High Early Strength Portland Cement Concrete for Rapid Concrete Repair

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The CalTrans Challenge

Find an alternative to proprietary “fast-setting cement” concrete mixtures!

Requirements:

- Fast setting, user-friendly and cost effective
- Develop 400 psi (2.8 MPa) within 4 hours after placement
Hence, the Name...

400 psi in 4 hours
4x4™ Concrete: System Components

- Selected local portland cements, and aggregates
  - manufactured sand

- Synthetic high-range water-reducing admixture - provides fluidity and strength

- Hydration control (extended-set) admixture - provides workability control

- Accelerating admixture - provides early strength
Hydration control admixture:

- Hydration control
- Provides unprecedented control over setting
  - Controls temperature rise
  - Provides slump retention
  - Effective in long hauls
Accelerating Admixtures

- Add and mix on site
- Uses portable dispenser system
- Accelerates concrete set and strength development
Where Can 4x4 Concrete be Used?

- Full-depth pavement replacement
- New pavement
- Bridge decks
- Overlays
- Where high early strength is required
Maturity Testing - a better indication of strength development in pavement slab.

\[ M(t) = \sum (T_a - T_o) \Delta t \]

- \( M(t) \) = Temperature-time factor
- \( \Delta t \) = Time interval
- \( T_a \) = Avg. temperature during \( \Delta t \)
- \( T_o \) = Datum Temperature
I-5, CA: Actual HES Data

4x4 Concrete: I-5 in Los Angeles
3/3/02

Flexural Str, psi = 0.001(Degree Hours)$^2$ + 0.09 (Degree Hours)
## I-5 in CA: Actual HES Data

### 4x4™ Concrete:

<table>
<thead>
<tr>
<th></th>
<th>Flexural Strength</th>
<th>Compressive Strength</th>
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<tbody>
<tr>
<td></td>
<td>psi</td>
<td>MPa</td>
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<tr>
<td>4-hour</td>
<td>480</td>
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<td>28-day</td>
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4x4™ Concrete: Conduct a Trial Slab

Fully-loaded truck on slab 4 hours after placement !!!

400 psi Flexural Strength in 4 hours
4x4™ Concrete Projects
Alamo Truck Stop:
- Ultra-Thin WhiteTopping application - Sparks Nevada

Challenge:
- Truck stop is a major source of revenue
- Rutted asphalt entering and exiting weigh scale
- Minimize scale closure time

Solution:
- Air-entrained 4x4 Concrete @ a 8 in. slump (200 mm) as an ultra-thin whitetopping
Alamo Truck Stop

Benefits:

- Very user-friendly and easy to place
- Weigh scale opened to traffic quickly
- Minimized closure time resulted in increased revenue
- 4x4 Concrete is expected to provide significantly longer service life compared to the asphalt
Poplar Street Bridge:
- Deck Repair - St Louis, Missouri

Challenge:
- Deteriorated bridge deck
- Minimize lane closure time
- Night repairs
- Requirement 3,200 psi (22.1 MPa) in 4 hours

Solution:
- Air-entrained 4x4 Concrete @ a 8 in. slump (200 mm)
  - placed as SCC
Poplar Street Bridge

Benefits:

- Ready mix truck provided mobility to repair areas
- Contractor optimized resources
- 4x4 Concrete more economical than conventional repair materials
- Profitable for producer and contractor
- Minimized lane closure time
- MO DOT pleased with results
Merced Intersection Replacement:
- Highway 140 and Applegate Road, Merced County, CA

Challenge:
- Minimize disruption to traffic flow and lane closures

Solution:
- 4x4 Concrete @ a 7 in. slump (180 mm)
Merced Intersection Replacement

Benefits:

- Very user-friendly and easy to place
- Exceptional high-early strength permitted rapid opening to traffic minimizing lane closures
- Project was completed in only 4 days!
- Traffic control savings = $250,000
- 4x4 Concrete technology allowed concrete to be used in lieu of asphalt
4x4™ Concrete Project

I-77/I-65 Pavement Replacement:
- West Virginia Turnpike, Beckley West Virginia

Challenge:
- Minimize inconvenience to motorists
- Develop high-early strength in cool springtime temperatures

Solution:
- Air-entrained 4x4 Concrete @ a 5 in. slump (125 mm)
I-77/I-65 Pavement Replacement

Benefits:

- Very user-friendly and easy to place
- Exceptional high-early strength developed
- Pavement replaced and opened to traffic from start to finish in only 12 hours!
4x4™ Concrete: In Summary....

- Producer/contractor friendly
- Easy to place and finish
- Set time and strength performance met consistently
- Save $$$$ on traffic control and placement
- No post-grinding for ride quality
- No cracking to date
- **Win-Win-Win-Win Situation for All Parties !!!**