Conquering the Challenges of Heavy Duty Pavements in California

John Harvey

Developments in Heavy Duty Pavements
Monday 3.30 pm

16th AAPA International Flexible Pavements Conference 2015
Innovation Driving Value
13-16 September 2015 Gold Coast, Australia

UC PRC
UNIVERSITY of CALIFORNIA | PAVEMENT RESEARCH
Davis • Berkeley | CENTER

Overview

- For Long-Life Rehabilitation and Reconstruction Caltrans uses:
  - Design method able to account for local climate, materials, traffic, and to be continuously updated for new materials
  - Pavement designs and specifications to minimize thickness, speed construction time
  - Performance related specifications for asphalt materials
  - Continuous and full directional closures in urban areas
  - Extensive traffic management planning and monitoring
- Outline:
  - Development of approaches
  - Details and experience
  - Lessons learned

Want Long Life, Fast Construction, Minimum Traffic Delay, Low Cost

- Pavement design strategies:
  - Longer life pavements take longer to construct
  - Materials vary locally and change over time
- Construction windows/traffic delays:
  - Urban areas are all about traffic delay
    - Shorter windows less efficient for construction
    - Some strategies impossible in 7-10 hour windows
    - Alternative windows: 55 hour weekend, 72 hour weekday, continuous
  - Rural areas use normal traffic handling
- Requires Pavement Engineering + Construction Engineering + Traffic Engineering
- Compete with concrete on all of these items

Origins of the California approach

Los Angeles Times LOCAL CALIFORNIA SPORTS ENTERTAINMENT BUSINESS

Santa Monica Freeway to Reopen on Tuesday : Recovery: The contractor will get a $14.5-million bonus for fini earthquake repairs 74 days early.

April 06, 1994 | NORA ZAMICHOW and VIRGINIA ELLIS | TIMES STAFF WRITERS

- Northridge earthquake damaged four bridges on th Monica Freeway in Los Angeles
  - Closure estimated to cost LA economy $1M per
- C.C. Myers, Inc. won the contract to replace them for $14.9M
  - Contract completion 140 days
  - $200,000 per day bonus for each day prior to the 140 days
  - Completed the job in 66 days, 74 days early

The Atlantic Photo

Origins of the California approach

Lessons Learned

Innovative materials

- fast-setting concrete for ramps

Full closures

- unavoidable in this case

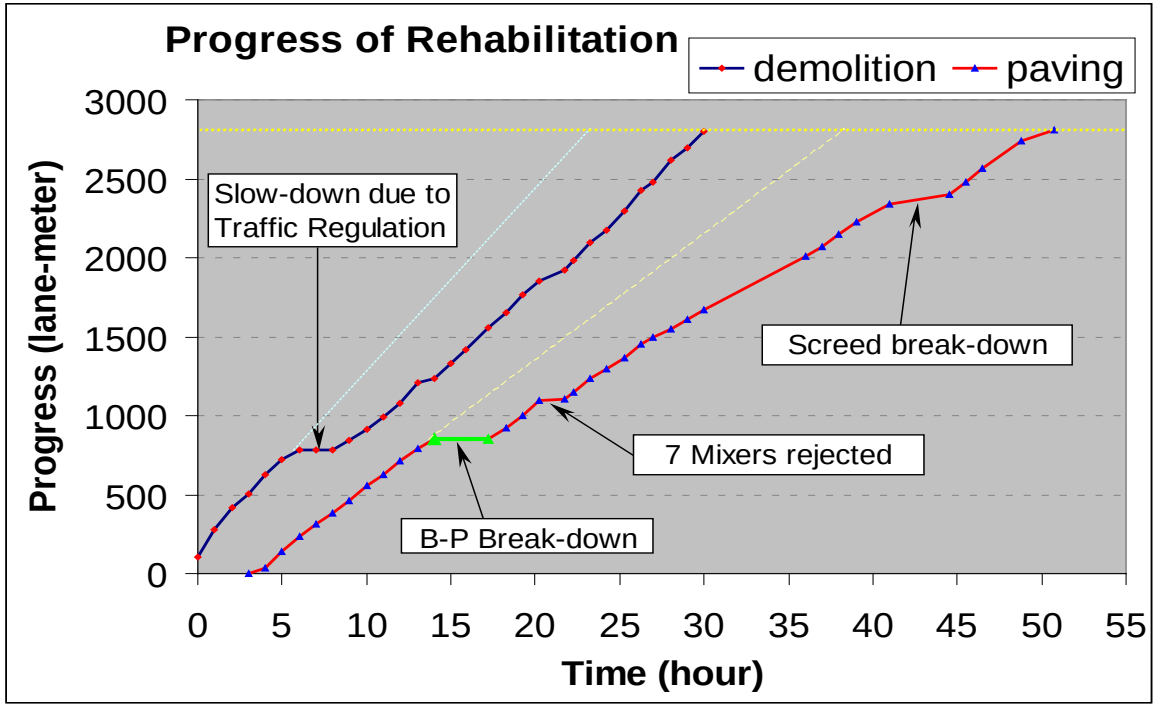
Schedule incentives

- if warranted by economic losses due to longer closures

1

I-10 Concrete Lane Replacement with 55 hour Weekend Closure in 2000

- 2.8 lane-km removed, replaced, opened to traffic
- Fast-setting concrete
- Moveable concrete barrier
- Back-up mixing plant
- Concurrent operations
- 1 ½ lanes available for traffic
- Need to remove closure and open within 4 hours if too much traffic delay



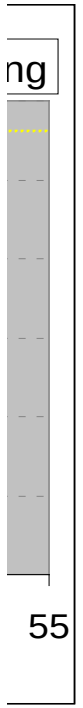
I-10 Concrete Lane Replacement with 55 hour Weekend

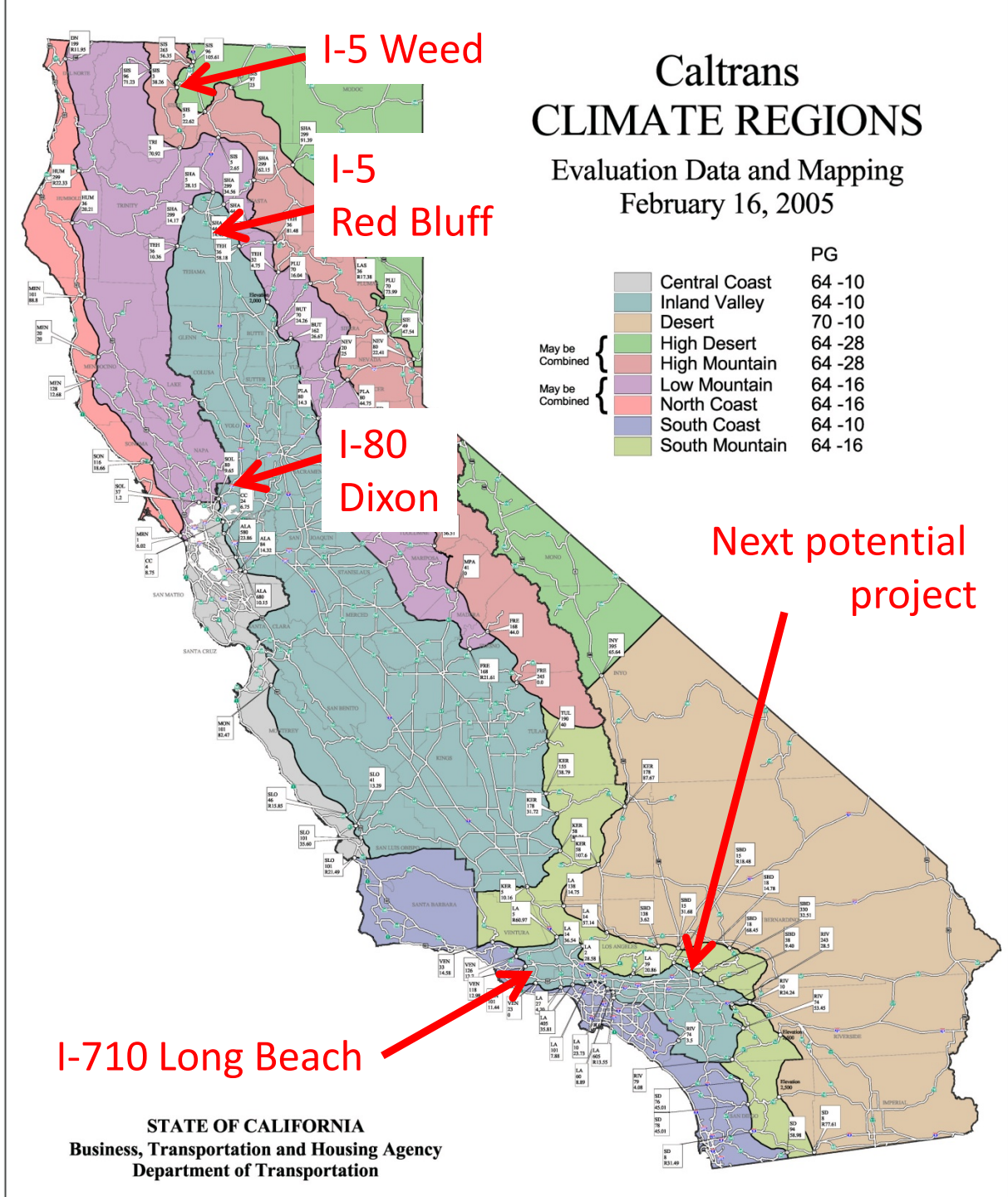
Lessons Learned

Moveable barrier worked well for fast closure changes

Some things contractors focused on were not necessarily the most important items controlling productivity

- Contractors: mixing plant, paver speed
- Experience:
  - adequate trucking
  - dedicated lanes for each concurrent operation
  - it’s a traffic problem on both sides of the barrier
  - need for simple and predictable materials
- Asphalt industry said “Hey, we can also innovate”

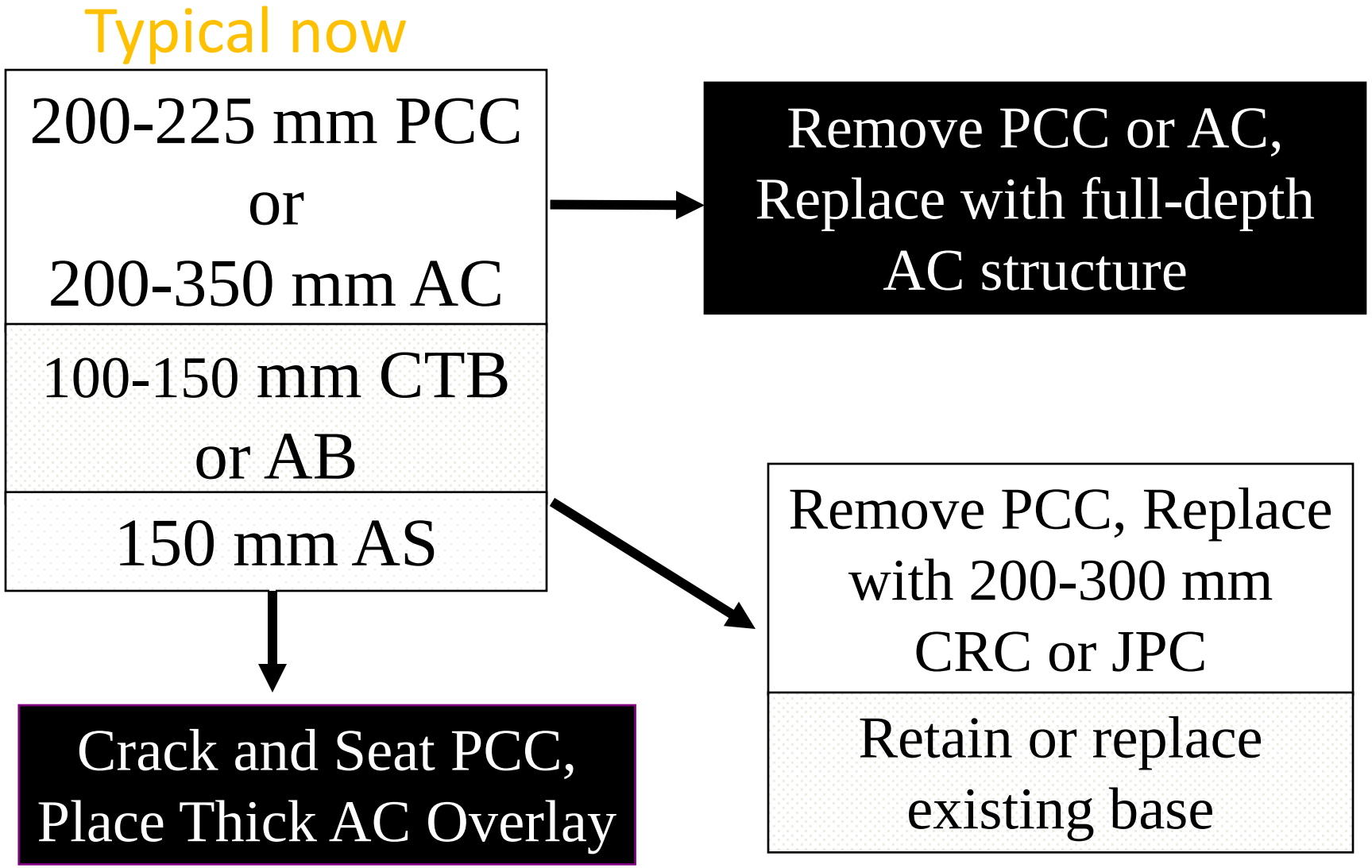




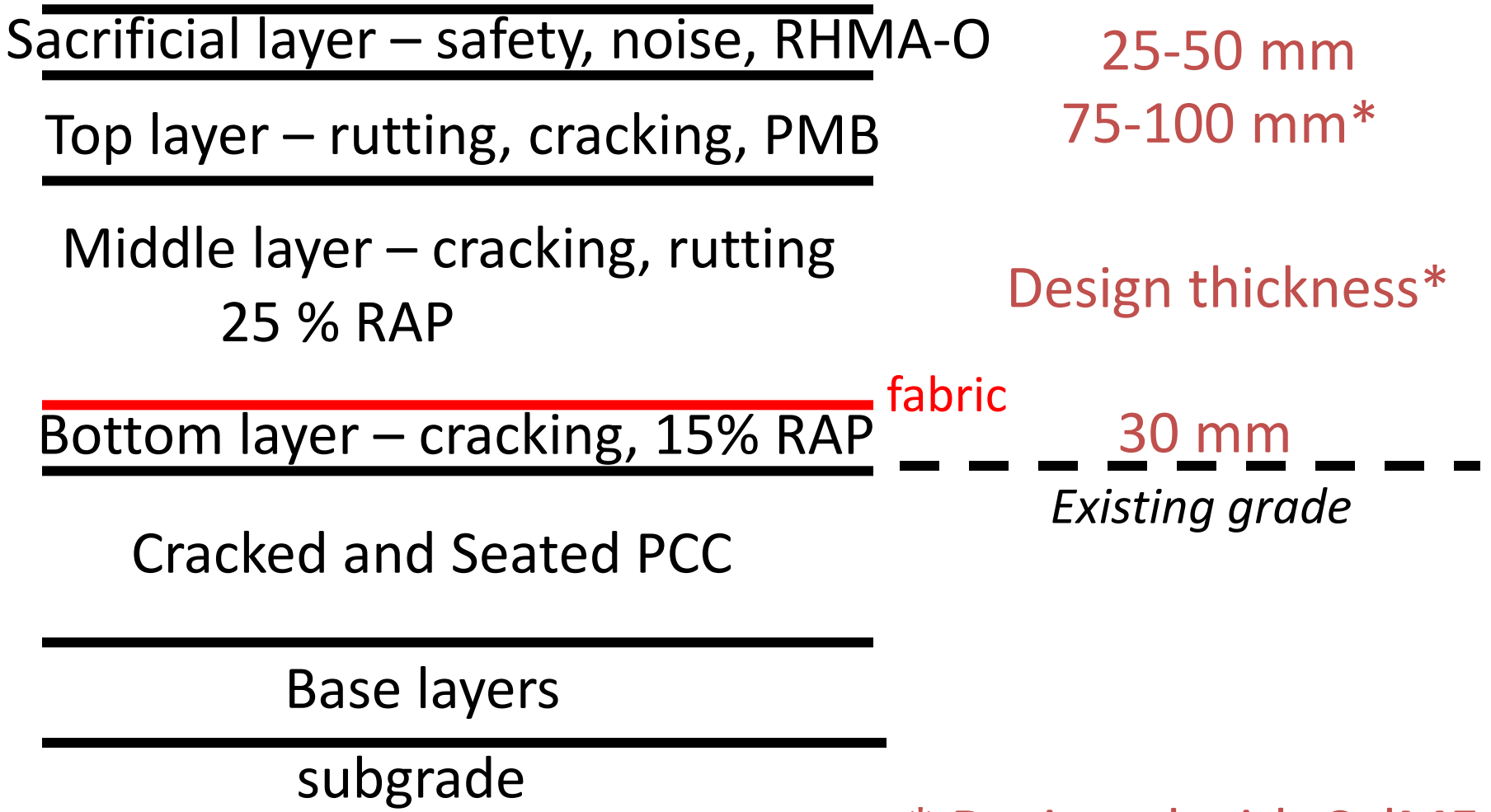
Projects to date

- Long Beach projects 2002-20XX
  - Four phases
  - About $650M
  - ME design
- 2012-2014 projects
  - Also pilots for inclusion of 25% RAP
  - About $100M
  - CalME design

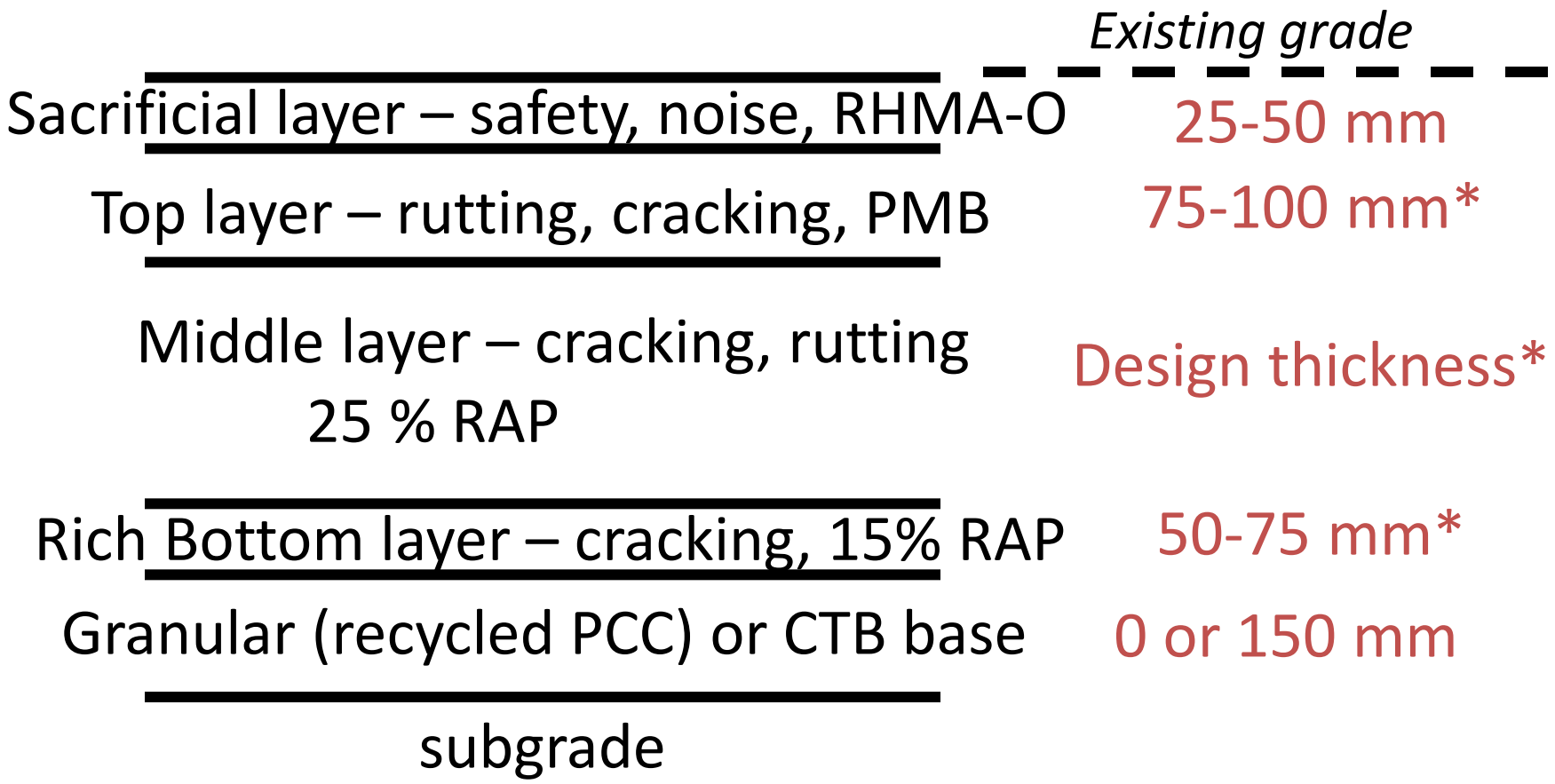
Current Long-Life Strategies



Crack, Seat and Overlay



Full-Depth Asphalt Concrete



* Designed with CalME

Rich-Bottom Layer

- Definition
  - Same materials as middle layer except for RAP content
  - 0 to 3 % air-voids
  - Bitumen content increased by contractor to achieve compaction (previously required +0.5%)
- Benefit is from increased compaction, not increased asphalt content
- Must be out of zone of rutting risk
  - More than about 150 mm below surface, depending on climate region

Current Performance Based Laboratory Tests

HMA Property	Test Type	Experiment Design
Stiffness Master Curve	Beam bending frequency sweep	3 Temp x 2 Replicates = 6
Fatigue Resistance	Beam bending fatigue (AASHTO T 321)	1 Temp x 2 Strain x 3 Replicates = 6 Previously used 3 T
Rutting Resistance	Repeated Simple Shear (AASHTO T 320) or Repeated Load Triaxial with AMPT	2 Temp x 3 Stress x 3 Replicates = 18

Asphalt Mix Performance-Based Specification for Red Bluff Project

Design Parameters	Test Method	Requirement
Permanent deformation (min.) **PG 64-28PM (with lime)[2a]** **PG 64-10 (with RAP and lime)[2b]**	AASHTO T 320 Modified[1]	 **360,000 stress repetitions[3,4]** **360,000 stress repetitions[3,4]**
Fatigue (min.) **PG 64-28PM (with lime)[5a,6]** **PG 64-10 (with RAP and lime)[5b,7a]** **PG 64-10 RB[11] (with lime)[5c,7b]**	AASHTO T 321 Modified[1]	 **23,000,000[4,8]** **345,000,000[4,9]** **25,000 repetitions[4,8]** **950,000 repetitions[4,9]** **182,000 repetitions[4,8]** **2,700,000 repetitions[4,9]**
PG 64-10 (with RAP and lime)	**AASHTO T 324 Modified[1]**	**20,000 repetitions[10]**

Asphalt Mix Performance-Based Specification for Red Bluff Project

Design Parameters	Test Method	Requirement
Permanent deformation (min.) **PG 64-28PM (with lime)[2a]** **PG 64-10 (with RAP and lime)[2b]**	AASHTO T 320 Modified[1]	**360,000 stress repetitions[3,4]** **360,000 stress repetitions[3,4]**
Fatigue (min.) **PG 64-28PM (with lime)[5a,6]** **PG 64-10 (with RAP and lime)[5b,7a]** **PG 64-10 RB[11] (with lime)[5c,7b]**	AASHTO T 321 Modified[1]	Fatigue testing specifications currently being changed to reduce testing time
PG 64-10 (with RAP and lime)	**AASHTO T 324 Modified[1]**	**20,000 repetitions[10]**

I-710 Long-Life Asphalt with 55 hour Weekend Closures 2002

- Total corridor
  - Ports to connectors
  - 32 miles, 6 to 10 lanes
- Four phases:
  - 1 to 3, completed 2002 to 2013
  - 4 in future
- Traffic ranges
  - 57,000 ADT, 28% trucks
  - 187,000 ADT, 14% trucks
  - 230,000 ADT, 8% trucks

Caltrans traffic http://traffic-counts.dot.ca.gov/docs/2011_aadt_truck.pdf

Before Construction

45 year old deteriorated PCC Pavement

Photo by EB Lee

Reduce Thickness to Speed Full-Depth Construction Under Bridges

Traditional materials
and Asphalt Institute ME design

535 mm thick

8 % air-voids
same mix design throughout
AR-4000 std binder

ME design using

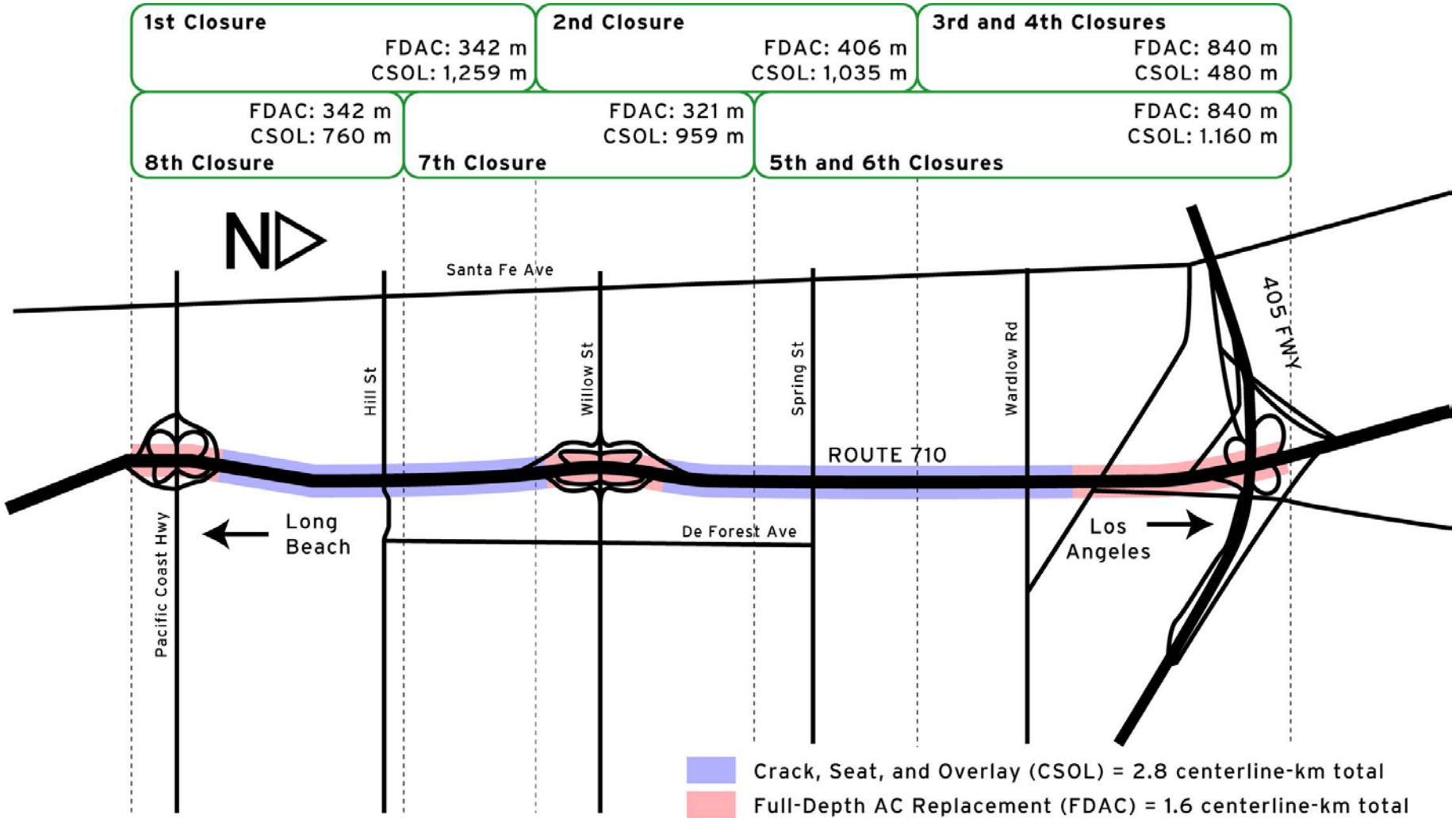
- Improved compaction
- Stiffer binder
- Rich Bottom
- 4 point beam materials characterization

300 mm thick

75 mm polymer 5% air-voids
150 mm AR-8000
5% air-voids
75 mm AR-8000, 2% air-voids
+0.5% binder

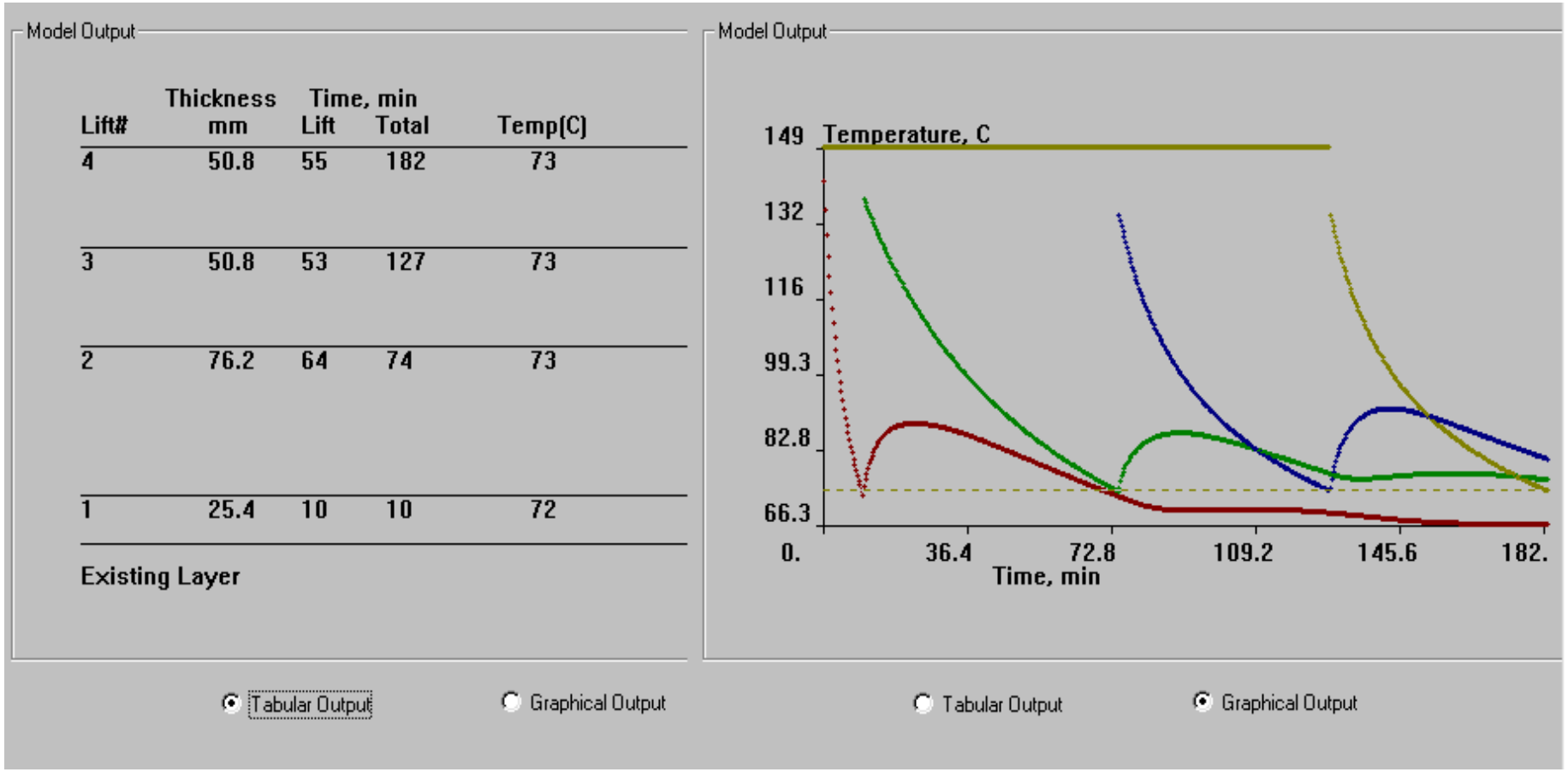
Staged construction:

Full directional closures, concurrent demolition and paving, 2 to 3 simultaneous asphalt paving operations



Paving Sequences Set Up to Permit Sufficient Cooling Between Lifts

MultiCool Analysis Software sponsored to provide model written by Voller and Timm



- Free download www.ucprc.ucdavis.edu/SoftwarePage.aspx or NAPA or NCAT websites

Accelerated Long-Life Rehabilitation Strategies

- 55-hour Weekend Closures for Major Rehabilitation OK
- Incentives/Disincentives (Phase 1 example)
  - $100K incentive per weekend if fewer than ten weekend closures
  - $100K disincentive per weekend for more than ten weekend closures
  - Hourly disincentives if past Monday open time
- Contractor's QA/QC and Pay Factor
  - Shear and fatigue PRS test results for mix approval
  - Field performance test results on asphalt content, gradation, and % of maximum theoretical density
  - Quality pay factors for the three quality characteristics
  - Maximum Obtainable Combined Pay Factor: 1.05
  - Minimum Acceptable Combined Pay Factor: 0.90

After Construction

FDAC Section near PCH

Photo by EB Lee

Lessons Learned from Phase 1 (1/2)

- Pre-bid conference should be mandatory
- For new performance-related test procedures
  - Work to reduce time required
  - Ensure tests and analyses done the same way
- Monetary Incentives proved to be effective
  - Contractor earned $200K incentive for early completion
- Pay factor effectively encouraged quality awareness and quality workmanship:
  - $70K extra earned by contractor
  - Some quality measures not met on early closures
- Monitoring to date indicates expected performance

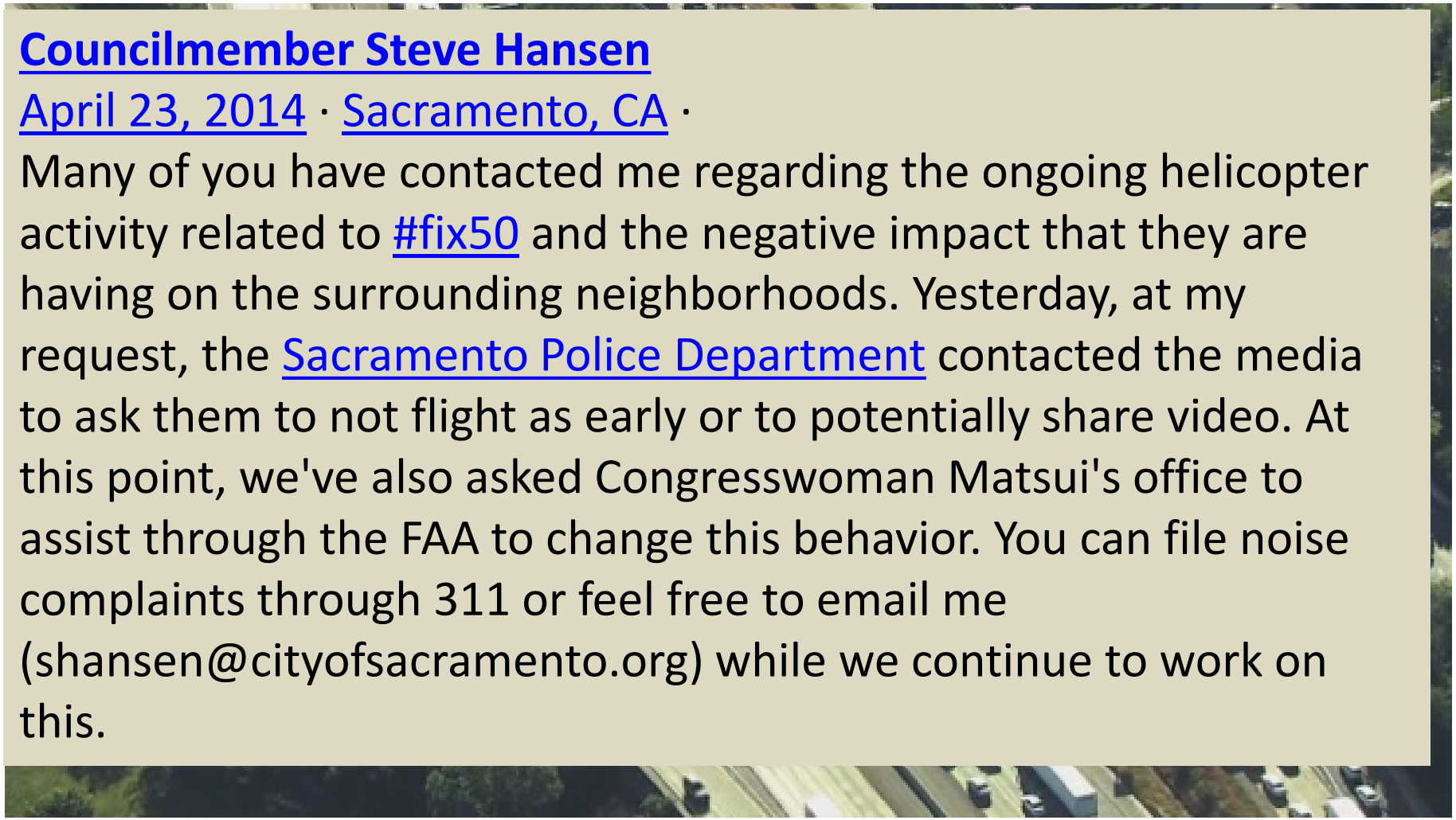
Detailed Lessons learned (contractor and CT recommendations) Report at www.ucprc.ucdavis.edu/PDF/UCPRC-SR-2008-04.pdf

Lessons Learned from Phase 1 (2/2)

- Software can help to standardize information and analyses for construction productivity and traffic delay
- RapidRehab (CA4PRS) software developed by UCPRC/Caltrans/industry
- Software database captures planning assumptions and data collected from field monitoring
- Software available through Caltrans and FHWA
  www.dot.ca.gov/newtech/roadway/ca4prs/
  www.fhwa.dot.gov/research/deployment/ca4prs.cfm

Lessons Learned: Traffic Management

Lessons Learned: Traffic Management



Councilmember Steve Hansen
April 23, 2014 · Sacramento, CA ·
Many of you have contacted me regarding the ongoing helicopter activity related to #fix50 and the negative impact that they are having on the surrounding neighborhoods. Yesterday, at my request, the Sacramento Police Department contacted the media to ask them to not flight as early or to potentially share video. At this point, we've also asked Congresswoman Matsui's office to assist through the FAA to change this behavior. You can file noise complaints through 311 or feel free to email me (shansen@cityofsacramento.org) while we continue to work on this.

I-5 Red Bluff

I-5 Red Bluff

Existing semi-rigid pavement, stripped AC

I-5 Weed

Varying underlying pavement thicknesses and types

I-80 Dixon

Existing badly cracked 50 year old PCC with IRI up to about 4 m/km in sections

I-80 Dixon: all night-time construction

I-80 Dixon: ready for single pass for smoothness of PMB top layer and RHMA-O surface

Summary and Takeaways

- Performance
  - Specifications and designs appear to be working; good performance on I-710 after 13 years
  - CalME design being moved out to districts
  - Need for continuing evolution of listening to feedback and improving practice: design, construction, materials, testing, specifications, traffic management, public outreach
- Takeaways: Overall
  - Ensure sufficient early success to be able to continue
  - Think about ALL client issues, many not pavement but affected by pavement: traffic, construction scheduling, etc
  - Listen, do post-project reviews of contractor and owner and other stakeholders

Takeaways

- Design
  - Use and improve ME design method to reliably get same performance with thinner pavement
    - Must be able to evaluate materials and construction
    - Must be well calibrated including reliability
  - Take advantage of specific materials properties to thin the structure
    - The right material in the right place
    - Strategic use of modified asphalt and recycled materials to improve properties

Takeaways

- Design
  - Use construction specifications in design:
    - Compaction levels and variability for asphalt
    - Compaction levels and variability for underlying layers
    - Light stabilization of underlying materials
    - Tie asphalt PBS to ME design inputs
- Construction
  - Keep design and materials as simple as possible
  - Make sure asphalt materials are compactable

Takeaways

- Contractors
  - Time needed for materials characterization is often more important than cost
  - Need to understand effects of binder on achieving PBS are not covered by PG spec (mid-temperature stiffness and fatigue life)
  - Need to understand mix improvement process to meet PBS
- Owners
  - Incentives to go beyond spec can help spur innovation
  - Continuous improvement in terms of setting bar for design and construction
  - Need critical mass of projects to get industry investment and maintenance of expertise
- All
  - Communication essential, source of most problems
  - Work together to communicate innovation to public and tradeoffs of long life rehabilitation life cycle cost versus short term traffic issues and initial cost

Thanks

- Caltrans HQ and District 2, 4 and 7 staff
- Contractors and their consultants
- NAPA
- More info:
  - http://calapa.net/Longlifepavement.html

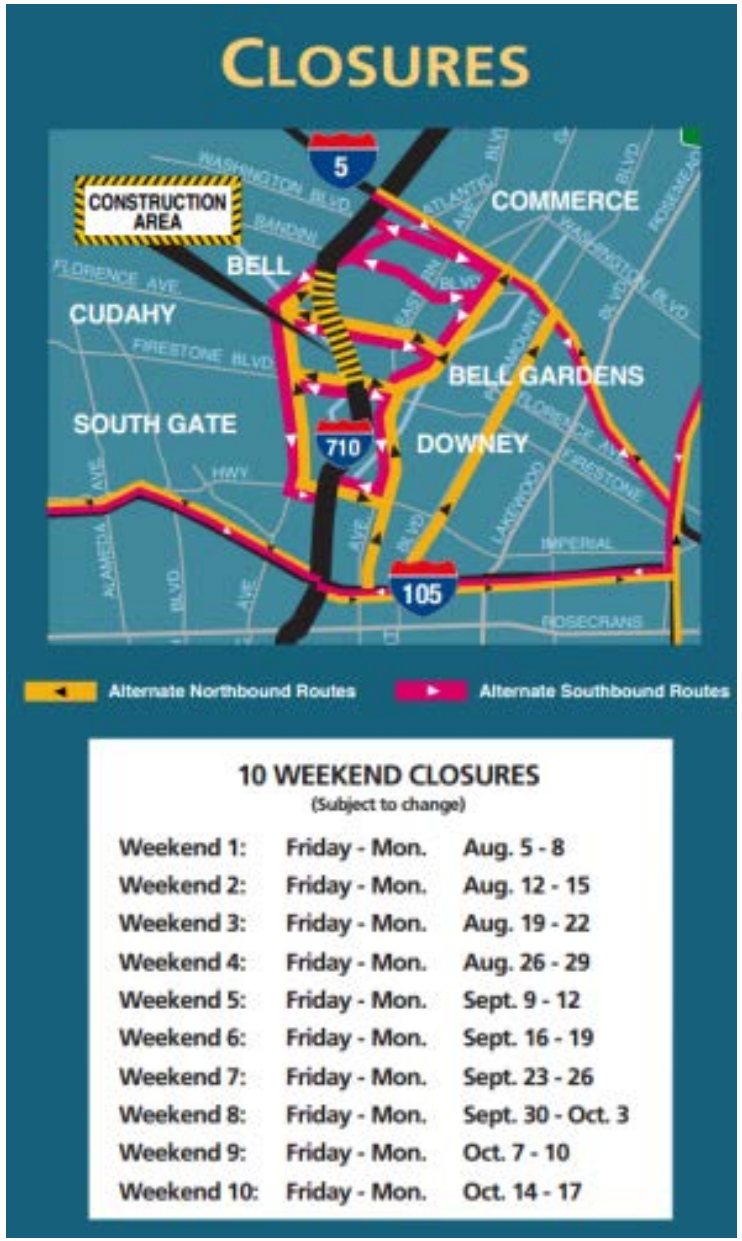
Caltrans wins Pavement Pioneer Award for Perpetual Pavement projects

AMANDA BAYHI

National Asphalt Pavement Association President Mike Acott (left) and California Asphalt Pavement Association Executive Director Russell Snyder (right) present the Pavement Pioneer Award to Caltrans Maintenance Chief Tony Tavares. (Photo courtesy of APA)

The California Department of Transportation (Caltrans) has received a national Pavement Pioneer Award for the long-life asphalt pavement projects recently constructed on Interstate 5 in Northern California.

Questions?



Sully-Miller photos