California – Partnered Pavement Research

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HVSIA Meeting
Pretoria, RSA
August 24-26, 2005
California – core partners

- CSIR – started APT ca. 1970 - experience
- Caltrans – APT interest ca. 1990 – technology transfer to California
- Demonstration pilot project 1993 – 6 months
- Caltrans purchase 1994
  - 2 HVS Mk III + 18 month research and tech transfer
- CAL/APT: Caltrans/UCB/Dynatest/CSIR 1995-96
- 2000-2004 PPRC – UCD&B/Dynatest/CSIR
- 2004-2005 PPRC – UCD&B/Dynatest/CSIR
California – other collaboration

• Principle – do not re-invent the wheel
• Universities – Washington, Illinois, Vienna, Ohio, Maine, Pretoria
• States – mainly SPTC (Ca., Mn., Tx., Wa.) and Gauteng (RSA)
• Corps of Engineers – WES, CRREL
• Industry
Update Since 2003 HVSIA

• Strategic Plan
  – “Quiet Pavement” (Arizona DOT catalyst)
  – Precast PCC, Super-Slab™ (with industry)
• M-E Design - CT Issue Memo (HVS catalyst)
• CA4PRS - “Rapid Rehab” (with 5-state SPTC)
• I-710 (with industry)
• MB Road (with industry)
• Calpine - Foamed Asphalt (CSIR catalyst)

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# Strategic Plan

<table>
<thead>
<tr>
<th>Strategic Plan Elements</th>
<th>Element Numbers</th>
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<tbody>
<tr>
<td><strong>Research Services – Basic</strong></td>
<td>2.1 to 2.3*</td>
</tr>
<tr>
<td>(1) Develop the PPRC program, (2) Continue developing the Pavement Research Database, and (3) Provide pavement technology advice to Caltrans</td>
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<tr>
<td><strong>Research Services – Special Forensic Investigations</strong></td>
<td>2.4.1 to 2.4.4</td>
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<tr>
<td>Investigate performance of existing pavement through sampling, laboratory testing, instrumentation, monitoring, analysis, and reporting results</td>
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<tr>
<td><strong>Research Services – Implementation Projects</strong></td>
<td>3.1.1 to 3.2.10*</td>
</tr>
<tr>
<td>For technologies under evaluation by Caltrans, help Caltrans with experiment design, developing specifications, construction, sampling, lab testing, instrumentation, monitoring, and analysis</td>
<td></td>
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<tr>
<td><strong>Research Goals</strong></td>
<td>4.1 to 4.15</td>
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<tr>
<td>Study of especially complex pavement issues that require longer project schedules and more resources for testing and analysis</td>
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</tbody>
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*These Elements are for finding ways to do partnering, collaborating, and complementary work
Strategic Plan

- Developed by research technical program management
- Input and priorities from: customers, operation staff, analysis staff
- Revised every two years
“Quiet Pavement”

• High priority for Caltrans; European tour
  – Cost and “quality of life” issue
• Grew from OGAC mix design project
• New Core Competency for PPRC
  – Sound intensity, standard car & equipment
  – Friction testing, field and lab
• Work with others, e.g. noise impedance tube
• Workplan approved, see Website
Precast PCC Panels - Super-Slab™

- Vendor (Fort Miller, NY)
  - Proprietary system used in bridge toll plaza
- Caltrans District 8 “champion”
- Dowels, tie bars
- Panels cast locally
- Caltrans evaluating 4 aspects: design specs, biddability, constructability, and long-term performance (HVS) compared with long life PCC
Super-Slab™ – HVS test site
Super-Slab™ – bedding preparation
SuperSlab™ – local fabrication
SuperSlab™ – local fabrication
Super-Slab™ - placement
Super-Slab™ – dowel bar grouting
M-E Design Caltrans Policy Memo

“Based on the few M-E pavement designs done to date, such as the I-710 pavement rehabilitation project in Long Beach, Caltrans has the potential to save from 10 to 40 percent on pavement costs for TI greater than 12. Additional savings also will be realized in traffic handling costs and construction time.”

- Quantifies benefits
- Identified risks
- Quantifies resources
- Sets schedule - 5 yrs
- Assigns accountability
- Specifies maintaining
- Identifies steps
- Functional buy-in
Construction Productivity, CA4PRS

- Need **Long Life, Fast Construction** and **Minimum Traffic Delay**
  - pavement design strategies:
    - longer life pavements take longer to construct
  - construction windows/traffic delays:
    - shorter windows less efficient for construction
    - some strategies can’t be built in 7- to 10-hour windows
    - which windows minimize total traffic delay: 55-hour weekend, 72-hour weekday, continuous?

- Requires Integration
  - Pavement Engrg + Construction Engrg + Traffic Engrg
What does CA4PRS do?

- CA4PRS calculates the maximum length of highway pavement that can be rehabilitated or reconstructed under a given set of project constraints.
- CA4PRS can be used to optimize construction and traffic management plans for highway rehabilitation projects by taking into account scheduling interfaces, pavement design and materials selection, lane closure tactics, and contractor logistics and resources.
“Rapid Rehab” I-15 Devore Project, Long Life PCC

- High traffic volume: Over 80,000 vehicles daily commute between the high desert and LA basin
- Weekend volume: 120,000 vehicles
- Heavy truck traffic: major truck route for freight
- Long Life goal: 30 years instead of 15 years
- Avoid daytime work, multiple lane closures, and traffic delays (commuters and trucks)
- Paving typically only allowable at night but
  - limits construction production
  - lengthens the time the project takes to complete: night construction would take 8 months to complete
  - worker safety: dangers working at close proximity to traffic at night
'Rapid Rehab' Accelerated Urban Highway Reconstruction: I-15 Devore Project Experience

Since 1998, the California Department of Transportation (Caltrans) has been implementing a Long-Life Pavement Rehabilitation Strategies (LLPRS) program to address the need for cost-effective approaches to rebuilding 2,800 lane-km of aging pavements in the urban highway network. This case study presents an innovative fast-track reconstruction approach applied to a heavily trafficked LLPRS project on Interstate-15 (I-15) in Devore in southern California. A 4.5-km stretch of badly damaged concrete-traffic lanes was rebuilt in only two 10-hour (about 9 days) one-lane continuous closures (called "extended closures" herein), using counter-flow traffic and 24-hour operations. The same project would have taken 10 months using traditional nighttime closures.

Innovations adopted for this groundbreaking "Rapid Rehab" project included:

- Automated Work Zone Information Systems (AWIS) to update travelers with real-time travel information
- Quick-change Moveable Barrier (QMB) system with a dynamic lane configuration to minimize traffic disruption

- Mix design of rapid strength concrete (RSC) to enable the project to be opened to traffic 12 hours after placement,
- Web-based information systems for disseminating project updates and surveying public perception,
- Incentive/disincentive provisions to encourage the contractor to complete the closures on time, and
- Multifaceted outreach program to gain public support.

Engineers on the project used C-A-PRESS (Construction Analysis for Pavement Rehabilitation Strategies) incorporated with traffic simulation models to arrive at an optimal and economical rehabilitation closure scenario, construction schedule, and traffic management plan. The post-construction data validated the analysis and simulation estimates of productivity and traffic delay.

As a result of AWIS and public outreach, a 20 percent reduction in traffic demand through the construction work zone (CWZ) was achieved, thereby reducing the maximum peak-hour delay by 50 percent (45 minutes instead of the expected 90 minutes).

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I-15 Devore Rapid Rehab Project

Latest News:
- Real-time Traffic Map for I-15 Devore Project now available
- Turning construction Commuter Survey for I-15 Devore Project now available
### Existing Road Condition Photos

1. **Northbound I-15 before the I-215 Interchange (Devore Overhead)**
   - Photo shows asphalt concrete (AC) patch repair in which pavement was replaced due to severe corner cracking.

2. **Northbound I-15 near Sierra Avenue**
   - Photo shows deterioration of pavement due to heavy truck wheelloads.

3. **Southbound I-15 near Glen Helen Parkway**
   - Photo shows severe corner cracking next to prior asphalt concrete (AC) patch repair.

4. **Southbound I-15 near Glen Helen Parkway**
   - Photo shows severe corner cracking and pavement settlement.
# I-15 Devore Project, Comparison of Construction and Traffic Alternatives

<table>
<thead>
<tr>
<th>Construction Scenario</th>
<th>Schedule Comparison</th>
<th>Cost Comparison ($M)</th>
<th>Max. Peak Delay (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Closures</td>
<td>Closure Hours</td>
<td>User Delay</td>
</tr>
<tr>
<td>72-Hour Weekday Continuous</td>
<td>8</td>
<td>512</td>
<td>5.6</td>
</tr>
<tr>
<td>55-Hour Weekend Continuous</td>
<td>10</td>
<td>550</td>
<td>14.2</td>
</tr>
<tr>
<td>1 Roadbed Continuous</td>
<td>2</td>
<td>400</td>
<td>6.9</td>
</tr>
<tr>
<td>10-Hour Night-time Closures</td>
<td>220</td>
<td>2,200</td>
<td>4.9</td>
</tr>
</tbody>
</table>

72-hour closure chosen based on PPRC analysis

Estimated Caltrans savings $7.8 Million vs 10-hour night-time closures
Outreach & Public Perception

• Goal: To achieve 20 percent reduction in traffic demand
• Caltrans created extensive public outreach program.
• Outreach materials: project brochure, construction flyers, construction advisory electronic bulletin, fast-fax through email, a project information help hotline, and several public meetings for local communities.
• 3 Caltrans Districts & local agencies created Project Website to provide up-to-date project information.
• Website had a total of about 100,000 hits for 3 months before & during the extended closures; lots of public input.
• Web survey results:
  Support “Rapid Rehab”?  
  
  ![Pre-construction](image1)  
  ![Post-construction](image2)
The California Department of Transportation has announced 13 winners in the annual Excellence in Transportation Awards. The honors are highly regarded in the industry because they recognize transportation projects that are among the best anywhere, said Caltrans Director Will Kempton.

Southern California

Southern California winners are: State Highway 56 Middle, an urban highway project by the city of San Diego, San Diego Association of Governments, Boyle Engineering and Caltrans' San Diego operations; San Ysidro Intermodal Transportation Center, a project by the Metropolitan Transit System, San Diego Association of Governments, Kimley-Horn and Associates and Parsons Brinckerhoff Construction Services; Malibu Seawall, a safety project by the City of Malibu, John S. Meek Company and the Caltrans Division of Construction in Los Angeles.

San Bernardino Santa Fe Depot, a historic preservation and cultural enhancement by the City of San Bernardino, San Bernardino Associated Governments, TransTech Engineering Inc., and Soltek Pacific; I-15 Devore "Rapid Rehab," which won twice, for public awareness and transportation innovations, UC Berkeley Intelligent Transportation Systems and Caltrans' San Bernardino Operations sponsored it.

Northern California
CA4PRS also used on I-710

- CA4PRS used on I-710 project in Long Beach
- Rehab of an existing concrete pavement in a series of 55-hour, weekend closures
- Original Caltrans estimate for completing the 4.4 km (26.3 lane-km) project: 10 weekend closures
- The contractor completed in 8 weekend closures
- CA4PRS credited with affecting time savings
I-710 Long Beach, Long Life AC

Rapid Pavement Rehabilitation with Long Life Asphalt Concrete
I-710 Long Beach, Long Life AC

- In service since 1952
  - 200 mm PCC, 102 mm CTB, 305 mm AB
  - Plain jointed undoweled
- High traffic: 164,000 vehicles per day
- High trucks: 13% trucks, Port of Long Beach
- High “visibility”
- By 2003, severe cracking and faulting
  - Rehab: Crack, Seat, and Overlay with Full-Depth AC under bridges
I-710 Project Map

- **1st Closure**: FDAC: 342 m, CSOL: 1,259 m
- **2nd Closure**: FDAC: 406 m, CSOL: 1,035 m
- **3rd and 4th Closures**: FDAC: 840 m, CSOL: 480 m
- **5th and 6th Closures**: FDAC: 840 m, CSOL: 1,160 m

- [Legend]
  - Crack, Seat, and Overlay (CSOL) = 2.8 centerline-km total
  - Full-Depth AC Replacement (FDAC) = 1.6 centerline-km total

- Key locations:
  - Pacific Coast Hwy
  - Santa Fe Ave
  - Hill St
  - Willow St
  - Spring St
  - Wadlow Rd
  - Long Beach
  - Los Angeles
  - De Forest Ave
Designs – M-E design of FDAC under bridge structures

Existing Portland Cement Concrete Prior to Rehabilitation
- Pavement Reinforcing Fabric

Crack, Seat, and Overlay
- Total Thickness = 230 mm (all above existing surface)

<table>
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<tr>
<th>Material</th>
<th>Thickness</th>
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<tbody>
<tr>
<td>RAC-O</td>
<td>25 mm</td>
</tr>
<tr>
<td>PBA-6a</td>
<td>75 mm</td>
</tr>
<tr>
<td>AR-8000</td>
<td>85 mm</td>
</tr>
<tr>
<td>AR-8000</td>
<td>45 mm</td>
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</tbody>
</table>

Full-Depth Asphalt Concrete
- Total Thickness = 325 mm
- Demolition = 625 mm

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<td>PBA-6a</td>
<td>75 mm</td>
</tr>
<tr>
<td>AR-8000</td>
<td>150 mm</td>
</tr>
<tr>
<td>AR-8000 RB</td>
<td>75 mm</td>
</tr>
</tbody>
</table>

Additional Clearance = 150 mm

RAC-O: Rubberized Asphalt Concrete – Open Graded
PBA-6a: Dense graded asphalt concrete with polymer-modified binder
AR-8000: Dense graded asphalt concrete with conventional binder
AR-8000 RB: Rich bottom dense graded asphalt concrete with conventional binder

Asphalt Inst. & Caltrans: 535 mm, 8% AV, AR-4000
I-710 Mix rutting resistance
PPRC Contributions to I-710

- Mix designs
- Structural pavement designs
- Construction feasibility analysis, CA4PRS
- Traffic management plan review
- Measure construction productivity and traffic delay
- Broader benefit: $$ savings from M-E designs justified Caltrans M-E Issue Memo
MB Test Sections

• Goal: to evaluate proposed Caltrans MB spec
• 6 test sections, 5 products
  – Full thickness DGAC
  – Half-thickness Asphalt Rubber-GG
  – Half & full thickness Terminal blends Modified Binders
MB Test Sections

• HVS1 – rutting tests July ’03 – January ’04
  – Channelized, 40 kN load, pavement temp. 50C at 50 mm
  – Tested to failure, rut depth 12.5 mm
  – Report in process DGAC best, MB4 full thickness 2nd

• HVS1 – fatigue tests
  – Jan-Jun ’04, MB4 full thickness, 20C, 2.1M reps, no cracks, 10mm rut
  – Jul’04-Mar’05 MB4 half thickness, 2.1M reps, no cracks
  – Apr-present RAC-G half thickness, 20C, ~2M reps, no cracks

• New chiller system
Calpine SR-89 – Deep In-Situ Recycling with Foamed Asphalt
Calpine State Route 89

- Report in process
- Started as a special forensic investigation
- HVS2 test – foamed bitumen treated, recycled asphalt pavement (RAP)
- Field surveys - pavement structure of the HVS2 test sections is not representative of the mainline and foamed bitumen treated, recycled asphalt concrete in general.
- The mode of distress differs between summer/fall and winter.
  - Summer/fall: gradual deformation leading to rut failure but limited fatigue cracking.
  - After the winter: faster rate of rutting; Sections tested during spring, shear failure of the base layer in certain locations. These sections also show extensive fatigue cracking
- Caltrans priority; planning on new HVS test project
Thank you!