Rapid Pavement Rehabilitation with Long Life Asphalt Concrete

Project experience from the rehabilitation of Interstate 710 in Long Beach, California using 55-hour weekend closures

In 1998, the California Department of Transportation (Caltrans) started the Long-Life Pavement Rehabilitation Strategies (LLPRS) program to rebuild approximately 2,800 lane-km of deteriorated freeway of the total 78,000 lane-km within the California state highway system. Among the LLPRS candidate corridors, the Long Beach Freeway (Interstate 710) stood out as an important route for its high traffic volume (164,000 vehicles per day), 13 percent of which is trucks serving the Port of Long Beach.

In service since 1952, the original pavement structure consisted of 200 mm Portland cement concrete (PCC) slabs placed on cement-treated and aggregate base layers. By 2003, the pavement exhibited severe faulting and cracking. A project was undertaken to rehabilitate a 4.4 centerline-km (26.4 lane-km in total) section of Interstate 710 (I-710) during a series of 55-hour weekend closures (Figure 1). The rehabilitation included all three lanes in each direction plus the shoulders and median. Encouraged by an incentive provision of $100,000 per weekend closure in the Caltrans contract, the contractor shortened the initial ten-weekend plan and was able to finish the main rehabilitation work in eight consecutive closures for a total award of $200,000.

Caltrans

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The project consisted of three full-depth asphalt concrete (FDAC) replacement sections (1.6 km total) under freeway overpasses, and two sections (2.8 km total) with crack, seat, and overlay (CSOL) of existing PCC slabs with AC. The designs for the new pavement structure were developed using mechanistic-empirical methodologies to accommodate 200 million equivalent single axle loads (ESAL) over 30 years. The contract included performance-related materials specifications for stiffness, fatigue resistance, and rutting resistance for the AC layers, as well as higher than normal compaction.

In the FDAC sections, the existing pavement was excavated to a depth of 625 mm and replaced with 150 mm new aggregate base and 325 mm AC (Figure 2). This FDAC design lowered the pavement surface 150 mm to meet current interstate bridge clearance requirements. The FDAC design included a "rich bottom" layer with 0.5 percent additional binder to facilitate compaction to the required air-void content of 0 to 3 percent for increased stiffness and fatigue resistance of the critical bottom AC layer. The CSOL sections received a total of 230 mm AC overlay, including mixes with conventional AR-8000 and polymer-modified PBA-6a binders. The CSOL design included a pavement reinforcing fabric to mitigate reflection cracking.

After the weekend closures were finished, nighttime closures were used to pave the entire project with a 25-mm surface layer of open-graded rubberized asphalt concrete (RAC-O) to reduce hydroplaning, tire spray, and noise.

Construction Work Zone Closures

During each weekend closure, Caltrans entirely closed one side of the freeway for construction. All traffic was redirected to the other side of the construction utilizing counter-flow traffic through the median crossovers. The shoulder was used as a temporary traffic lane to provide two traffic lanes in each direction, down from the usual three. A moveable concrete barrier (MCB) was used to close the freeway and reroute traffic. The entire freeway (both directions) was closed for 6 hours at the beginning of each closure to enable preparation of the traffic crossovers on the median, stripe temporary lanes, and place the MCB. During this time, traffic was detoured to local arterial roads. The entire freeway was closed again at the end of each closure for 6 hours to remove the MCB, temporary striping, and prepare the freeway for Monday morning rush hour traffic. Construction activities ran around the clock during the 55-hour weekend closures (10 p.m. Friday to 5 a.m. Monday).

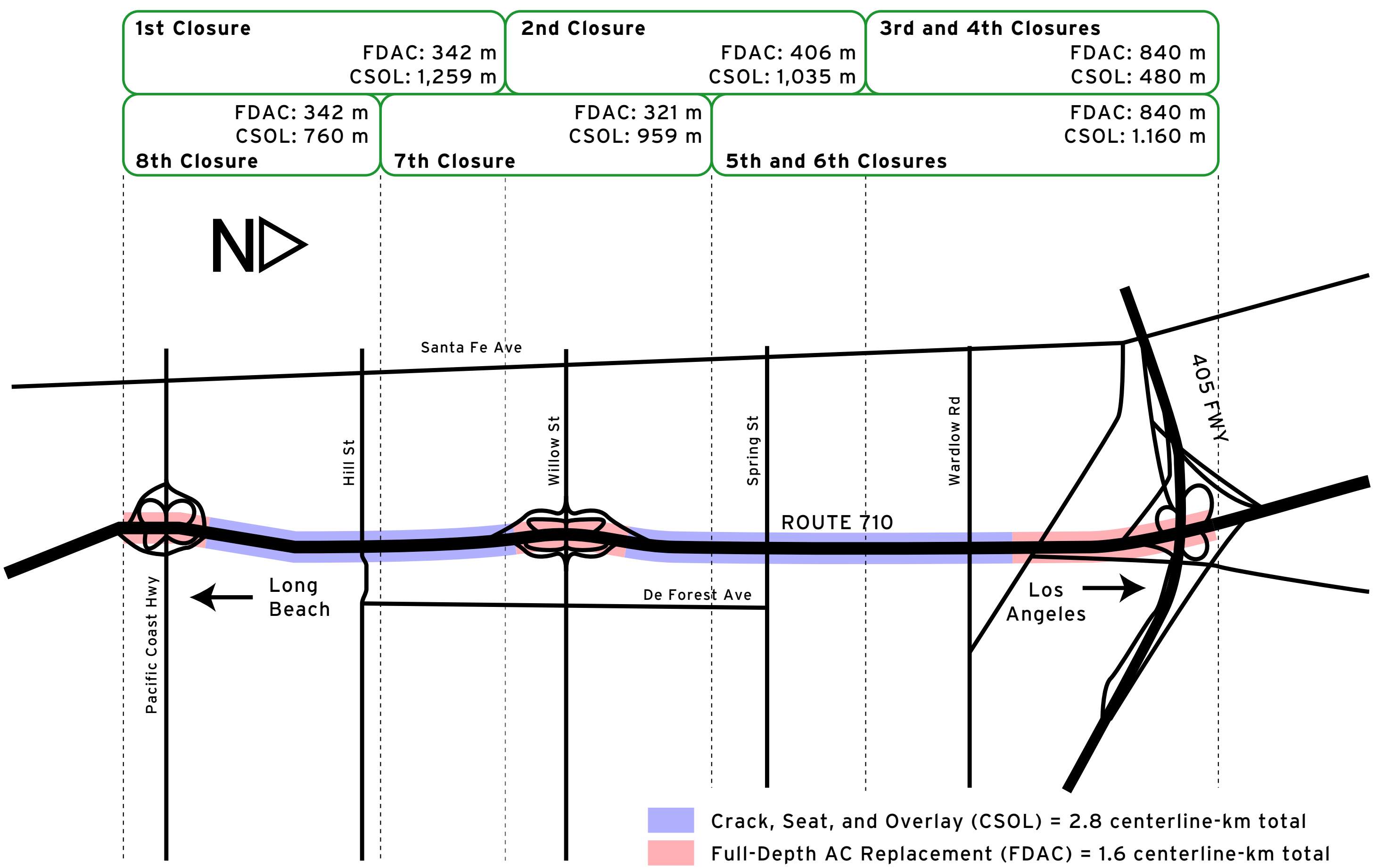

Figure 1: Map of project.

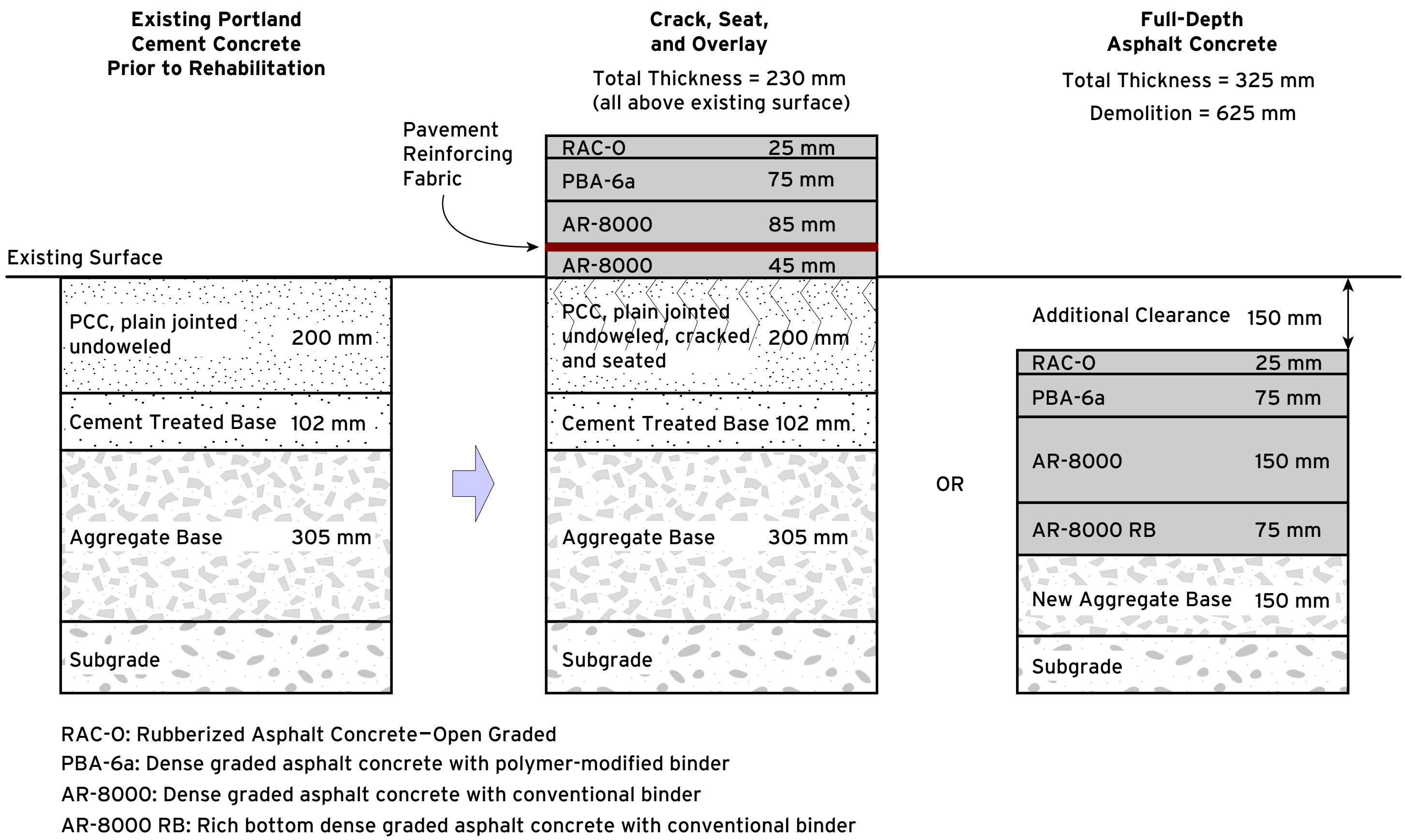

Figure 2: Pavement cross sections before and after rehabilitation.

Productivity Analysis Using CA4PRS

The University of California Pavement Research Center developed Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) software as a planning tool for LLPRS projects. Funding for the development of CA4PRS was provided by a Federal Highway Administration pooled fund project sponsored by the State Pavement Technology Consortium (California, Florida, Minnesota, Texas, and Washington).

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.

Prior to the start of the mainline rehabilitation, the University of California (Berkeley and Davis) Pavement Research Center team used CA4PRS to estimate that the maximum production capability in the 55-hour weekend closures was one CSOL section (about 1.3 km) and one FDAC section (about 0.4 km). However, the CA4PRS analysis indicated that the contractor's initial plan of rehabilitating two FDAC sections and one CSOL section in one 55-hour closure was overly optimistic. The contractor revised his plan before beginning the mainline work to match the CA4PRS production estimate.

Contractor's Learning Curve

The research team monitored material quantities, planned and actual activity durations, truck turnaround times, and hourly production rates for major rehabilitation operations during three of the eight weekend closures. The contractor's measured production was within 5 percent of CA4PRS production estimates. CA4PRS predicted demolition hauling truck and AC delivery truck flow rates similar to the contractor's measured respective average of 10 to 12 trucks per hour.

The contractor's production rates increased after the first weekend, especially in demolition/excavation and paving operations, indicating a "productivity learning curve." The increase in the demolition production rate probably occurred because the contractor realized that this activity most constrained total production, and thus allocated extra resources to this task. The contractor's records show that the production rates during the five closures that were not monitored matched the contractor's learning curve. Demolition and paving production rates achieved by the seventh closure are probably near the maximums possible for rapid urban freeway AC rehabilitation in California with current equipment and methods.

Traffic Impact Measurements

Researchers evaluated the impact of the 55-hour weekend closures on traffic by measuring changes in the traffic performance (volume, speed, and travel time) for weekends before and during construction. The results indicate that efforts to inform the public of detours, as indicated in the Caltrans Traffic Management Plan (TMP), resulted in a significantly lower traffic demand in the construction work zone (CWZ). Despite initial concerns about traffic delay, there was no significant congestion and traffic operated at free-flow speeds throughout the surrounding network during construction weekends, including the I-710 corridor, neighboring freeways, and detour arterials.

Traffic measurements in the work zone showed that peak hour traffic flow decreased by 37 percent and average daily traffic decreased by 39 percent compared to the preconstruction weekend flows. The peak hourly flow through the CWZ during the first weekend closure was 1,350 vehicles/lane/hour. Traffic gradually increased with each weekend closure, finally stabilizing at around 1,500 vehicles/lane/hour. The traffic increases in the work zone during successive closures appear to show a learning curve, with many drivers avoiding the work zone during the first weekend closure, in apparent anticipation of delays, only to return to their usual driving patterns in subsequent weekends once it was apparent that delays were not going to be significant.

Traffic flow on freeways adjacent to the work zone did not change significantly during the closures, except on the parallel Harbor Freeway (Interstate 110) where traffic increased by about 7 percent. Parallel arterial streets designated as detours in the TMP saw significantly more traffic during the closure. Overall, the total traffic demand reduction (no-shows) across the 20-km^2 network study area was only about 1 percent, compared with the TMP estimate of 5 percent. This indicates that drivers detoured around the CWZ and then re-entered the freeway.

Conclusions

The I-710 Long Beach rehabilitation project proved that asphalt concrete is viable with respect to construction productivity in eight 55-hour weekend closures when designed to meet long-life pavement rehabilitation design criteria, even on the most heavily truck-loaded route in the state.

This case study was funded by Caltrans and the Asphalt Pavement Alliance and will be useful for transportation

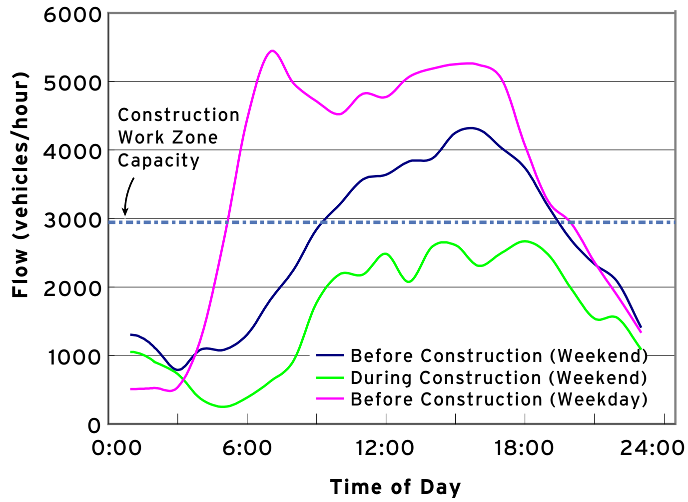

Figure 3: Traffic flow before and during construction.

agencies and contractors in developing integrated construction and traffic management plans for rapid highway rehabilitation projects that maximize construction productivity and minimize traffic delay in high volume situations.

Overall, the construction productivity data collected indicates that the rehabilitation plans developed by Caltrans and the contractor were accurate and reliable. Almost all rehabilitation activities were completed as scheduled and the freeway was reopened to the public by 5 a.m. Monday after each closure. The traffic measurement data indicates that the Caltrans TMP minimized the impact of construction on drivers.

For More Information…

Caltrans on the Web:
http://www.dot.ca.gov/research/roadway/roadway.htm

Pavement Research Center:
http://www.its.berkeley.edu/pavementresearch

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