MICHIGAN CONCRETE ASSOCIATION

JOINT LAYOUT FOR ROADS, PARKING LOTS & ROUNDABOUTS

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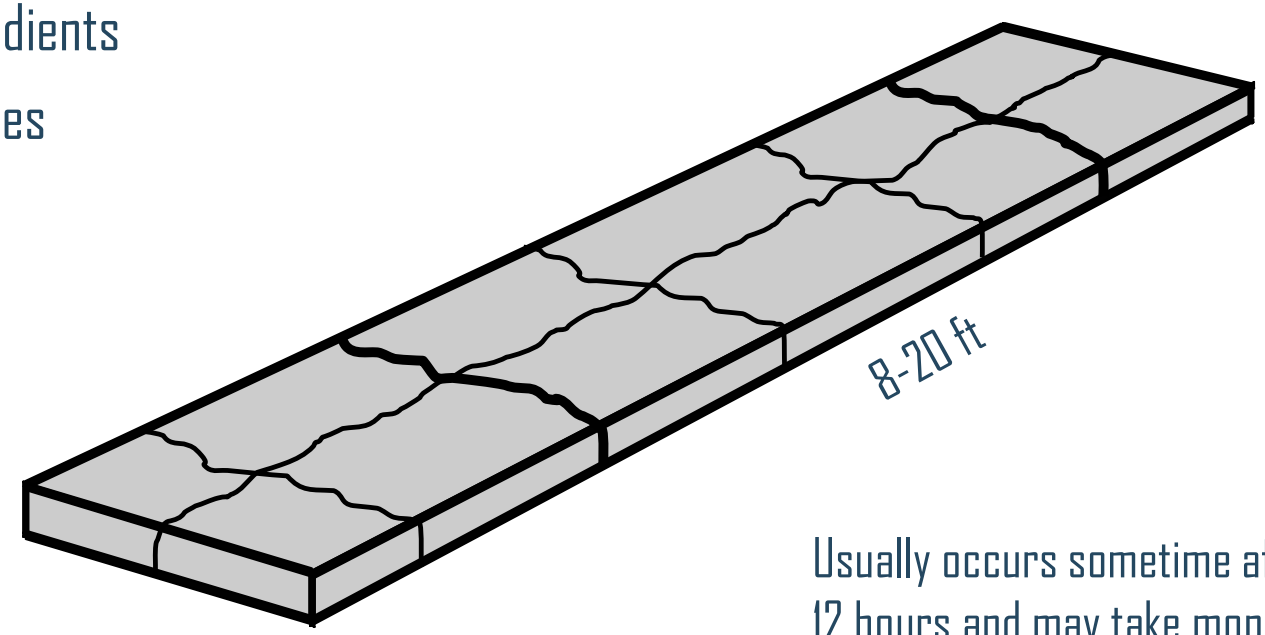
Purpose of Joints in Concrete Pavements:

- Control natural transverse & longitudinal cracking from internal slab stresses.
- Divide pavement into construction lanes or increments.
- Jointing needs to perform the following:
  - Accommodate slab movements.
  - Provide load transfer.
  - Provide uniform sealant reservoir.

Natural Crack Development

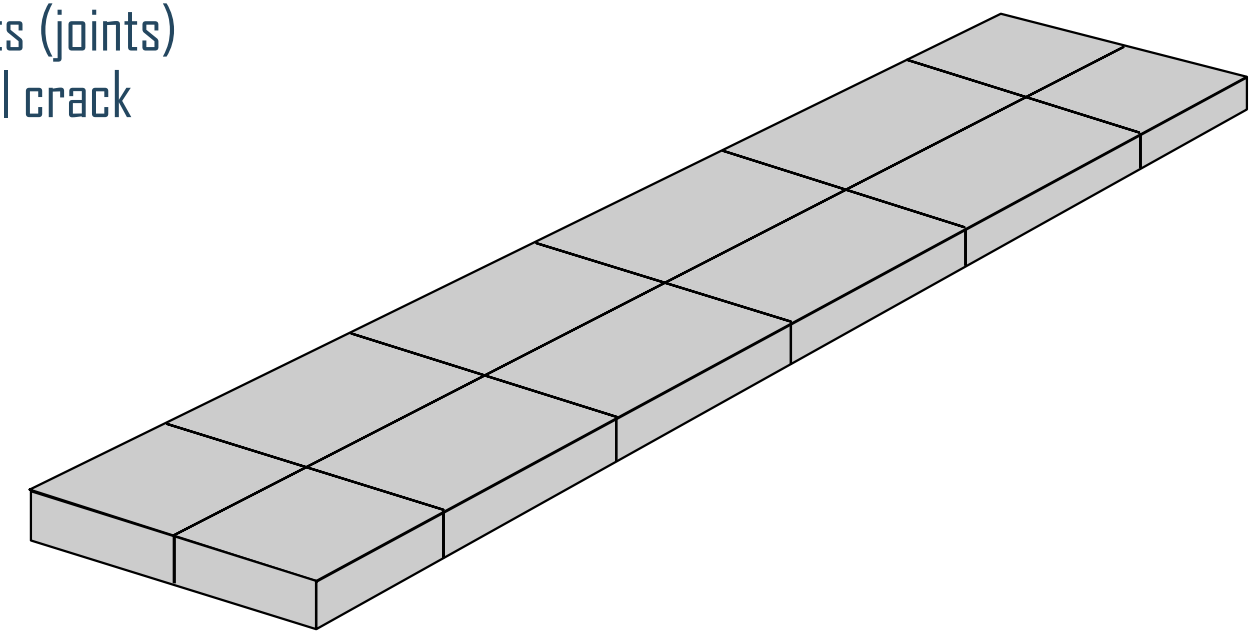
- Temperature Gradients
- Moisture Gradients
- Thermal Cycles
- Loading



Usually occurs sometime after
12 hours and may take months

Natural Crack Development

- Proper jointing provides a series of saw cuts (joints) spaced to control crack formation

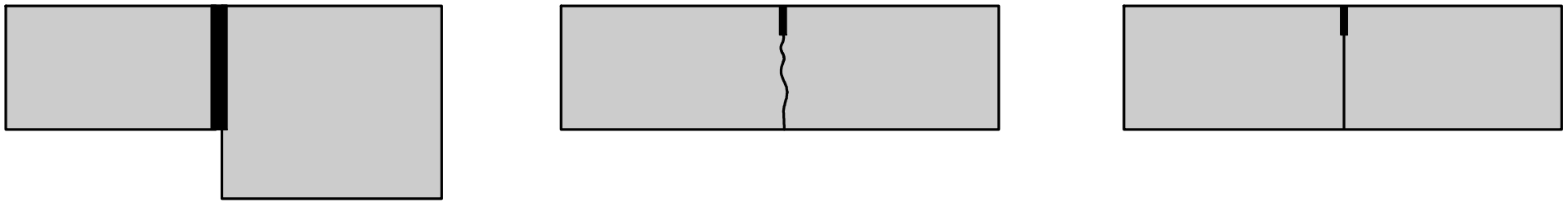


Steel Mesh

- **NOT** a structural element
- Holds cracks together **after the cracks form**.
- Needs to be cut/stopped at joints – **locks up the joint**
- **NOT RECOMMENDED** to be used in Michigan

Types of Joints

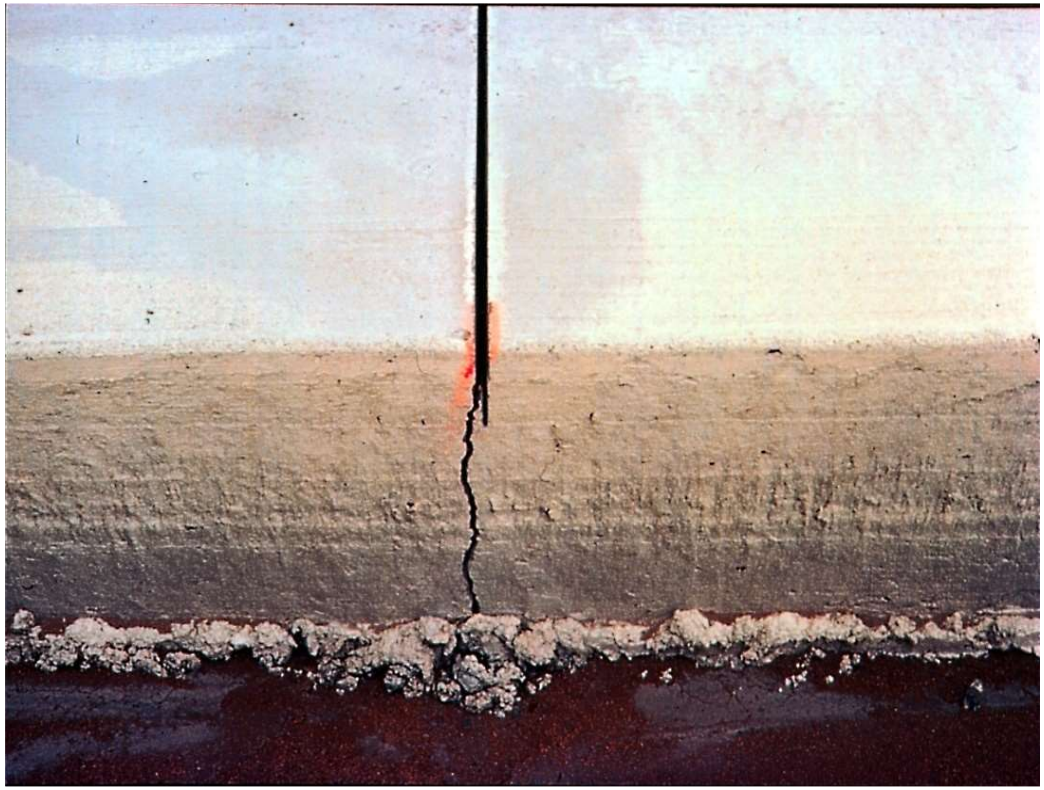
- **Isolation/Expansion** – between slabs or at structures
- **Contraction** – Saw cuts or tooled
- **Construction** – Edge of pours or form lines



Isolation/Expansion Joint

What were they thinking?

Transverse Contraction Joint



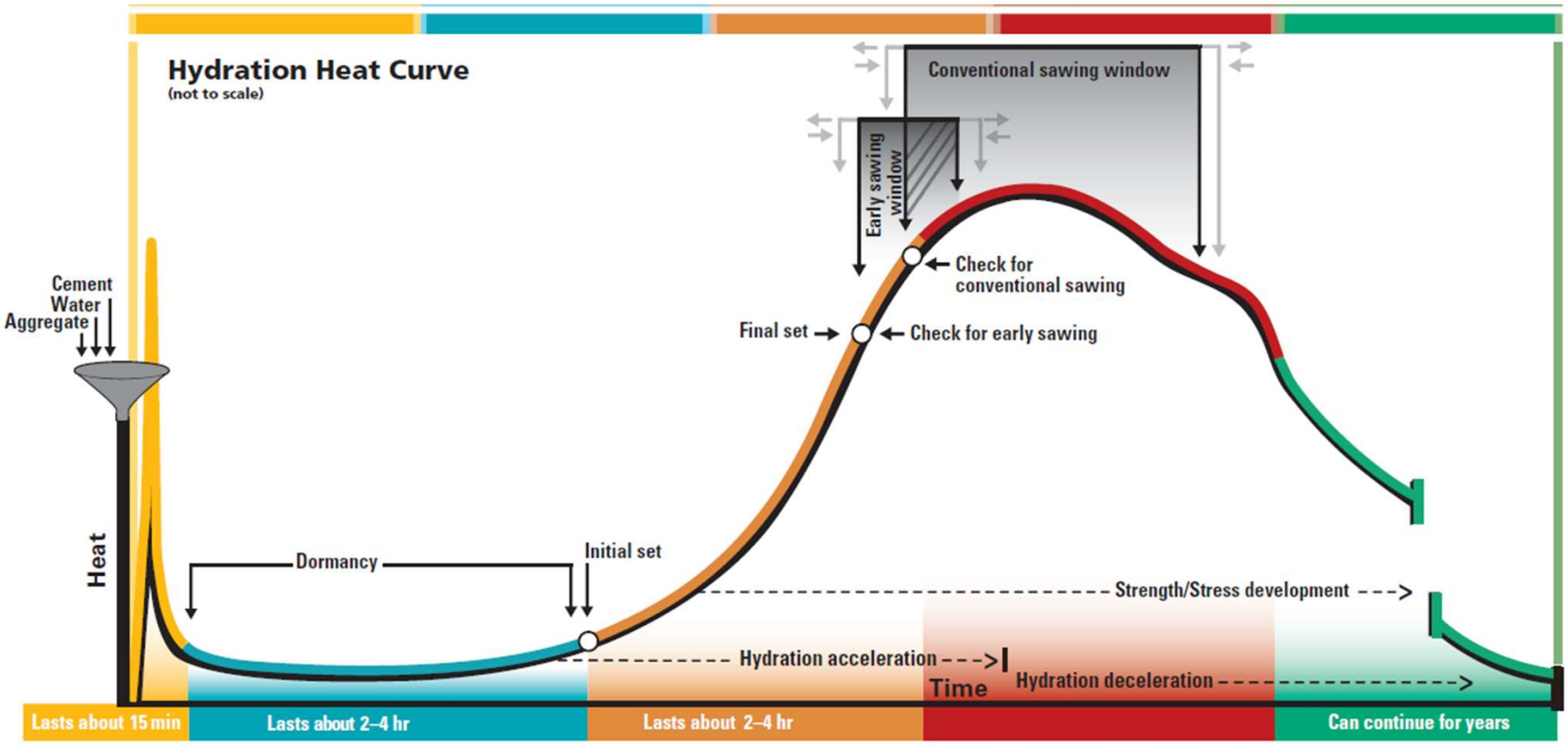
Transverse Contraction Joints

- Conventional Sawing
  - Joint Depth:
  - T/4 min.
- Early Entry Saws
  - Min. 1" deep depending on pavement thickness.

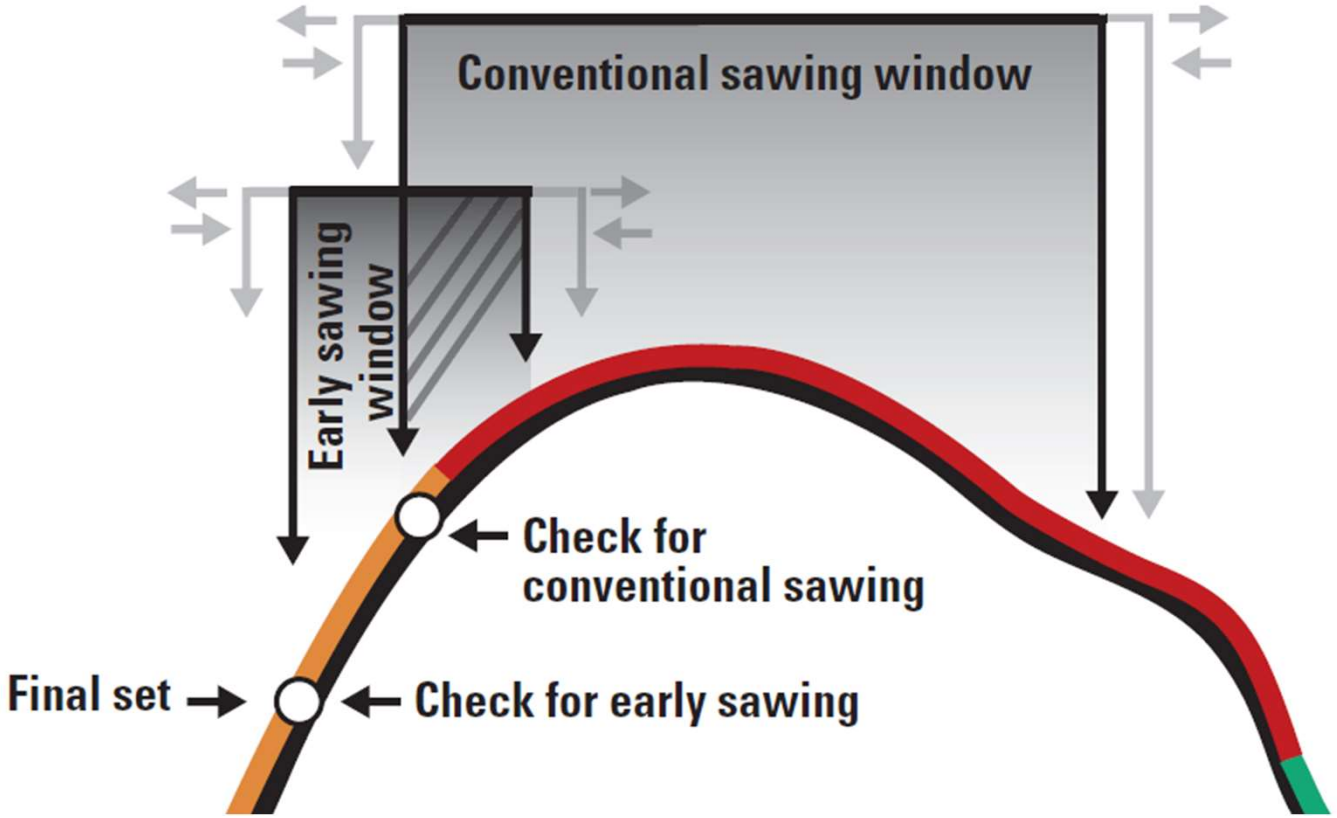
Sawing - Preparation

- Develop plan for joint location prior to placement
  - Concrete panels will try to become square
  - Look for inlets, manholes and intersecting streets
  - Look at the other side of the road
- How will joints be marked for saw crew?
- How will the saw crew get water?
- Sawing of longitudinal joint is just as critical as transverse

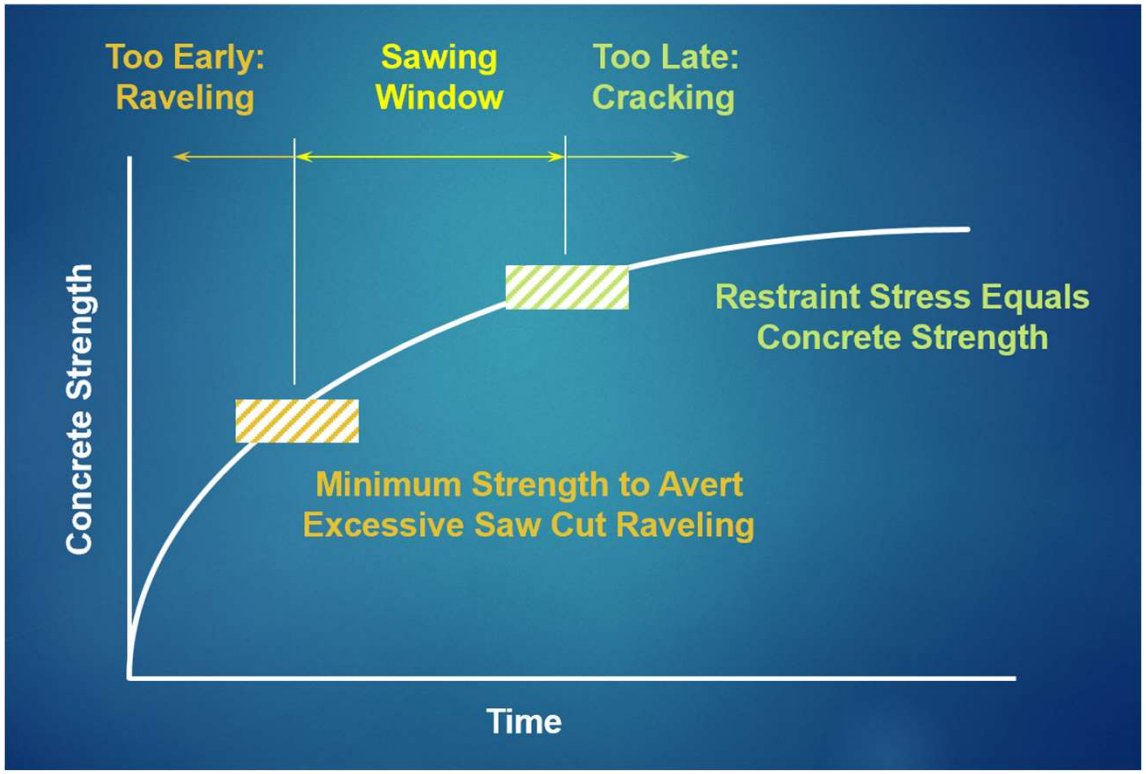
Heat of Hydration Curve



Sawing Window



Sawing Window



Sawing Window

The Sawing Window varies with:

- Temperature
- Admixtures
- Humidity/Weather

We need to be aware of these effects on the concrete sawing window and be prepared to make adjustments as necessary for optimal placement.

Saw Cut Timing

The "**sawing window**" is the brief period of time during which joints can be sawed successfully.

- Begin saw cuts after the concrete has hardened enough to permit sawing with out raveling or moving aggregates.
- Finish saw cuts before random, uncontrolled cracking takes place.
- Conventional saws – There is generally a **6 – 12 hour window** for when you commence sawing.
- Early entry saws – The window begins as soon as walking on the pavement is permitted, generally within approx. 3 hours.
- To finish sawing joints before the window ends, it may be necessary to continue regardless of weather or daylight conditions.
- **IMPORTANT NOTE**: if cracks develop ahead of a saw, STOP sawing that joint. Later use crack saws to form joint sealant reservoirs along the crack line.

The Rules of Jointing

THINGS TO DO

- Match existing joints or cracks
- Place joints to meet in-pavement structures
- Remember max. joint spacing
- Place isolation joints where needed
- Can make field adjustments to joint location!
- Be Practical

THINGS TO AVOID

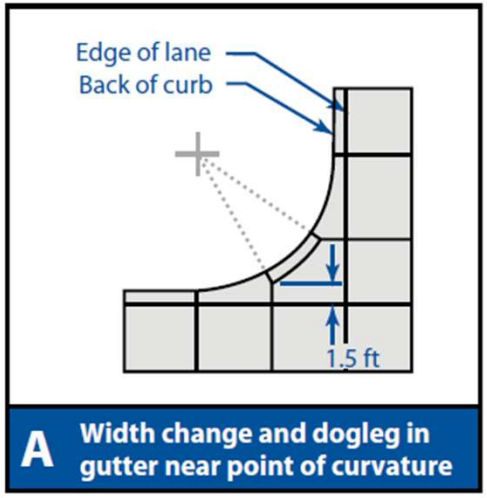
- Slabs < 1 ft (0.3 m) wide
- Slabs > 15 ft (5.0 m) wide
- Angles < 60º (~90º is best)
- Do this by dog-legging joints through curved radius points
- Creating interior corners (L-shaped slabs)
- Odd Shapes (keep slabs square or pie-shaped)

Joint Spacing Recommendations

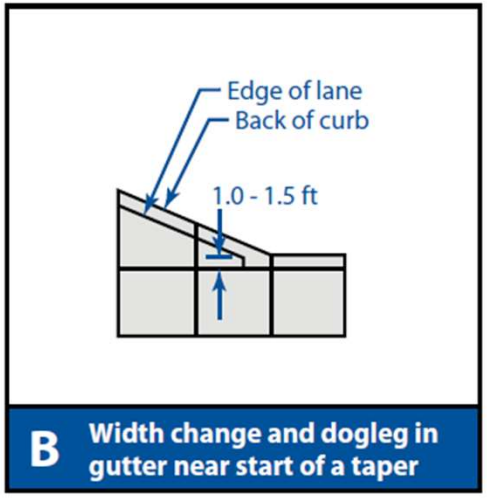
- Max. slab size = 2 x thickness (inches⇨feet)
  = 24 x thickness (inches⇨inches)
- 15 ft absolute max.
- Smaller is better
  - 4-inch: 6 feet
  - 6-inch: 10 feet
  - 8-inch: 12-14 feet
  - 9-inch+: 15 feet

Doglegs

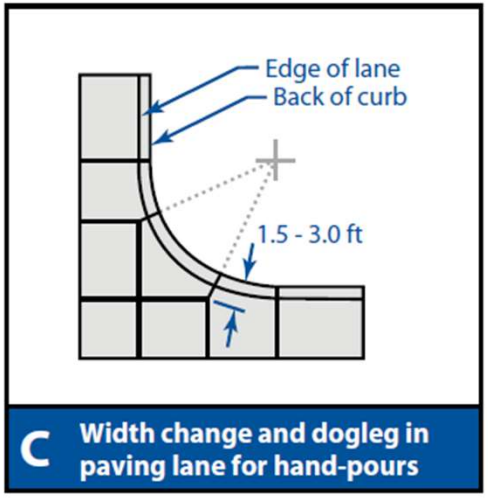
Definition: Construction Block-outs where the pavement changes width



A Width change and dogleg in gutter near point of curvature



B Width change and dogleg in gutter near start of a taper



C Width change and dogleg in paving lane for hand-pours

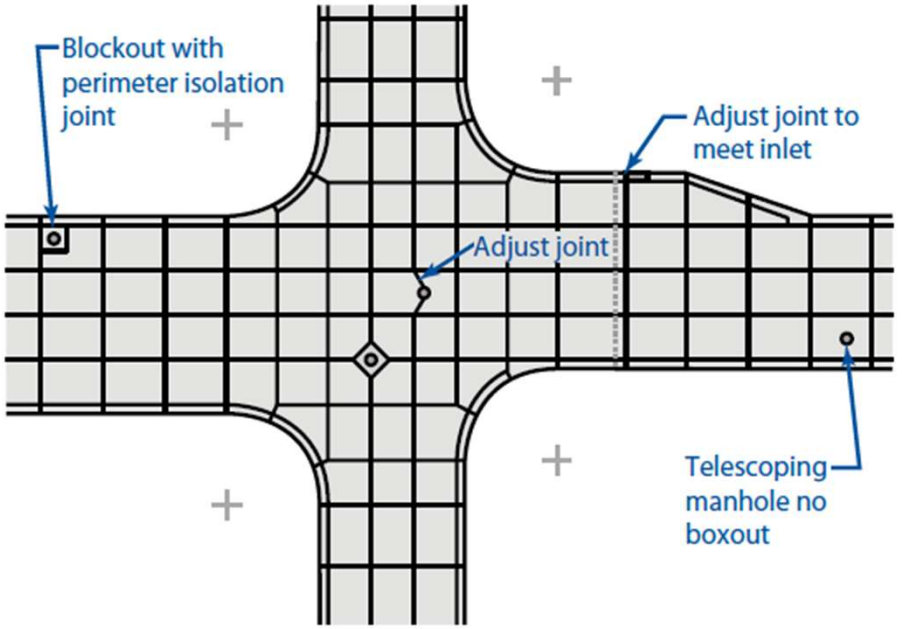
Adjusting Joints for Fixtures

Define any catch basins, manholes or other fixtures that are inside the pour area.

- Non-telescoping manholes will require a boxout or isolation to allow for vertical and horizontal slab movement.
  - Consider using rounded boxouts or placing fillets on the corners of square boxouts to avoid crack-inducing corners.
- Telescoping manholes can be cast integrally within the concrete, and do not necessarily require a boxout.
  - The two-piece casting does not inhibit vertical movement and is less likely to create cracks within the pavement.

Adjusting Joints for Fixtures

When a joint is near a fixture, it is desirable to adjust the joint so that it will pass through the fixture or the boxout surrounding the fixture. This diagram shows several acceptable ways to dogleg or shift a joint to meet a fixture.

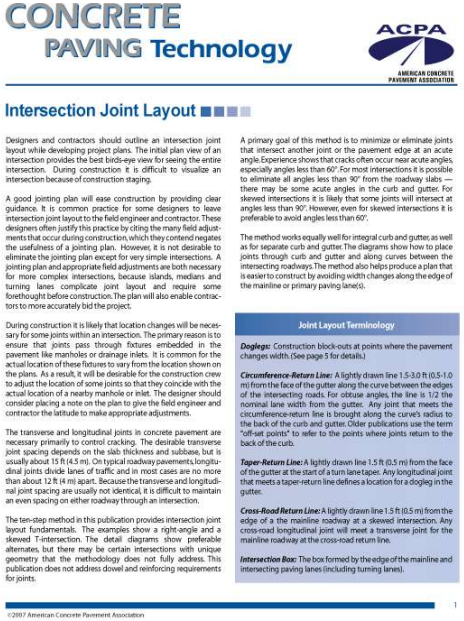


Developing a Joint Layout

1. Decide your maximum joint spacing – based upon slab thickness
2. Decide if you will be pouring the slabs or curbs first
3. Define lanes, entrance/exit drives, and parking/interior drives
4. Define all control points – places where there has to be a joint or an intersection of joints
   a) Find where all grade changes occur (eg. Note high points and low points)
   b) Find all structures (manholes, inlets, catch basins, buildings, light poles, etc.)
      - Place joints intersecting the structures
   c) Place joints in line with the edges of islands (round vs. square islands)
5. Measure distances and add joints in both directions at equal spacing < than the maximum recommended (this is where you fill in the remaining point of the jointing plan.)
6. Define all areas that need expansion joints
   a) All fixed structures, pre-existing concrete, loading docks, foundations, walls, light fixtures, etc..

Intersection Joint Layout

- The common sense logic can be applied anywhere
- Remember that concrete wants to be square
- You can predict where cracks will happen
- Step by step process



CONCRETE PAVING Technology

ACPA AMERICAN CONCRETE PAVEMENT ASSOCIATION

Intersection Joint Layout

Designers and contractors should outline an intersection joint layout while developing project plans. The initial plan view of an intersection provides the best birds-eye view for seeing the entire intersection. During construction it is difficult to visualize an intersection because of construction staging.

A good jointing plan will ease construction by providing clear guidance. It is common practice for some designers to leave intersection joint layout to the field engineer and contractor. These designers often justify this practice by citing the many field adjustments that occur during construction, which they contend negates the usefulness of a jointing plan. However, it is not desirable to eliminate the jointing plan except for very simple intersections. A jointing plan and appropriate field adjustments are both necessary for more complex intersections, because islands, medians and turning lanes complicate joint layout and require some forethought before construction. The plan will also enable contractors to more accurately bid the project.

During construction it is likely that location changes will be necessary for some joints within an intersection. The primary reason is to ensure that joints pass through fixtures embedded in the pavement like manholes or drainage inlets. It is common for the actual location of these fixtures to vary from the location shown on the plans. As a result, it will be desirable for the construction crew to adjust the location of some joints so that they coincide with the actual location of a nearby manhole or inlet. The designer should consider placing a note on the plan to give the field engineer and contractor the latitude to make appropriate adjustments.

The transverse and longitudinal joints in concrete pavement are necessary primarily to control cracking. The desirable transverse joint spacing depends on the slab thickness and subbase, but is usually about 15 ft (4.5 m). On typical roadway pavements, longitudinal joints divide lanes of traffic and in most cases are no more than about 12 ft (4 m) apart. Because the transverse and longitudinal joint spacing are usually not identical, it is difficult to maintain an even spacing on either roadway through an intersection.

The tee-step method in this publication provides intersection joint layout fundamentals. The examples show a right-angle and a skewed T-intersection. The detail diagrams show preferable alternates, but there may be certain intersections with unique geometry that the methodology does not fully address. This publication does not address dowel and reinforcing requirements for joints.

A primary goal of this method is to minimize or eliminate joints that intersect another joint or the pavement edge at an acute angle. Experience shows that cracks often occur near acute angles, especially angles less than 60°. For most intersections it is possible to eliminate all angles less than 90° from the roadway slabs — there may be some acute angles in the curb and gutter. For skewed intersections it is likely that some joints will intersect at angles less than 90°. However, even for skewed intersections it is preferable to avoid angles less than 60°.

The method works equally well for integral curb and gutter, as well as for separate curb and gutter. The diagrams show how to place joints through curb and gutter and along curves between the intersecting roadways. The method also helps produce a plan that is easier to construct by avoiding width changes along the edge of the mainline or primary paving lane(s).

Joint Layout Terminology

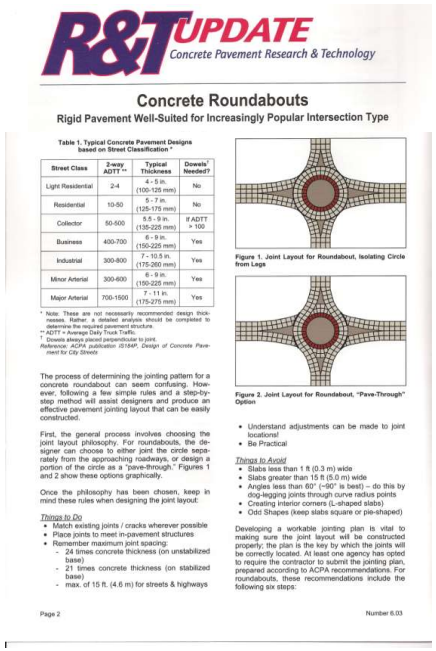
Dogleg: Construction block-outs at points where the pavement changes width. (See page 5 for details.)

Circumference-Return Line: A lightly drawn line 1.5-3.0 ft (0.5-1.0 m) from the face of the gutter along the curve between the edges of the intersecting roads. For obtuse angles, the line is 1/2 the nominal lane width from the gutter. Any joint that meets the circumference-return line is brought along the curve's radius to the back of the curb and gutter. Older publications use the term "off-set points" to refer to the points where joints return to the back of the curb.

Taper-Return Line: A lightly drawn line 1.5 ft (0.5 m) from the face of the gutter at the start of a turn lane taper. Any longitudinal joint that meets a taper-return line defines a location for a dogleg in the gutter.

Cross-Road Return Line: A lightly drawn line 1.5 ft (0.5 m) from the edge of a the mainline roadway at a skewed intersection. Any cross-road longitudinal joint will meet a transverse joint for the mainline roadway at the cross-road return line.

Intersection Box: The box formed by the edge of the mainline and intersecting paving lanes (including turning lanes).



R&T UPDATE Concrete Pavement Research & Technology

Concrete Roundabouts

Rigid Pavement Well-Suited for Increasingly Popular Intersection Type

Table 1. Typical Concrete Pavement Designs based on Street Classification *

Street Class	2-way ADTT **	Typical Thickness	Dowels† Needed?
Light Residential	2-4	4 - 5 in. (100-125 mm)	No
Residential	10-50	5 - 7 in. (125-175 mm)	No
Collector	50-500	5.5 - 9 in. (135-225 mm)	If ADTT > 100
Business	400-700	6 - 9 in. (150-225 mm)	Yes
Industrial	300-800	7 - 10.5 in. (175-260 mm)	Yes
Minor Arterial	300-600	6 - 9 in. (150-225 mm)	Yes
Major Arterial	700-1500	7 - 11 in. (175-275 mm)	Yes

* Note: These are not necessarily recommended design thicknesses. Rather, a detailed analysis should be completed to determine the required pavement structure.
** ADTT = Average Daily Truck Traffic.
† Dowels always placed perpendicular to joint.
Reference: ACPA publication ID184P, Design of Concrete Pavement for City Streets

Figure 1. Joint Layout for Roundabout, Isolating Circle from Legs

Figure 2. Joint Layout for Roundabout, "Pave-Through" Option

The process of determining the jointing pattern for a concrete roundabout can seem confusing. However, following a few simple rules and a step-by-step method will assist designers and produce an effective pavement jointing layout that can be easily constructed.

First, the general process involves choosing the joint layout philosophy. For roundabouts, the designer can choose to either joint the circle separately from the approaching roadways, or design a portion of the circle as a "pave-through." Figures 1 and 2 show these options graphically.

Once the philosophy has been chosen, keep in mind these rules when designing the joint layout:

Things to Do

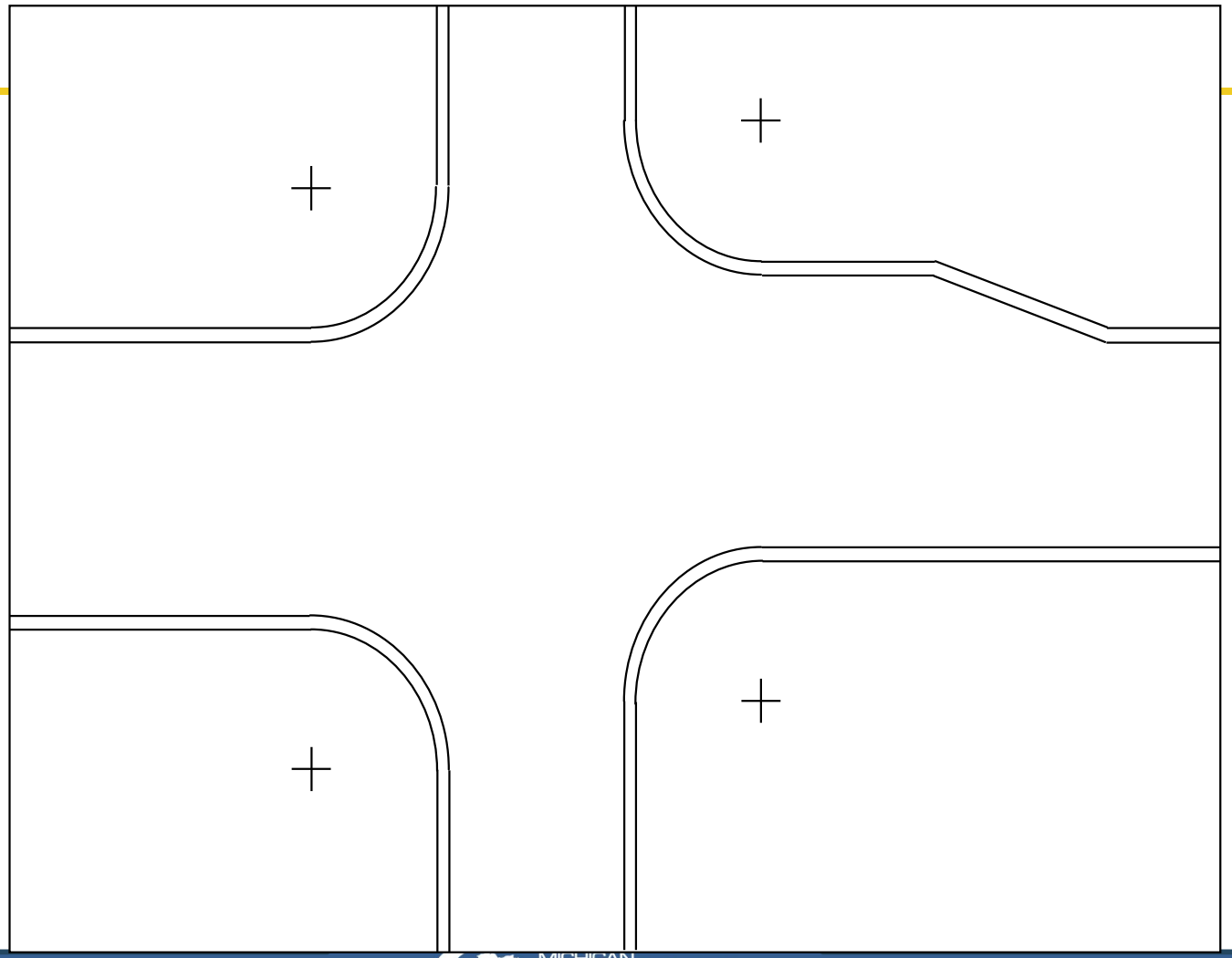
- Match existing joints / cracks wherever possible
- Place joints to meet in-pavement structures
- Remember maximum joint spacing:
  - 24 times concrete thickness (on unstabilized base)
  - 21 times concrete thickness (on stabilized base)
  - max. of 15 ft. (4.6 m) for streets & highways
- Understand adjustments can be made to joint locations!
- Be Practical

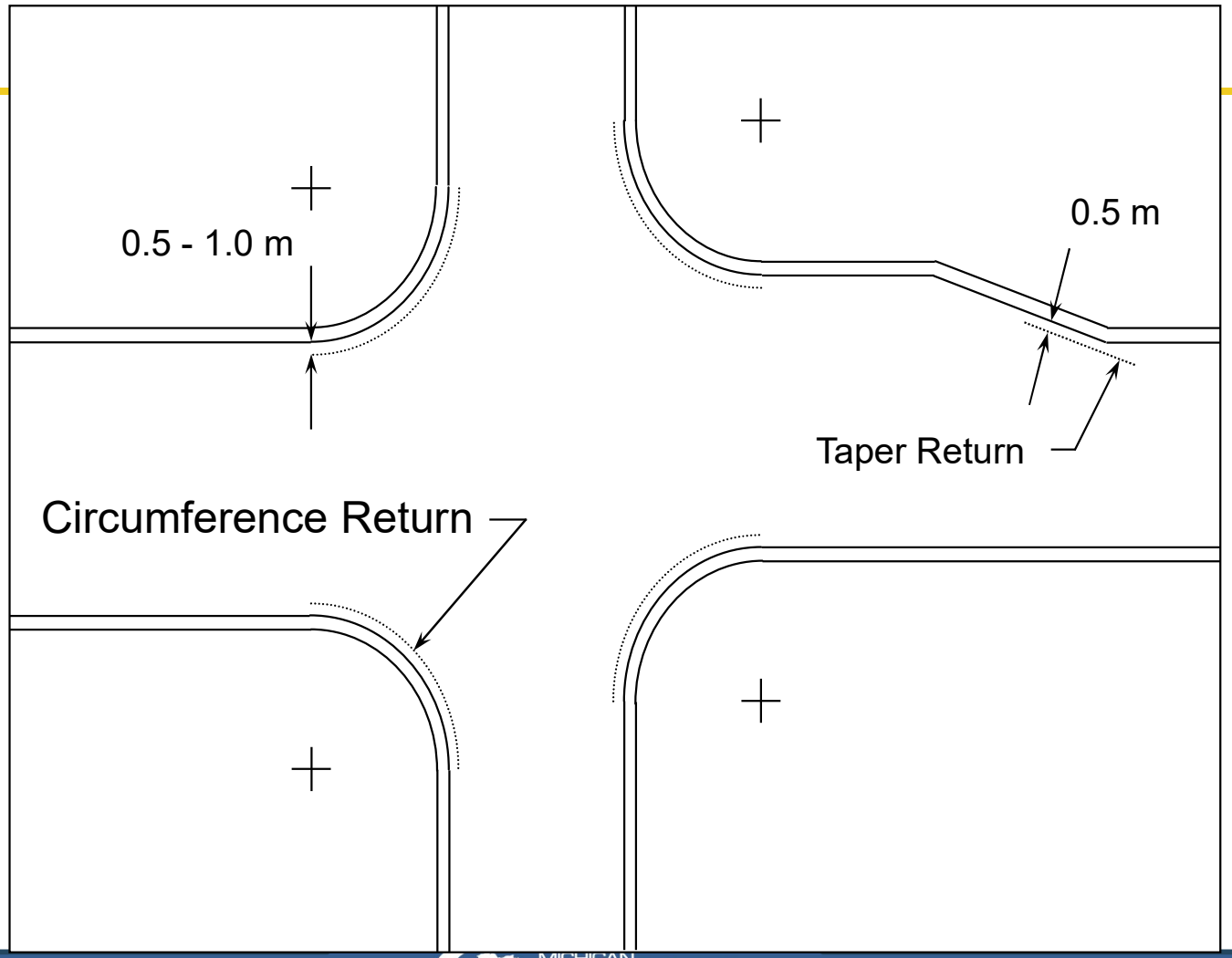
Things to Avoid

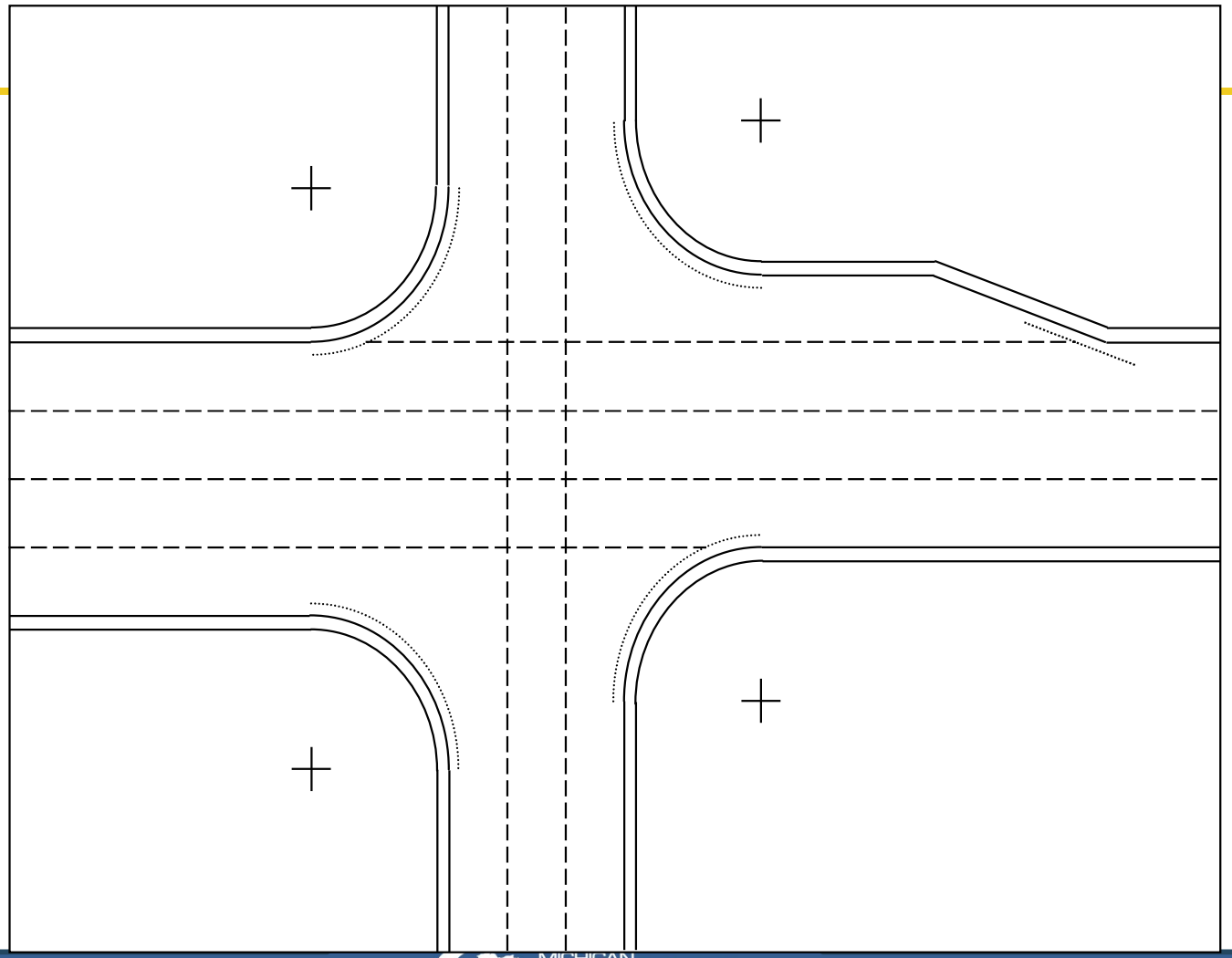
- Slabs less than 1 ft (0.3 m) wide
- Slabs greater than 15 ft (5.0 m) wide
- Angles less than 60° (~90° is best) – do this by dog-legging joints through curve radius points
- Creating interior corners (L-shaped slabs)
- Odd Shapes (keep slabs square or pie-shaped)

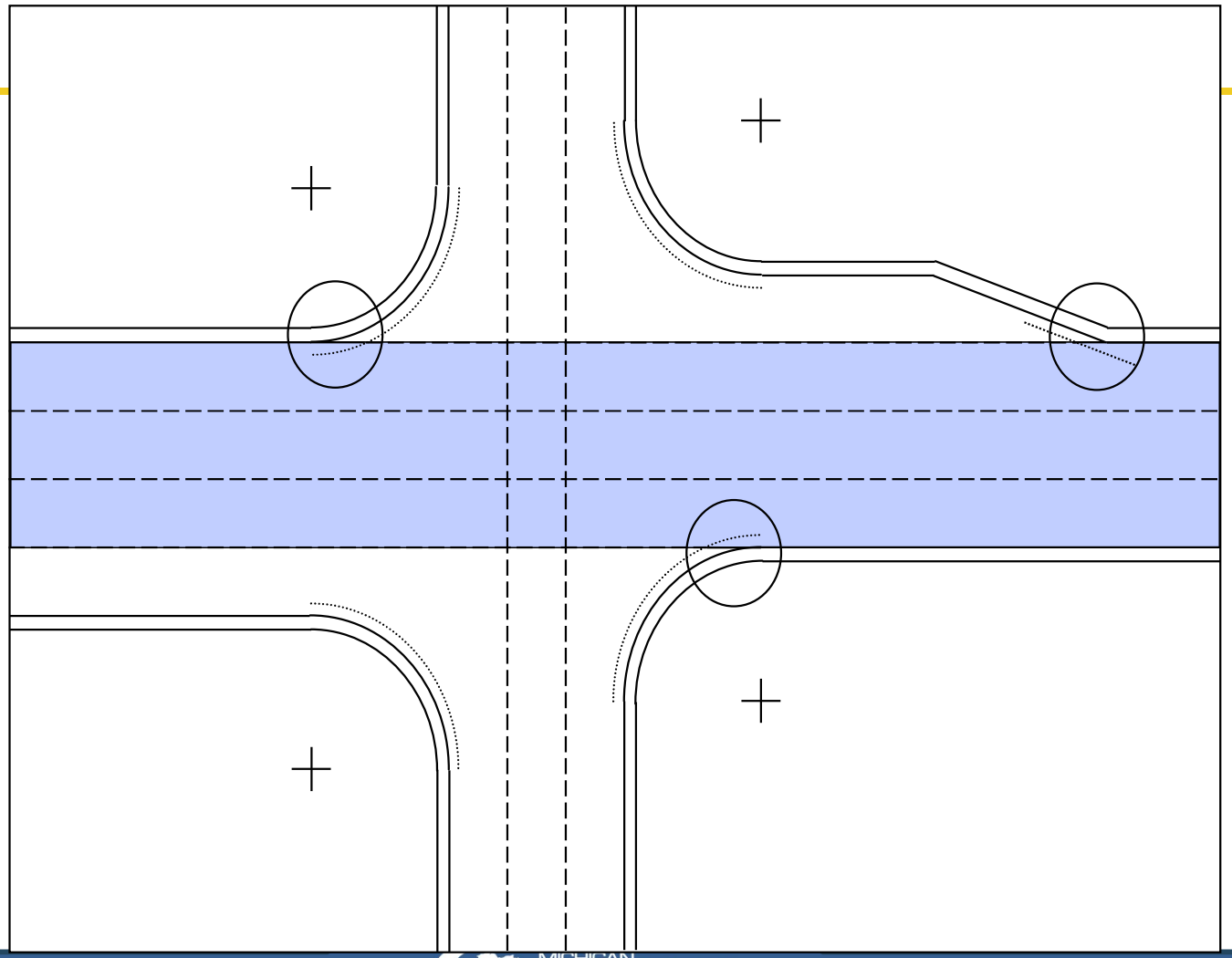
Developing a workable jointing plan is vital to making sure the joint layout will be constructed properly; the plan is the key by which the joints will be correctly located. At least one agency has opted to require the contractor to submit the jointing plan, prepared according to ACPA recommendations. For roundabouts, these recommendations include the following six steps:

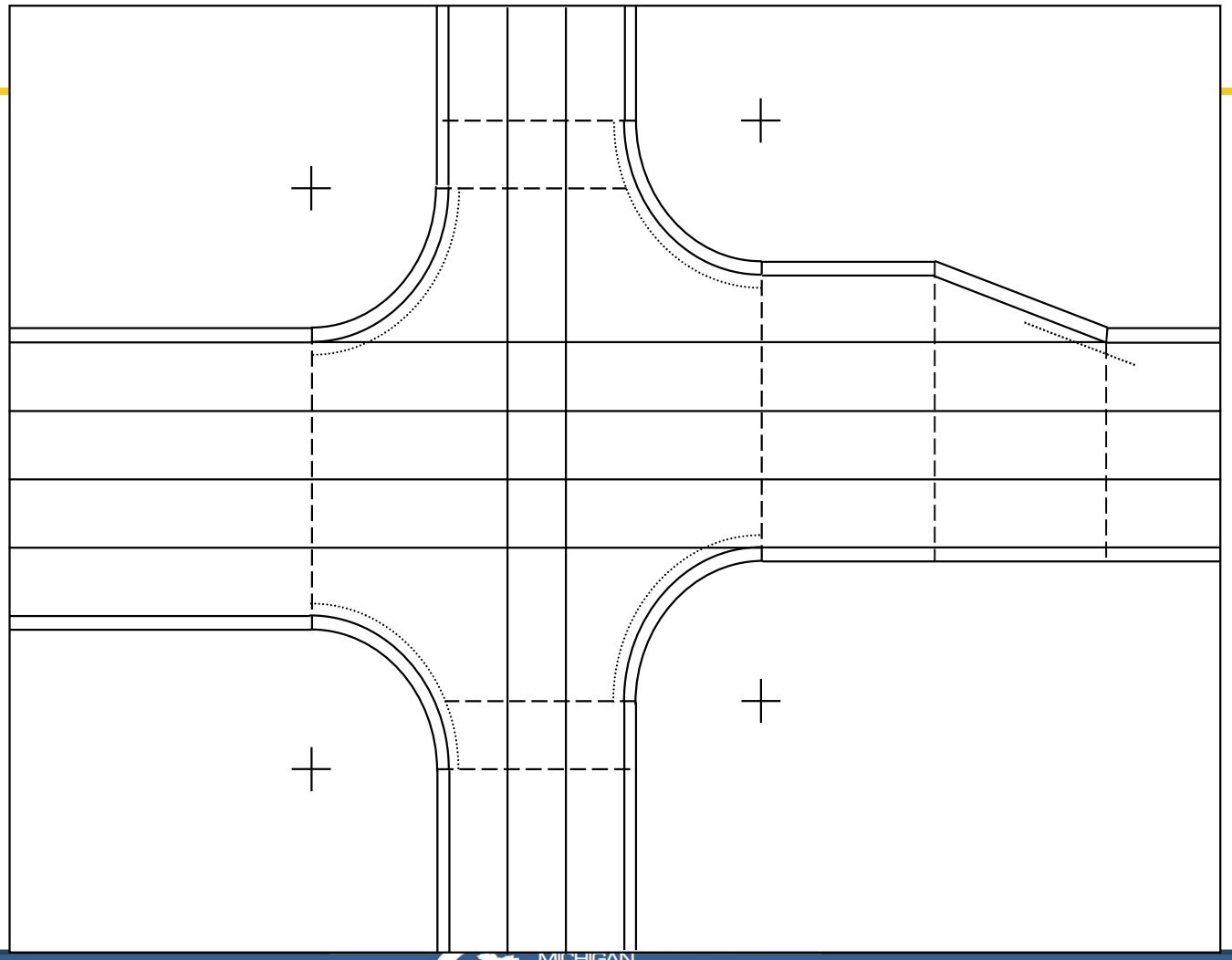
LET'S PRACTICE!

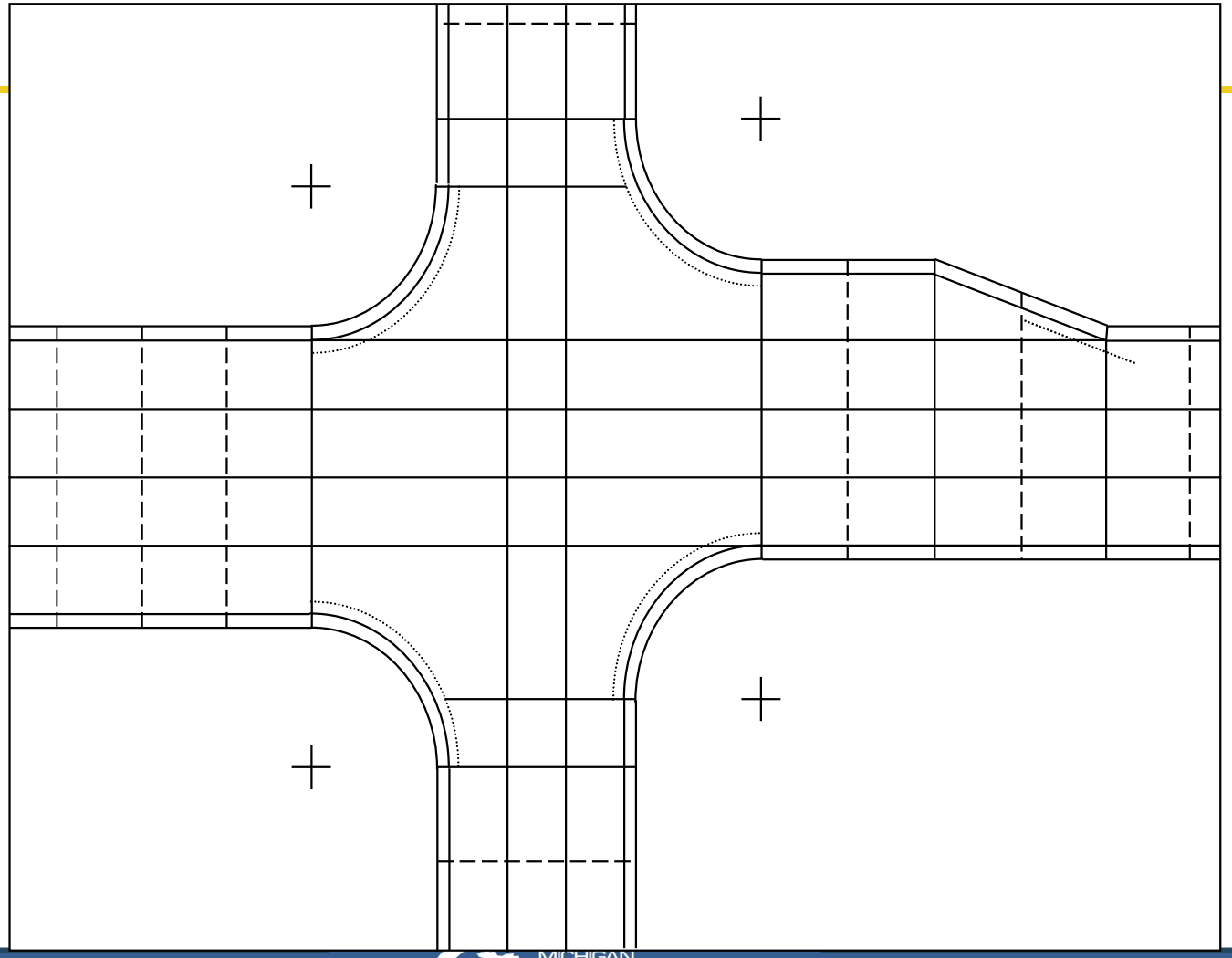


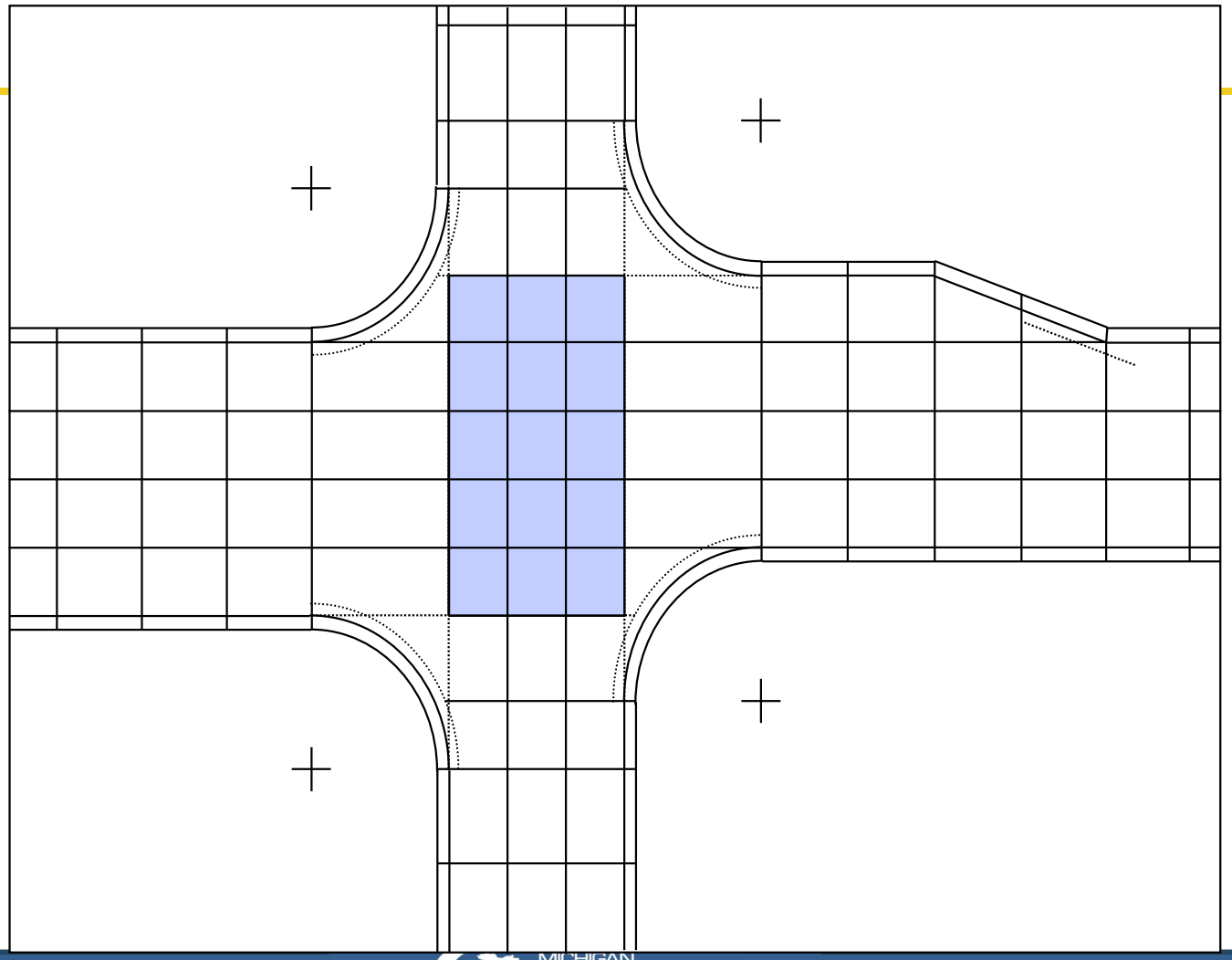

0.5 - 1.0 m
0.5 m
Taper Return
Circumference Return

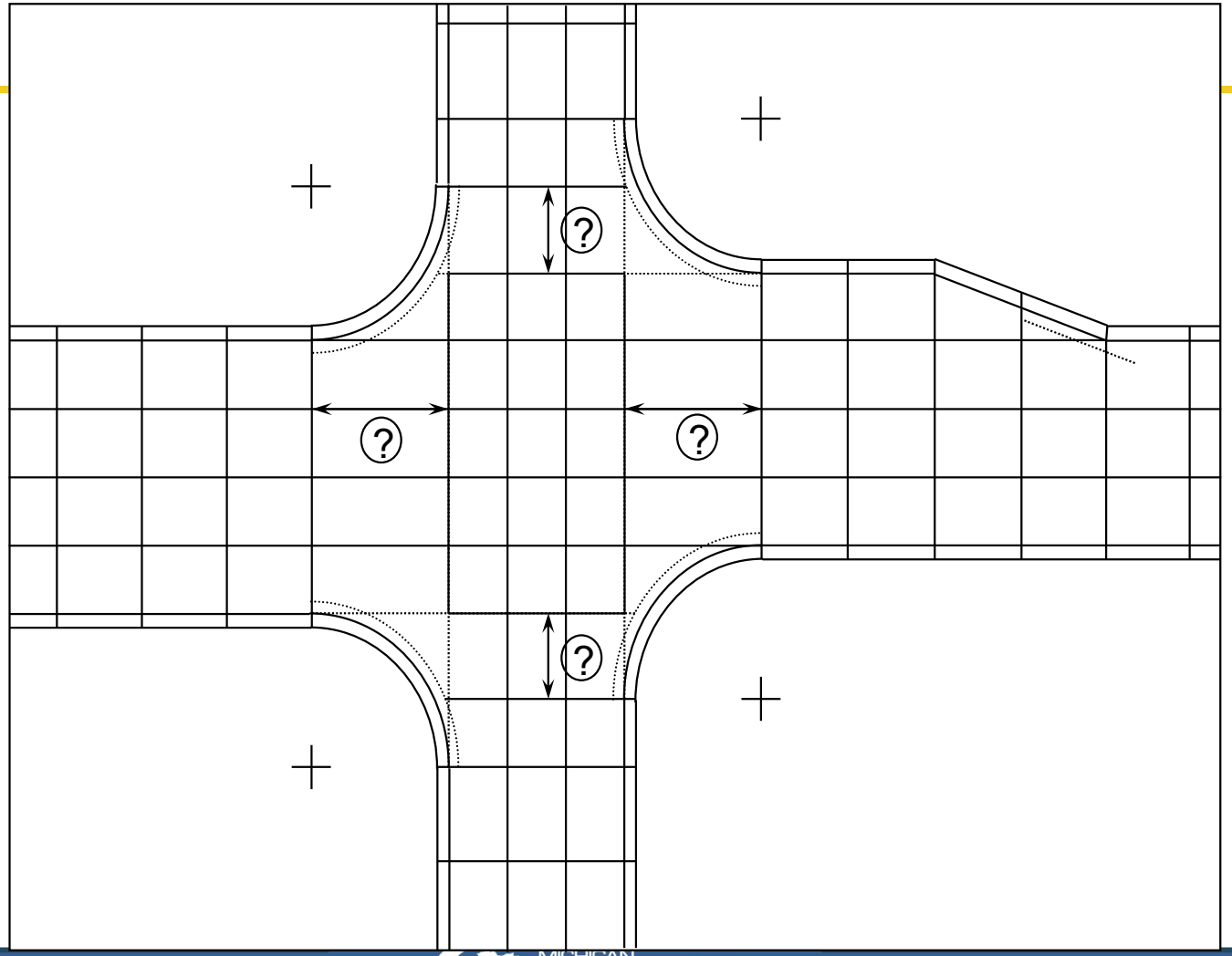


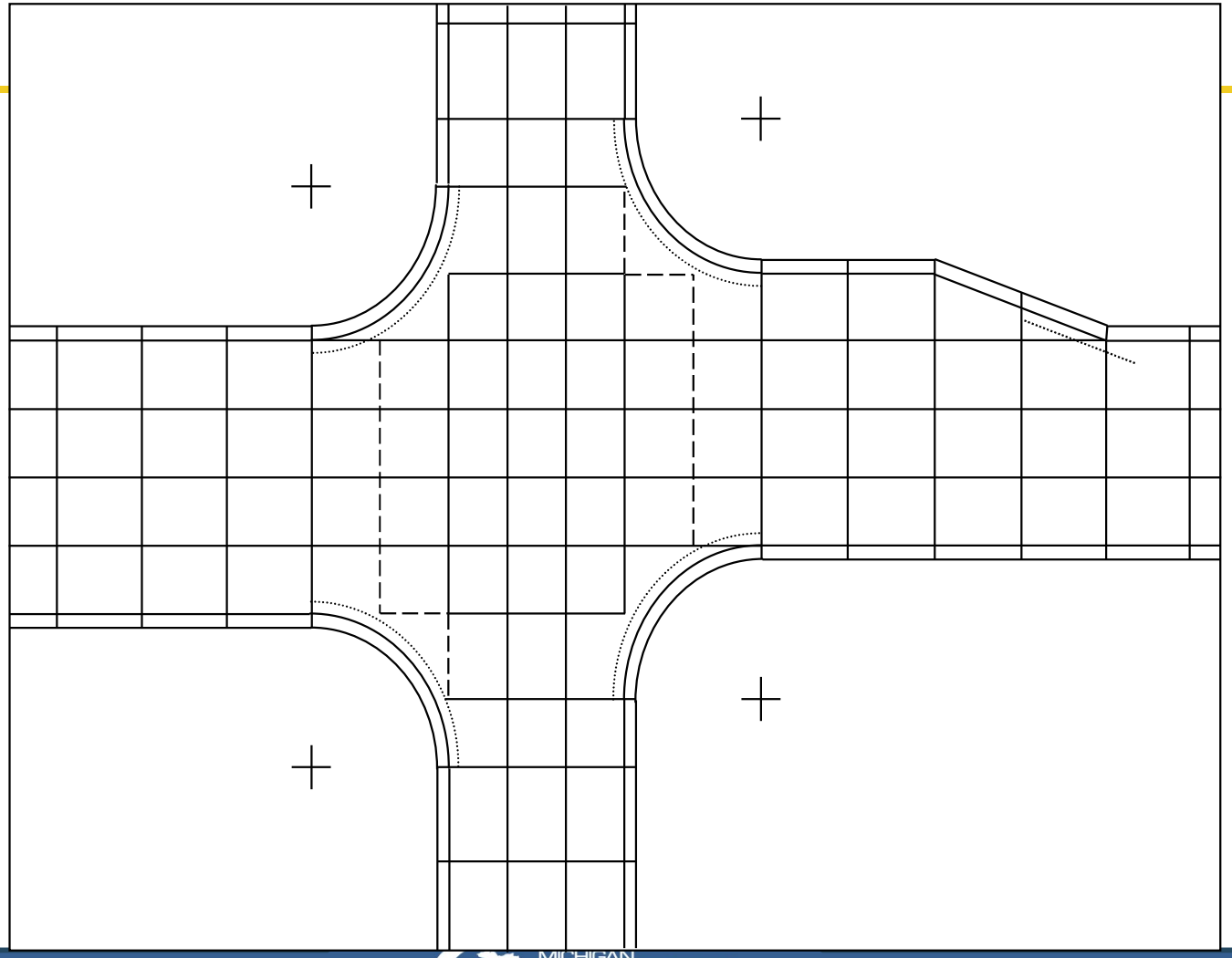


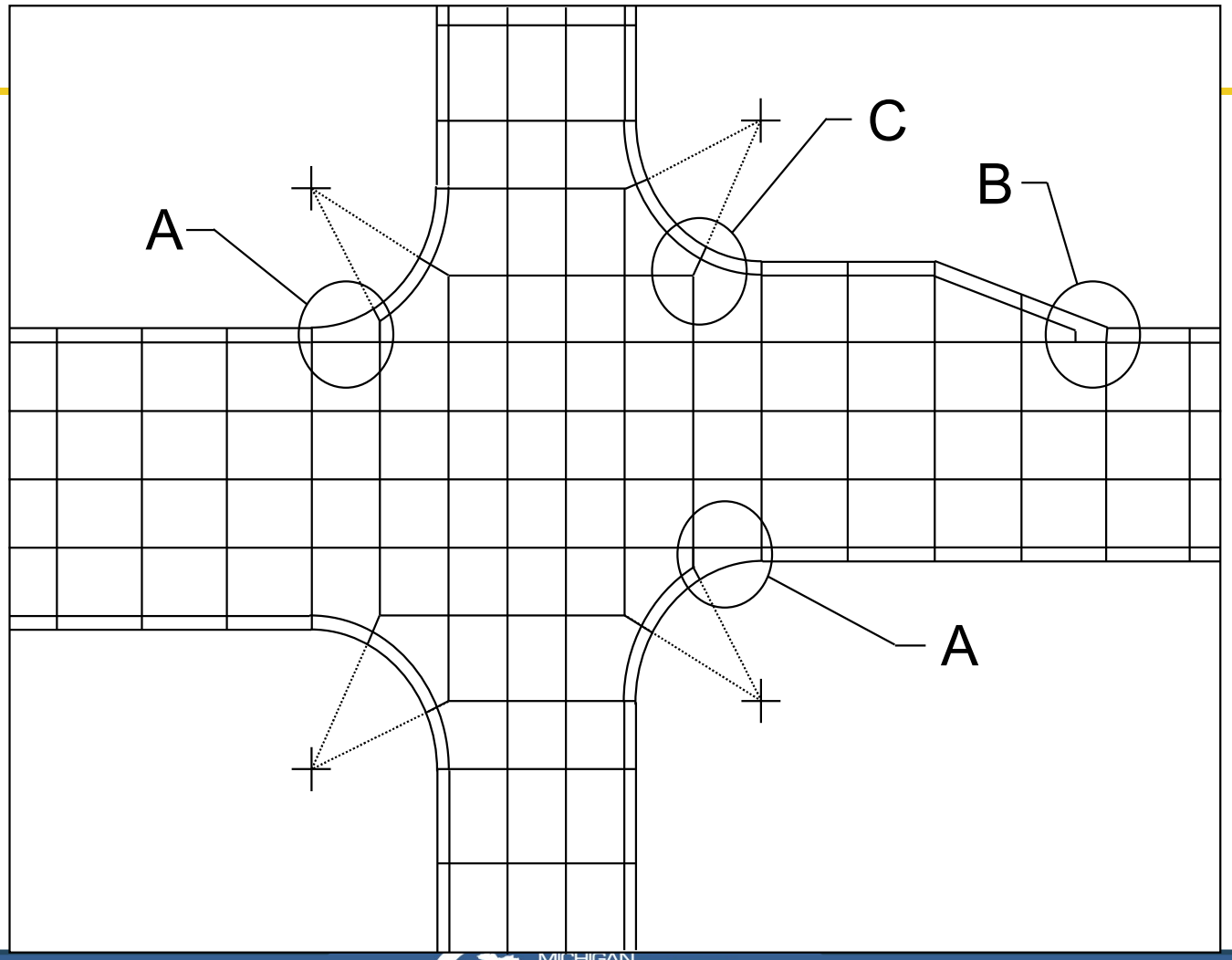











C
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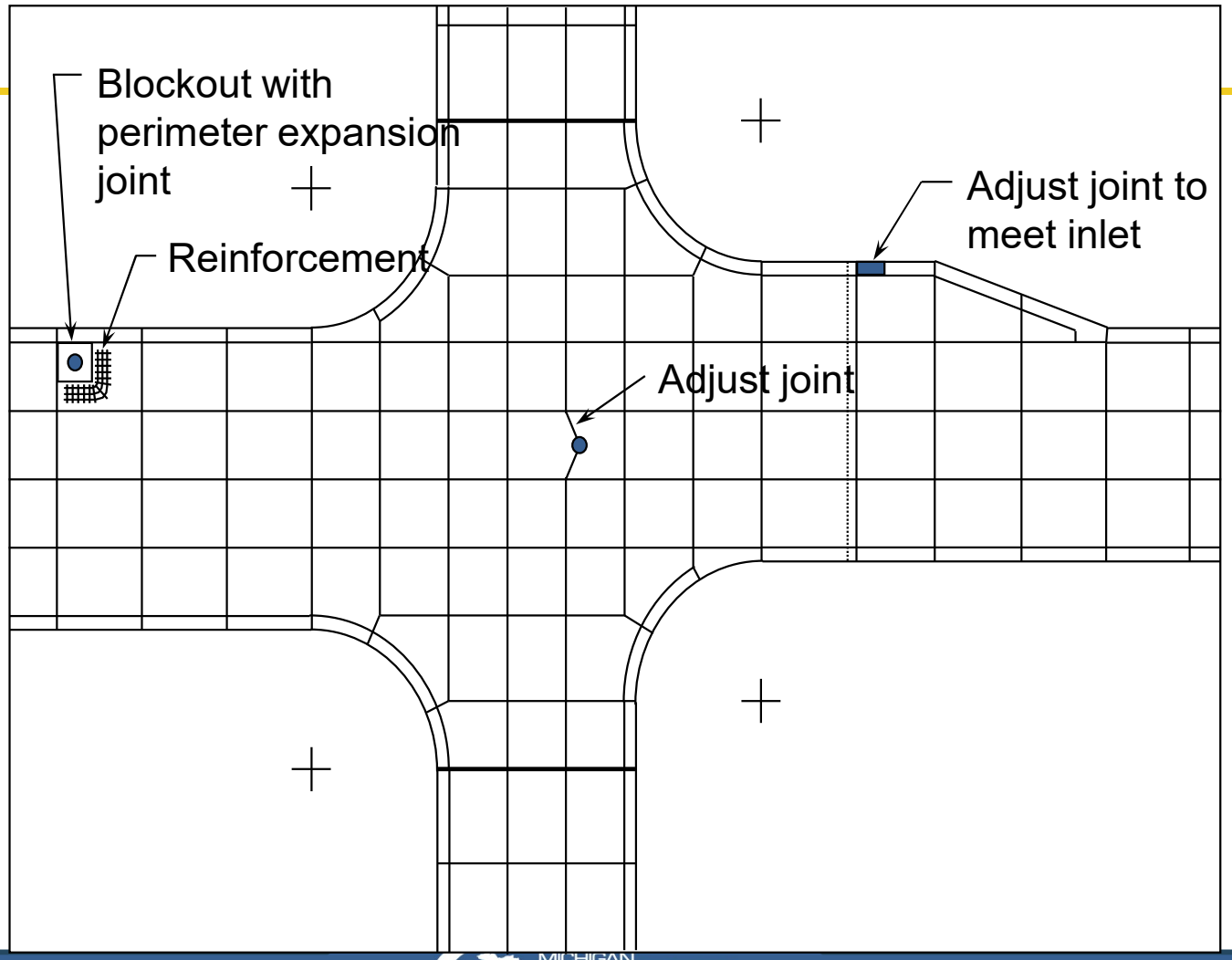
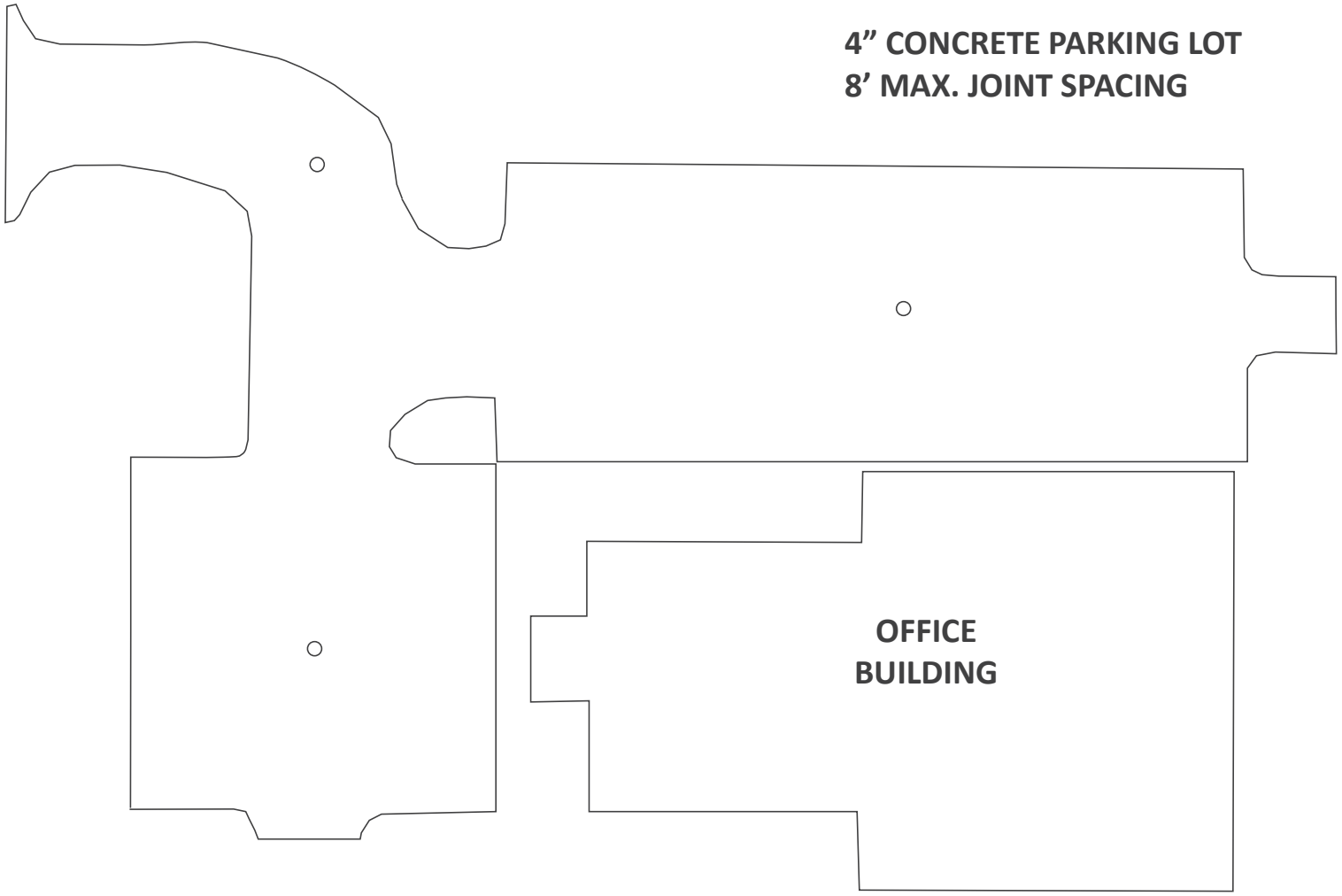

Blockout with perimeter expansion joint
Reinforcement
Adjust joint to meet inlet
Adjust joint

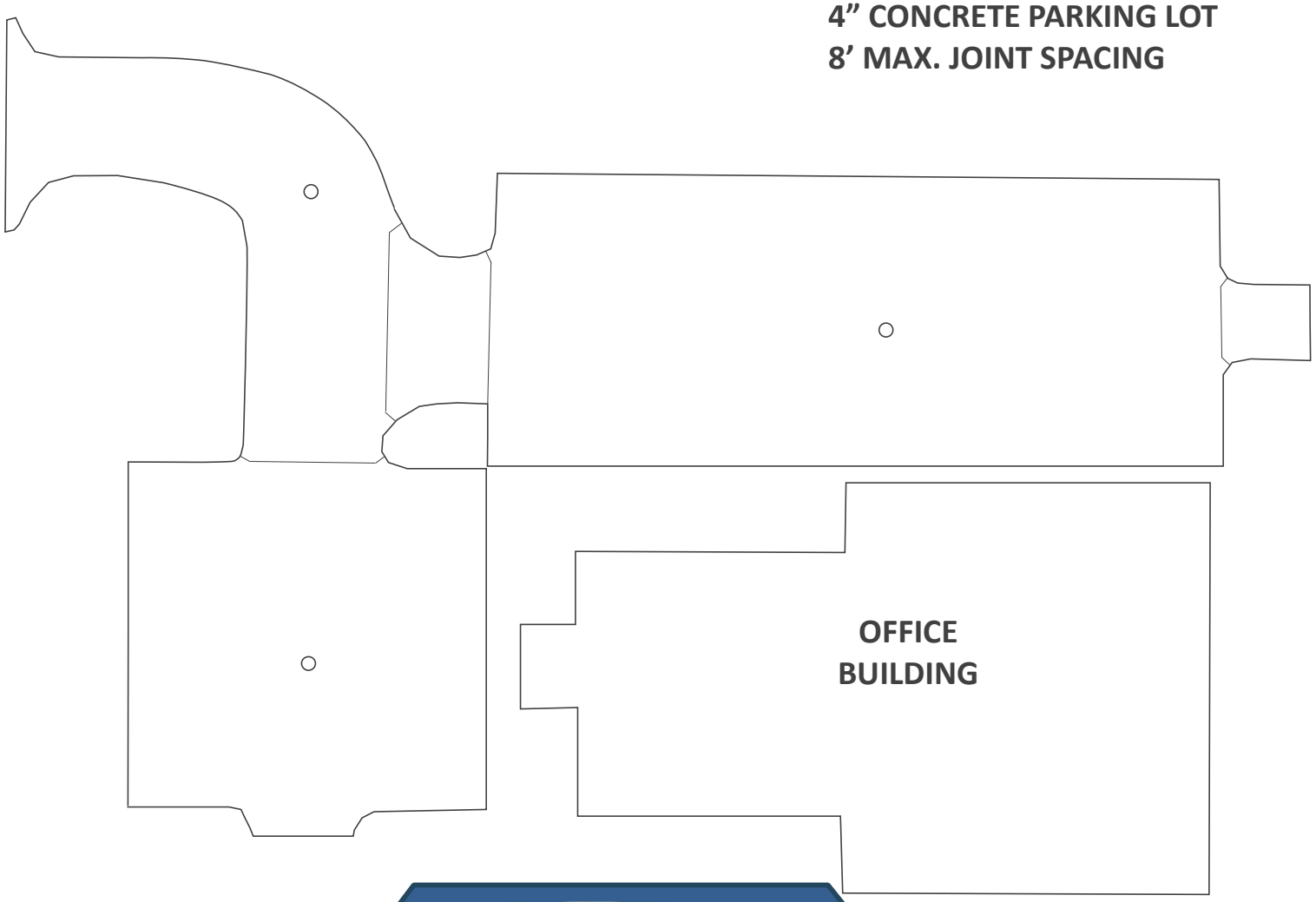
LET'S PRACTICE!


N
Map
Traffic
Kendall Psychological Services
DKI Security
20 ft
5 m
Edit in Google Map Maker
Report a problem


Map
Traffic
Kendall Psychological Services
DK Security
OFFICE BUILDING
20 ft
5 m
Edit in Google Map Maker
Report a problem


4” CONCRETE PARKING LOT
8’ MAX. JOINT SPACING
OFFICE
BUILDING

4” CONCRETE PARKING LOT
8’ MAX. JOINT SPACING



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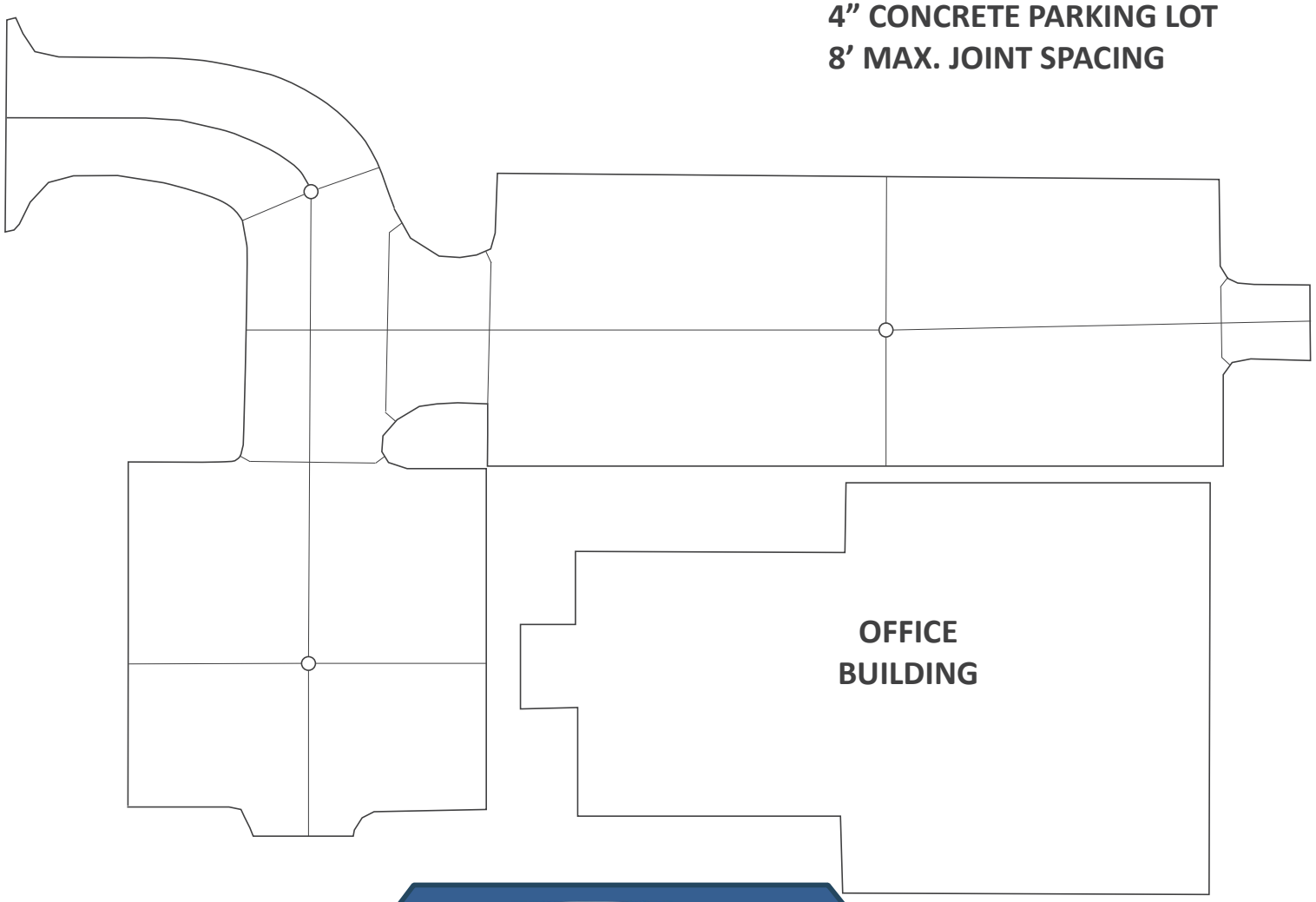
= 8’ 1” = 20’

4” CONCRETE PARKING LOT
8’ MAX. JOINT SPACING



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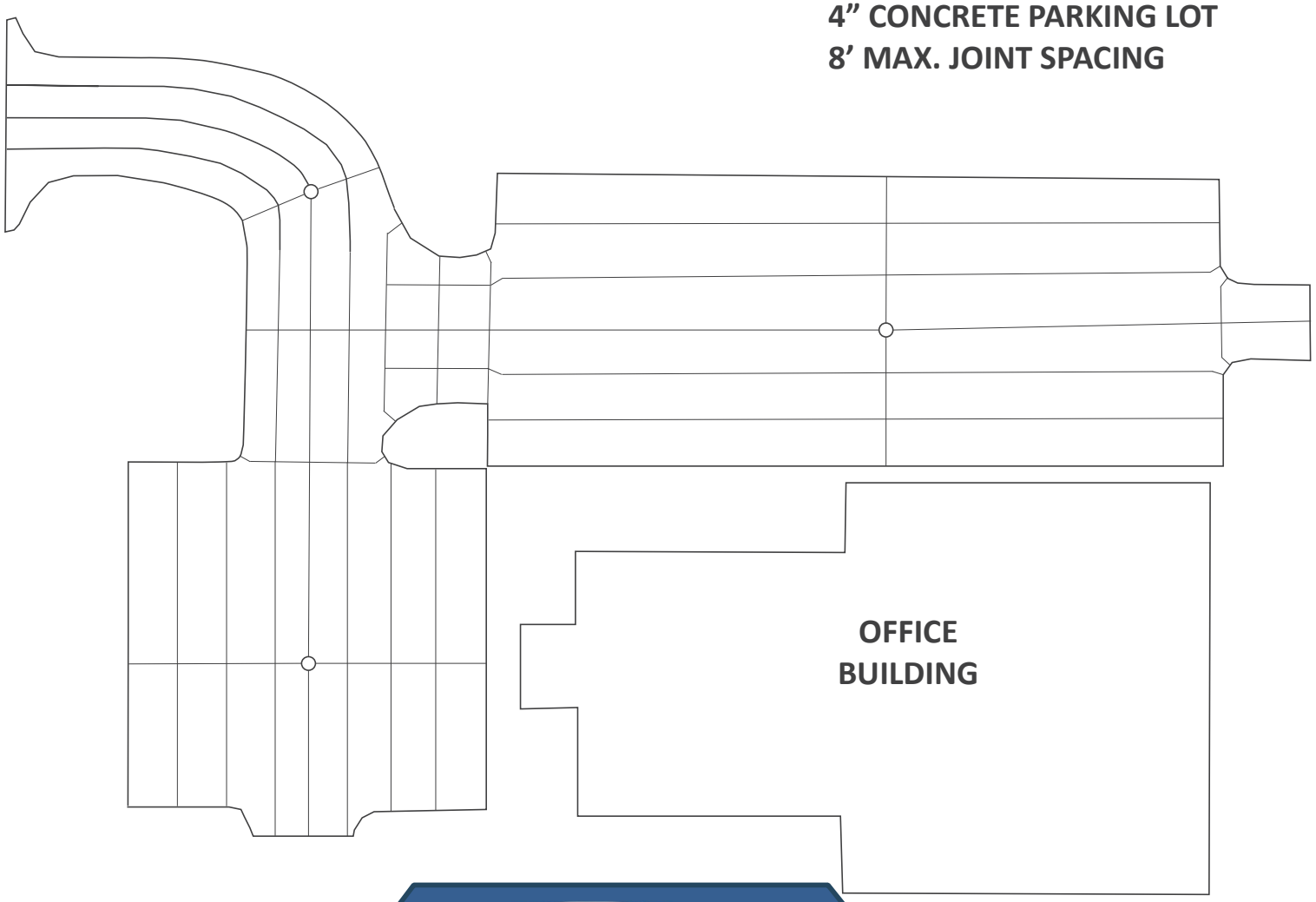
= 8’ 1” = 20’

4” CONCRETE PARKING LOT
8’ MAX. JOINT SPACING



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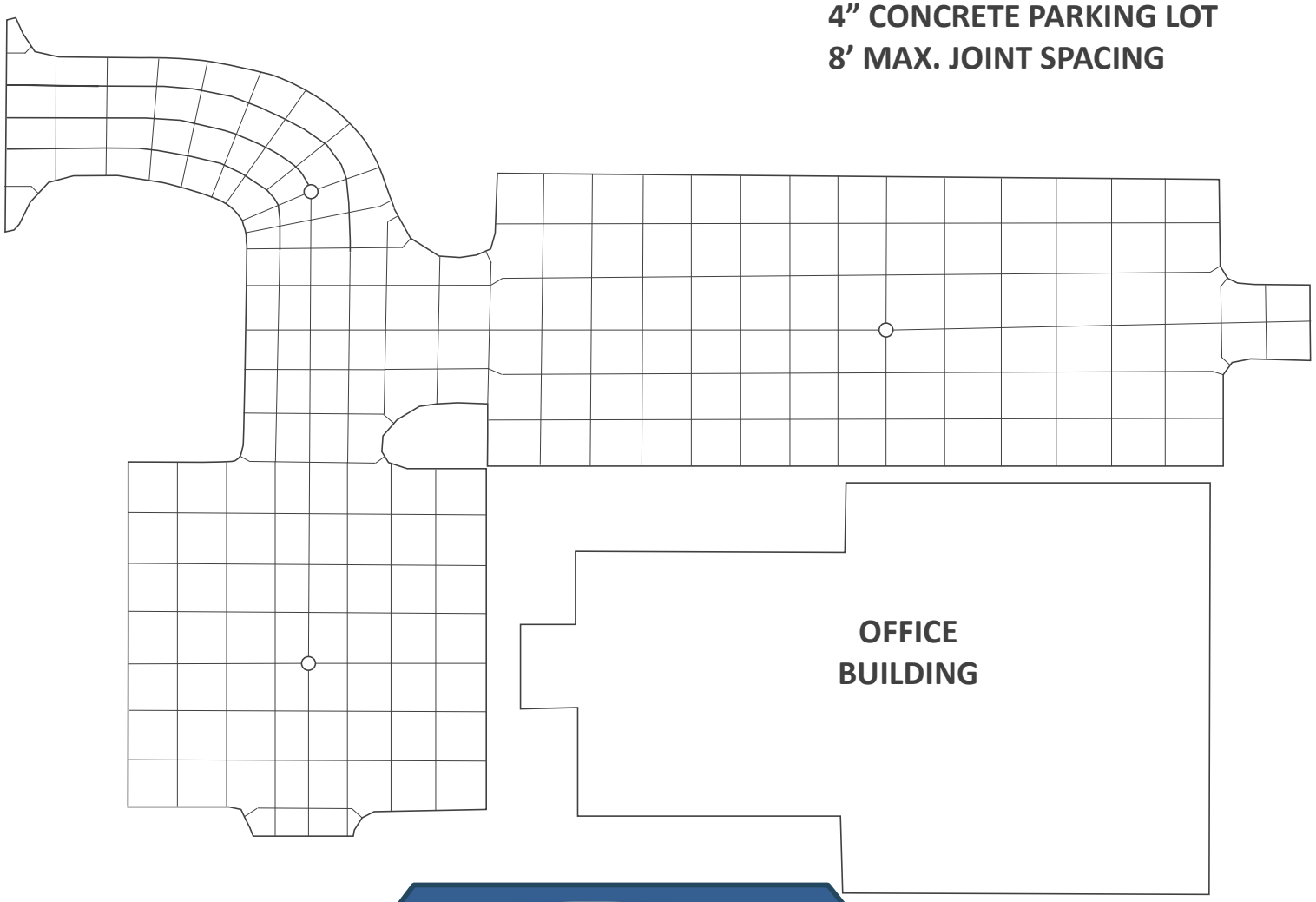
= 8’ 1” = 20’

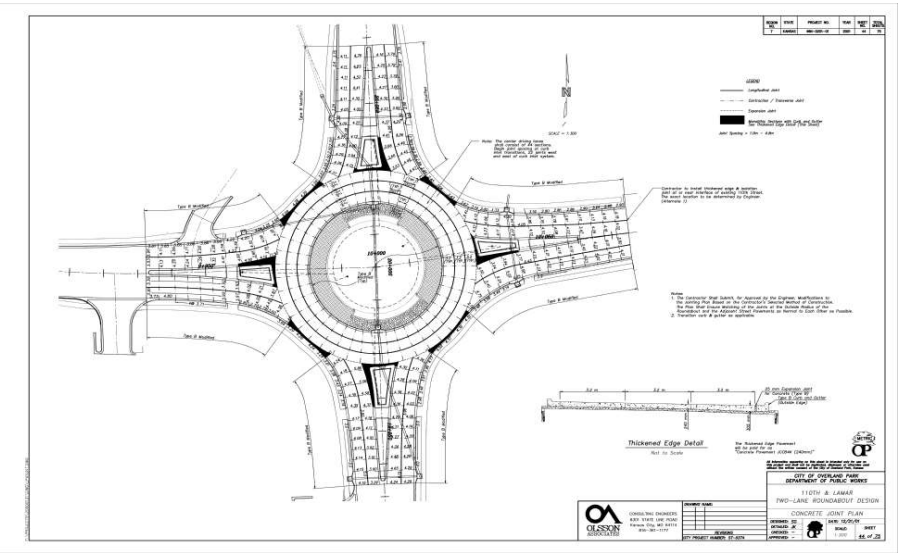
4” CONCRETE PARKING LOT
8’ MAX. JOINT SPACING



MICHIGAN CONCRETE ASSOCIATION

= 8’ 1” = 20’

Concrete Roundabout Jointing



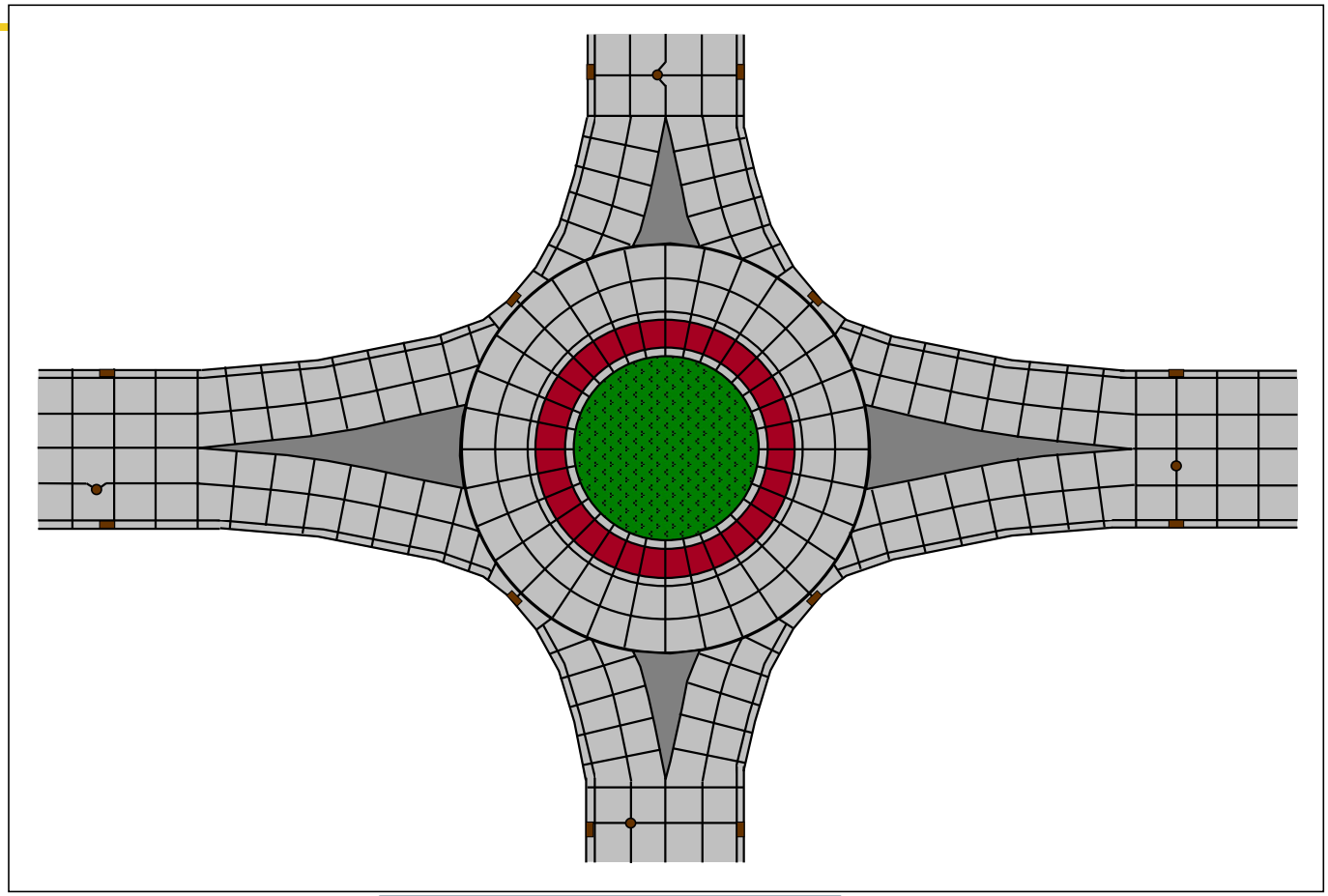
- Develop a jointing plan
  - Bird's eye view
- Remember rules
- Follow the steps
- Be practical!
- Allow for field adjustments

Joint Layout Philosophy

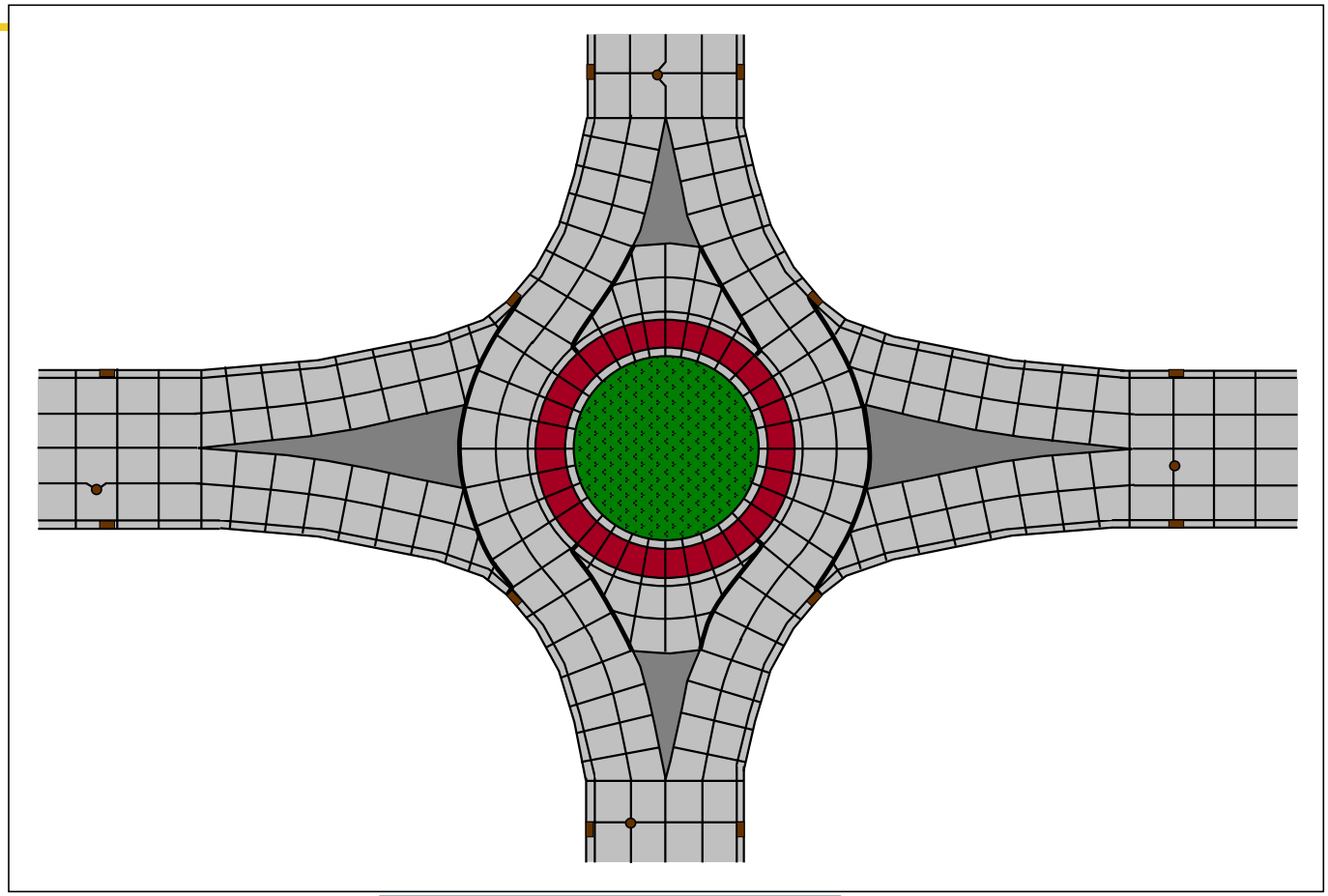
Isolation Joints are Necessary:

- Isolate circle from legs
  - Joints in circular portion radiate from center
  - Joints in legs are normal (perpendicular)
- Pinwheel
  - Joints follow traffic patterns and pavement markings, and guide motorists safely out of the roundabout

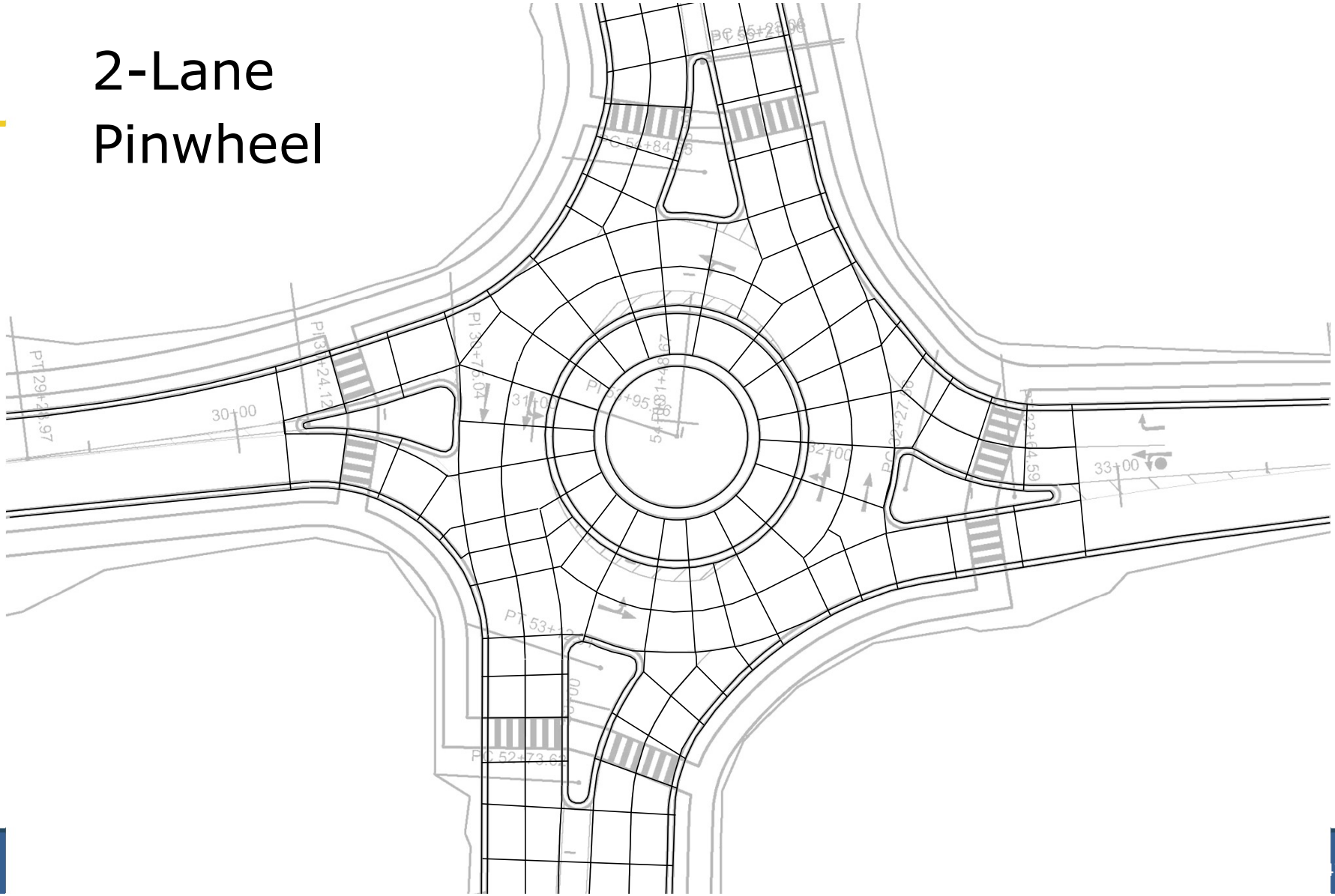
Isolate Circle

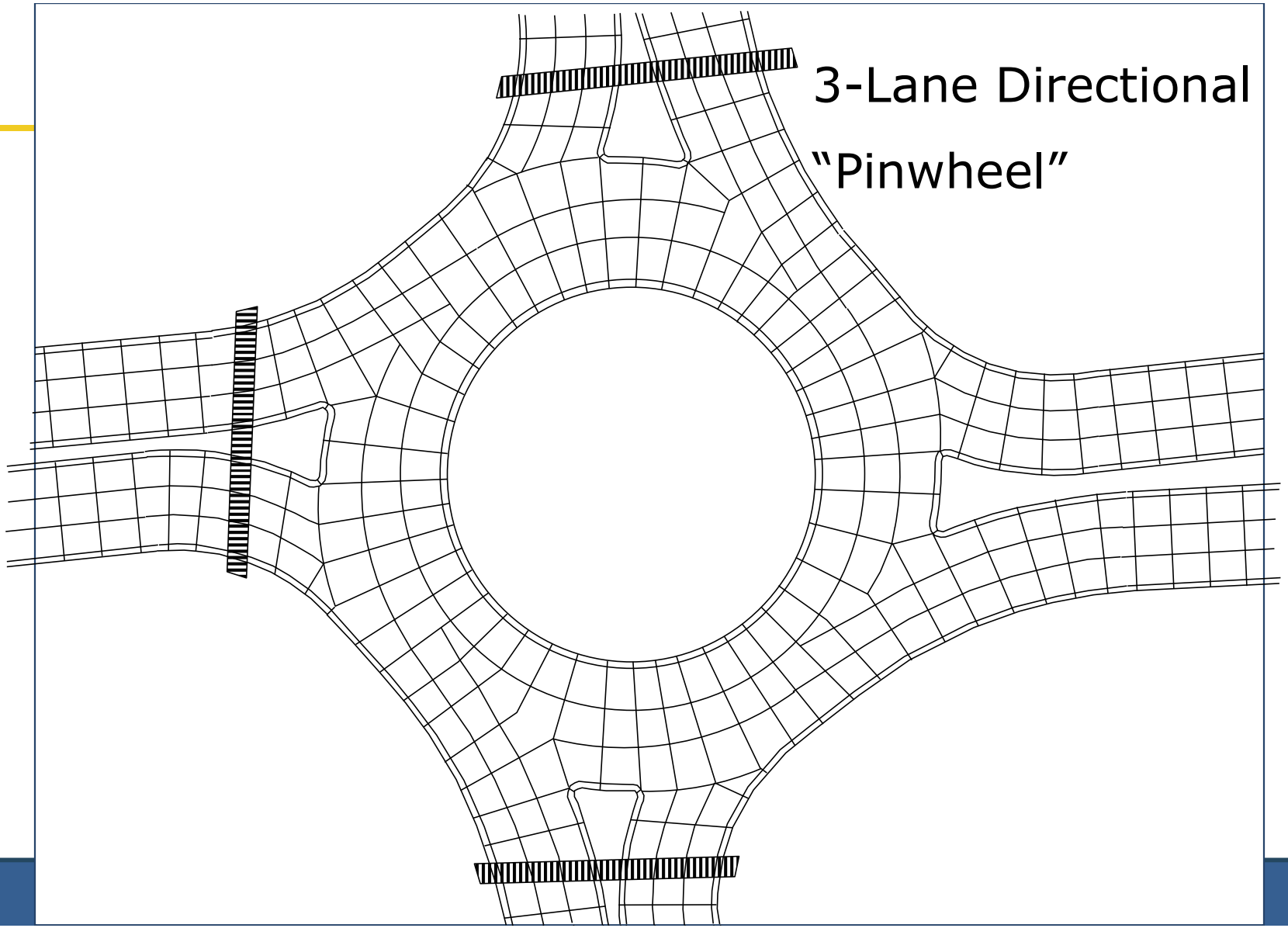


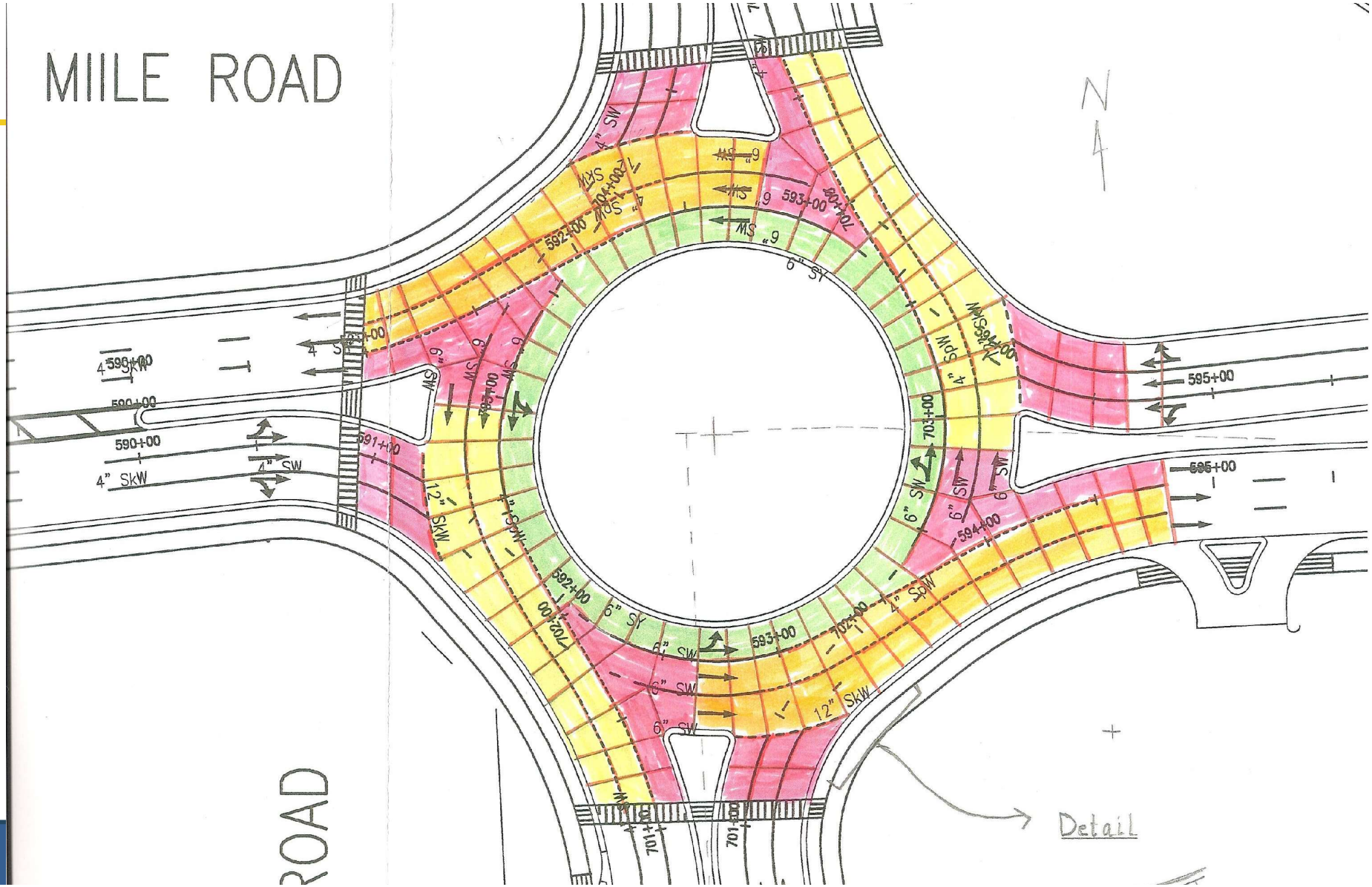
Pave Through



2-Lane Pinwheel

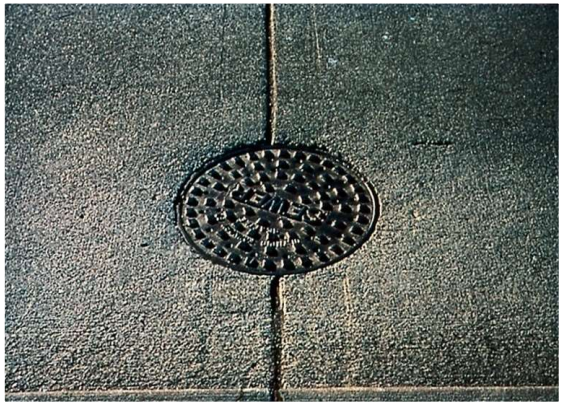



3-Lane Directional
"Pinwheel"


MIILE ROAD
N
Detail
590+00
591+00
592+00
593+00
594+00
595+00
596+00
701+00
702+00
703+00
4" SkW
4" SW
12" SkW
6" SW

Curb Placement – Widened Gutter

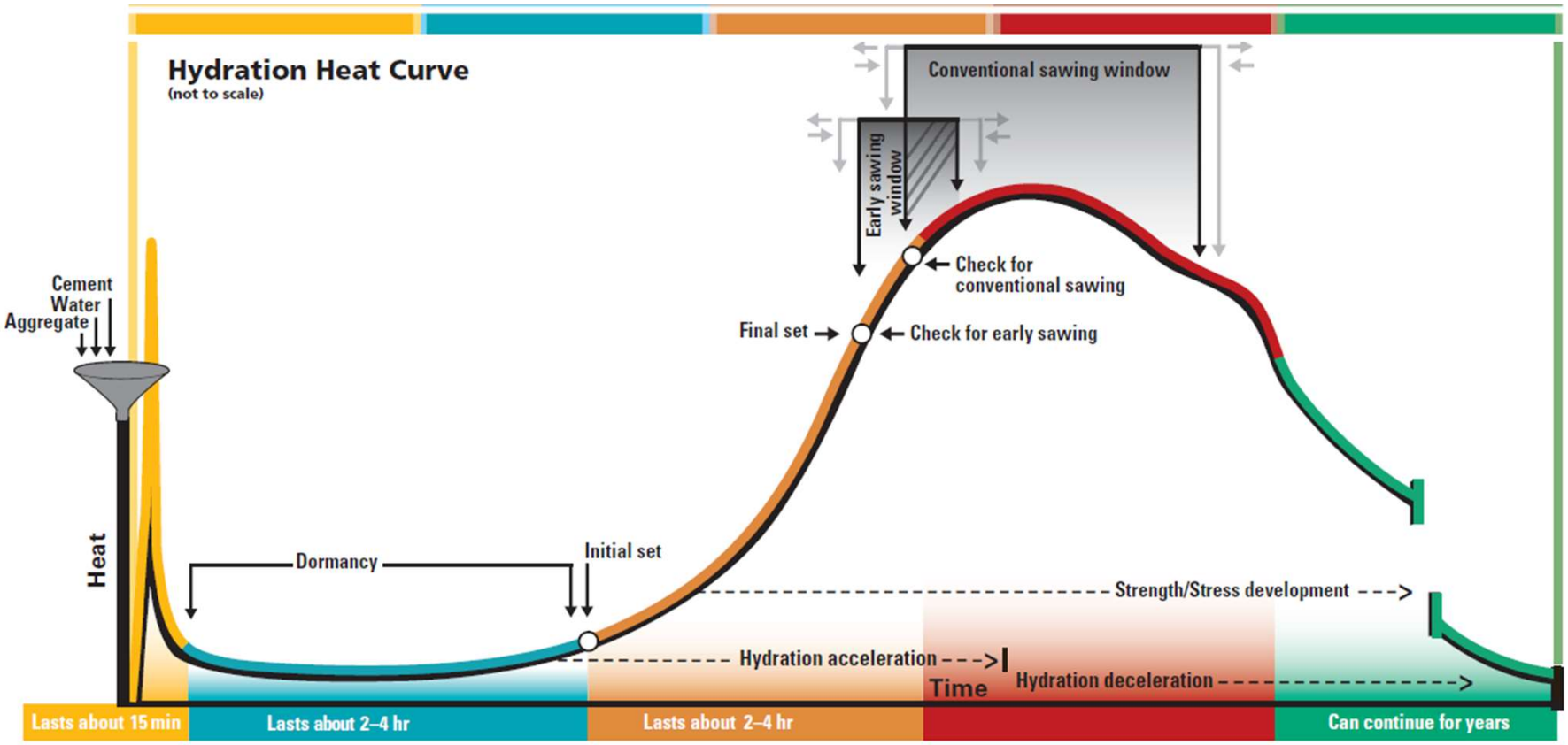
Good Practice - Yes



Sawing - What Happened?

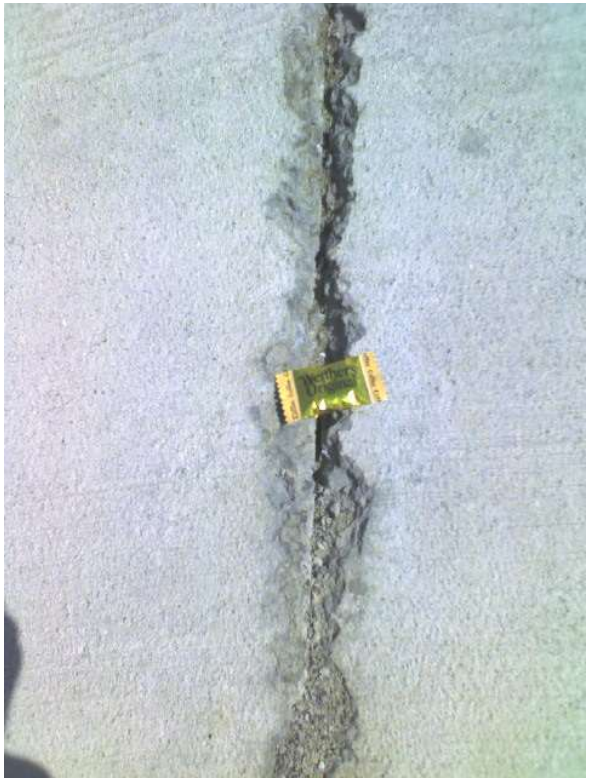
Here are a few examples of where adjustments should have been made on-site

Heat of Hydration Curve



Sawing (What Happened?)

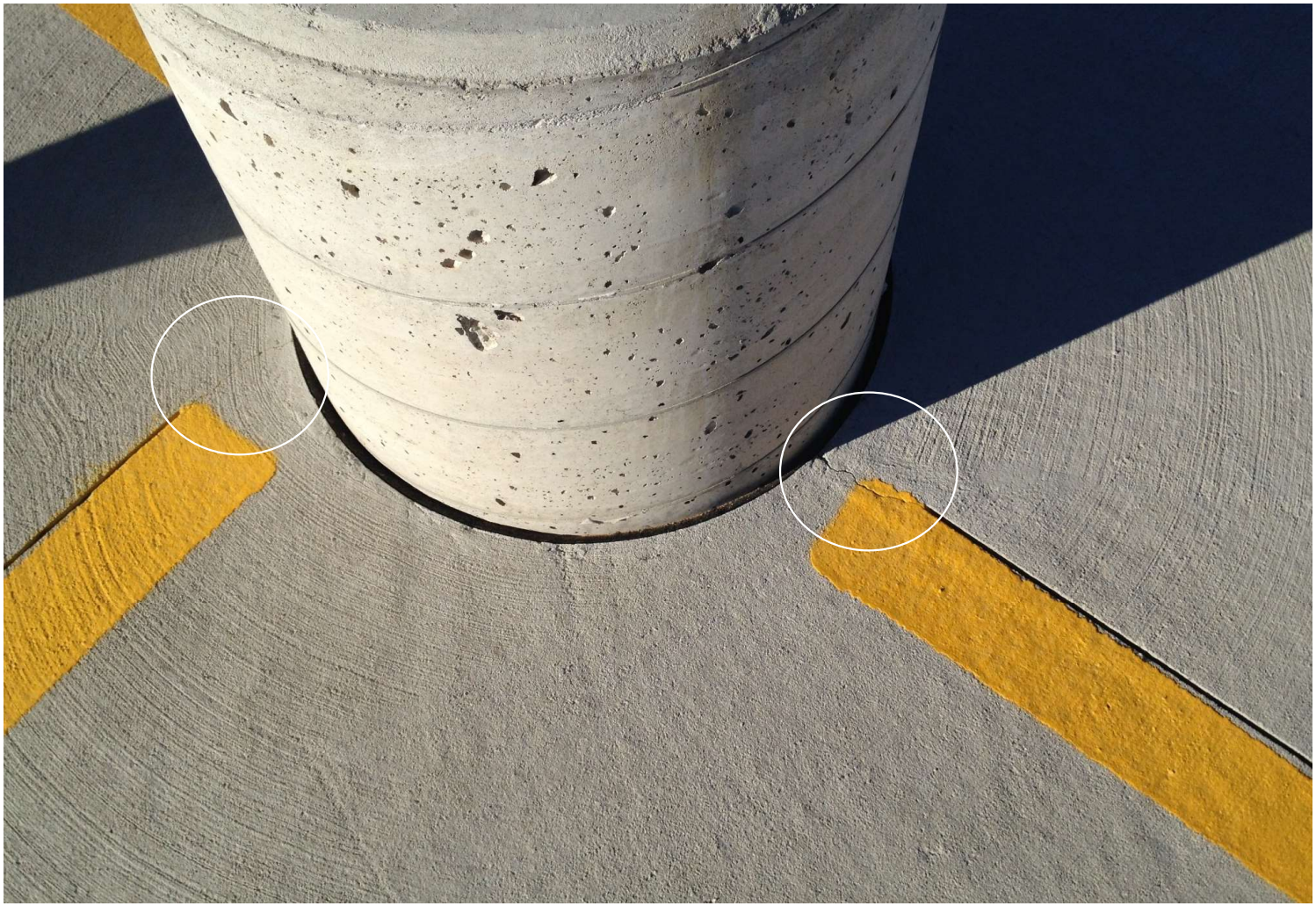
Sawing (What Happened?)

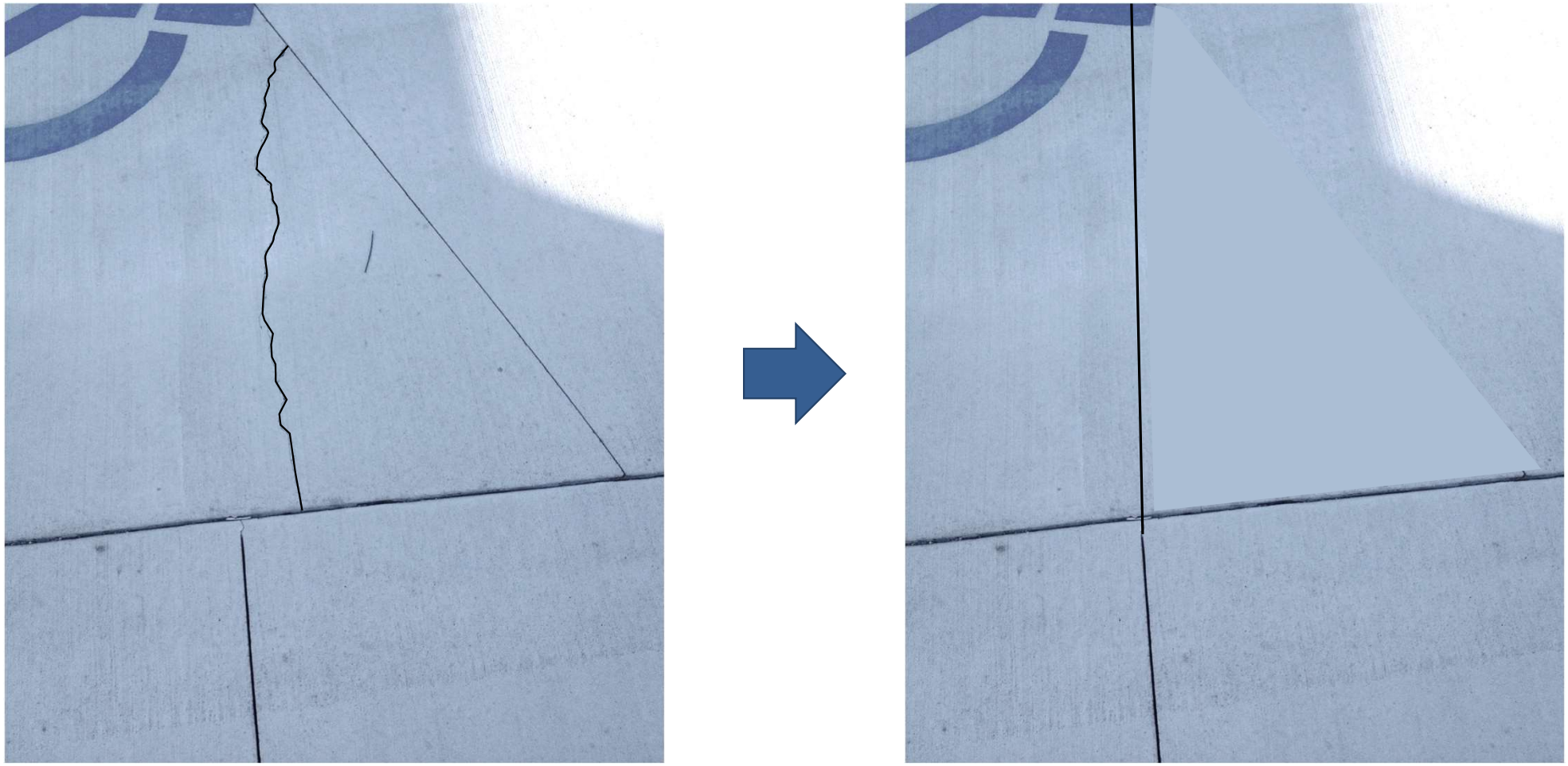


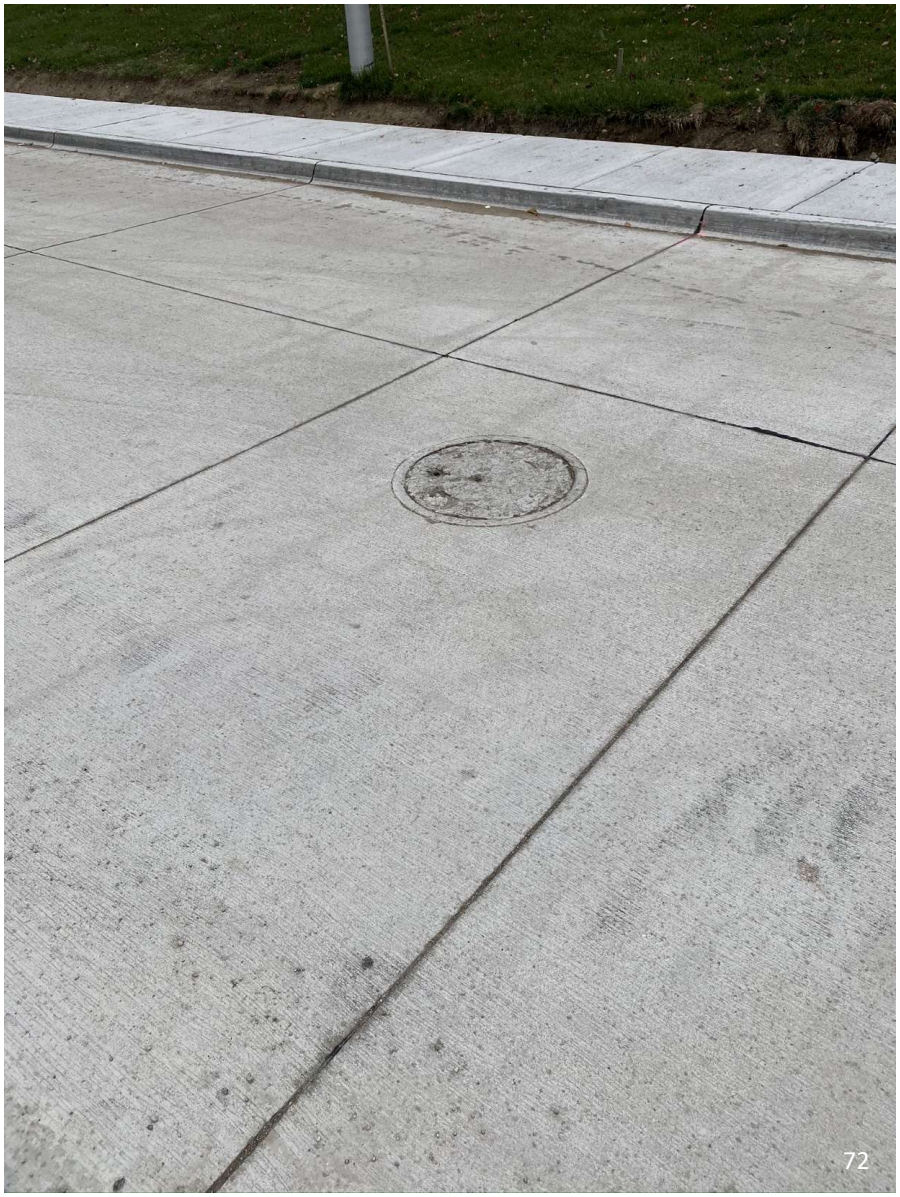
Sawing (What Happened?)

What Happened/Should've Been Done?

Here are a few examples of where adjustments should have been made on-site







TAKE THE COMMON SENSE APPROACH

If something is not right

STOP THE WORK!!!

Questions?

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616-633-9629

THANK YOU!