Bridge Deck Crack Prevention

Shared By: Craig Knapp
Concrete Committee Chair
Caltrans
Division Of Engineering Services

Deck cracking is a long standing problem.

BRIDGE DEPARTMENT

WEBBER CREEK

DECK CRACK STUDY

Final Report

March 1972

Prepared in Cooperation With
The U.S. Dept. of Transportation,
Federal Highway Administration

We spend annually on deck crack mitigation.

$50 Million

We have a solution.

Specification Summary

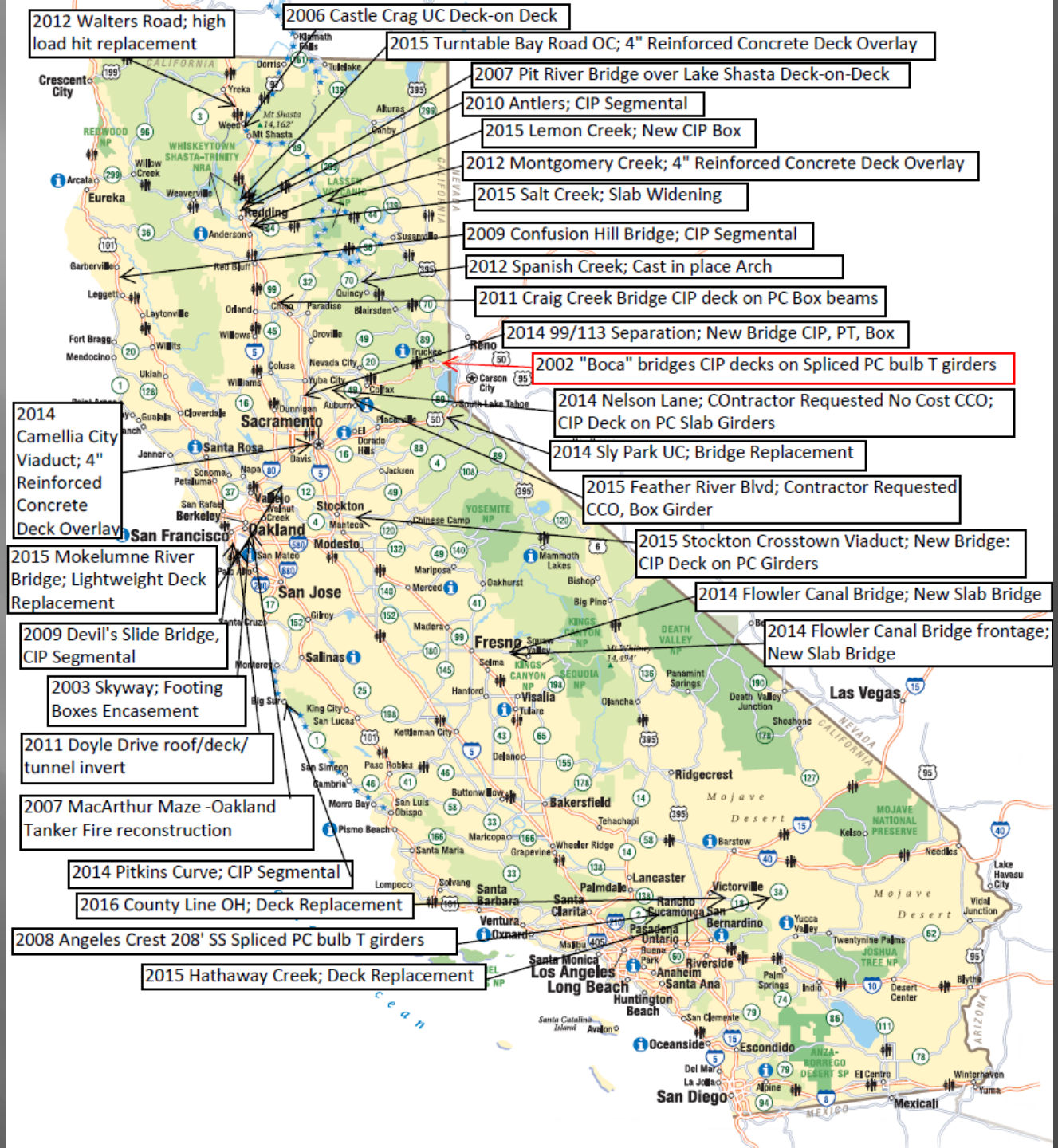
- The 28 day shrinkage required maximum of 0.032%.
- Minimum SRA dosage of ¾ gal/cy.
- Require 1 lb/cy of micro fibers and 3lb/cy of macro fibers (polyolefin).
- Continuous misting from finished strike off until curing medium is applied.

Shrinkage Measurement

- AASHTO T 160, modified as follows:
- 4 X 4 prism.
- Cure 7 days.
- **Take a comparator reading at 7 days age and record it as the initial reading.**
- Take subsequent readings at 7, 14, 21, and 28 days drying.

Fibers

Misting

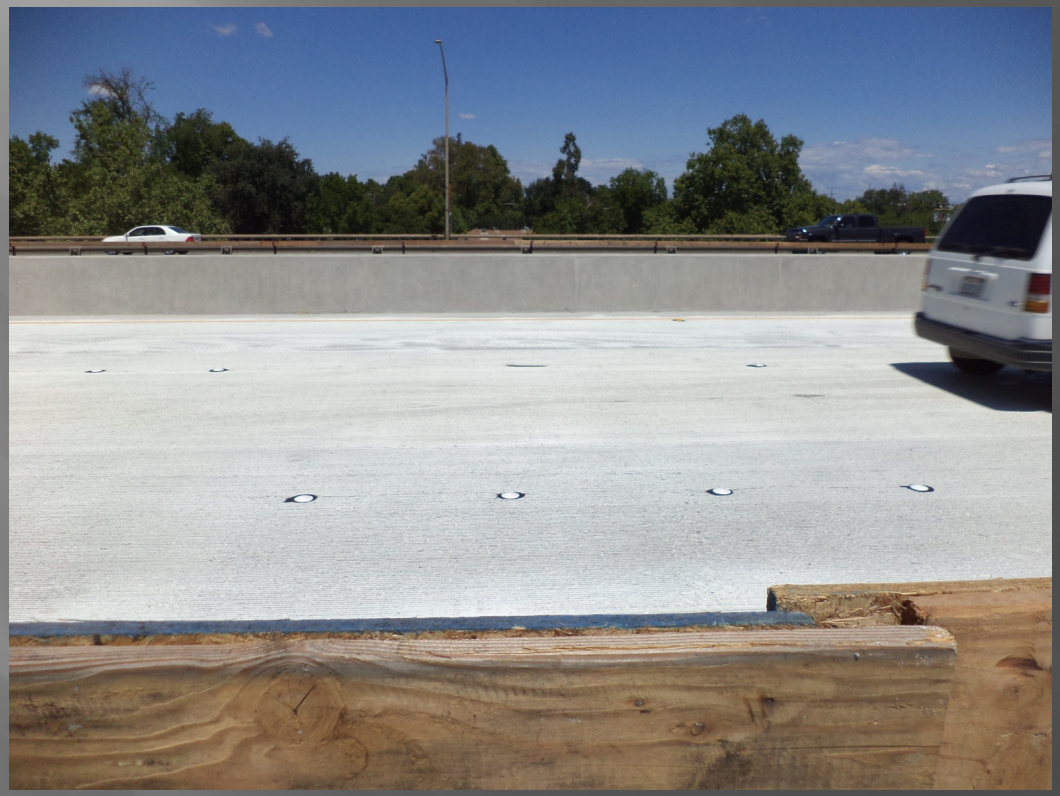

2012 Walters Road; high load hit replacement
2006 Castle Crag UC Deck-on Deck
2015 Turntable Bay Road OC; 4" Reinforced Concrete Deck Overlay
2007 Pit River Bridge over Lake Shasta Deck-on-Deck
2010 Antlers; CIP Segmental
2015 Lemon Creek; New CIP Box
2012 Montgomery Creek; 4" Reinforced Concrete Deck Overlay
2015 Salt Creek; Slab Widening
2009 Confusion Hill Bridge; CIP Segmental
2012 Spanish Creek; Cast in place Arch
2011 Craig Creek Bridge CIP deck on PC Box beams
2014 99/113 Separation; New Bridge CIP, PT, Box
2002 "Boca" bridges CIP decks on Spliced PC bulb T girders
2014 Nelson Lane; COntractor Requested No Cost CCO; CIP Deck on PC Slab Girders
2014 Sly Park UC; Bridge Replacement
2015 Feather River Blvd; Contractor Requested CCO, Box Girder
2014 Camellia City Viaduct; 4" Reinforced Concrete Deck Overlay
2015 Stockton Crosstown Viaduct; New Bridge: CIP Deck on PC Girders
2015 Mokelumne River Bridge; Lightweight Deck Replacement
2014 Flowler Canal Bridge; New Slab Bridge
2014 Flowler Canal Bridge frontage; New Slab Bridge
2009 Devil's Slide Bridge, CIP Segmental
2003 Skyway; Footing Boxes Encasement
2011 Doyle Drive roof/deck/ tunnel invert
2007 MacArthur Maze -Oakland Tanker Fire reconstruction
2014 Pitkins Curve; CIP Segmental
2016 County Line OH; Deck Replacement
2008 Angeles Crest 208' SS Spliced PC bulb T girders
2015 Hathaway Creek; Deck Replacement
Crescent City
Eureka
Redding
Sacramento
San Francisco
Oakland
San Jose
Stockton
Modesto
Fresno
Bakersford
Las Vegas
Los Angeles
Long Beach
San Diego
Reno
Mexicali

This is what it costs.

- **The pilot projects show no measurable change to the price bid for structure concrete.**
- **When implemented via CCO the cost has been about:**
  - **SRA @ 1 Gal/CY = $25/CY**
  - **Fibers @ 4 lb/CY = $25/CY**

Results

- At about 1 year, Structure Maintenance deck evaluation.



“The westbound (left) structure exhibited no visible cracks on the surface. This is remarkable given the volume of concrete placed and the application (deck on deck)… “

State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

Memorandum

Serious drought.
Help save water!

To: ALL STRUCTURE DESIGN STAFF

Date: March 18, 2016

File:

From: JANICE BENTON
Deputy Division Chief (Interim)
Structure Design
Division of Engineering Services

Subject: **STRUCTURE DESIGN ALERT**

Subject Area:

Concrete Bridge Decks

Purpose:

The purpose of this memorandum is to alert Structure Design staff that new construction specifications for concrete bridge decks, including a new bid item, are being implemented.

Background:

A 2013 fact sheet produced by Structure Maintenance & Investigations estimated Caltrans spends $50,000,000 annually on sealing deck cracks. In order to prevent early-age bridge deck cracking from occurring, the Concrete Committee and the Bridge Preservation Committee, over a 14-year period, have developed new construction specifications for concrete bridge decks, including deck overlays. These new construction specifications include:

1. Limiting the 28-day shrinkage performance of the deck concrete to 0.032 percent.
2. Requiring a minimum dosage of shrinkage reducing admixture
3. Requiring polymer fibers in deck concrete
4. Revising the concrete deck curing specifications

State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

Memorandum

Serious drought.
Help save water!

To:

JEFF WILEY, Deputy Division Chief, Structure Design
STEVE ALTMAN, Deputy Division Chief, Structure Construction
SHIRA RAJENDRA, Deputy Division Chief, Program/Project & Resource Management
ROBERTO LACALLE, Deputy Division Chief, Materials Engineering & Testing Services &/Geotechnical Services
DOLORES VALLS, Chief, Structure Maintenance And Investigation

Date: August 11, 2016

From: THOMAS A OSTROM
State Bridge Engineer
Structure Policy & Innovation
Division of Engineering Services

Subject: **CONSTRUCTION SPECIFICATIONS FOR BRIDGE DECK CRACK PREVENTION**

The Bridge Preservation and Concrete Committees have developed new construction specifications to reduce concrete bridge deck cracks caused by volumetric changes of concrete. see attached. The new construction specifications should significantly reduce long-term costs associated with the repair of deck cracking and mitigate safety risks associated with use of methacrylate currently used for crack repair.

For projects that have not been advertised, the plans, specifications and estimate must be updated to include the new specifications.

For projects that have been advertised, the Project Engineer shall request that an addendum be issued to incorporate the revisions. See "Structure Design Alert".

For projects in construction, it is recommended that these changes be incorporated by Contract Change Order, if it is administratively appropriate.

Forward technical questions related to the crack-less deck specifications to Craig Knapp, Concrete Committee Chairperson, at 916-227-8554.

Attachments:

1) Construction Special Provisions 51-1.01C(1), 51-1.02B, 51-1.03H, 90-1.01C, 90-1.02A, and 90-1.02K
2) Structure Design Alert, Concrete Bridge Decks, March 18, 2016

State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

Memorandum

Serious drought.
Help Save Water!

To: DEPUTY DISTRICT DIRECTORS, Construction
DEPUTY DIVISION CHIEF, Structure Construction
CONSTRUCTION MANAGERS
SENIOR CONSTRUCTION ENGINEERS
RESIDENT ENGINEERS

Date: October 11, 2016

File: Division of Construction
CPD 16-13

From: RACHEL FALSETTI, Chief
Division of Construction

Subject: **Bridge Deck Crack Prevention**

This directive allows for implementing new specifications to prevent premature bridge deck cracking. Structure Maintenance & Investigations estimated the California Department of Transportation spends $50,000,000 annually on sealing deck cracks. To prevent early-age bridge deck cracking, the Concrete Committee and the Bridge Preservation Committee, over a 14-year period, have developed new construction specifications for concrete bridge decks, including deck overlays.

The new specifications include:

- Limiting the 28-day shrinkage performance of the deck concrete to 0.032 percent.
- Requiring a minimum dosage of shrinkage reducing admixture.
- Requiring polymer fibers in deck concrete.
- Revising the concrete deck curing specifications.

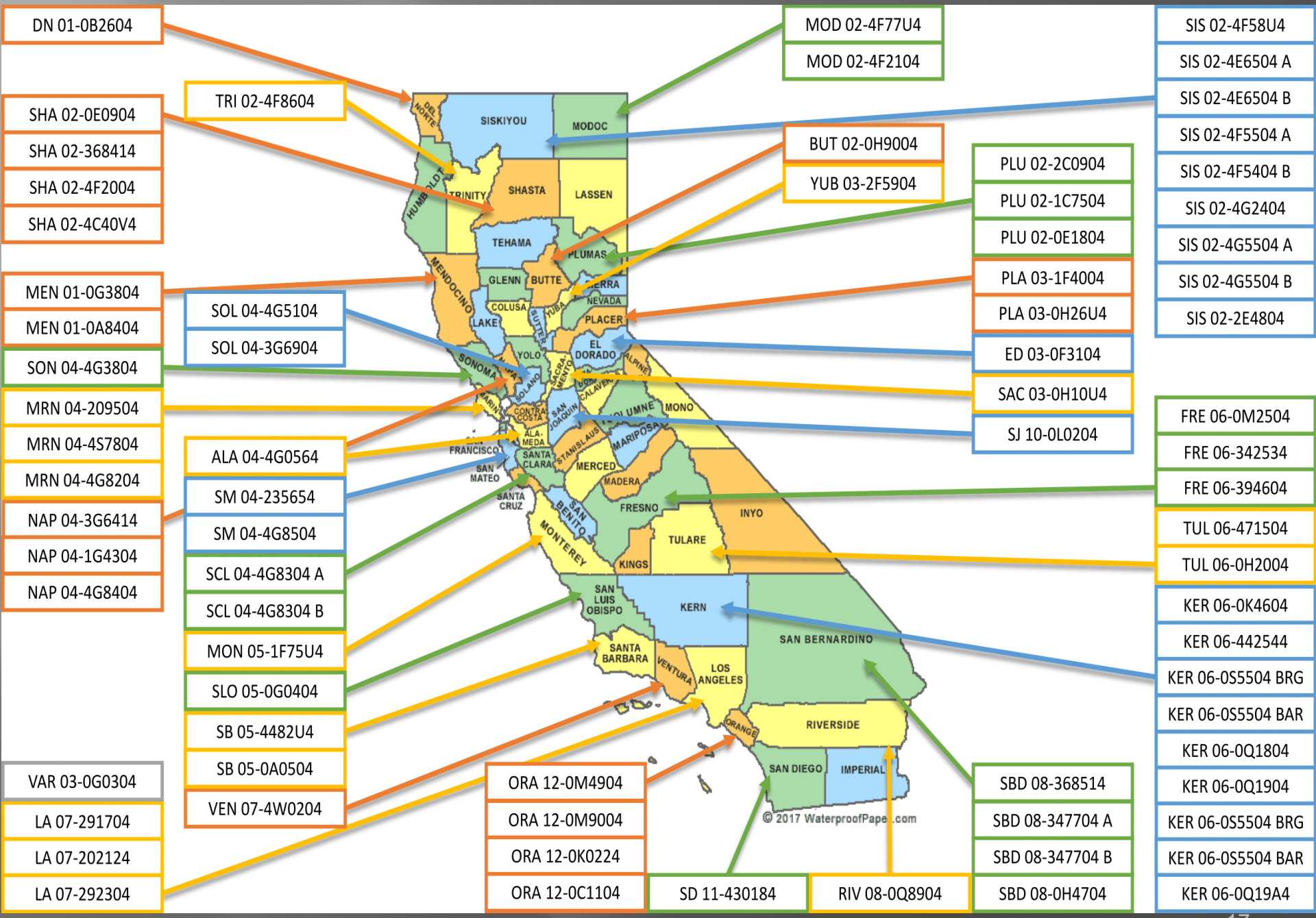
The attached memorandum from the State Bridge Engineer dated August 11, 2016 describes the recommendation that these specification changes be incorporated by change order for ongoing construction projects where administratively possible.

This change will require a new concrete mix design, addition of polymer fibers, and use of shrinkage reducing admixture for bridge deck concrete which will result in increased cost for this change. If the bridge deck concrete placement affects the controlling activity, contract time adjustment may be required for performing concrete shrinkage performance testing and for compressive strength testing for bridge deck concrete that is designated by compressive strength.

A sample change order memorandum, sample change order, and a Federal Highway

Results

- **Specifications to prevent premature bridge deck cracking were included:**
  - **In all new projects.**
  - **Included via CCO on existing Projects.**
  - **Incorporated via addendum on advertised projects.**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MODOC
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
COLUSA
PLACER
LAKE
YOLO
EL DORADO
SONOMA
MENDOCINO
MARIN
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
SAN MATEO
SANTA CLARA
SANTA CRUZ
SAN BENITO
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STANISLAUS
MERCED
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FRESNO
MARIPOSA
MONO
INYO
TULARE
KINGS
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
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Summary

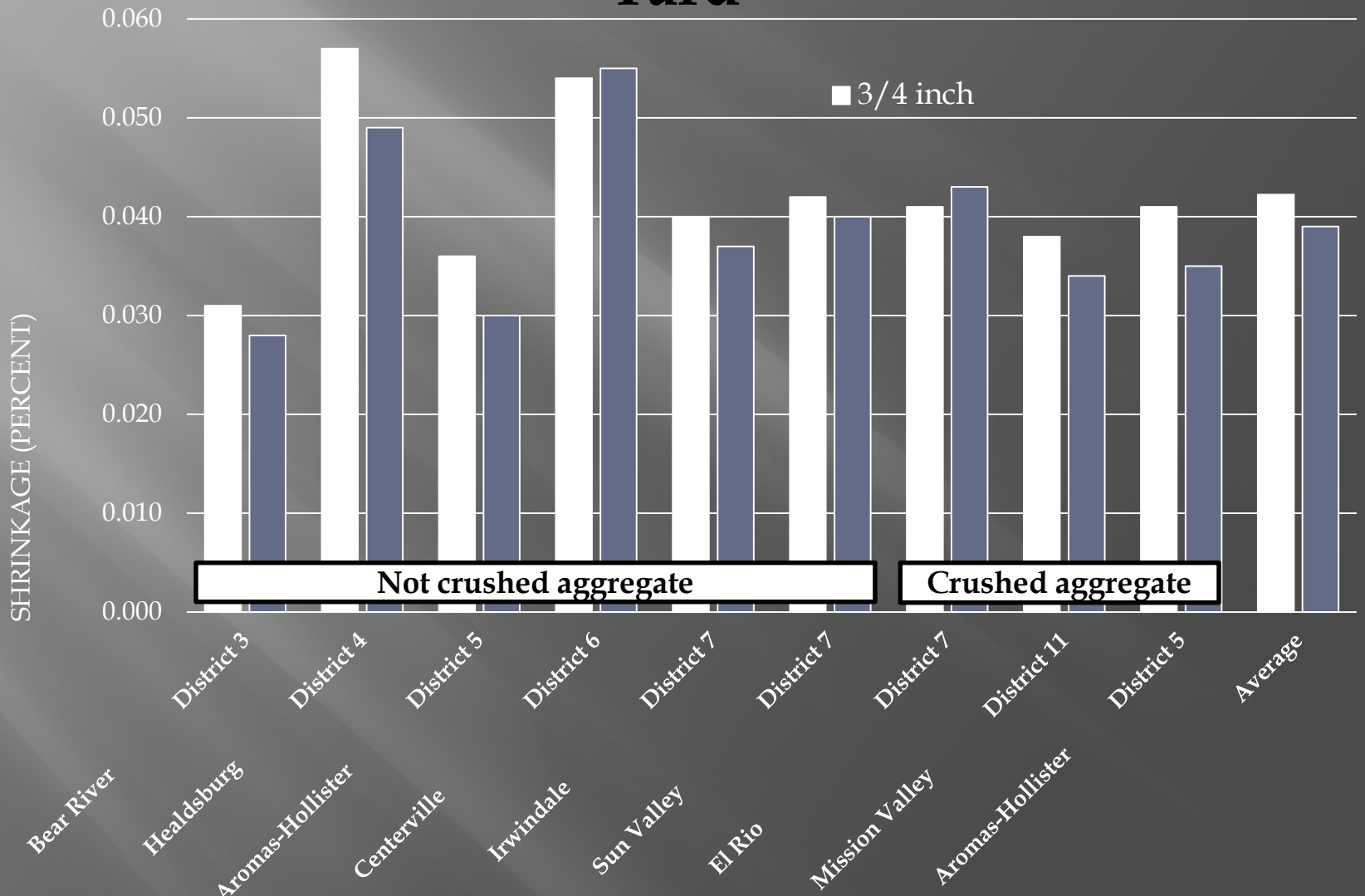
- Rigorous attention to best curing practices
- Fibers
- .032% max shrinkage at 28 days
- Minimum SRA .75gal/cy
- Thanks to my predecessors for the launch pad.
- Special thanks to my colleagues Ric Maggenti and Sonny Fereira

Questions?

For more information:

Controlling Shrinkage Cracking
Available technologies can provide nearly crack-free concrete bridge decks
by Ric Maggenti, Craig Knapp, and Sonny Fereira
Concrete International, July 2013

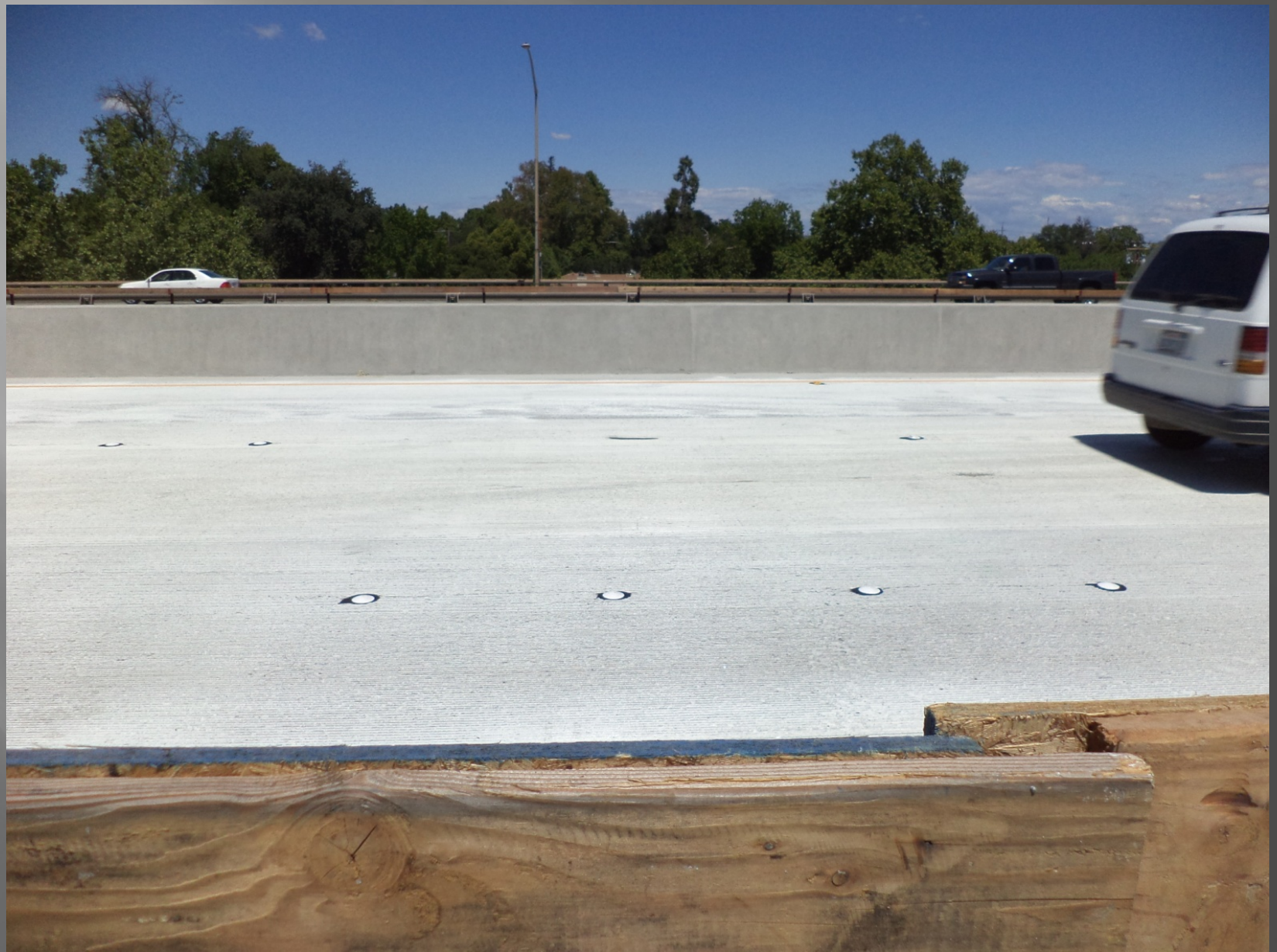
Drying Shrinkage (Percent) 28-Days Drying at 7 ½ Sacks per Cubic Yard



4year old

4.75 years old

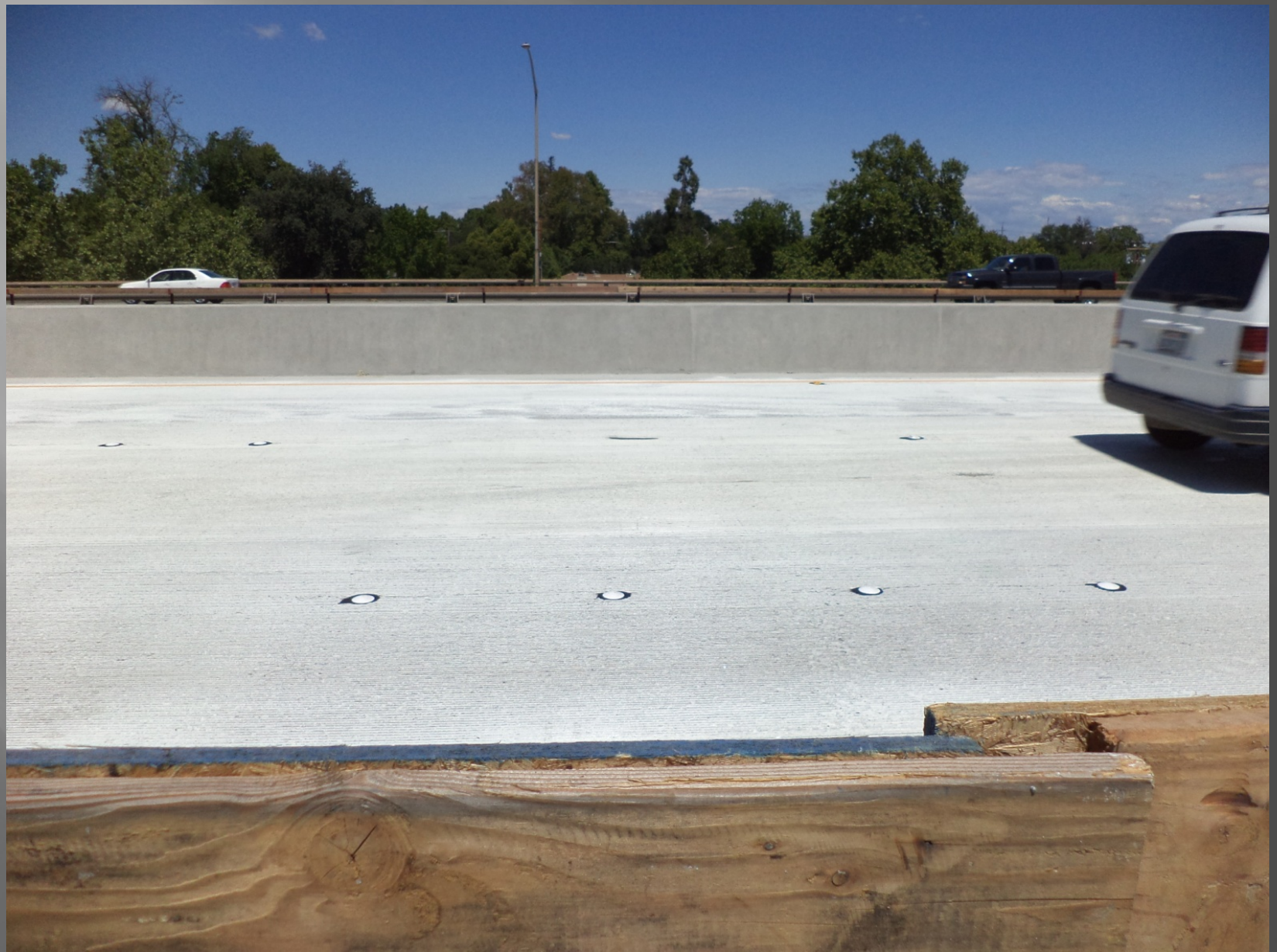
5 years old



6 years old

11 years old

28 shrinkage = .032 with SRA



28 shrinkage = .032 with SRA

28 shrinkage = .032 without SRA