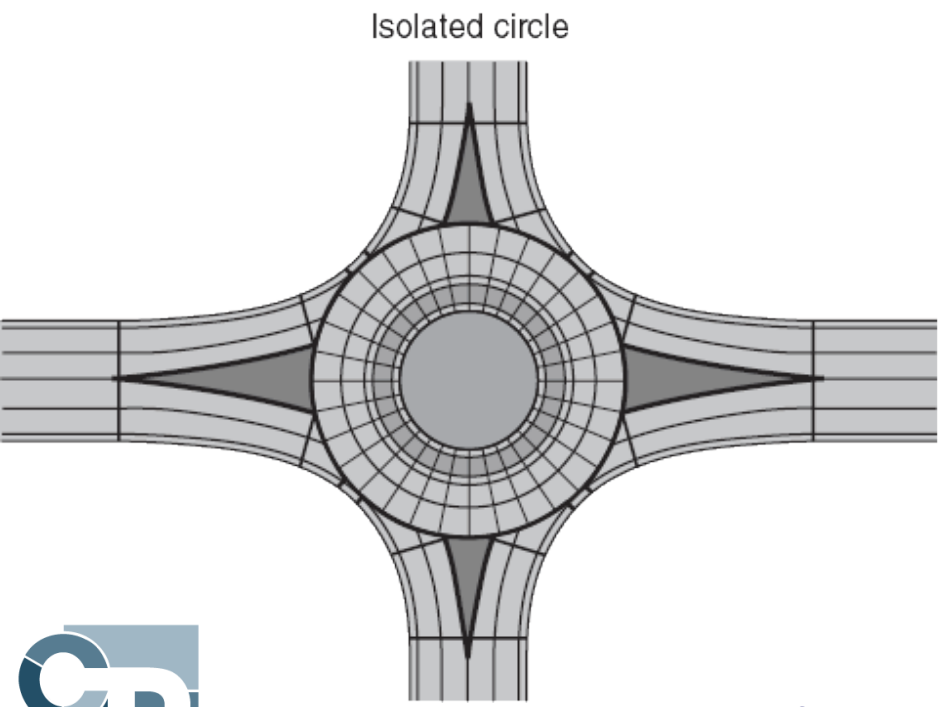


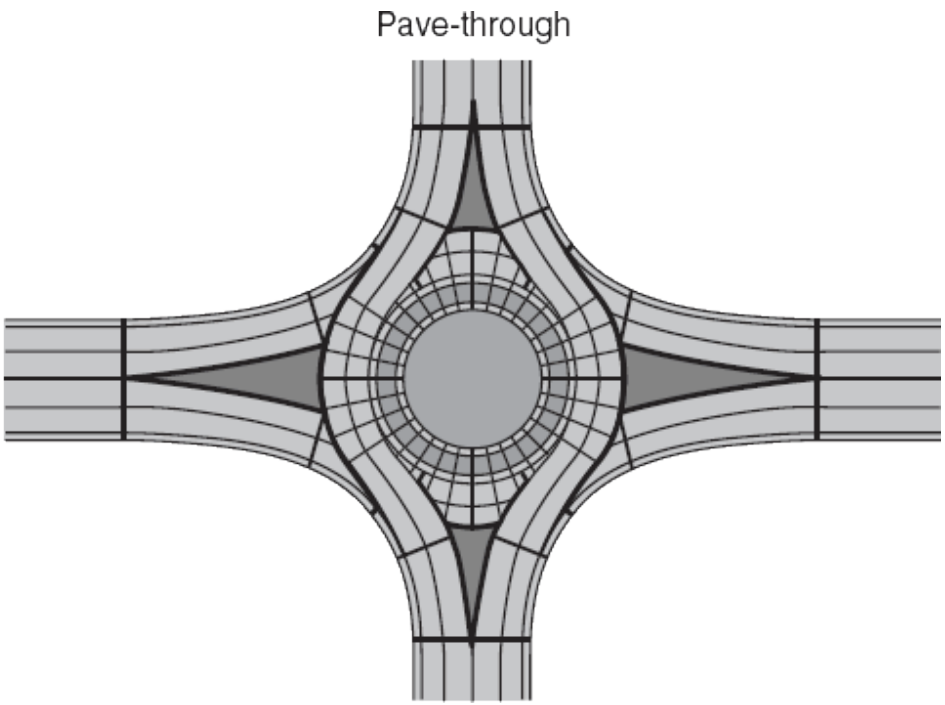
Joints are not perpendicular to each other but to edge of pavement

Source – ACPA Wikipave “Joint Layout”

Jointing a Roundabout

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





Perpendicular to the edge of pavement at bullnose of median, begin/ends curves, tapers, tangents

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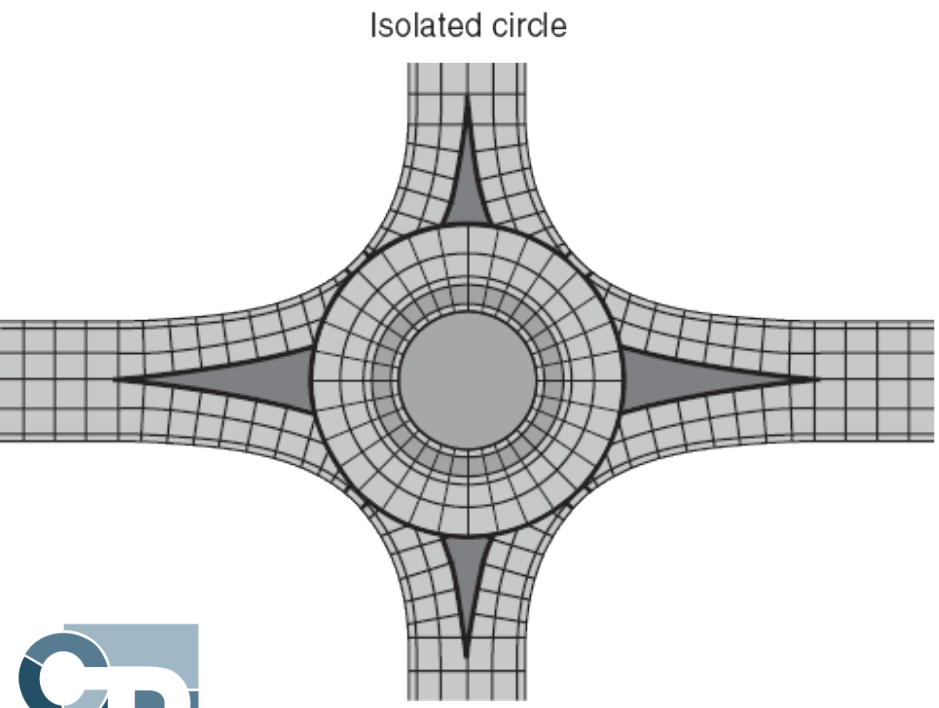
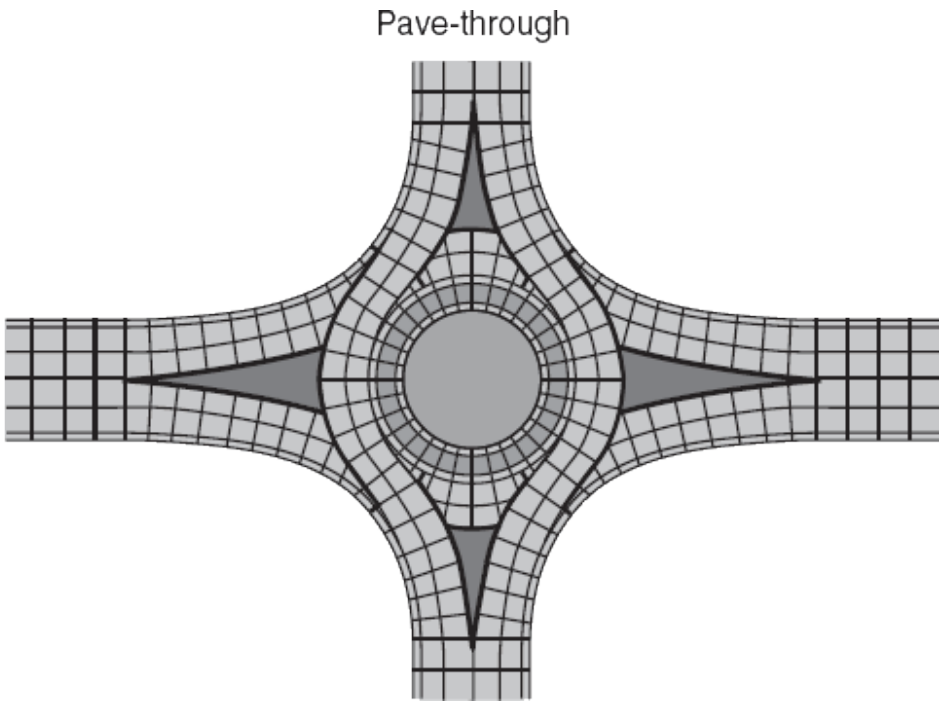
Source – ACPA Wikipave “Joint Layout”

Jointing a Roundabout

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





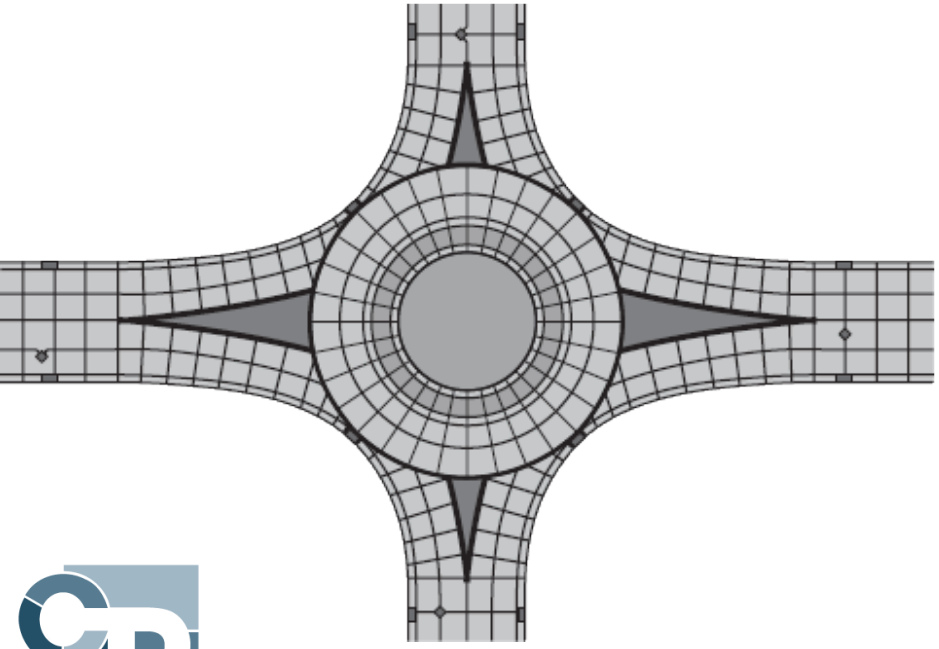
Space joints evenly & perpendicular to pavement edge and extend thru back of curb

Source – ACPA Wikipave “Joint Layout”

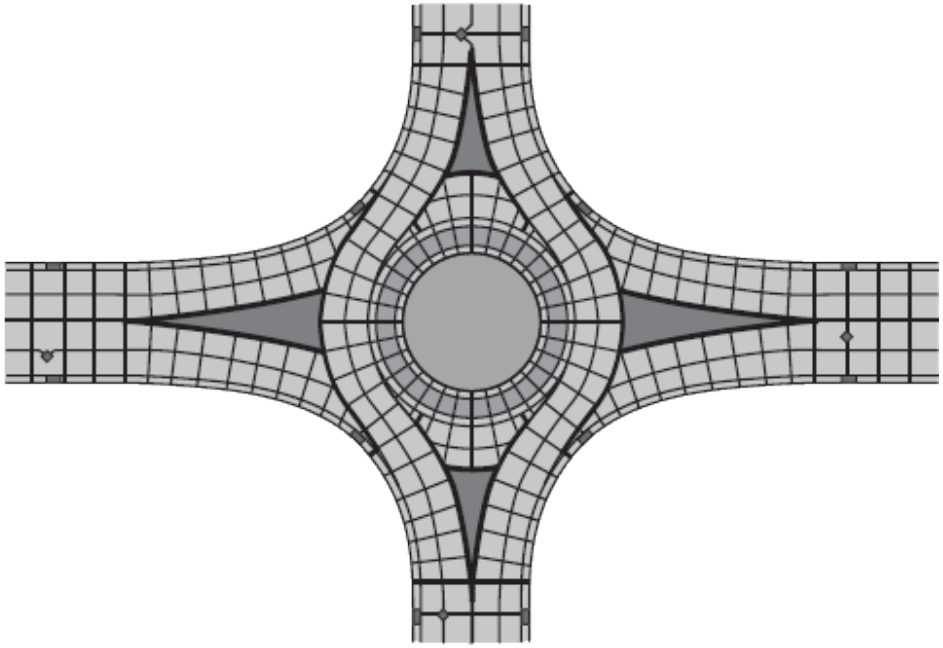
Jointing a Roundabout

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

Isolated circle



Pave-through

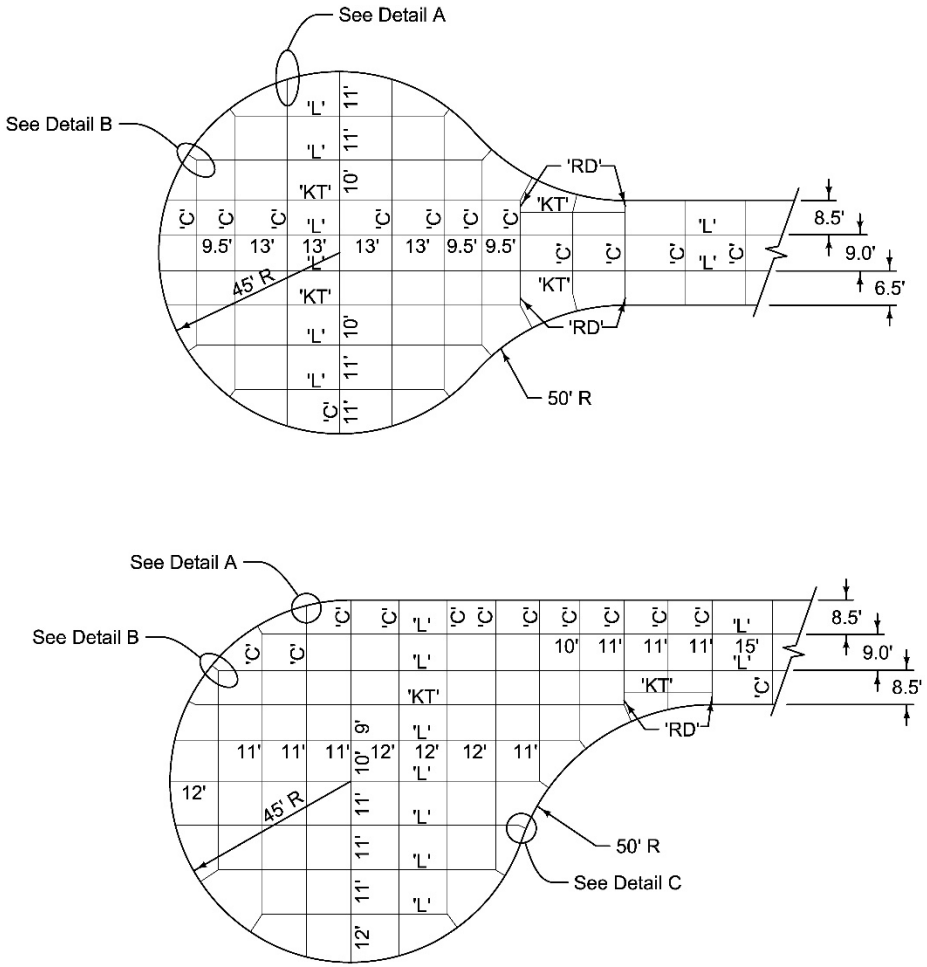


Allow for field adjustments with review by Engineer

Source – ACPA Wikipave “Joint Layout”

Cul-De-Sacs

SUDAS Design Manual Ch. 5G-3 & Specifications Fig 7010.905



THIRD POINT JOINTING

FIGURE 7010.905 SHEET 2 OF 3

SUDAS

REVISION New 10-19-10

7010.905

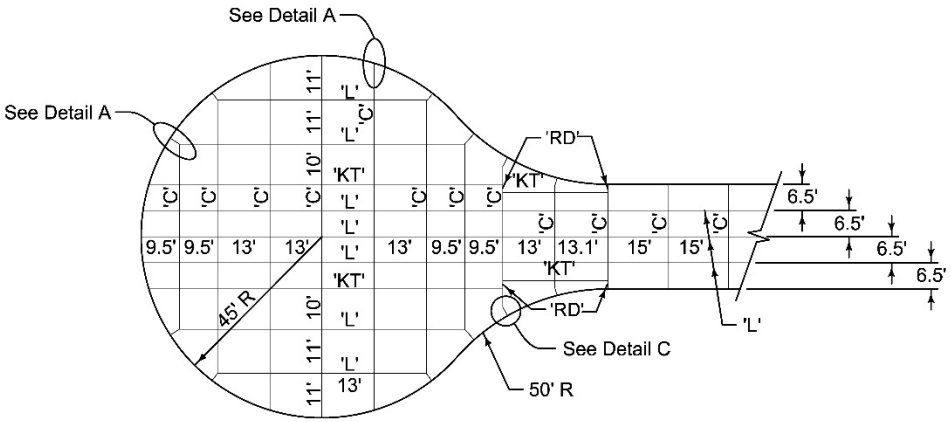
SHEET 2 of 3

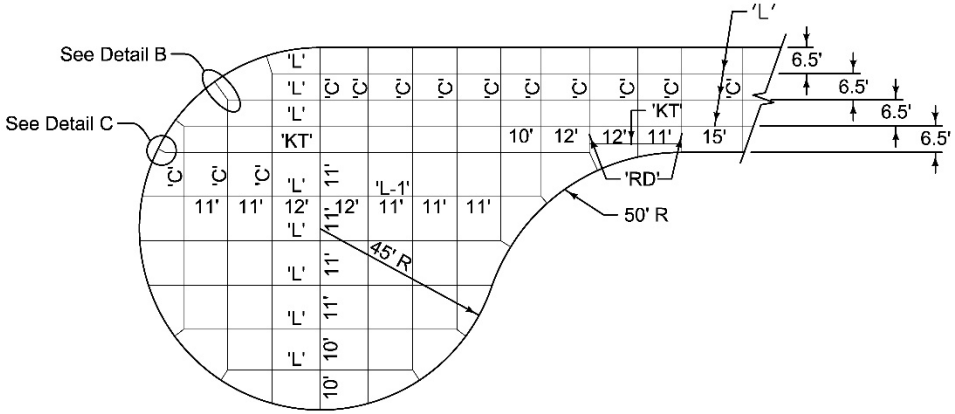
SUDAS Standard Specifications

PCC CUL-DE-SAC JOINT LOCATIONS

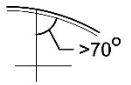
Cul-De-Sacs

SUDAS Design Manual Ch. 5G-3 & Specifications Fig 7010.905

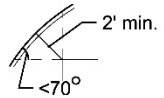




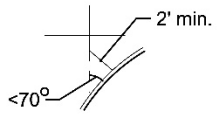
QUARTER POINT JOINTING



DETAIL A



DETAIL B



DETAIL C

FIGURE 7010.905 SHEET 1 OF 3

SUDAS

REVISION	
New	10-19-10

7010.905

SHEET 1 of 3

SUDAS Standard Specifications

PCC CUL-DE-SAC JOINT LOCATIONS

Runway Joint Layout

- No tiebars on interior panels
  - Similar to parking lot tension ring design
- General Aviation (GA) runways
  - Last 3 transverse joints receive tiebars
  - Last longitudinal joint receives tiebars
    - Except

      When it is a construction joint AND the pavement is greater than 6” in thickness (then use dowels)
- Commercial Aviation runways
  - Last 3 transverse contraction joints are doweled
  - All longitudinal construction joints are doweled
  - Longitudinal contraction joints
    - ≥ 9” thick
      - Undoweled for interior joints
      - Dowelled for all of the last three joints
    - <9” thick (All are tied)

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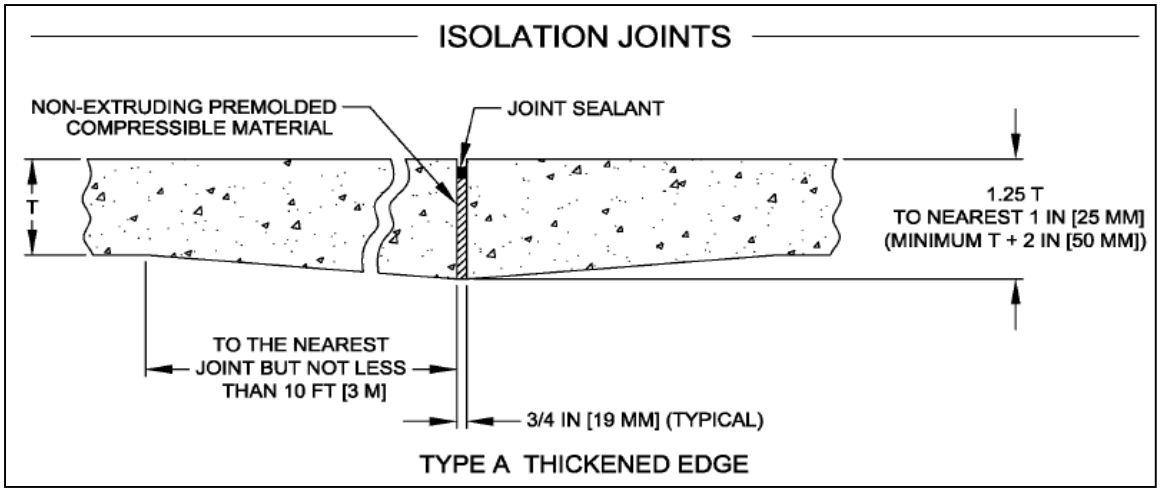
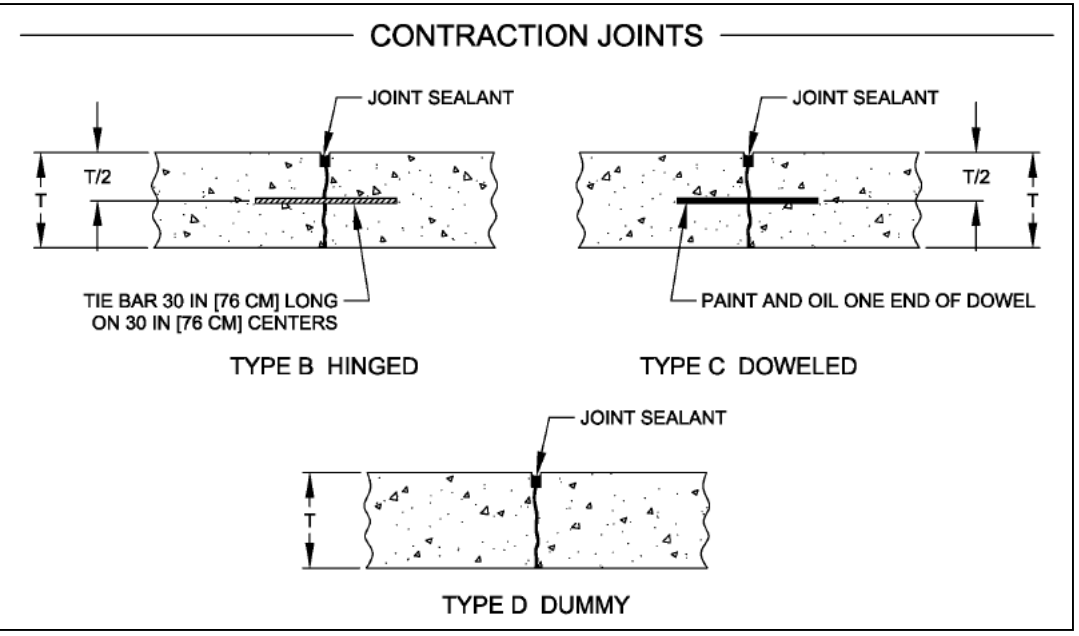
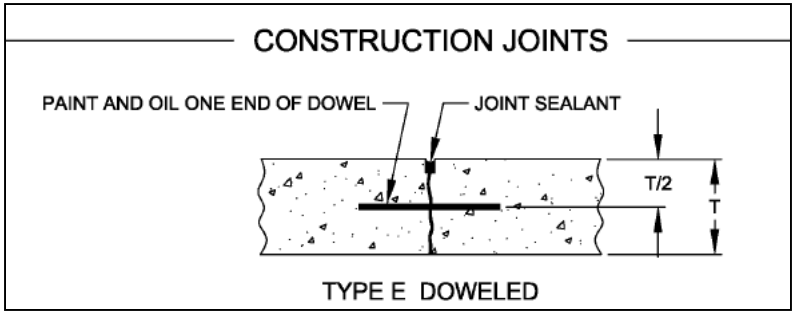
Airport Standard Details

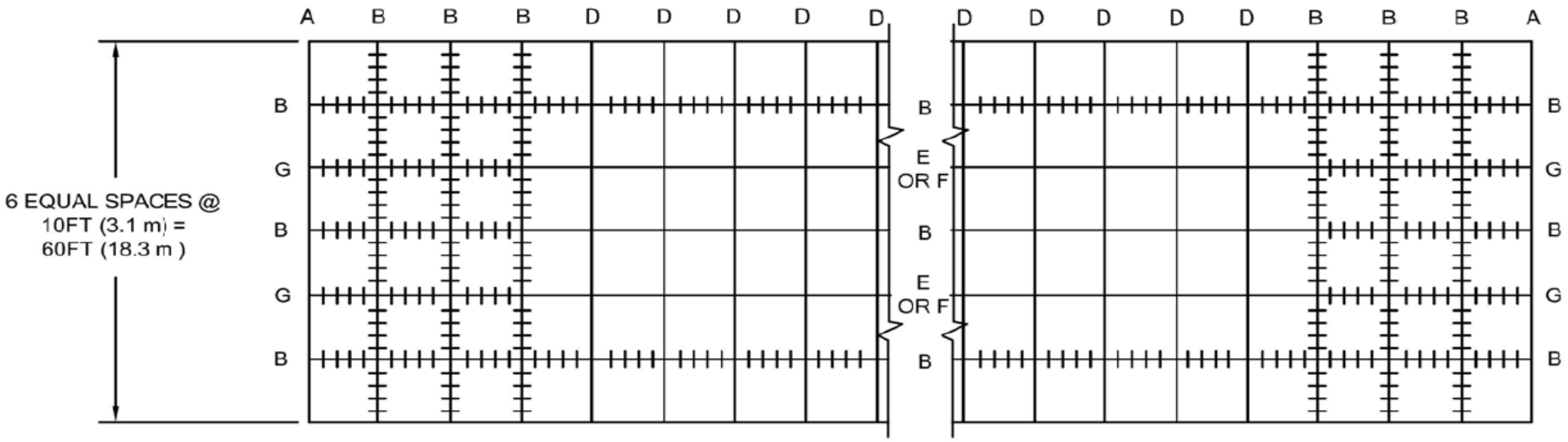






Source – ACPA Wikipave “Airfield Joints”

General Aviation Runway



General Aviation

- Tie bars may be used instead of dowels
- Last three joints are tied
- Joint spacing = 12.5’ to 15’ (T=6”-9”)

LEGEND:

A: THICKENED EDGE

B: HINGED CONTRACTION

D: DUMMY CONTRACTION

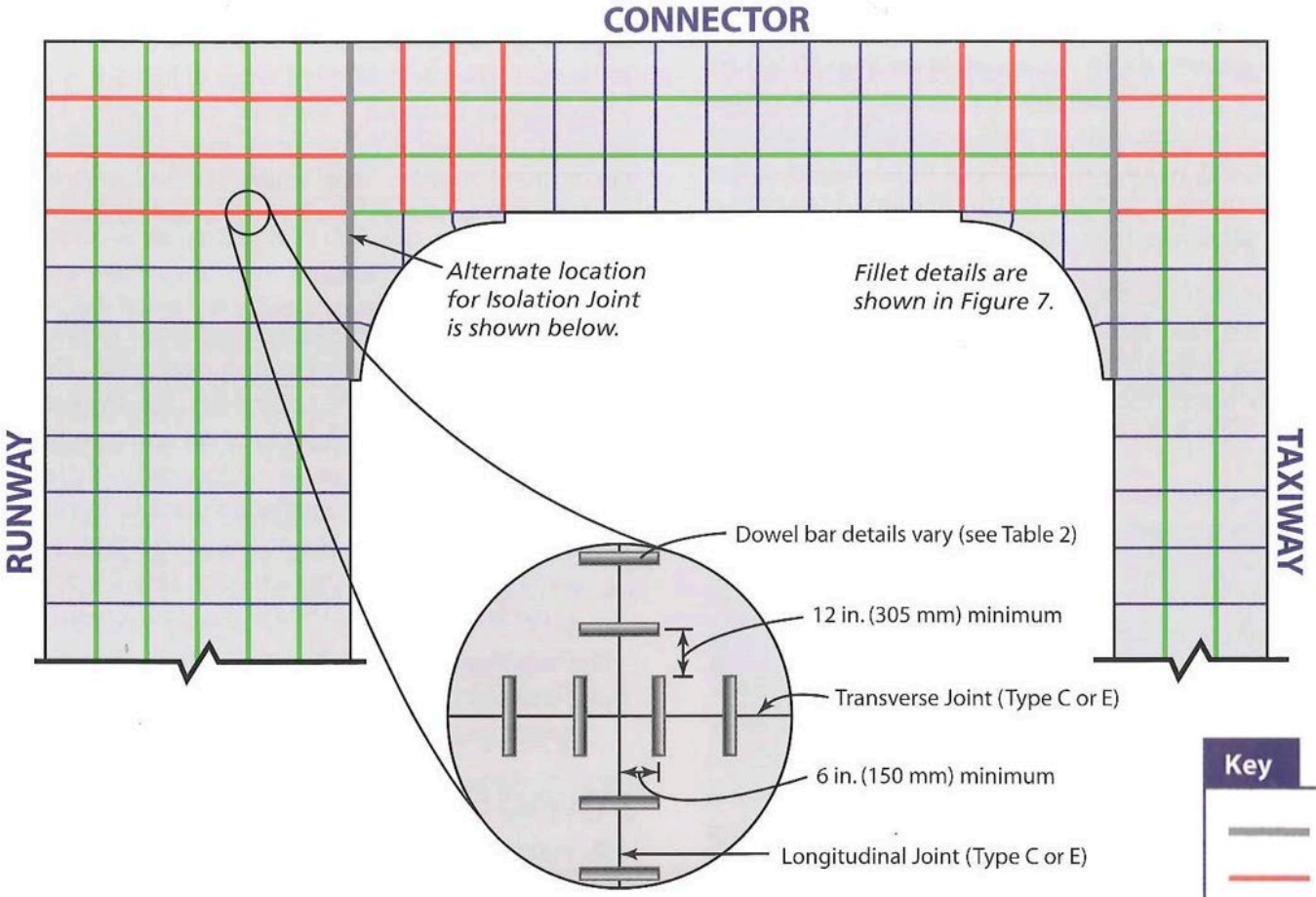
E: DOWELED CONSTRUCTION

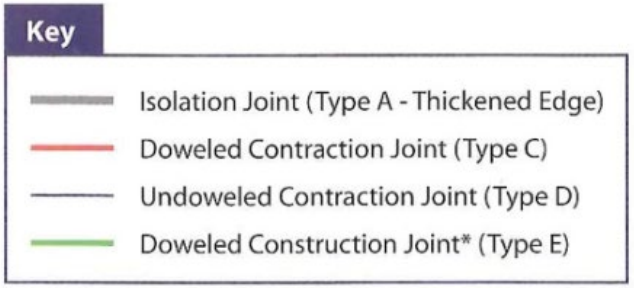
F: BUTT CONSTRUCTION

G: TIED BUTT CONSTRUCTION

FIGURE 5-6. JOINTING LAYOUT PATTERNS FOR LIGHT-LOAD RIGID PAVEMENT – 60 FEET WIDE

Commercial Aviation Runway





* *Intermediate longitudinal joints alternatively may be Tied (Type B), Doweled (Type C) or Undoweled (Type D) Contraction Joints; see section titled "Load Transfer at Longitudinal Joints."*

- Dowel bars are used
- Last three joints are doweled

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Figure 6 from ACPA TB017P
& Fig. 9.3 ACPA Best Practices for Airport Concrete Pavement Construction

Airfield Panel Sizes

Table 6. FAA Recommended Maximum Joint Spacings (FAA 2009a)

Concrete Pavement on Unstabilized (Granular) Subbase		
Slab Thickness	Maximum Longitudinal Joint Spacing	Maximum Transverse Joint Spacing
5 - 6 in. (125 - 150 mm)	12.5 ft (3.8 m)	12.5 ft (3.8 m)
6.5 - 9 in. (165 - 230 mm)	15 ft (4.6 m)	15 ft (4.6 m)
> 9 in. (230 mm)	20 ft (6.1 m)	20 ft (6.1 m)
Concrete Pavement on Stabilized Subbase		
Slab Thickness	Maximum Longitudinal Joint Spacing	Maximum Transverse Joint Spacing
8 - 10 in. (203 - 254 mm)	12.5 ft (3.8 m)	12.5 ft (3.8 m)
10.5 - 13 in. (267 - 330 mm)	15 ft (4.6 m)	15 ft (4.6 m)
13.5 - 16 in. (343 - 406 mm)	18.75 ft (5.7 m)	17.5 ft (5.3 m)
> 16 in. (406 mm)	20 ft (6.1 m)	20 ft (6.1 m)

When subgrades may be stiff, smaller panels are recommended

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Table 6 from ACPA IS202P

Parking Lots

- Primary reference for guidance
  - Design & Construction
  - SUDAS Design Manual Ch. 8

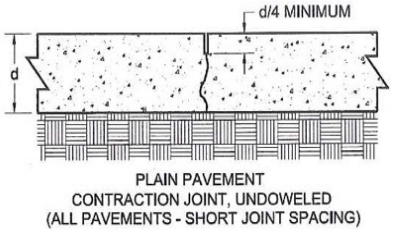
- Concrete parking lots
  - ACI 330R-08 – Parking Lots (cars & trucks)
    - 1 ADTT through 700 ADTT

pavementdesigner.org

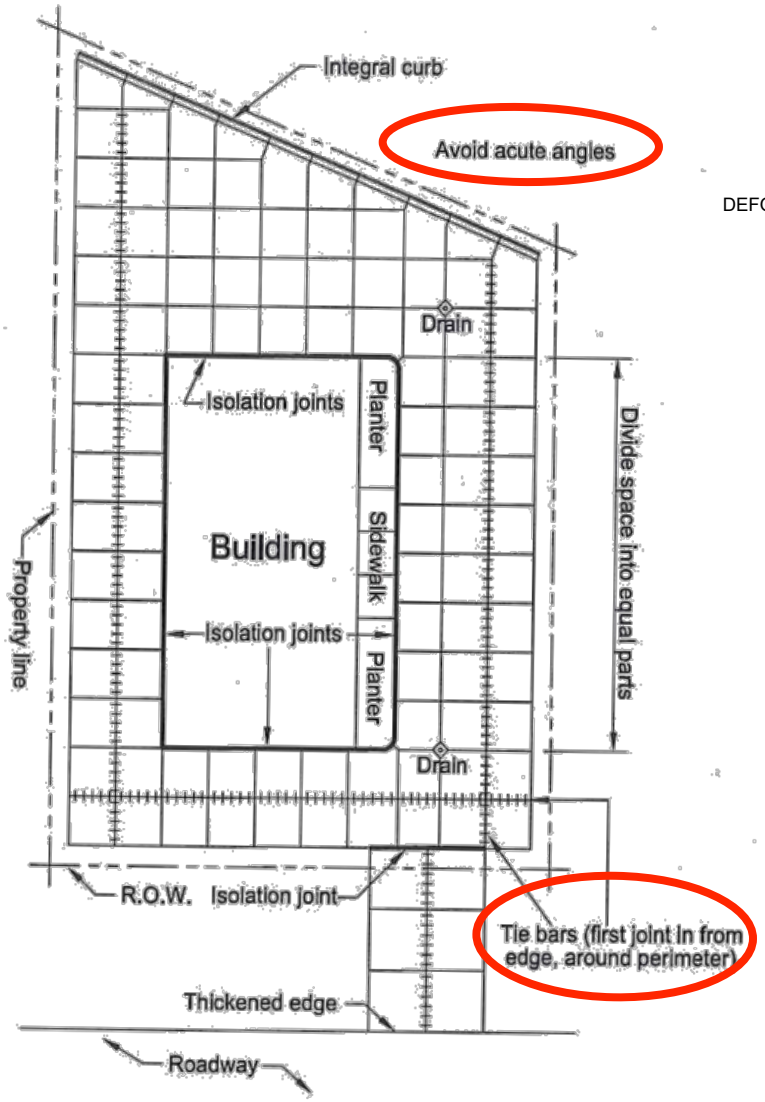
  - ACPA IS416.01P - Trucking Facilities
    - 70 trucks/day through 1,200 trucks/day

ACI 330.2R17 – Industrial Facilities

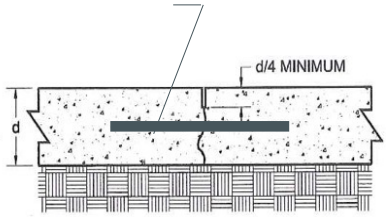
Parking Lots - Tension Ring



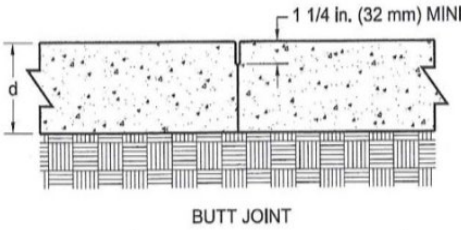
Without tiebars

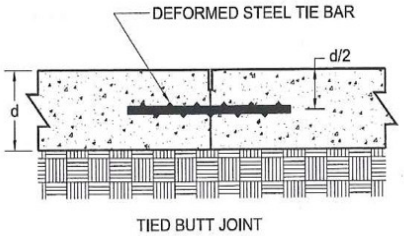


DEFORMED STEEL TIE BAR



With tiebars
- First joint in from edge

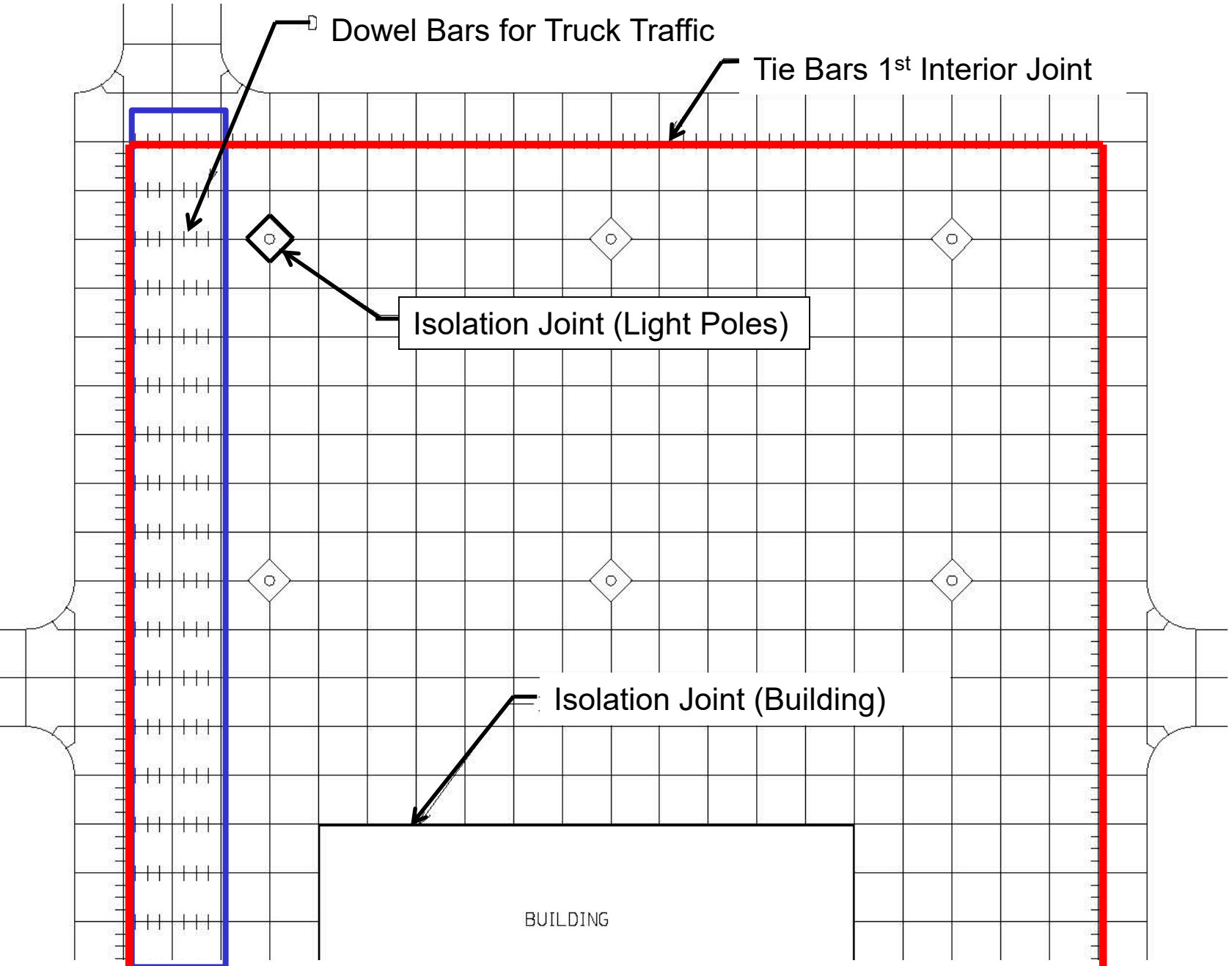




MAY BE USED FOR A LONGITUDINAL JOINT NEAR PAVEMENT EDGE OR FOR A TRANSVERSE JOINT THAT DOES NOT ALIGN WITH THE REGULARLY SPACED JOINTS IN ADJACENT LANES.

Figure C.1 ACI 330

Parking Lot Jointing Plan



Parking Lot Panel Size

- Table 3.5 in ACI 330
- Note that spacing never exceeds 15 feet

Pavement Thickness, in.	Maximum Spacing, ft.
4, 4.5	10
5, 5.5	12.5
6 or greater	15

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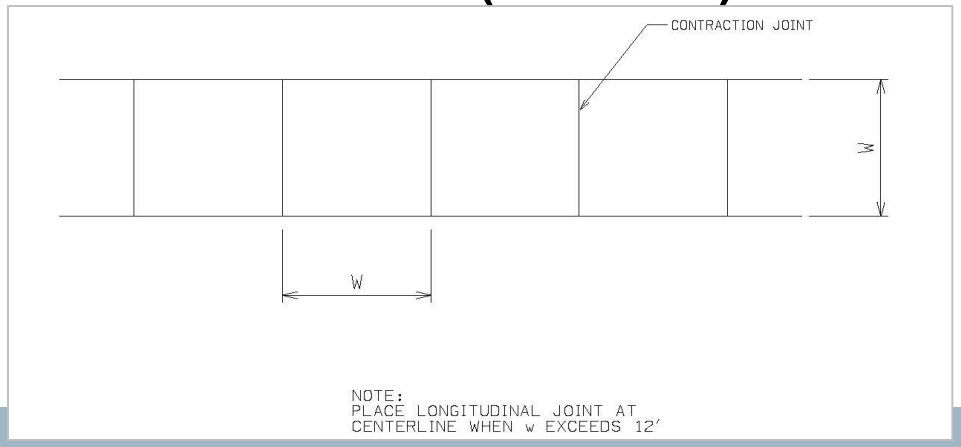
Shared Use Path Panel Size

- Iowa DOT Spec Section 2511
- SUDAS Spec Section 7030
- Transverse joints spacing = pavement width
  - 10’ width demands 10’ transverse spacing
- Longitudinal joints at centerline when trail width **exceeds** 12’ (tie-bar)



Shared Use Path Thickness

- SUDAS
  - Design Chapter 12B-2
  - Minimum of 4”
    - ➢Recommend min. 5”
    - ➢Allows less than 4” (with pavement determination)

- Iowa DOT
  - Typical cross-section #7402
  - 4” thickness
    - ➢5” for widths greater than 10’

Shared Use Path - Joint Construction

- SUDAS
  - Sawcut (1/8” width, T/3 depth)
  - OR Tooled (prefer sawed)
  - No Seal
- Iowa DOT
  - Sawcut only (1/8” width, 1” depth)
  - No Seal

Questions

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