Troubleshooting: Concrete Projects February 5, 2021

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IOWA STATE UNIVERSITY

Institute for Transportation

National Concrete Pavement

Technology Center









- December 11, 2020 PEM and Reduced-Cement Pavement Mixes in Iowa, Dan King, ICPA & Todd Hansen, Iowa DOT Reduced-cement concrete pavement mixes used in Iowa and how this fits into the Performance-Engineered Mixtures (<u>PEM</u>) program and testing regime.
- January 8 PCC Overlays Fabric and Fiber, Tom Cackler, Ingios Geotechnics & Dan King, ICPA
 Discussion on new technologies for concrete overlays, including fiber-reinforced concrete and geotextile fabric interlayers,
 and their applications on recent lowa projects.
- January 22 Subgrade & Subbase: Iowa DOT Research and Next Steps, Melissa Serio, Iowa DOT Hear how the Iowa DOT is working to improve design and testing of subgrade and subbase layers for concrete pavements.
- February 5 Troubleshooting: Concrete Projects, Jerod Gross, Snyder & Associates, Inc. Tips, tricks and advice for sorting through common problems during concrete pavement construction.
- February 19 Concrete Industry and the Environment Sustainability and How Concrete is Reducing its Environmental Impact, Lori Tiefenthaler, Lehigh Hanson
 Learn how the cement and concrete industries are moving forward in the 21st century to adapt to environmental needs and

Learn how the cement and concrete industries are moving forward in the 21st century to adapt to environmental needs and reduce their carbon footprint.

 March 5 - Construction Inspection – Just in Time Inspection Refresher, John Hart, Iowa DOT & Jerod Gross, Snyder & Associates, Inc.

Whether you will be building or inspecting, gear up for a new year of concrete pavement construction with a refresher on best practices.

https://cptechcenter.org/events/concrete-lunch-and-learn/

Is a Concrete Crack a Failure?

All concrete cracks during curing and shrinkage

We control the cracks with sawcuts

Tight (non-working) cracks can remain

Not All Cracks are Created Equal

Many times, cracks have no detrimental effect on long-term pavement performance.

Map cracking and other near surface cracking usually does not impact pavement life.

Cracks that extend full-depth of the slab must be either "non-working" or repaired.

Duke Cares ...



The early test drive....it happens

What do you do about tracks in the pavement?



Shallow scarring/surface depressions are correctable

Most do not harm the integrity of the pavement



Large depressions and edge damage need replacement





"-man drives through fresh cement"





- Shallow depressions can be corrected with diamond grinding
- Deeper ruts should be repaired
 - Partial-depth
 - Full-depth





What's wrong here?















Transition gutterline jointing



•Use of gutter joints not recommended for T < 9"

• Thinner pavements may not crack at gutter joint, causing longitudinal cracks at mid-panel

•Saw depth must be T/3

Longitudinal Spacing	
6.5' -12.5'	for T < than 9"
14.5' max.	for T ≥ 9"





Gutterline Jointing

Joint Layout





SUDAS 5G-2

Urban Joint Layout



Jointing Tips

Rules for Joint Layout

Things to do:

- Match existing joints or cracks.
- Place joints to meet in-pavement structures.
- Be mindful of the maximum joint spacing.
- Place isolation joints where needed.
- Allow necessary adjustments to joint locations in the field.

Things to avoid:

- Slabs < 2 ft (0.6 m) wide.
- Slabs > 15 ft (4.5 m) wide, unless local experience dictates otherwise.
- Angles < 60° (~ 90° is best); do this by dog-legging joints through curve radius points.
- Creating interior corners.
- Odd shapes (keep slabs near-square or pie-shaped).

http://wikipave.org/index.php?title=Joint_Layout

OR Google: ACPA Wikipave joint layout

Jointing Tips

ACPA Wikipave - Joint Layout

АСРА	Page Discussion						
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 - 3.4 Adjusting Joints for Utility Fixtures
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http://wikipave.org/index.php?title=Joint_Layout

Jointing Tricks

• Longitudinal joint termination (dead end joints)

Core hole





Jointing Tricks

- Longitudinal joint termination (dead end joints)
- Add tie bars





FHWA Technical Advisory Concrete Pavement Joints T 5040.30, Jan. 2019





- Longitudinal crack from frost heave is the likely culprit
- New pavement
- Recommended to remove all snow or no removal at all



- New pavement
- Curb wasn't backfilled at the time, added moisture
- Frost heave

D. Edge-to-Edge (typical of support frost heave/settlement):





- New pavement
- Radial cracking



D. Edge-to-Edge (typical of support frost heave/settlement):



- New pavement
- Radial cracking

D. Edge-to-Edge (typical of support frost heave/settlement):







Cracking from Settlement / Poor Support



Dan DeGraaf, Michigan Concrete Association

Corner Cracking



Pavement too thin & saturated subgrade

Tie Bar Displacement





Tie Bar Displacement

- Verify steel at joint
- Sawcut and remove exposed steel
- Surface patch
- Install tie bars by cross-stitching





Figure 8.19. Drilling holes for cross stitching



Figure 8.20. Completed cross stitching

What happened? Plastic Shrinkage

Preparation: Watch the weather

Apply adequate cure quickly



If it happens: Do Nothing Diamond grind Surface sealers

What happened? Sawcut to shallow





Joint Sawing

- Check saw cut
- Check saw depth
- Maintain blades and equipment
 Tighten and replace blades
 - Skid plate on early entry saw
- If longitudinal isn't deep enough, may have time to re-saw

a) No raveling—sawed later in the window



b) Moderate raveling—sawed early in the window



c) Unacceptable raveling—sawed too early



ACPA



Combined Shrinkage and Curling Stresses



If the sum of stresses exceeds established strength, cracks can develop.

www.hiperpav.com

What Happened?

Partial Depth Repair

Joint not restored properly

Expansion & contraction

Patch de-bonded



Construction – Partial Depth Repairs





Critical to Restore the Joint

- Better results with compressive relief material (board)
- <u>Saw to full depth</u> of patch **only** if board cannot provide complete separation of patch material on both sides of joint (Iowa DOT)
- SUDAS requires board

Chapter 5 - Concrete Pavement Preservation Guide

Construction – Partial Depth Repairs



Chapter 5 - Concrete Pavement Preservation Guide

Duke Cares ...

- Duke wants good concrete...
- Low water/cementitious material ratio
 w/cm 0.40 0.42
- Good air distribution
 - Target 8%, 0.008 in. spacing
- Supplementary Cementitious Materials SCMs (fly ash, slag)
- Durable & well graded aggregates
- No Magnesium Chlorides
- Adequate curing



Duke Cares ...

• If one or more parameter is off, we have risk for material related distress





Don't Add Water Like This



Ensure Uniform and Adequate Cure



Paint it White!

Aggregate Stockpile Management

Contamination - mud balls





In the aggregate



On the tires



Dig too deep

Repairs for PCC Cracking

	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	Transvorso	LUC Description	Full Danith	Undowelled	Saw/route and seal crack	T 13 T T	1
	Crack	Transverse	Mid-Panel	Full-Depth	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		Iowa DOT Construction Manual Appx 9-6
		Transverse			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	Full-Depth	Undowelled	Saw and seal crack Seal joint	<u></u>	
	on don		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	X	A7

Plastic Shrinkage Cracking



Diamond Grind Surface

Transverse Cracking (mid-panel)



Saw/route and seal crack if undoweled*

Full-depth repair if doweled

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Transverse Cracking (<5' from joint)



Saw/route and seal the crack if undoweled

Full-depth repair if doweled



Sawed too late

Transverse Cracking (<5' from joint)



a. Proper weakened plane saw cut and induced crack Jeff Uhlmeyer, Washington State DOT



b. Slab cracking occurring parallel to weakened plane saw cut Derek Tompkins, American Engineering Testing, Inc.

Spalled Transverse Joint



Longitudinal Cracking (<1' from joint)





Saw/route and seal the crack or crossstitch the crack

Epoxy sawed joint if uncracked

Longitudinal Cracking (> 5' from joint)





Cross-stitch the crack*

*If working crack

Saw too late or not deep enough

Controlling Popouts



Lightweight materials sneak around from the grout box if head is too low

Good example of keeping enough material in front of paver

Controlling Popouts



May result from insufficient material in front of paver

Mitchell County, Iowa



Boxouts



Protect new pavement when removing forms from boxouts





Rain Damage







Cover it and leave alone

Do not finish rain water into the surface

Diamond grind to re-establish texture

3 levels of rain damage – lowa DOT

Rain Damage







Case 1

Texture is absent from practically all of surface area. <u>Surface appearance may have a "sandy" appearance</u> or may be "pock" marked from the rain droplets. An occasional edge repair may be required due to excess edge slump or from edge rounding. <u>Small areas along edge may</u> <u>have coarser particles of fine aggregate exposed</u>. Surfaces finished in the rain or after a rain are also included in Case I. This includes any manipulation of the pavement surface including mopping of the surface to attempt to remove rainwater or retexturing while rainwater is present.

Case 2

<u>Texture is totally absent from the surface and cement</u> <u>mortar has been eroded</u> to an extent that coarser particles of the fine aggregate fraction are generally exposed. <u>Some</u> <u>slight troughs or depressions</u> are apparent, exposing coarse aggregate particles, but this damage is confined to a limited area or randomly spread intermittently throughout damaged area. Some edge repairs may be required to restore eroded edges. <u>Surface mortar that was removed by</u> <u>rain water, but later replaced</u> or supplemented with plastic concrete is included in Case II since a cold joint or sand lens with minimal portland cement paste contact may have been inadvertently incorporated into the slab.

Case 3

<u>Surface mortar has been practically all removed to an</u> extent that coarse particles of the coarse aggregate fraction are visible. <u>Considerable erosion of edges has occurred</u>, but not to an extent that pavement width is affected. Intermittent edge repair may be required as well as some surface patching of slight troughs or depressions that may have formed in pavement surface due to flowing water.

85% payment

RESOURCES

- Iowa DOT PCC Paving Field Inspection
 https://iowadot.gov/training/ttcp/training_manuals/PCCField.pdf
- ACPA WikiPave
- SUDAS Section 7010
- Iowa DOT Section 2301
- CP Tech Center cptechcenter.org



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Thank you

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