Overview of Fast Setting Concrete Repair

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84th Annual NESMEA Conference"
Atlantic City, NJ
October 7-8, 2008

Goals

- Identify new techniques for expediting concrete pavement repairs
- Explain purpose and techniques for rapid-repairs
- Describe applications of rapid-repairs techniques

Presentation Outline

- Rapid-repairs of PCCP…
  - Why rapid-repairs?
- What qualifies a job as fast setting concrete?
- Planning for rapid repairs
  - What the owner/agency can (should) do
  - What the contractor can (should) do
- Other considerations
  - Nighttime paving, equipment, construction, materials…
- Summary

Why rapid repairs?

- What is a rapid repair?
  - A series of techniques that decrease concrete pavement construction or repair time
  - Rapid pavement repair is not difficult, nor does it have to be expensive
- Why rapid repairs?
  - Traveling public does not like orange barrels
  - Get in, do it quickly (and correctly), get out, and stay out

Why rapid repairs?

- Improve safety
- Expedite construction
- Ease traffic congestion
- Ease traffic confusion

What Qualifies a Job for fast setting concrete?

- Short construction window
  - High user delay costs
  - Night-time closures
  - Weekend closures
- Revenue loss if facility closed
- Need to open to traffic quickly
  - Concrete paving is critical path in schedule

Early Opening!

Planning for fast setting concrete

Owner:

- Access for local traffic
- Local business disruption
- Utility work & coordination
- Construction equipment access
- Pavement edge drop-off requirements
- Accelerated damage to detour routes
- **Aggressive Public Relations Campaign**

Planning & Specifications

- Use partnering-based project management
- Consider night construction
- Use innovative equipment & materials
- Consider more than one concrete mixture
- Provide multiple options for contractors
  (not step-by-step procedures)
- Be flexible & allow for innovation
- Use incentives and disincentives

Planning for fast setting concrete

Contractor:

- Construction phasing
- Traffic control switches
- Access to site for construction vehicles
- Haul roads / access for concrete trucks
- Adequate width for paving equipment

Innovative Equipment

- Minimum clearance pavers
- Dowel bar inserters
- Belt placers/spreaders
- Ultra-light saws
- Utility coring machines

Material Considerations for Fast Setting Concrete

- Rapid strength gain
- Long-term strength
- Freeze-thaw durability
- Workability
- Abrasion Resistance

Materials
Possible Changes from Conventional

- Try different cement types
  - Type I, or III
  - Special blended cements
- Use admixtures
- Optimize aggregate grading
- Keep water-cementitious ratio below 0.43

Mix Proportioning

- No specific proportions
- Most local materials acceptable
- Verify compatibility of components in lab

Typical Mix Components
for fast setting project

Material	Type	Quantity
Cement	Type I	700-800 lb/yd^3
	Type III	600-800 lb/yd^3
Fly ash	Class C or F	0%-20% cement wt.
Aggregate Ratio	Coarse/Fine	1:1 to 1.5:1
Water-Cementitious Ratio		0.37-0.43
Air-entraining Admixture	ASTM C260	As necessary
Water-reducing Admixture	ASTM C494	As necessary

Mix Proportions from Actual Projects

Material	Runway Ext. Dane Co. Wisconsin	US-71 BOL Storm Lake Iowa	US-81 Recon. Menominee Nebraska	Interchange I-90 & SR-832 Pennsylvania
Cement Type	Type III	Type III	Type III	Type I
Cement (lb/yd^3)	660	640	612	750
Fly ash (lb/yd^3)	0	42 (Class C)	0	0
Coarse Agg. (lb/yd^3)	1180	1695	1241	1724
Fine Agg. (lb/yd^3)	883	1129	900	983
W/C Ratio	0.455	0.45	0.423	0.37
AE Admixture	Yes	Yes	Yes	Yes
Other Admixtures	WR-Type A	WR-Type A	WR-Type F	SRA-Type D WR-Type F

Supplementary Cementing Materials

- Tend to slow initial set!
- Act as fine particle fillers for workability
  - Fly ash
  - GGBFS

Chemical Admixtures

- Air-entraining
- Water-reducing
  - Improves workability at constant water content
  - Reduces necessary water by dispersing cement particles
- Accelerating
  - Increases reaction rate of C_3A

Aggregate
for Fast Setting Mixes

- ASTM C 33 generally acceptable
- Can optimize mix properties
  - Well-graded
  - Particle shape
- Optimizing may require additional stockpile or additional bin at concrete plant

Mix Water
for Fast Setting Mixes

- Typical requirements apply
- Heating to 140-150˚F (60-66˚C)
  - Raise plastic concrete temperature
  - Cool weather construction
  - Small projects like intersections
- Heating only lasts short time without insulation

Placement Considerations for Fast Setting Concrete

- All methods proven successful
  - Hand forming
  - Form-riding equipment
  - Slipform equipment
- Well-planned staging/sequencing
- Avoid long/congested haul routes
- Do not modify smoothness specifications

Curing & Temperature Considerations for Fast Setting Concrete

- Maintain moisture condition
- Maintain temperature condition
- Control ambient condition
  - Air temperature
  - Wind
  - Relative humidity
  - Sunshine
  - Subbase

Curing Compound
for Fast Setting Concrete

- ASTM C 309 acceptable
- Most conditions
  - White-pigmented Type 2/Class A
- Harsh or arid conditions
  - Resin-based Type 2/Class B

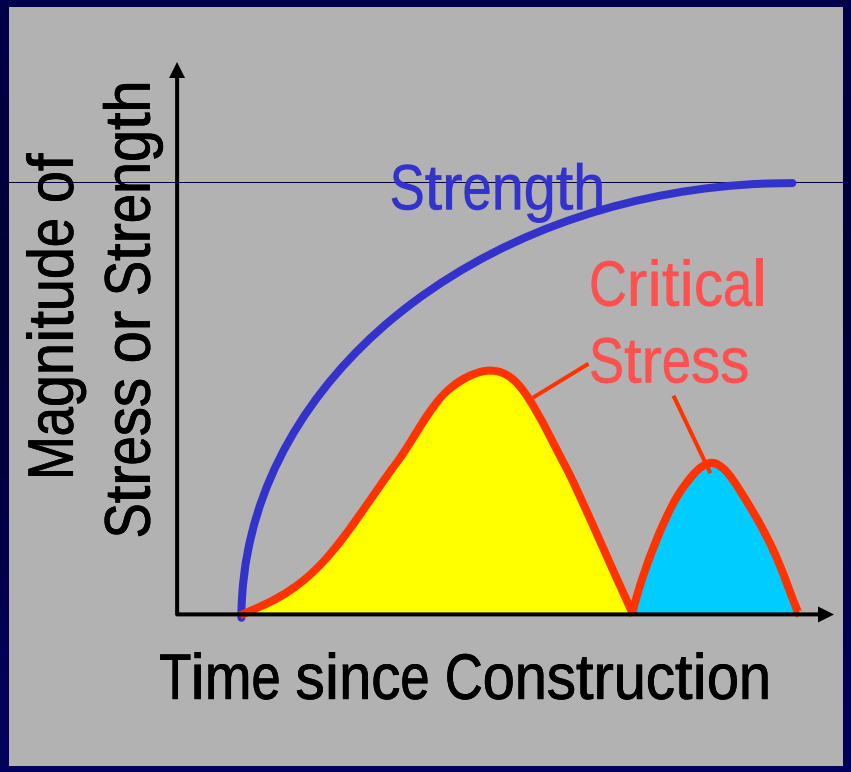
Jointing & Sealing - Possible Changes for Fast Setting Concrete

- Use green sawing with ultra-light saws
- Use dry-sawing blades
- Use step-cut blades for single pass joint sawing
- Use a sealant that is unaffected by moisture or reservoir cleanliness

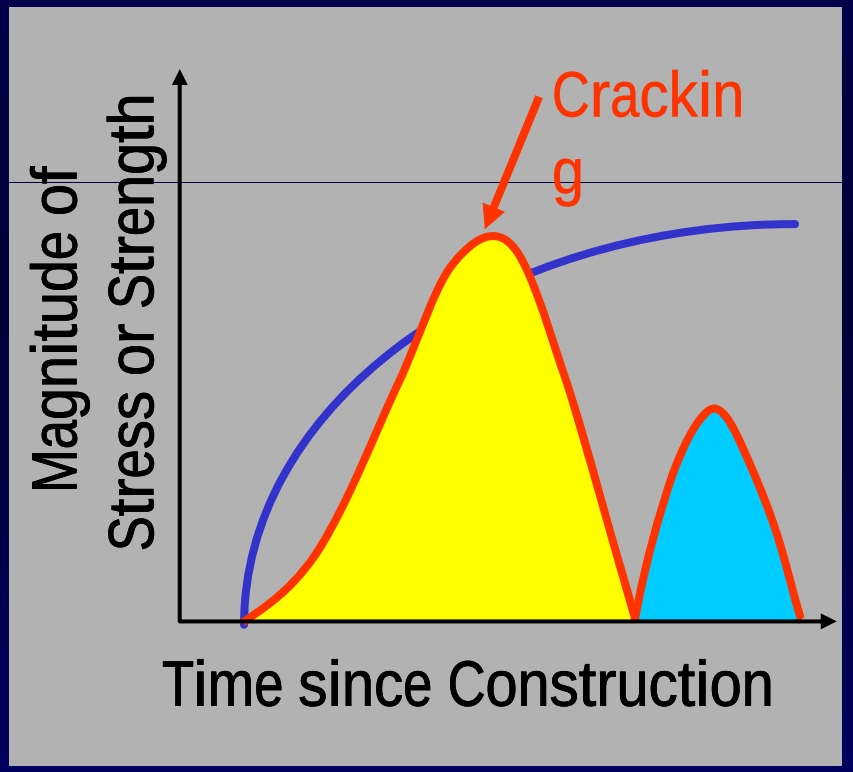
Joint Sawing
for Fast Setting Concrete

- Time sequence is different
- Be aware of factors that influence the sawing window
  - Weather
  - Concrete strength development
  - Concrete temperature
  - Aggregate hardness & shape
  - Subbase type
  - Edge restraint
- Determine sawing time using HIPERPAV

HIPERPAV
Stress and Strength Development



Scenario #1
Cracking should not occur



Scenario #2
Cracking may occur

Strength Testing
Possible Changes for Fast Setting Concrete

- Use non-destructive methods
  - Supplement cylinders and beams
  - Replace cylinders and beams
- Use Concrete maturity
  - Monitor concrete temperature and strength
- Use time criterion with known mixes

Maturity Testing

- ASTM C 1074
- Internal temperature of concrete relates directly to concrete strength
- Develop correlation curve in lab
- Precision to baseline cylinders: ±5%

Traffic Opening
Possible Changes for Fast Setting Concrete

- Revise criteria from time to strength
- Channel early loads away from slab edges
- Restrict early use to automobile traffic
- Use maturity meters!!!

Opening Recommendations for Span Saws

Slab Thickness in	Foundation Support, k psi/in	Flexural Strength to Support psi
6	100 200 500	215 190 115
6.5	100 200 500	190 160 145
7	100 200 500	145 145 145

- No fatigue in pavements >7 in thick
- 145 psi practical minimum for sawing

Opening Recommendations for Construction Trucks

Slab Thickness in	Foundation Support, k psi/in	Flexural Str. to Support Axle Loads, psi	
		10 loads	50 loads
6	100	400	460
	200	360	390
	500	300	300
6.5	100	360	390
	200	300	350
	500	300	300
7	100	300	330
	200	300	300
	500	300	300

- 145 psi practical minimum for sawing
- 300 psi minimum for truck loads
- Assume wheels 2 ft from free edge

Opening Recommendations
for Public Traffic

- Many different vehicles
- Estimate ESAL's until reach design strength
- Allow 1% fatigue consumption
- Min. allowable opening strength 300 psi flexural

Opening Recommendations for Public Traffic

Slab Thickness in	Foundation Support, k psi/in	Flexural Str. to Support ESALs, psi		
		100	1000	5000
6	100 200 500	500 400 330	560 460 380	620 520 430
7	100 200 500	380 300 300	430 360 300	480 400 320
8	100 200 500	300 300 300	330 300 300	380 330 300

Summary

- Fast Setting Concrete works for all pavements
- Start by considering fast setting in planning
- Use specifications that give contractors options
- Consider more than one mix
- Use innovative equipment
- Use non-destructive testing

Summary of Benefits for Fast Setting Concrete

- Expedites construction operations
- Reduces work zone congestion
- Allows residents and businesses access to pavement quicker than normal
- Useful for all traffic conditions and climates

Thank you!