Continued Development of California’s Accelerated Pavement Reconstruction/Rehabilitation Approach

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Overview

• For Long-Life Rehabilitation and Reconstruction Caltrans uses:
  – Pavement designs and specifications to minimize thickness, speed construction time
  – Continuous closures and full directional closures
  – Extensive traffic management planning
  – Continuous traffic monitoring and adjustments
  – Extensive public outreach
  – Provision of alternative transportation

• Outline:
  – Development of approaches
  – Details and experience
  – Lessons Learned
Want Long Life and 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 impossible in 7-10 hour windows
  - which windows minimize total traffic delay:
    55 hour weekend, 72 hour weekday, continuous?

- Requires
  - Pavement Engineering + Construction Engineering + Traffic Engineering
Origins of the California approach

Northridge earthquake damaged four bridges on the Santa Monica Freeway in Los Angeles
  – Closure estimated to cost LA economy $1M per day

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
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
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

Progress of Rehabilitation

- Slow-down due to Traffic Regulation
- Screed break-down
- 7 Mixers rejected
- B-P Break-down
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
I-710 Long-Life Asphalt with 55 hour Weekend Closures 2002

• Total corridor
  – Ports to connectors
  – 32 miles, 6 to 10 lanes
  – Estimated $650M total cost

• 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
# AC Mix and Pavement Designs

## Pavement Cross-section Changes

### Existing PCC

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thick.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCC</td>
<td>203 mm</td>
</tr>
<tr>
<td>CTB</td>
<td>102 mm</td>
</tr>
<tr>
<td>AB</td>
<td>305 mm</td>
</tr>
<tr>
<td>SG</td>
<td></td>
</tr>
</tbody>
</table>

### CSOL

**Total thick. = 230 mm**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thick.</th>
</tr>
</thead>
<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 (RB)</td>
<td>45 mm</td>
</tr>
</tbody>
</table>

### FDAC

**Total thick. = 325 mm**

**Demolition = 625 mm**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thick.</th>
</tr>
</thead>
<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>150 mm</td>
</tr>
<tr>
<td>AR-8000 (RB)</td>
<td>75 mm</td>
</tr>
<tr>
<td>New AB</td>
<td>150 mm</td>
</tr>
</tbody>
</table>

### Existing Surface

**more clearance = 150 mm (6")**

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Slide from EB Lee

- Removed
- Retained
- Fabric
- AC (Weekend Closure)
- AC (Nighttime Closure)
Reduce Thickness to Speed Full-Depth Construction Under Bridges

Traditional materials and ME design

535 mm thick (21 in.)
8 % air-voids
same mix design throughout
AR-4000 std binder

ME design using
• Improved compaction
• Stiffer binder
• Rich Bottom

300 mm thick (12 in.)
75 mm polymer 5% air-voids
150 mm AR-8000
5% air-voids
75 mm AR-8000, 2% air-voids
+0.5% binder
Paving Sequences Set Up to Permit Sufficient Cooling Between Lifts

MultiCool Analysis Software sponsored to provide model

<table>
<thead>
<tr>
<th>Lift#</th>
<th>Thickness (mm)</th>
<th>Time, min</th>
<th>Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>50.8</td>
<td>55</td>
<td>182</td>
</tr>
<tr>
<td>3</td>
<td>50.8</td>
<td>53</td>
<td>127</td>
</tr>
<tr>
<td>2</td>
<td>76.2</td>
<td>64</td>
<td>74</td>
</tr>
<tr>
<td>1</td>
<td>25.4</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Existing Layer

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

- **1st Closure**: FDAC: 342 m, CSOL: 1,259 m
- **2nd Closure**: FDAC: 406 m, CSOL: 1,035 m
- **8th Closure**: FDAC: 342 m, CSOL: 760 m
- **7th Closure**: FDAC: 321 m, CSOL: 959 m
- **5th and 6th Closures**: FDAC: 840 m, CSOL: 480 m
- **3rd and 4th Closures**: FDAC: 840 m, CSOL: 1,160 m
Moveable concrete barrier to safely split traffic in each closure
Accelerated Rehabilitation Strategies (1/2)

- 55-hour Weekend Closures for Major Rehabilitation Works
  - Continuous operations Friday 10 pm to Monday 5 am
- Counter-flow Traffic
  - Upgrading of an outside shoulder to accommodate two-by-two traffic on temporary traffic roadbed
  - Traffic diversion through median crossovers
  - Moveable Concrete Barrier to counter flow traffic
- 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
Accelerated Rehabilitation Strategies (2/2)

- **Contractor’s QA/QC and Pay Factor**
  - Shear and fatigue 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

- **Construction Work Zone Traffic Controls**
  - Comprehensive Traffic Management Plan providing contractor construction access to ramps, and defining best closure times, lane closure schemes, required detours and alternative routes
  - Extensive public awareness campaigns to inform the public of potential delay and alternative routes
Full Closure (Counter-flow Traffic)
Concurrent operations: Every major operation gets its own access lane

Traffic Roadbed

Construction Roadbed

Demolition
AC Base
PCC Paving
De-mob.

progress (L-km)

0.0 0.3 0.6 0.9 1.2 1.5 1.8

0 12 24 36 48 60 72 hour

SB TRAFFIC
NB TRAFFIC
ACCESS
RECONSTRUCTION

S1 L1 L2 L3 L4 S2

S1 L1 L2 L3 L4 S2
Half or Partial Closure

Sequential operations: Each operation has to wait to be able to use access lane
Contractor’s Learning Curve I-710 Phase 1

- **Demolition+Excavation (FDAC)**
- **Paving (CSOL+FDAC)**

Productivity (tonne/hour) vs. Weekend Closure Number

Slide adapted from EB Lee
Negotiation with Local Government for Alternative Traffic Routes; Eliminate other construction in the area

Phase 1 Example of alternative routes and planning area

Construction site
### Effectiveness of Traffic Management Plan Phase 1

<table>
<thead>
<tr>
<th>Weekend Measurements</th>
<th>North Bound</th>
<th>South Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before Construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADT (veh/day)</td>
<td>61,255</td>
<td>61,044</td>
</tr>
<tr>
<td>Peak (veh/hr)</td>
<td>4,299</td>
<td>3,900</td>
</tr>
<tr>
<td><strong>During Construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADT (veh/day)</td>
<td>38,667</td>
<td>35,544</td>
</tr>
<tr>
<td>Peak (veh/hr)</td>
<td>2,733</td>
<td>3,498</td>
</tr>
<tr>
<td><strong>Reduction (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADT</td>
<td>36.9%</td>
<td>41.7%</td>
</tr>
<tr>
<td>Peak</td>
<td>37.2%</td>
<td>35.8%</td>
</tr>
<tr>
<td><strong>Peak Reduction Comparison</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulation</td>
<td>31.2%</td>
<td>18.9%</td>
</tr>
<tr>
<td>TMP</td>
<td>35.0%</td>
<td>45.0%</td>
</tr>
</tbody>
</table>

Slide adapted from EB Lee
Phase 1 Construction Work Zone Traffic Flow Comparison

North Bound Traffic

- **Before Construction (Weekend)**
- **During Construction (Weekend)**
- **Before Construction (Weekday)**

**CWZ Capacity**
After Construction
FDAC Section near PCH
Lessons Learned from Phase 1 (1/3)

• 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 from Phase 1 (2/3)

• 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
• Human resources “stretched” across multiple closures
  – maximum 3 to 5 successive closures with 1 or 2 in between
• Contractor should select closure locations
• Input from meteorologists is important for contractor
• Contingency planning is extremely important
  – materials, equipment, traffic, weather, accidents, work force

Lessons Learned from Phase 1 (3/3)

• Use of repeated weekend closures for similar types of operations led to noticeable productivity gains as well as learning effect

• Monetary Incentives proved to be effective in this fast-track project
  – Contractor earned $200K incentive for early completion

• Pay factor effectively encouraged quality awareness and quality workmanship:
  – $70K extra for meeting the minimum quality requirements
  – Some quality measures not met on early closures

• Monitoring to date indicates expected performance

More traffic lessons learned on subsequent asphalt and concrete projects.
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## I-15 Devore Selection of Closure Type using CA4PRS

<table>
<thead>
<tr>
<th>Construction Scenario</th>
<th>Total Closures</th>
<th>Closure Hours</th>
<th>User Delay</th>
<th>Agency Cost</th>
<th>Total Cost</th>
<th>Max. Peak Delay (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Roadbed Continuous</td>
<td>2</td>
<td>400</td>
<td>5.0</td>
<td>15.0</td>
<td>20.0</td>
<td>80</td>
</tr>
<tr>
<td>72-Hour Weekday Continuous</td>
<td>8</td>
<td>512</td>
<td>5.0</td>
<td>16.0</td>
<td>21.0</td>
<td>50</td>
</tr>
<tr>
<td>55-Hour Weekend Continuous</td>
<td>10</td>
<td>550</td>
<td>10.0</td>
<td>17.0</td>
<td>27.0</td>
<td>80</td>
</tr>
<tr>
<td>10-Hour Night-time Closures</td>
<td>220</td>
<td>2,200</td>
<td>7.0</td>
<td>21.0</td>
<td>28.0</td>
<td>30</td>
</tr>
</tbody>
</table>
I-15 Devore Web-Surveys
Public Perception Changes

Before-construction

- No, Cancel project: 14%
- Negative: 11%
- Continuous closures: 7%
- Adding lane: 4%
- Other: 11%

After-construction

- No, Nighttime or weekend: 64%
- Yes: 30%

Do you support 72-h (3-weekday) Weekday closures?

Do you support future “Rapid-Rehab” projects?
Lessons Learned: Traffic Management

- Consider contractor recommendations for staging
- More money spent for early finish
  - Fix 50 bridge rehab from $17.3M to $24.3M
  - Contractor bonuses ($150k/day in continuous closures) and local government arrangements
- Local government arrangements
  - Change traffic light timing, restriping of lanes and intersection reconfigurations
  - Increased transit capacity
  - More police officers on parallel routes and at intersections
  - Arrangements with emergency services to maintain access
  - Arrangements with major employers for flexible hours, telecommuting, transit incentives, communication
Lessons Learned: Traffic Management

• Contractor did hour by hour scheduling
• Central traffic command during operations
  – Continuous monitoring and messaging
  – Daily teleconferences (all stakeholders, contractor, Caltrans, employers, public safety)
  – 24 hour look ahead, progress
  – Then given to media

• Media
  – “scare the heck out of everybody”
  – “the media is your friend” (with one exception)
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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.
Questions?

Closures

CONSTRUCTION AREA

10 WEEKEND CLOSURES
(Subject to change)

Weekend 1: Friday - Mon. Aug. 5 - 8
Weekend 2: Friday - Mon. Aug. 12 - 15
Weekend 3: Friday - Mon. Aug. 19 - 22
Weekend 4: Friday - Mon. Aug. 26 - 29
Weekend 5: Friday - Mon. Sept. 9 - 12
Weekend 6: Friday - Mon. Sept. 16 - 19
Weekend 7: Friday - Mon. Sept. 23 - 26
Weekend 8: Friday - Mon. Sept. 30 - Oct. 3
Weekend 9: Friday - Mon. Oct. 7 - 10
Weekend 10: Friday - Mon. Oct. 14 - 17