Western/Pacific Smooth Ride Sentinel

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The right CSOL-ution

February 10, 2018

Washington State DOT's last-ditch play against aging pavements is a unique success

Asphalt (https://www.roadsbridges.com/asphalt)
Article
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February 09, 2017

Paving crews worked the inside lanes at night utilizing the notched wedge joint on the shoulder lane.

State DOTs have a primary responsibility to maximize the return on investment from the considerable public funds spent to build and maintain their highways and interstates.

To manage the long-term costs of its aging inventory of concrete pavements, the Washington State Department of Transportation (WSDOT) has adopted a wide variety of strategies, but there comes a point when large sections of these aging pavements can no longer be efficiently maintained at acceptable service levels.

At that point, increasingly, WSDOT is turning to its variation of cracking, seating and overlaying (CSOL) of distressed concrete pavements.

The process cracks the old existing concrete panels into smaller panels to eliminate future reflective cracking and to eliminate slab "bridging" over possible subgrade voids. The cracked panels are then "seated" with a heavy pneumatic roller to stabilize the concrete so it can serve its revised role as the new pavement base structure. In the final step of the process, the pavement is fully renewed with a "deep strength" section of hot-mix asphalt structural pavement. The result is that WSDOT essentially recycles the old concrete slabs in place. By doing so, the agency captures the remaining structural value of the old pavement as a base platform for a new asphalt-surfaced highway. The result of this conversion—from concrete to asphalt surfacing—is a new long-lived pavement, ready to serve many future generations of travelers.

The challenges inherent in rehabilitating Washington's older concrete pavements was recognized well ahead of time thanks to the comprehensive data maintained in WSDOT's Pavement Management System (WSPMS). Armed with this information and seeing the coming need, the agency began to explore which methods for rejuvenating failing concrete pavements were the most practical and cost effective.

The decision tree WSDOT used to evaluate the CSOL option started with an initial scoping analysis in line with the Strategic Highway Research Program's software for Long Life Pavement Design Guidelines (SHRP2 R23). This tool, used in concert with WSDOT's own life-cycle cost analysis (LCCA) protocol, resulted in the early realization that CSOL should be considered a key strategy for pavement rehabilitation.

Crews perform WSDOT's "most ambitious" CSOL project on a busy section of I-5 in King County, just south of Seattle's urban core.

King's ambition

WSDOT performed its first modern CSOL project in 2011 on I-5 near the city of Burlington, about 50 miles south of the Canadian border. With the favorable results of that project and with additional lessons learned from two CSOL projects on I-90 in the intervening years, WSDOT was ready in 2015 to put this strategy to work on its most ambitious "conversion" project to date—the crack, seat and overlay on a busy section of I-5 in King County, just south of Seattle's urban core.

MidMountain Contractors Inc., based in Kirkland, Wash., was the successful bidder in December 2015 for the I-5 southbound So. 320th Street to Duwamish River Bridge Project with its price of $20.471 million. The project included the replacement of 238 select broken concrete panels, the replacement of aging and worn bridge expansion joints, repaving five on-/off-ramps and, most critically, repaving 2.7 miles of the five southbound lanes using CSOL within the nearly 14-mile project corridor. MidMountain was to perform the critical demolition, grading and slab seating tasks required for the CSOL operations, as well as handle overall contract management as the general contractor.

MidMountain's CSOL team included two key subcontractors: Antigo Construction of Boise, Idaho, as the slab-cracking contractor, and ICON Materials, an Oldcastle Co., of Pacific, Wash., as the asphalt production and paving company. This team was responsible for partnering with WSDOT to effectively tackle the bulk of the challenges presented in the CSOL section of the project.

The traffic count through this portion of I-5 is currently 200,000 ADT with 8.7% trucks. The technical assessment used by WSDOT's pavement managers for describing the stretch of freeway was "just worn out." The end-of-life condition of these pavements was easy to recognize by the rough, noisy ride and extensive random cracking. Panel-by-panel triage was no longer economically feasible . . . but WSDOT knew how to fix the problem.

Down to three

One of the critical features of this project was the foresight to schedule the bulk of the work during three 55-hour partial freeway closures (three closed lanes from 10 p.m. Friday through 5 a.m. Monday). The entire CSOL process was programmed to be accomplished during these closures, minimizing disruption for travelers.

After extensive negotiations with WSDOT to provide more flexibility for lane-closure hours for the critical center lane of the freeway, the team settled on a plan that called for transition panel excavation and paving, cracking and seating all the lanes and placing the initial leveling lift (0.15 ft) of asphalt during the first two closures. The final lifts of asphalt pavement were to be placed during the third weekend or during additional 13-hour Friday-night-to-Saturday-morning closures.

The beauty of this plan included a public relations benefit—drivers who had experienced the noisy, rough ride on their way home Friday night were pleasantly surprised by the ultra-smooth asphalt pavement they experienced during the Monday morning commute. It was as if a little bit of magic had descended on I-5 over the weekend.

A 35-ton pneumatic roller reseats concrete panels on I-5.

Dialing it in

The team was fortunate that Antigo had been the crack-and-seat subcontractor for WSDOT's three previous CSOL projects. Antigo's extensive résumé in crack-and-seat work has helped WSDOT to subtly refine its specifications, recognizing and incorporating practical applications of current practices employed by Antigo.

Data from the WSPMS was again used in the CSOL planning process, providing accurate details about the existing pavement structure (9 in. of plain concrete pavement over 8 in. of gravel base and crushed rock). That WSPMS information allowed the work to progress without the interference of schedule-

killing surprises.

The T8600 Badger Breaker is Antigo's choice for best meeting WSDOT's panel-cracking specifications. The breaker has a 12,000-lb guillotine-style variable drop height hammer with a perpendicular wing. Once the ideal hammer drop height is determined for a specific concrete panel type, the T8600 can move into high production mode with very consistent results.

The effectiveness of the cracking process was initially evaluated within a 500-ft test section. After getting "dialed in," Antigo set to work with the T8600, cracking each of the 2.5-mile lanes in five to six hours. The operation was monitored continuously for compliance with WSDOT's specifications for both the cracking pattern and for full-depth vertical cracking effectiveness. MidMountain then permanently "seated" the cracked concrete slabs using a 35-ton pneumatic roller.

This instant

ICON Materials approached this high-profile project with the intent to illustrate speed of construction and "instant smoothness" as powerful attributes of the CSOL process. The ability to produce and pave continuously over extended weekend closures and to effectively provide a near-finished product at the end of each closure are key to a positive perception of CSOL from the travelling public. The speed and quality of the asphalt paving is what the public notices. ICON has met similar challenges many times in the past, and it proved equal to the task once again.

The initial leveling lifts over the cracked and seated concrete were paved with a WSDOT HMA Class ⅜-in. PG 64-22 dense-graded asphalt pavement mix. ICON paved with two paving crews, working in echelon configuration, to match the capacity of its Gencor HMA plant and to minimize the number of cold longitudinal joints.

ICON's paving train for each crew typically consisted of a Roadtec SB-2500 Shuttle Buggy material transfer vehicle, a Caterpillar AB1055E paver, a Dynapac CC624HF roller in breakdown mode, a Hypac pneumatic roller in the middle, and a Cat CB54 finish roller. Pavement edges left open to traffic between closures were paved to meet WSDOT's notched-wedge joint specification, providing non-abrupt transition edges for traffic and resulting in high-quality, high-density longitudinal joints when echelon paving was not practical.

WSDOT specified an HMA Class ½-in. mix with PG 64-22 binder for the two intermediate pavement lifts (2.4 in. each) placed above the initial leveling course. The pavement structural design also incorporated the HMA Class ½-in. mix for the final wearing course, but the binder was upgraded to PG 70-22ER (polymer modified) in order to address the high traffic volume and variable speeds present on this stretch of the interstate.

In all, a total of 8.4 in. of HMA was placed above the repurposed cracked concrete panels. ICON placed a total of 60,000 tons of asphalt pavement mix on the project, all of it paved either within the 55-hour closure windows or during strategic extended night closures for the center lane paving or for incidental work (e.g., off- and on-ramp paving).

The CSOL road segment of I-5 after paving completion.

Rolling to a stop

With MidMountain coordinating the overall team, the project rolled along without a hitch and with very few issues. WSDOT's public-awareness campaign kept the work zone safe and the traffic delays manageable even during peak flows. Traffic volumes were decreased from the norm as many informed travelers chose an alternate route.

The quality of the finished pavement speaks for itself (albeit in a soft, smooth whisper). The resulting average IRI on the newly paved CSOL road segment is 46 in. per mile, with the outside passing lane the smoothest of all at 41 in. per mile. Compaction levels on all the paving lifts averaged greater that 93% of maximum theoretical density, with the wearing course lift exceeding 94% density across the board.

As the result of good project planning, a strong project team and the speed and flexibility inherent in HMA paving, the citizens of Washington State received a great value—maximizing the usable structural benefit remaining in the old pavement while creating a new, smooth HMA pavement that can carry the load well into the future.

About the author:
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