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Program Background and Introduction to Specifications

9th Annual Meeting - Construction of
Crack-Free
Concrete Bridge Decks
July 19, 2011
Kansas City, MO

Outline

- Overview of LC-HPC
- Specifications and their application
- Where we stand

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Scope of Work

Low-Cracking High Performance Concrete (LC-HPC) Bridge Decks

23 LC-HPC decks (28 placements) completed through 2010
1 LC-HPC deck to be constructed this year
More to be let in MN

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Bridges

Primarily composite steel girder bridges
Full-depth slabs
Removable forms
Matching bridges to serve as a control where possible (Phase I)

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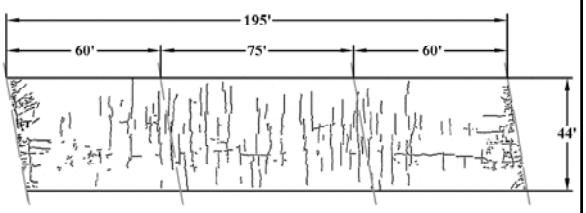
Why LC-HPC?



Cracks

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Why LC-HPC?

Negative impact of cracks on concrete in the decks.

Negative impact of cracks on corrosion performance of both conventional and epoxy-coated reinforcement.

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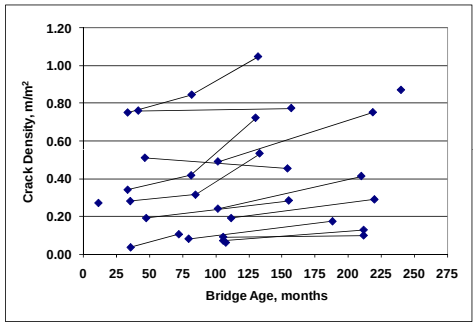
Our goal

- Eliminate cracking in bridge decks
- To do this, we need to minimize cracking due to
  - Plastic shrinkage
  - Settlement over reinforcing bars
  - Thermal contraction
  - Drying shrinkage

Factors that affect cracking

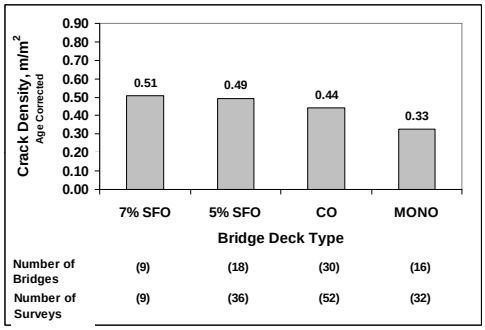
- Age
- Deck type
- Cement paste content
- Compressive strength
- Air content
- Slump
- Temperature
- Construction date
- Curing
- Construction techniques

Age

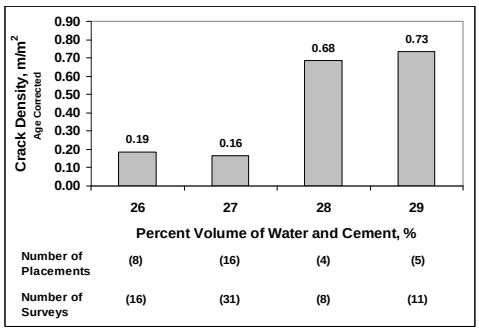


Monolithic

Bridge Deck Type



Paste Content



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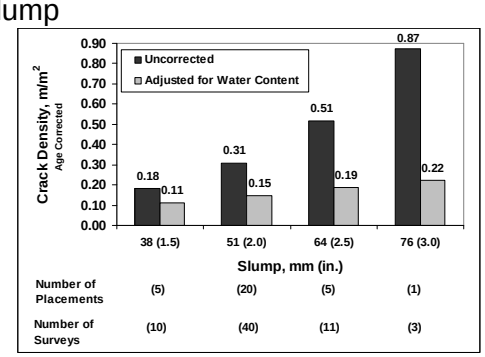
Slump



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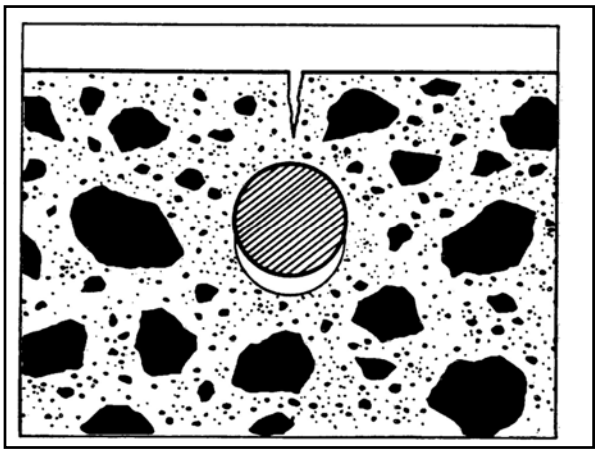
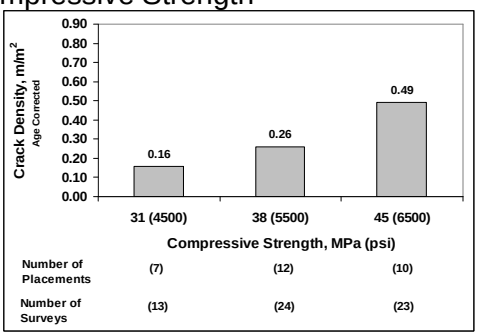


Compressive Strength



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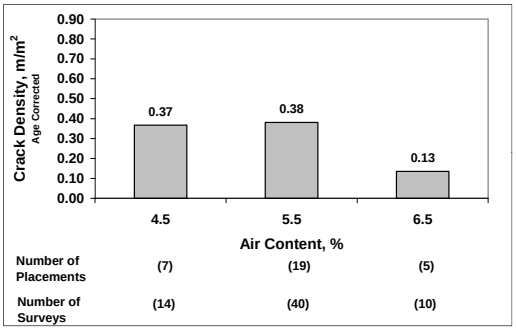
Air Content



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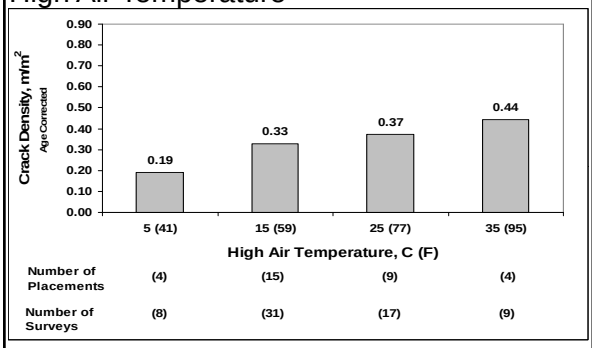
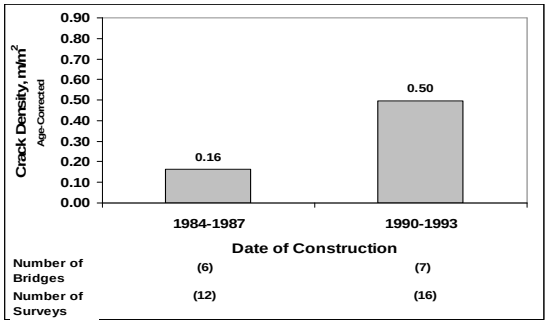
High Air Temperature

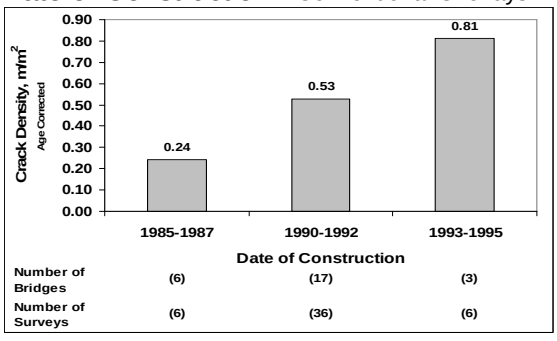


Monolithic

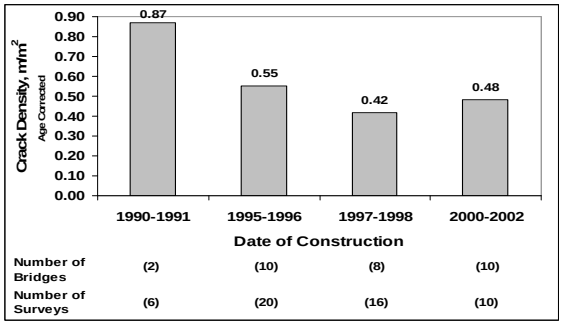
Date of Construction - Monolithic



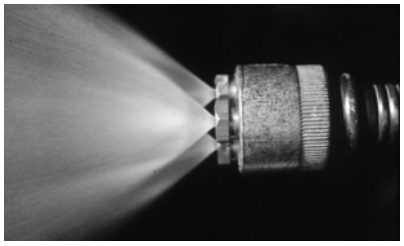
Date of Construction - Conventional Overlays



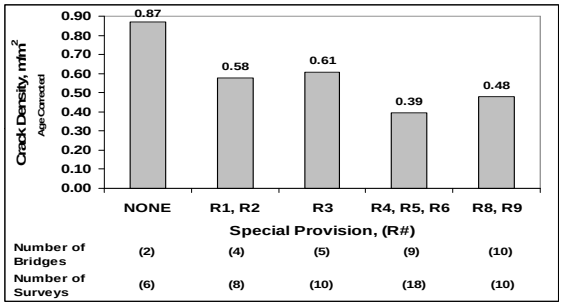
Date of Construction - Silica Fume Overlays

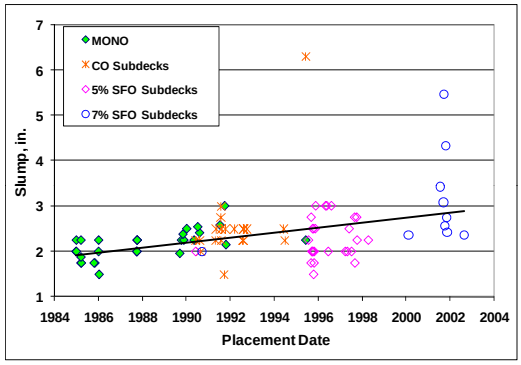


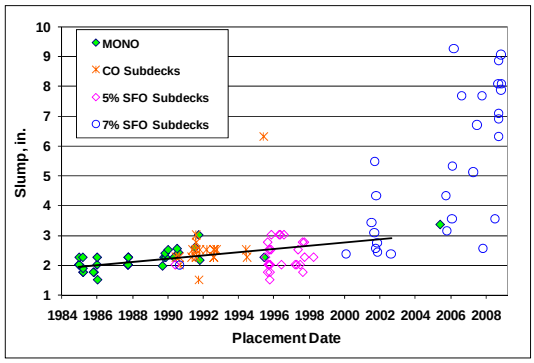
Control of early evaporation and improved curing



Control of early evaporation and improved curing - Silica Fume Overlays







Overall Approach

Work to reduce plastic, settlement, thermal and drying shrinkage cracking

Low cement & water contents

Low slump

High strength is not good

Low evaporation rate

Construction methods and materials matter

More early cracking means more total cracking

LC-HPC Specifications

- Optimized Aggregate Gradation
- Low-absorption Aggregate
- 1 inch Max Size Aggregate
- Cement Content ≤ 540 lb/yd^3
- w/c ratio = 0.43 – 0.45
- Air Content of 8 ±1½%
- Designated slump 1½ – 3 in. (~~4~~ 3½ in. max)
- Controlled temperature
- Improved curing

Concrete temperature control

55 – 70°F

50 – 75°F if approved by Engineer

Cold-weather concreting

Maintain temperature of both girders and deck.

Alternatives to Pumping

- Concrete Buckets
- Conveyor Belts

Placing

- Air cuff/bladder valve on pump or limit drop with conveyor
- Filling end walls and diaphragms ahead of slab

Consolidation Requirements

Vertically mounted internal gang vibrators

Concrete Finishing

- General Rule:
  Less is More
  - Pan or burlap drag
  - Bullfloating only if needed
  - Water is not a finishing aid!

Curing

- Presoaked burlap
- Timely placement
- Constantly wet
  - Spray hoses
  - Soaker hoses
  - 14 days

Three work bridges. Four rolls of pre-cut, pre-soaked burlap, two on each side

Cost effectiveness

- Cost of equipment: approximately $5000
- Cuts work crew to handle burlap on day of placement from 11 to 5
- Contractor added power to move the work bridges between first and second deck

Curing

Followed by curing compound to slow the rate of evaporation

Construction Schedule

- Qualification Batch & Slab

- Bridge Construction

Concrete Testing & Acceptance

- Clearly define testing schedule ahead of time
- Communicate how out-of-spec concrete will be handled

Specifications

07-PS0167 Construction
07-PS0166 Concrete
07-PS0165 Aggregates

Where we stand

- LC-HPC decks are working
- Current provisions, however, don't encompass all of the technologies that can be brought to bare
- We chose not to propose those technologies until we were assured that they posed no durability problems

- We've now evaluated those technologies for durability and are prepared to recommend their adoption
- Ready for some more decks!

This year's crack surveys

- Adherence to the rules...

Questions

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