Overview of Fast Setting Concrete Repair

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FHWA Resource Center

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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

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Cement</td>
<td>Type I</td>
<td>700-800 lb/yd³</td>
</tr>
<tr>
<td></td>
<td>Type III</td>
<td>600-800 lb/yd³</td>
</tr>
<tr>
<td></td>
<td>Class C or F</td>
<td>0%-20% cement wt.</td>
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<tr>
<td></td>
<td>Coarse/Fine</td>
<td>1:1 to 1.5:1</td>
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<tr>
<td>Fly ash</td>
<td></td>
<td>0.37-0.43</td>
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<tr>
<td>Aggregate Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-Cementitious Ratio</td>
<td>ASTM C260</td>
<td>As necessary</td>
</tr>
<tr>
<td>Air-entraining Admixture</td>
<td>ASTM C494</td>
<td>As necessary</td>
</tr>
<tr>
<td>Water-reducing Admixture</td>
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# Mix Proportions from Actual Projects

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</thead>
<tbody>
<tr>
<td>Cement Type</td>
<td>Type III</td>
<td>Type III</td>
<td>Type III</td>
<td>Type I</td>
</tr>
<tr>
<td>Cement (lb/yd³)</td>
<td>660</td>
<td>640</td>
<td>612</td>
<td>750</td>
</tr>
<tr>
<td>Fly ash (lb/yd³)</td>
<td>0</td>
<td>42 (Class C)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coarse Agg. (lb/yd³)</td>
<td>1180</td>
<td>1695</td>
<td>1241</td>
<td>1724</td>
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<tr>
<td>Fine Agg. (lb/yd³)</td>
<td>883</td>
<td>1129</td>
<td>900</td>
<td>983</td>
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<tr>
<td>W/C Ratio</td>
<td>0.455</td>
<td>0.45</td>
<td>0.423</td>
<td>0.37</td>
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<tr>
<td>AE Admixture</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Other Admixtures</td>
<td>WR-Type A</td>
<td>WR-Type A</td>
<td>WR-Type F</td>
<td>SRA-Type D</td>
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<td></td>
<td></td>
<td>WR-Type F</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Slab Thickness in</th>
<th>Foundation Support, k psi/in</th>
<th>Flexural Strength to Support psi</th>
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<tr>
<td>6</td>
<td>100</td>
<td>215</td>
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<td>190</td>
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<tr>
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<td>115</td>
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<tr>
<td>6.5</td>
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<td>7</td>
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<td>145</td>
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<td>500</td>
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</table>

- No fatigue in pavements >7 in thick
- 145 psi practical minimum for sawing
# Opening Recommendations for Construction Trucks

<table>
<thead>
<tr>
<th>Slab Thickness in</th>
<th>Foundation Support, k psi/in</th>
<th>Flexural Str. to Support Axle Loads, psi</th>
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<td>10 loads</td>
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- 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

<table>
<thead>
<tr>
<th>Slab Thickness in</th>
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<th>Flexural Str. to Support ESALs, psi</th>
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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!