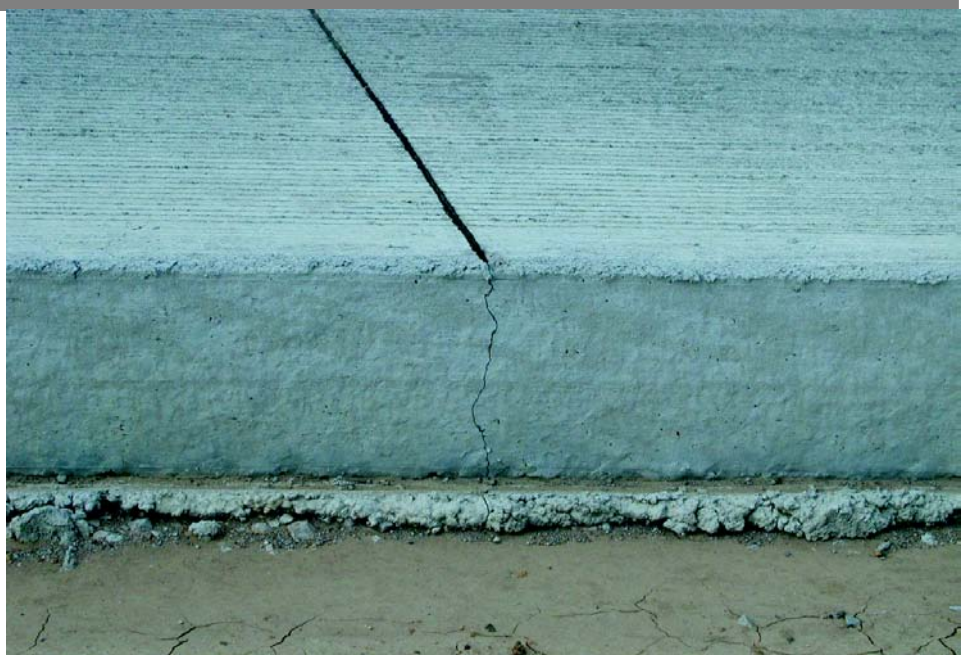
concrete paving workforce reference no. 3

CONCRETE PAVEMENT JOINT SAWING, CLEANING, AND SEALING



PCC Center
Iowa State University
2901 South Loop Drive, Suite 3100
Ames, IA 50010
www.pcccenter.iastate.edu

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3.1. Providing Load Transfer Mechanisms

Overview

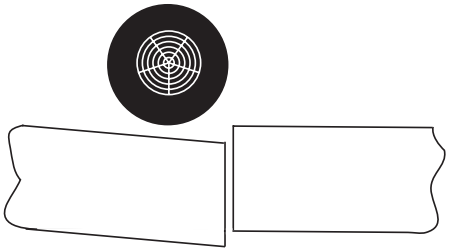
As heavy traffic crosses a pavement joint, the slab on either side may move up and down. This can lead to subgrade pumping and ultimately pavement damage. Joints need load transfer to minimize up and down movement. Load transfer mechanisms include aggregate interlock, doweled joints, and keyed joints.

Common Problems

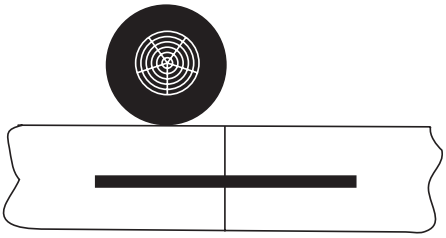
- Pavement damage due to slab movement
- Faulting of the pavement joint caused by insufficient load transfer
- Loss of base support caused by pumping of subgrade material

Aggregate Interlock

Aggregate particles on each side of a joint interlock, reducing pavement movement. Pavement slabs less than 8" thick generally depend on aggregate interlock in the crack below the saw cut to keep the slabs in place. Aggregate interlock can provide load transfer at contraction joints on low-volume roads where contraction joints are closely spaced and truck loading is minimal.



Pavement slabs moving due to lack of load transfer mechanism



Dowels providing load transfer between pavement slabs

Doweled Joints

For 8" or thicker pavements, smooth dowel bars are placed across joints to transfer heavy loads without restricting horizontal joint movement. Properly sized and placed dowel bars can provide the needed load transfer and are recommended at transverse contraction joints when the pavement will experience high traffic volumes and/or large truck traffic. The dowels are typically installed in prefabricated baskets or inserted into the pavement using a dowel bar inserter during construction.

Recommended Procedures

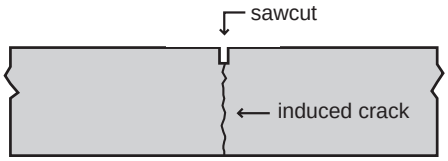
- After the subgrade has been prepared for paving, dowel assemblies can be placed. Set out pins or paint marks on either side of the roadway to mark locations.
- Align dowels exactly centered over the joint line.
- Anchor dowel baskets securely into the subgrade. For 12' or 14' lane widths, typically a minimum of 4 stakes are installed on the leave side of both basket legs.
- Do not place bent dowel baskets. Do not leave bent dowel baskets in place.
- As a final check, make sure
  - All dowels are parallel to the center line of the roadway
  - All dowels are parallel to the base
  - All baskets are properly pinned
  - The center of each basket (i.e., the joint location) is clearly marked

Staking dowel baskets (paver traveling ↓)

3.2. Joint Sawing

Overview

Without planned joints, new pavement will experience random cracking within the first 72 hours of life. This random cracking is aesthetically undesirable and can be detrimental to the long-term durability of the pavement. Joints are cut to control random cracking, accommodate slab movements, ensure joint locations match load transfer device placements, and divide the pavement into practical construction elements. Cuts sawed into the surface of hardening concrete form a line of weakness, causing the concrete to crack below the sawcut instead of cracking randomly.

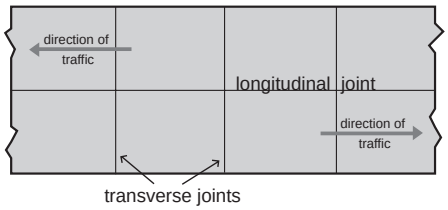


Cross section of contraction joint

Description

Joint Orientation

Joint orientation can be either longitudinal (parallel to the centerline) or transverse (perpendicular to the centerline).



Plan view of transverse and longitudinal joint orientations

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Sawing Window

The timing of saw cutting is critical to preventing random cracking. New pavement must develop enough strength to allow saw equipment to get on the slab and to resist raveling of the joints. The sawing window is the brief period of time during which joints can be sawed before stresses in the concrete cause random cracks to develop.

Conventional Sawing vs. Early Sawing

Early-age (or green) saws can be used to create transverse joints earlier than conventional, heavy sawing equipment. Early-age saws are light weight and use a special skid plate to allow sawing of tender concrete.

Common Problems

- Early cracking due to subgrade restraint, concrete drying shrinkage, temperature/moisture differentials, traffic loading, and/or the combined effects of daytime/nighttime slab curling and warping
- Random crack forming due to late sawing
- Joint raveling due to saw cutting performed too early or improper joint sawing, resulting in spalled joints
- Pavement surface scarring due to sawing equipment operating on pavement too early
- Saw cuts too shallow, thereby insufficient to initiate a crack and prevent random cracking
- Saw cuts too deep, requiring an unnecessary amount of time and work and resulting in reduced aggregate interlock

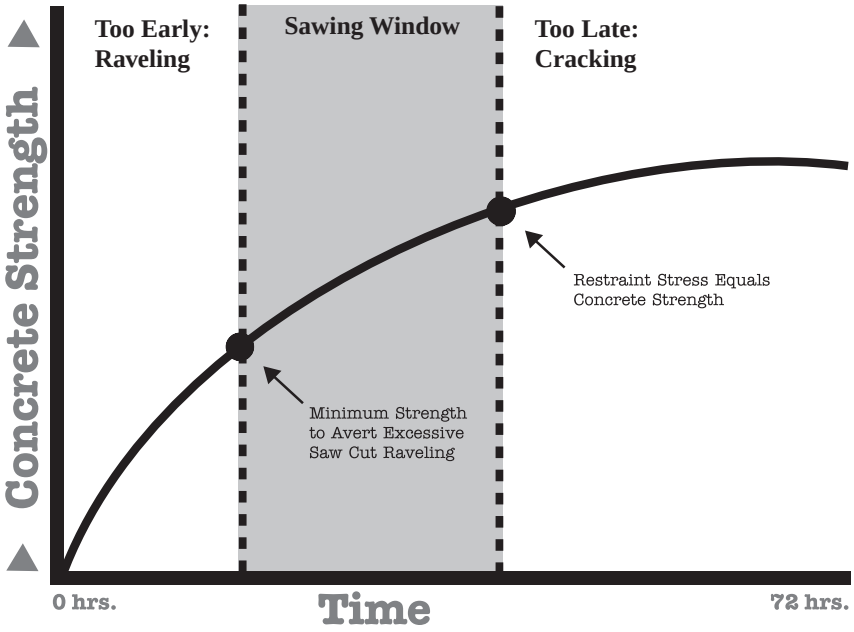
Recommended Procedures

Before Sawing

- Follow the layout on project plans. The engineer must approve any change. If joint layout plans are not available, work with the engineer.
- Clearly and carefully mark the centerline of dowels on forms or the subgrade so joints can be cut in the correct location after concrete is placed.

Conventional Sawing

- Begin saw cutting immediately after the concrete has hardened enough to permit sawing without raveling.



Window of time for sawing

- Start sawing at the beginning of the sawing window, usually 8–12 hours after placement for conventional saws.
- Saw at the minimum design depth, usually about 1/3 of the pavement thickness for conventional saws.
- Continue sawing regardless of weather or daylight conditions in order to complete sawing before random cracking occurs.

Early Sawing

- Perform scratch test, using a nail or knife blade, to see how deeply the surface scratches. As surface hardness increases, scratch depth decreases. Do not saw if scratching removes surface texture.
- Begin sawing as soon as the slab supports the weight of the saw and operator without disturbing the finish, often within about 3 hours of placement, depending on mix and weather conditions.
- Saw at least 1-1/4" deep.
- Monitor the concrete surface temperature. Complete the sawing before the surface temperature begins to fall. On a large pour or thin overlay, several saws may be needed to complete sawing within the sawing window.
- Stop saw cuts 1/2" short of the pavement edge to prevent “blow out” spalls at the slab edge. Once the crack forms at the joint, it will proceed through the uncut portion of the slab to the edge.

Sawing Troubleshooting

- Monitor blade wear and buildup of curing compound on the wheels of the sawing equipment to ensure the minimum depth of saw cuts.
- Saw joints in succession, but if random cracking starts to be encountered, skip three or four joints at a time and move down the slab as rapidly as possible and/or add additional saws. Skipped joints should be sawed with a conventional saw once the cracking potential has been controlled.
- If crack forms before sawing begins, don’t saw the design joint but use a crack saw along the line of the crack.
- If crack develops ahead of the saw, stop sawing immediately. Form the joint sealant reservoir later with a crack saw along the line of the crack.
- If joint begins to ravel, stop sawing and wait for more strength to develop.

Stop early-age saw cut just short of pavement edge

3.3. Constructing Headers (Construction Joints)

Overview

Headers are constructed at the end of a section of pavement, when paving is delayed by 30 minutes or more, or at the end of a day's pour. Common interruptions include bridges or structures, intersections, and emergency shutdowns.

Headers are oriented perpendicularly to the centerline, even if the regular transverse joints are designed to be skewed. The two most common methods of header construction are (1) installing header boards for fresh concrete construction and (2) sawing header joints for hardened concrete construction.

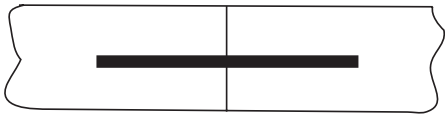
Common Problems

- Headers installed incorrectly, resulting in cracking or other joint problems
- Header slabs not strong enough when paving resumes the following day
- Dowel bars not level, resulting in future joint deterioration
- Misalignment of dowel bars on header using smooth dowels, resulting in a nonworking joint that was intended to allow movement

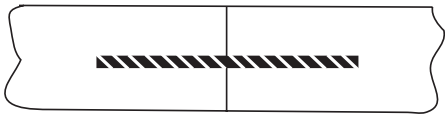
Recommended Procedures

Installing Header Boards

- Install header board.
- To construct a header at the normal location of a transverse contraction joint, properly install spaced smooth dowel bars.
- To construct a header at a location other than at the normal location of a transverse contraction joint, install the header within the middle third of a planned panel with properly sized and spaced deformed tie-bars. Deformed tie-bars should be the same size as transverse joint dowel bars.
- Place dowels or tie bars through the header board in predrilled locations.
- Ensure proper encasement of the dowel bars through additional consolidation with a hand held vibrator.
- Take special care to make sure that the tie or dowel bars are perfectly level and straight.
- Remove the header board before resuming paving.



Header at transverse joint; smooth dowel bar coated to prevent bond



Header at location other than transverse joint; deformed tie bar used

Sawing Header Joints

- Use this preferred method to reduce chance or severity of bump at joint.
- Saw header joint at the location specified.
- Mix the last two concrete batches approaching a sawed header for high early strength gain so that construction can resume the next day.
- Saw excess material full depth and remove it from the planned location.
- Drill holes and grout the dowel bars into the header face.
- Set epoxy grout before resuming paving.

3.4. Joint Cleaning

Overview

Before joints are sealed, joints must be cleaned to remove incompressible materials such as saw-cut swarf, soil, sand, or gravel. Cleaning can be accomplished by water or air blasting.

Common Problems

- Incompressible materials in joints, preventing proper sealant adhesion, resulting in joints that do not function properly.
- Debris in the joints, resulting in spalling, cracking, and other joint distresses

Recommended Procedures

Air Blasting

- After dry-sawing, remove residue by air blasting.
- Air blast immediately prior to sealing.
- Hold the nozzle no more than 2" from the paving surface to blow debris out of the joint.
- Repeat at those joints remaining open overnight or for extended period of time.
- Make sure that the air stream is free of oil. Many modern compressors automatically insert oil into air lines for lubrication. When air blasting joints, disconnect the oil line and install an effective oil and moisture trap.

Water Blasting (after wet sawing)

- Within three hours of wet-sawing, flush the residue away using a minimum water pressure of 1000 psi (7000 kPa).

3.5. Joint Sealing

Overview

Joint sealing prevents incompressible materials from getting lodged in the joint space, which can cause spalls. Joint sealing needs to be done properly to prevent water from entering the subgrade. Sealant materials must be able to withstand repeated expansion and compression as the pavement slabs expand and contract with temperature and moisture changes.

There are three different categories of sealants: hot-poured liquid sealants, cold-poured silicone sealants, and preformed compression sealers.

Hot-Poured Liquid Sealants

Common Problems

- Poured joint sealant does not adhere to the pavement because the joint face is not clean, the shape is not correct, or the face is too moist when the sealant is placed
- Hot-poured liquid sealant does not adhere because of overheating or underheating
- Backer rod traps moisture

Recommended Procedures

- Make sure sealant materials meet the design specification for the application, including compatibility between the sealant and concrete aggregates.
- Clean and dry the saw cut reservoir before sealing the joint. Seal joints only when the joint surfaces appear dry.
- Place joint sealer when the pavement and surrounding air temperature are about 40°F or higher because joint sealer is sensitive to temperature.
- Where specified, backer rods can be installed to provide proper shape factor.
- Use an indirect heating kettle with an agitator to prevent localized overheating. Discard overheated material.
- Use insulated hoses. Fit the application wand with a recirculation line to prevent the temperature of the sealant in the hose from dropping below application temperature.
- Make sure that the top of the sealant is 1/8"–1/4" below the pavement surface.
- Clean any spilled or overfilled joint sealant from the concrete surface.

Cold-Poured Silicone Sealants

Common Problems

- Poured joint sealant does not adhere to the pavement because the joint face is not clean, the shape is not correct, or the face is too moist when the sealant is placed
- Backer rod traps moisture

Recommended Procedures

- Make sure sealant materials meet the design specification for the application, including compatibility between the sealant and concrete aggregates.
- Clean and dry the saw cut reservoir before sealing the joint. Seal joints only when the joint surfaces appear dry.
- Place joint sealer when the pavement and surrounding air temperature are about 40°F or higher because joint sealer is sensitive to temperature.
- Where specified, backer rods can be installed to provide proper shape factor.
- Use joint primer provided by the manufacturer to ensure a good bond between the sealant and the joint reservoir face.
- Tool non-self-leveling sealants before the material cures.
- Clean any spilled or overfilled joint sealant from the concrete surface.

Preformed Compression Sealers

Common Problems

- Preformed compression sealer is loose in the reservoir because the sealant is not sized properly, the joint width is too large, or the sealant is overstretched

Recommended Procedures

- Make sure sealant materials meet the design specification for the application.
- Check joint width for compatibility.
- Make sure the joint width doesn't vary, especially at points where the saw re-enters the joint.
- Clean and dry the saw cut reservoir before sealing the joint. Seal joints only when the joint surfaces appear dry.
- Follow the manufacturer's recommendation for sealant sizing and installation.
- Make sure the sealant is lubricated, straight, vertical, and undamaged before installation.
- Make sure that the installation device does not stretch the sealant.