Basics of Concrete Paving Construction and Inspection

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

Tech Center

IOWA CONCRETE PAVING ASSOCIATION

Introduction

- Concrete paving operation:
  - Delivery
  - Placement
  - Finishing
  - Texturing
  - Curing
  - Sawcutting

- Inspection – What is it and Why?
  - Provide a level of oversight
  - Assure conformity with plans and specs
  - Opportunity for timely remedial action to problems
  - What it is Not- Running Contractors Operation

Resources

Section 7010:
Portland Cement Concrete Pavement

Section 2301
Portland Cement Concrete Pavement

Iowa DOT Construction Manual

Construction Manual

Chapters	Descriptions
Foreword	
Chapter 1	General Information
Chapter 2	Contract Administration
Chapter 3	General Inspection
Chapter 4	Construction Survey
Chapter 5	Safety
Chapter 6	Grading
Chapter 7	Erosion Control
Chapter 8	Hot Mix Asphalt (HMA) Pavement, Bases and Subbases
Chapter 9	Portland Cement Concrete (PCC) Pavement
Chapter 10	Environmental
Chapter 11	Structures
Chapter 12	Incidental Construction

Safety

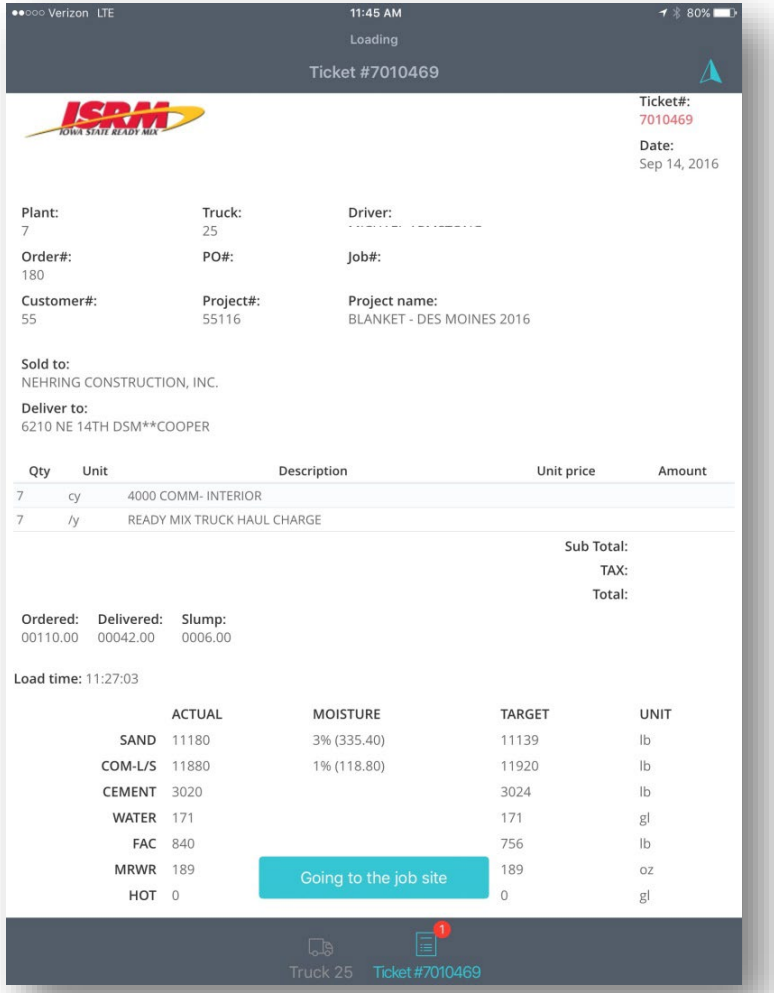
What operations cause safety risks?

- Trucks backing
- Spreader belt
- Finishing
- Noise
- Batch tickets
- Traffic control
- Trip hazards (stringline, windrows, dowel baskets, etc)

Safety

What can be done to improve safety?

- **E-Ticketing**
- Safety meetings / training
- High visibility gear
- Never assume operators see you
- Parking off site
- Dust control
- Communication
- Checklists



Traffic Control

- Review the work zone day and night
- Communicate deficiencies to Contractor/Inspector
- Be timely in repairs and adjustments
- Document

Pre-Pour Conference

- Chain of Command / Responsibilities
- Approved Mix Design & Source
- Batch Plant Operation / Certification
- Paving Schedule
  - ✓Prime
  - ✓Subs
- Paving Survey
- Hot/cold Weather Protection
- Water truck to wet the subgrade/subbase & haul road
- Backup Saws
- Sampling and Testing

Role of the Inspector – Paving Day

- Check the grade
- Wetting the grade
- Concrete Delivery
    - Delivery time
    - Adding water
    - Mixing
    - Clean boxes
- Concrete placement
- Concrete testing
    - Air content
    - Slump
    - Temperature
- Concrete pavement testing
    - Edge slump
    - pavement width
    - cross slope
    - depth/thickness
    - Yield
- Vibration
- Steel placement
- Finish
- Texture
- Curing
- Sawing
- Station Markers
- Strength
    - beams
    - maturity
- Date stamp
- Haul road
- Documentation
- Non-compliance

Iowa DOT PCC Paving Field Inspection
https://iowadot.gov/training/ttcp/training_manuals/PCCField.pdf

Check Grade & String line

- Check grade using stringline and level for inconsistencies
- Look for debris, bar positioning & grade conditions
- View paver stringline for misalignment, sags or rises
- Periodically walk ahead of paver
- Check grade profile with stringline

Steel Placement

- Insure proper placement, fastening & alignment (if not, integrity is compromised)
- CD basket provides load transfer

Paint mark to guide sawing operation

Iowa DOT
Article 2301.03, E
Construction Manual
9.25 & 9.26
Standard Road Plan
PV-101

SUDAS
Sect. 7010 3.02, E

Steel Placement

- Walk the grade, look for bar placement and alignment
- Check joint locations with adjoining joints particularly in multiple pass construction
- Review at intersections, crossovers, intakes or anywhere where joint has to match another feature
- Typically 8 stakes per lane width

Sighting the grade for dowel alignment

Producing Concrete

Central/ Portable mixed batch plant

- Mixed prior to discharge
- Increased production
- Direct control
- Check in

Stationary dry-batch plant (Ready Mix)

- Batched directly into truck
- Truck does the mixing

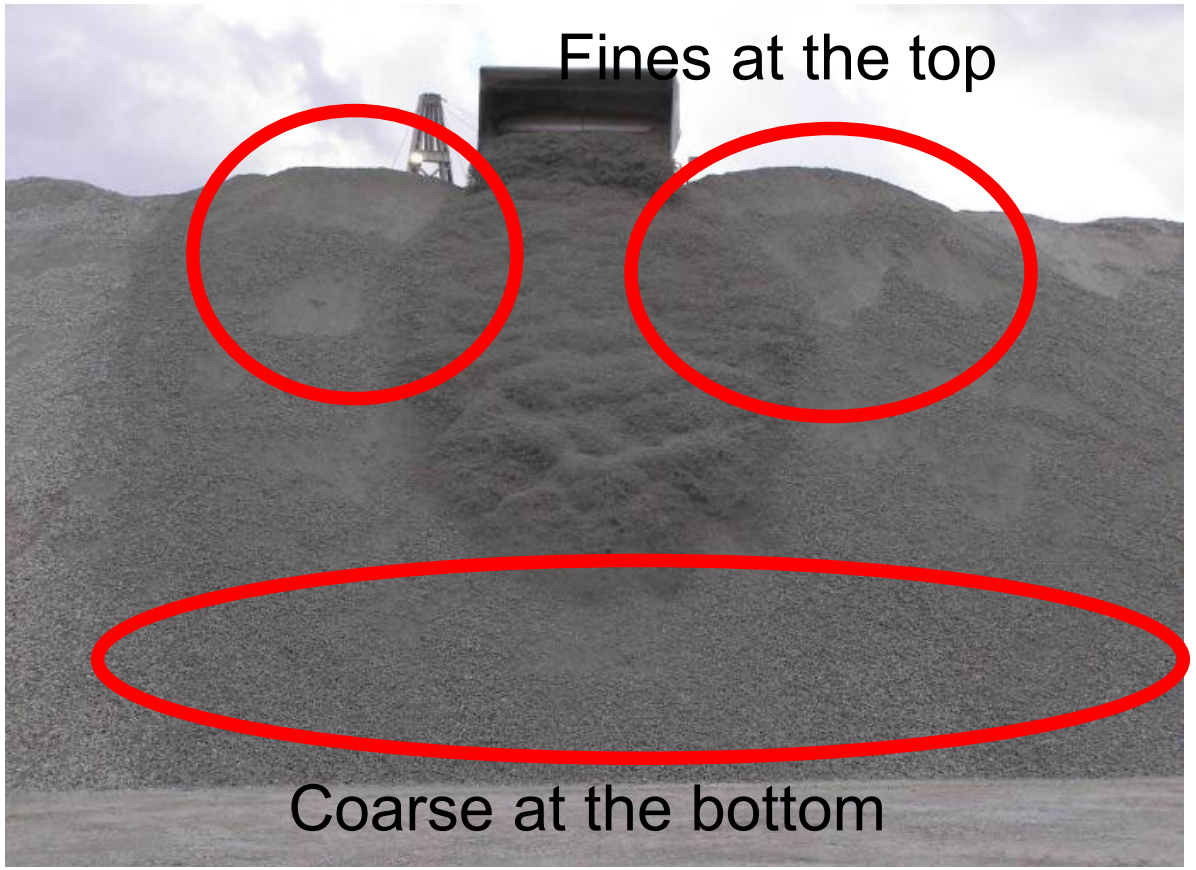
Safety at the Plant

- Safely sample
- Check in
- Be aware of flow
- Acknowledgement with operators
- Follow rules of Contractor
- Production vehicles have ROW

Plant

Minimize Segregation

- Avoid high cone shape piles
- Pile should be no higher than end loaders dump
- Build pile outward
- Limited space use 4ft. tall lifts



Plant

Adequate Mixing Time

- Uniformity
- Air entrainment
- Strength
- Workability

Wetting the Grade

Grade must be moist ahead of the paver

- Very important step (especially if hot, dry windy)
- Dry subgrade draws water from the concrete
  - Can lead to cracking
- Do not over water

Concrete Delivery

Dump truck – 30 minute time limit
May be extended 30 min with approved retarder

Ready mix truck – 90 minute time limit

Iowa DOT:
Articles 2301.02, D, & 2001.21

SUDAS:
1.05 & 3.01, A (References Iowa DOT)

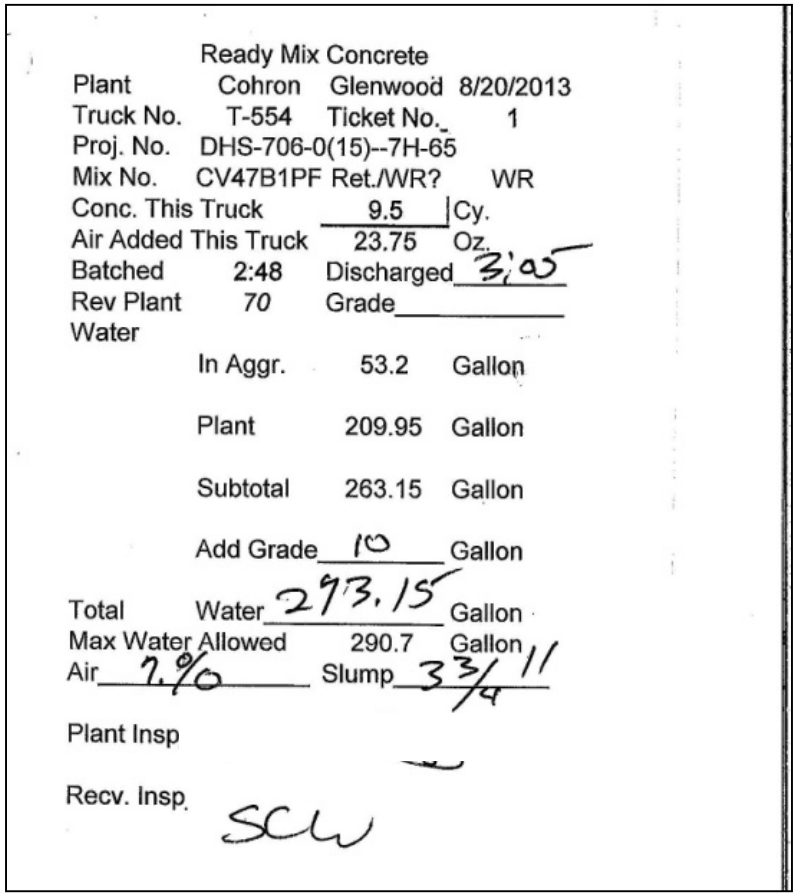
Adding Water

Wet burlap drag

- Specs prohibit adding water to slab by spray, wand, brush or other methods
- Wet burlap drag is allowed
- Decrease moisture if slurry or small bubbles develop on trailing edge of burlap

Adding Water (Ready Mix)

- Watch the amount of added water!
- Added water not to exceed max w/c (check batch tickets)
- If water added, mix for additional 30 revolutions



Ready Mix Concrete

Plant	Cohron	Glenwood	8/20/2013
Truck No.	T-554	Ticket No.	1
Proj. No.	DHS-706-0(15)--7H-65		
Mix No.	CV47B1PF	Ret./WR?	WR
Conc. This Truck	9.5	Cy.	
Air Added This Truck	23.75	Oz.	
Batched	2:48	Discharged	3:05
Rev Plant	70	Grade	
Water			
	In Aggr.	53.2	Gallon
	Plant	209.95	Gallon
	Subtotal	263.15	Gallon
	Add Grade	10	Gallon
Total	Water	273.15	Gallon
Max Water Allowed		290.7	Gallon
Air	7.0%	Slump	3 3/4

Plant Insp

Recv. Insp SCW

Adding 1 gallon / cu. yd:

- Increases workability ~1”
- Lowers strength ~200 psi
- Increases drying shrinkage ~10%
- Increases permeability ~ 50%

Air Testing

- Calibrate the air meter & backup air meter
- Iowa DOT & SUDAS

8.0% ± 2% (slip form)

7.0% ± 1.5% (non slip form)

Air Content:

Iowa DOT:

Article 2301.02, B

I.M.

318,327,527,204,530

SUDAS:

7010, 3.08 B

Location & frequency of Tests

Iowa DOT:

I.M. 327, 204

Construction Manual 9.61

SUDAS:

7010, 3.08 A

Air Testing – Aggregate Correction Factor

Source #	Name	Beds
A07008	Morgan	5, 9
A09006	Tripoli Platte	1-5
A10008	Oelwein	4-5
A10010	Hazelton	4
A10016	Oelwein #2	13-16
A10030	S. Aurora	1-3
A16006	Stonemill	4
A23004	Behr	1-2
A23006	Shaffton	16-17
A42002	Alden	0-3, 3
A44006	Leeper	8-11
A45008	Dotzler	7-10A
A49020	Preston	7-10
A49024	Maquoketa	1-8
A50002	Sully Mine	36-41
A52004	Conklin	23-24
A52006	Klein	23-24
A53002	Behrends	1-5
A53010	Ballou-Olin	3, 2-3
A53016	Stone City	2B-3
A54002	Keswick	13-15
A57008	Bowser-Springville	6-7, 8-9
A57018	Cedar Rapids	2-9
A57028	Beverly	6-7
A58002	Columbus Junction	16-19
A63002	Durham	101
A82002	McCausland	17-19, 1-16
A89002	Douds Mine	6-13
A92002	Westchester	14-16

Iowa DOT I.M. 318

Example: For slip form PCC paving utilizing ready mixed concrete, specified air is 8.0% plus or minus 2.0%. For an aggregate correction factor of 1.0%, the target would be 9.0% (9.0% equals the specified target of 8.0% plus the aggregate correction factor of 1.0%) plus or minus 2.0%.

Air Testing – Behind the Paver

- Slipform pavers can have air loss of 2 % or greater
- Specs allow for checking behind the paver
- Allow check once in morning & if mix changes, once again

Sampling concrete behind the paver

Air content should be checked behind the paver once each day for the first three days of paving. After that, air should be checked once per week behind the paver to verify the amount of air loss through the paver is consistent. **Iowa DOT Construction Manual 9.63**

Slump Test

Iowa DOT:
2301.02 B, IM 204

SUDAS:
7010 2.02 B

- Used to check consistency between loads
- Used to approximate workability and measure consistency
- Iowa DOT not required for slip form paving
- SUDAS ½” – 2 ½” (machine finish) ½” – 4” (hand finish)

Strength Testing

- Concrete strength determined by beam breaks (unless using Maturity Method)
- Min of two beams per day
- Cured like pavement and stored on site
- Strength and time required to determine pavement opening
- Smaller beams / cylinders (and rods) now (depending on coarse aggr. Size)

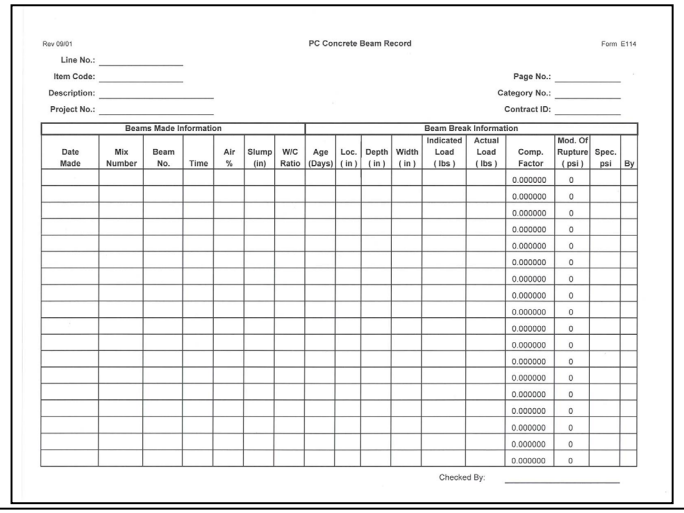
Iowa DOT:
Article 2301.03, U
I.M. 316, 328, 383

SUDAS:
7010 3.08, A

Maturity Testing

- I.M. 383
- Time-Temperature Factor wires
- Inspector monitors periodically

Maturity probe location with hand held thermometer



Rev 09/01 — PC Concrete Beam Record — Form E114

Line No.: _____ Page No.: _____
Item Code: _____ Category No.: _____
Description: _____ Contract ID: _____
Project No.: _____

Beams Made Information							Beam Break Information								
Date Made	Mix Number	Beam No.	Time	Air %	Slump (in)	W/C Ratio	Age (Days)	Loc. (in)	Depth (in)	Width (in)	Indicated Load (lbs)	Actual Load (lbs)	Comp. Factor	Mod. Of Rupture (psi)	Spec. psi	By
													0.000000	0		
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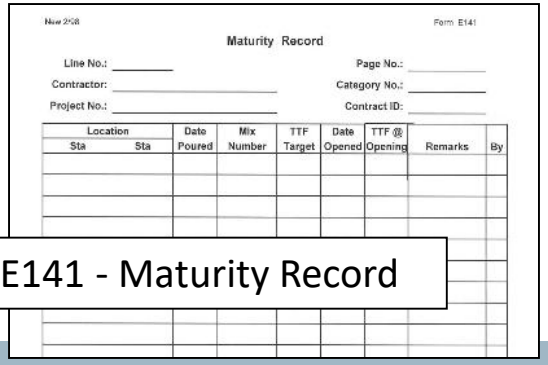
Checked By: _____

Form E114- Maturity Strength Curve



Maturity Record — Form E141

Line No.: _____ Page No.: _____
Contractor: _____ Category No.: _____
Project No.: _____ Contract ID: _____

Location Sta	Location Sta	Date Poured	Mix Number	TTF Target	Date Opened	TTF @ Opening	Remarks	By

Form E141 - Maturity Record

Check Cross Slope and Edge

- Check periodically & before finishing operation
- Increase in mix water may cause edge slump
- ½” edge slump permissible if no abutting pavement.
- ¼” edge slump permissible if abutting pavement

Check Thickness

- Check periodically
- Notify contractor of thickness discrepancies
- Document in inspector daily diary

Iowa DOT:
Article 2301.03, A, IM 346

SUDAS:
7010 3.07.D

Check Thickness

MIT T2 Scan

Iowa DOT DS 15064 - PCC Paving Non-Destructive Thickness Determination

Keep discs a minimum of 3’ away from steel

Images: FHWA

Yield Calculation

- During the paving operation, the inspector should run yield checks throughout the day.
- Compared delivered with placement. Calculate cubic yards per station.
- Cubic yards delivered will be obtained from the concrete tickets.
- A yield of 103% to 106% Is normal.

New 2/98 — PCC Pavement Field Page — Form E137

Line No.: _____
Item Code: _____
Description: _____
Project No.: _____
Page No.: _____
Category No.: _____
Contract ID: _____

Date	Station From	Station To	Lane	Mix No.	Time Start	Time Stop	Length (ft)	Width (ft)	Estimated CY Today	Used (CY) Today	Used (CY) To Date	Est. Used (%)	Slip or Fixed (S / F)	Cold Wethr (Y / N)	By
							0.00				0.00	0.0			
							0.00				0.00	0.0			
							0.00				0.00	0.0			
							0.00				0.00	0.0			
							0.00				0.00	0.0			
							0.00				0.00	0.0			
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Document paving information on Iowa DOT Form E137

Vibration Monitoring

- Vibration gives proper consolidation
- Over-vibration can segregate aggregates & lower air content
- Check twice per day for allowable (<50,000 sq.yds.)

Iowa DOT:
Article 2301.03, A
Construction Manual 9.64
I.M. 384

SUDAS:
7010 3.01, B

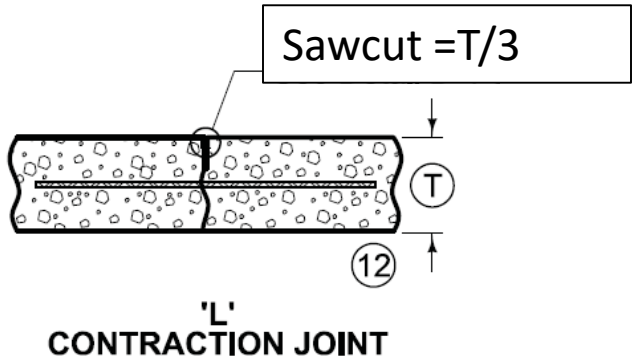
Vibration Monitoring

Vibrator frequency display

- Internal vibrations 4,000 – 8,000 vpm
- Surface & hand-held 3,500 – 6,000 vpm
- Iowa DOT specs require a display on the paver for projects over 50,000 SY

Tie-Bar Insertion

- L – bars are placed manually or mechanically
- Timing device used to obtain spacing



Finishing

Hand float and straight edge

- Remove small imperfections
- Tight surface with few holes
- Extensive finishing can damage integrity of slab
- Do not add free water

Iowa DOT:
Article 2301.03, A, & H
Chapter 9.14, 9.41

SUDAS:
7010 3.02, H

Texturing (Micro)

- Micro texture placed using burlap or artificial turf
- Adequate contact area
- Keep moist (not soaking)
- Keep clean

Iowa DOT:
Article 2301.03, H
Construction Manual 9.42

SUDAS:
7010 3.02, H, 5

Texturing (Macro)

Macro Texture

- Longitudinal tining produces less noise
- Shallow produces less noise than deep
- Adjust tine angle and length for desired depth (consistency)
- Minimize positive texture by keeping tines straight and clean
- Don’t stop the tine rake in down position
- Some hand work areas can be excluded

Texture

SUDAS
Microtexture:
Turf or Burlap Drag
Macrotexture:
(when specified)

Iowa DOT
Microtexture:
Turf or Burlap Drag
Macrotexture when speed limit is greater than 35 mph. (Table 2301.03-1)

Pavement/Placement Type	Macrotexture Orientation		Macrotexture Not Required
	Longitudinal	Transverse	
Mainline - slip-form	X		
Mainline - handwork		X	
Turn lanes - slip-form	X	1	
Turn lanes - handwork		X	
Ramps - slip-form	X	1	
Ramps - handwork		X	
Gapped sections of mainline - slip-form	X	1	
Gapped sections of mainline - handwork		X	
Radii			X
Crossovers			X
Paved Medians			X
Shoulders			X
Irregular Areas			X
Bridge Approaches		2	

1. Transverse macrotexture permitted for placements less than 600 feet in length.
2. Transverse tining required unless longitudinal grooving in concrete is specified in the contract documents.

Make Curing Uniform

- Surface should be uniform white on surface and vertical edges
- Windy days require additional effort
- Application rate = 0.067 gal per SY
- Apply within 30 min.
- Should not track after 12 hours

Curing

- Agitate before and during application
- Check lot number with approved list from Iowa DOT Office of Materials

Iowa DOT:
Article 2301.03, K, & Section 4105

SUDAS:
7010 3.02, I

Cold Weather Protection

Min. temp needed to pave:
34ºF and rising

Temp for stopping:
38ºF or less and falling

Min. mix temp:
40ºF

- Burlap cover can be used to accelerate curing process or protect during cold weather
- Monitor forecast temperature to determine if protection is necessary

Conventional Saws

- Saw 8-12 hours after paving
- Diamond blades used
- Can be dry or wet sawing

Figure 8-23. Close-up of different degrees of raveling caused by joint sawing (ACPA)

Conventional saw on longitudinal joint

Early Entry Saws

- Used on Transverse and Longitudinal Joints
- Saw within 3 hours
- Minimal dust
- Quieter than conventional saws

Residue from early entry sawing

Sawcut at Edge

Pull up of sawcut before edge of slab

Blowout at edge of slab

- Iowa DOT Const. Manual Sec 9.21
- Prevents spalls or blow outs
- Prevents sealant from running out of slab edge

Late Sawcut

- Sawing must be continuous regardless of weather
- Sawing discontinued if crack develops ahead of saw
- Article 2301.03, N defines repair for random transverse cracks
- Appendix 9-6 Iowa DOT Construction Manual – Recommended Repairs for PCC Cracking

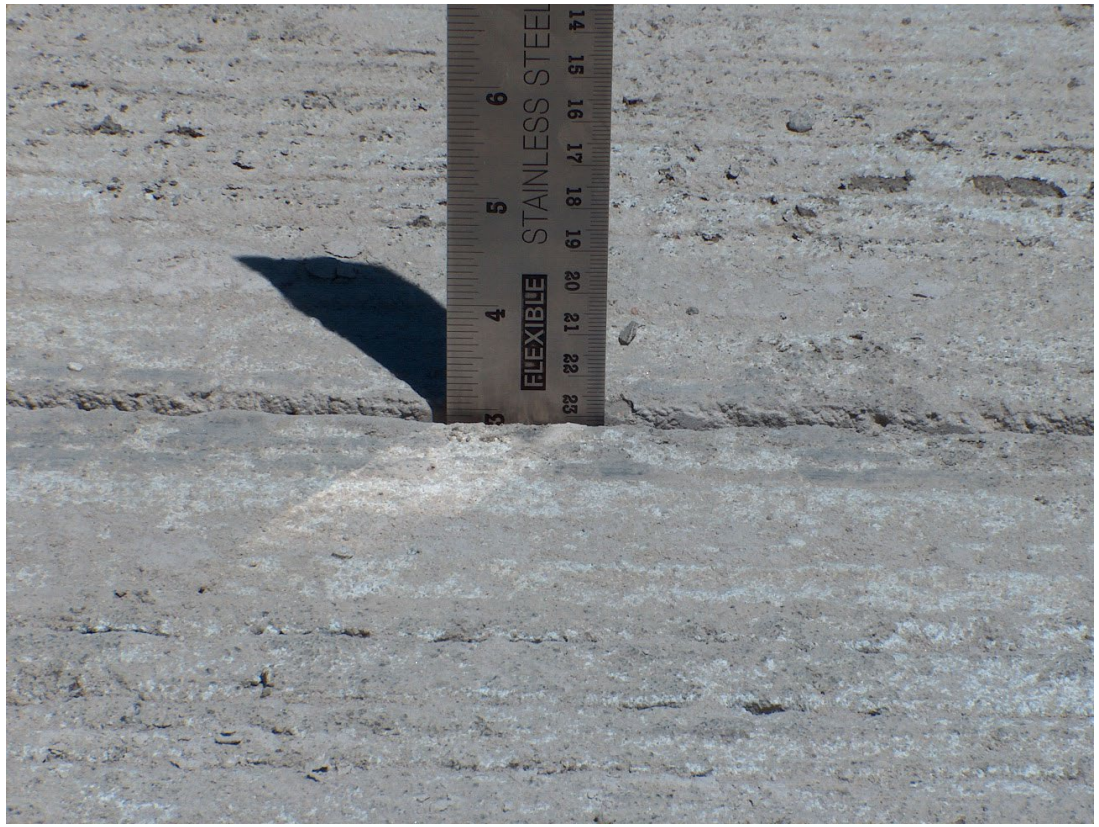
Late sawing crack

Compliance

- Inspector encounters work that is outside of the specifications, it is considered to be non-complying
- Inspector should notify the Project Manager
- Project Manager will then issue a Non-Compliance Notice
- Iowa DOT has a non-compliance Form 830245
- Can result in price adjustment
- Const. Manual 2.53

Communicate with the contractor when questionable activities are observed

Sawcut Depth



- Road Standard PV-101 (Iowa DOT & SUDAS) defines all joints
- Check saw depth and width daily
- Inadequate depths may lead to cracking

Iowa DOT:
Article 2301.03, N
Road Standard PV-101
Construction Manual 9.21, Appendix 9-6

SUDAS:
7010 3.02, J

Joint Sealing

Air blast of joint prior to sealing

- Joint sealer must meet Section 4136
- Flush residue within 3 hours of wet saw
- Blow residue within 3 hours of dry saw

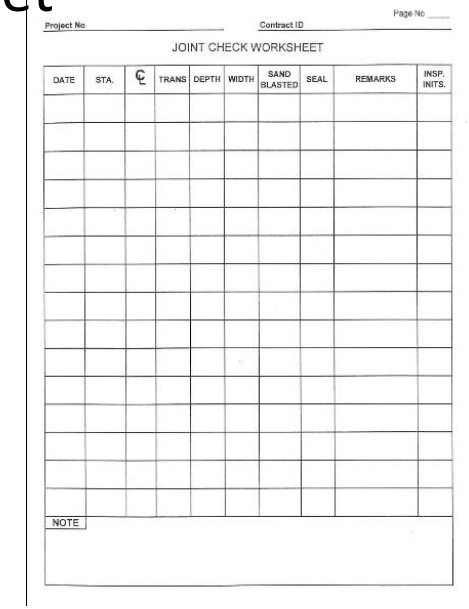
Iowa DOT:
Article 2301.03, P & Section 4136
Road Standard PV-101
Construction Manual 9.22 and 9.23

SUDAS:
7010 3.02, K

Joint Sealing

Installing hot pour sealant

- Place when air temperature is 40 degrees F or higher
- Seal when joint surface appear dry
- Iowa DOT joint worksheet



Project No Contract ID Page No

JOINT CHECK WORKSHEET

DATE	STA.	℄	TRANS	DEPTH	WIDTH	SAND BLASTED	SEAL	REMARKS	INSP. INITS.

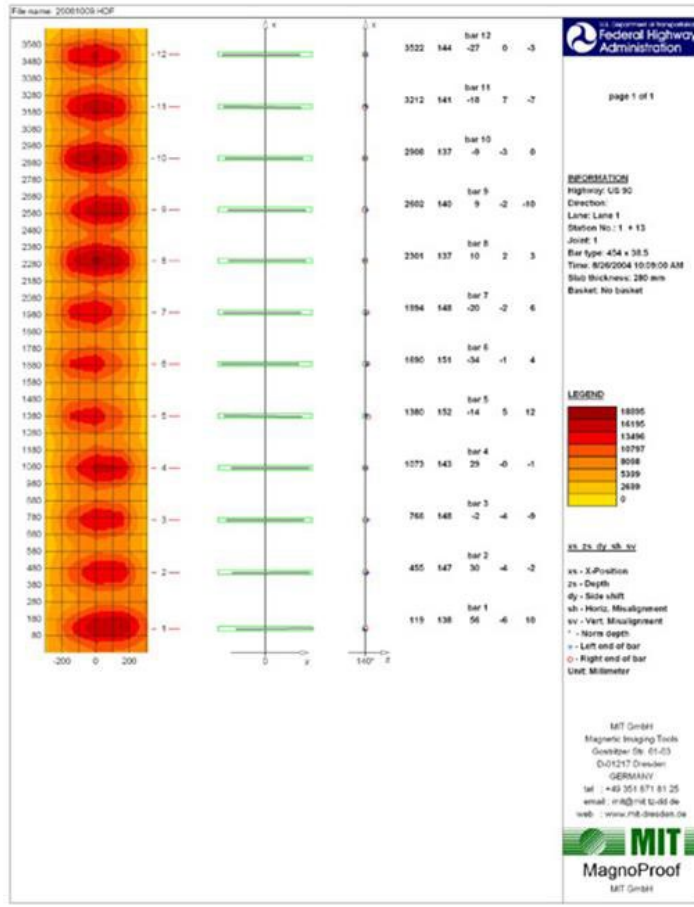
NOTE

Joint Check Worksheet

Steel

Dowel Baskets

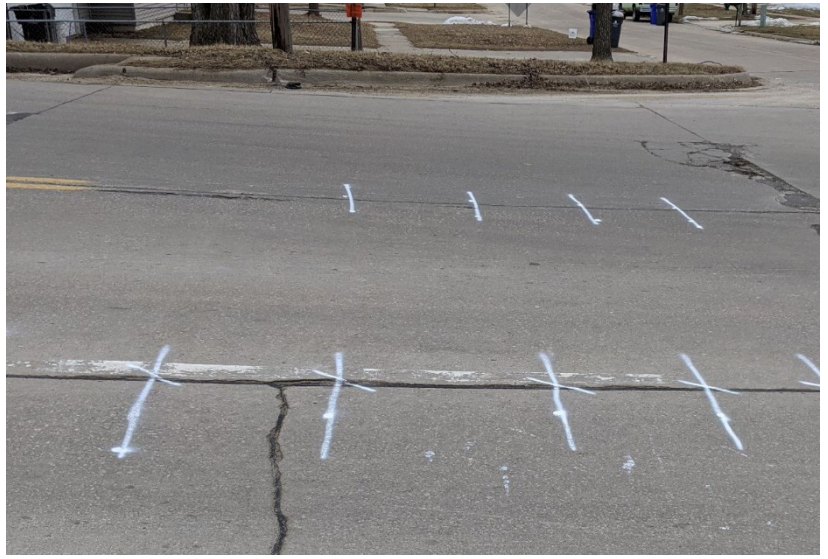
- Correct alignment of bars
- Correct placement of transverse saw cut
- MIT Dowel Scan



Steel

Tie Bar

- Placed on longitudinal joints
- Perpendicular to centerline
- Approximately 18 inches from transverse joint
- MIT T2 Scan
    - NDT or probing during construction for contraction joints



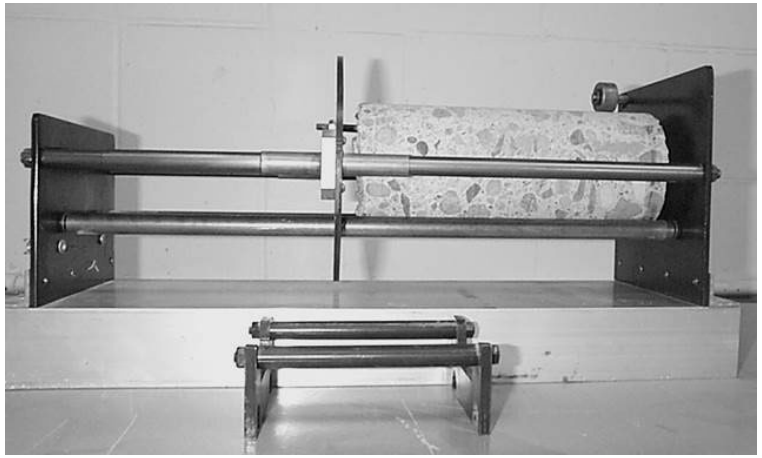
Pay Factors

SUDAS
Air Content
Smoothness
Thickness

Tables 7010.04
7010.05
7010.06

Iowa DOT
Smoothness
Thickness

Tables 2316.05 Smoothness
2301.05-1 Thickness



Smoothness

California profilograph

Inertial profiler

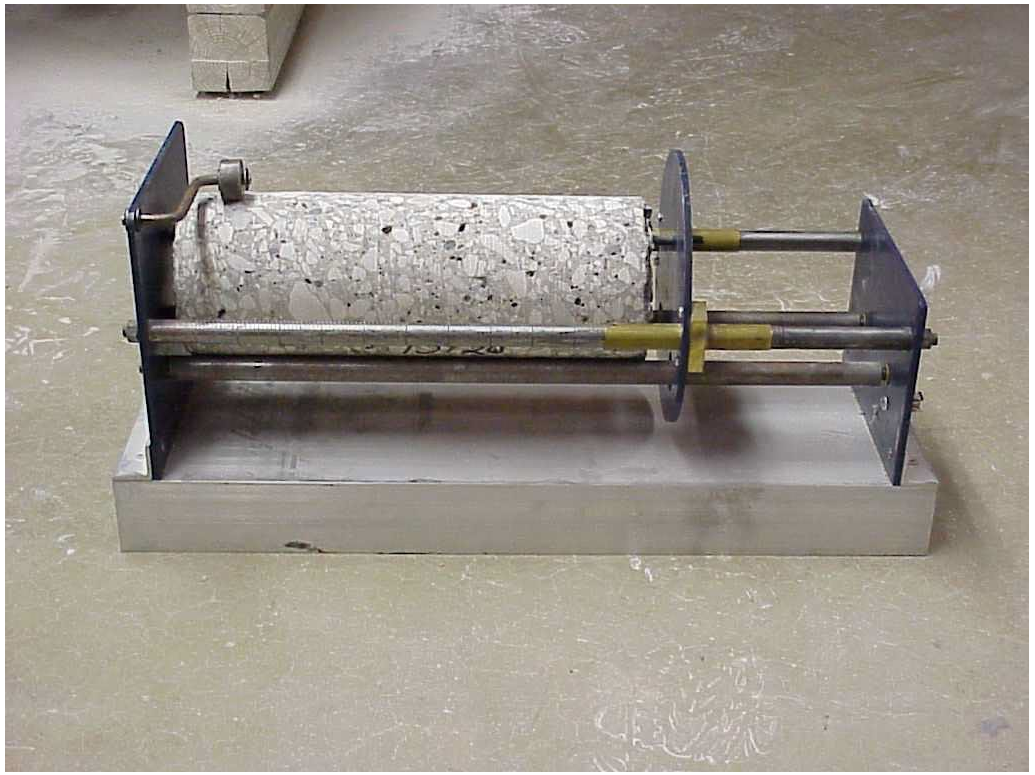
- Check with 10’ straightedge should not deviate more than 1/8”
- Profilometer or inertial profiler
- Evaluate within 48 hours after paving

Iowa DOT:
Sections 2316 & 2317
I.M. 341

SUDAS:
7010 3.08

Thickness

- Iowa DOT I.M. 346 – Process to identify core locations
- Iowa DOT I.M. 347 – Process to measure thickness & determine thickness index



Nine-point core length measuring device

MIT T2 Scan

Iowa DOT:
Articles 2301.04 and 2301.05
I.M. 346, 347

SUDAS:
7010 3.08, D

Questions

www.cptechcenter.org
jgross@snyder-associates.com