Caltrans Plans for Perpetual Pavements

BY ASPHALTPRO STAFF ON MARCH 14, 2023

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The Interstate 5 Corridor enhancement project is a $370 million project to rehabilitate 67 lane-miles of pavement, ramps and connectors along 15 miles of I-5 near Sacramento, California.

Although the size of the project is interesting in its own right—requiring approximately 625,000 tons of asphalt—what makes the project particularly unique is its use of 475,000 tons of long-life asphalt.

California's long-life asphalt pavement design is a perpetual pavement design that aims to produce a pavement that lasts 40 years or longer with minimal maintenance. The design strategy was a culmination of another collaboration between industry, the California Department of Transportation (Caltrans) and the University of California Pavement Research Center (UCPRC).

Other projects using similar design criteria have been built on I-5 in northern California, on Interstate 80 between Sacramento and the San Francisco Bay Area, and Interstate 710 in Los Angeles County.

The project is a joint venture between Granite Construction, Watsonville, and Teichert Construction, Pleasanton. According to Granite project managers Kelly Curtis and Bob Mihal, the project has two main goals: rehabilitating the existing pavement and widening the road to accommodate increased traffic.

On top of the cracked and seated concrete, Granite's crew placed a 1.2-inch leveling course followed by a geosynthetic pavement interlayer (GPI), 5.4 inches of intermediate mix, 2.4 inches of a high-polymer surface course mix and 1.2 inches of rubberized OGFC.

"Some of the lanes in the areas close to downtown Sacramento were paved in the 1950s, during the original construction of I-5," Curtis said. "Being such an old highway, it was in need of a complete rehab."

Furthermore, Curtis added, I-5 has seen a major increase in traffic along the project section, with heavy congestion every morning and afternoon "worse than anywhere else in Sacramento." Mihal said the south end of the project has an average daily traffic count of 94,300 with 16% truck traffic, while the north end has an ADT of 217,800 with 6% truck traffic.

Not only is I-5 an international trucking corridor from Mexico to Canada, but it's also one of only two freeways for north-south traffic in Sacramento, Curtis said. Elk Grove and the surrounding southern suburbs, he added, have also been among the fastest growing communities in northern California over the last 20 to 30 years.

"In that time, there hasn't been any widening of the road," Curtis said. That's why the project is also adding a high-occupancy vehicle (HOV) lane from downtown Sacramento to Elk Grove. "Even if the project didn't have that widening component, we would be rehabilitating it one way or another. So even though there were two purposes, the road was still at the end of its life."

Crack and Seat

Although the road was in rough shape, the concrete pavement was in good enough condition for Caltrans to perform crack-and-seat.

“Crack-and-seat overlay is a method being used more and more throughout the state,” Mihal said. “It’s a standard method for Caltrans that allows you to use the concrete pavement as your subbase material, so you don’t have to remove and replace it.”

The bigger benefit in most cases, Mihal added, is that this method allows for continued use of the roadway. “We never restricted the lanes on this project during peak hours,” he said. “We only had nightly and weekend closures, but kept the same number of lanes open to the public during commuting hours.”

The process uses a guillotine to create hairline cracks in the concrete to relieve the stress on the panel. The typical crack pattern for Caltrans is to break a 12-foot-wide lane into 6-foot by 4-foot panels.

Crack-and-seat overlays can only be used on concrete panels in somewhat decent shape, Mihal said. For panels that had failed, the Granite crew had to remove and replace them before cracking the new panels alongside the old ones.

“After making those cracks, you can open that pavement back up to traffic for a temporary duration, and pave those lanes at night,” Mihal said. “There’s also the benefit of the structural capacity of the base compared to rubblizing it.”

However, Mihal added, Caltrans can only use this method when the panels are in “halfway decent” shape. “If they’re totally deteriorated, crack-and-seat is not an applicable method,” he said.

The condition of the panels varied throughout the length of the project, Curtis said. While some panels were from the interstate’s original construction in the 1950s, others had been done in the past 10 to 30 years, he added. The crews had to replace panels that had failed and then crack them, though Curtis estimates this only accounted for 2% of the panels on the project. “Even over the course of our job, we

had panels that had corner cracking one day totally fail the next and we'd have to perform emergency work to repair them," Curtis said.

Despite those setbacks, subcontractor Antigo Construction was able to use its purpose-built equipment to drive the highway, cracking and seating multiple lane miles each night.

Although Curtis said there are differences throughout the pavement design for the widening sections, the standard outside layer on main sections included a Triax geogrid layer in contact with the subgrade, 1 foot of Class 2 aggregate base, 2.4 inches of a rich bottom mix, 8.4 inches of intermediate course, a 2.4-inch surface course, then 1.2 inches of OGFC.

Designed for Long Life

After the concrete, which ranged from 0.7 to 1 foot deep, had been cracked and seated, the crews could begin laying asphalt on the project. First, the crews placed a 1.2-inch leveling course with a standard ½-inch hot-mix asphalt (HMA).

"It wasn't structural, but leveled out the panels so we had a smooth surface to place the geosynthetic pavement interlayer (GPI)," Curtis said, "which was meant to prevent any rocking in the concrete that could propagate cracks up to the asphalt surface into the asphalt."

On top of the GPI, the crews placed 5.4 inches of intermediate mix with ¾-inch aggregate with PG64-16 and 25% recycled asphalt product (RAP), 2.4 inches of a high-polymer surface course mix with ¾-inch aggregate with PG64-28M and 15% RAP, and 1.2 inches of rubberized open graded friction course (OGFC).

The widening portion of the project, which added a fifth lane to each direction of travel on the north end of the project and a third lane to each direction of travel on the south end of the project, followed a different process.

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Although most of the paving was performed by one paving train at a time, Curtis said Granite had a lot of backup equipment available in case of breakdowns.

“The purpose of the rich bottom layer on the widening sections, the shoulder, and the median—anywhere we didn’t have concrete below and were placing a full-depth pavement built atop an aggregate base layer—was to offer more flexibility of the bottom of the pavement surface and be more resilient to cracks forming from the bottom,” Curtis said.

“That type of mix wouldn’t serve as well as a surface layer, but that’s part of the elegant nature of this design,” Curtis said. “Instead of just building one type of asphalt that’s great under all conditions, you design a mix for the type of conditions that asphalt undergoes in that particular section. They’re looking for different performance in the asphalt at different layers.”

The rich bottom mix was denser, with higher asphalt binder content and higher compaction of 97 to 100% to be more resilient to cracking. “The intermediate mix is more along your standard type design, that has both flexibility and rideability and fits all parameters,” Mihal said. “And the surface course with polymer is designed to avoid rutting.”

All 625,000 tons of asphalt on the project follows Caltrans' long life pavement specification. "They're looking for higher performing, longer lasting asphalt, so there's a lot more to prove in our mix design to meet those requirements," Curtis said.

Maintenance plays a key role in any perpetual pavement. "Perpetual pavement projects are a method of how they choose to rehab the pavement and at what stage," Mihal said, adding that it's based on a 40-year lifespan. Maintenance includes removal of the OGFC rubberized top course every 10 years and the removal and replacement of the top 2/10ths of the surface course asphalt below the OGFC every 20 years.

The Interstate 5 Corridor enhancement project along 15 miles of I-5 near Sacramento, California, requires approximately 625,000 tons of asphalt.

Partners Make Perfect

Granite and Teichert broke up the work based on the direction of travel. Granite did the majority of the work on the southbound lanes, and Teichert did all the work on the northbound lanes.

"A key reason for the joint venture was to have the manpower and capacity to build at this scale," Mihal said. "If you drove on this job at night, you'd not only see work in both directions but also at multiple locations in each direction any given night. There was so much to build."

"Throughout the course of the job, even though we worked on separate directions of travel, we coordinated with each other to work hand in hand," Curtis said. "If we built our side without coordinating with their side, the job would grind to a halt."

For example, both contractors had to be working on the median at the same time. “We couldn’t demolish the median barrier unless both contractors were working on the same phase at the same time, so the job required us to plan as one,” he added.

Not only was it important for Teichert and Granite to have strong communication between the two companies, but the scale of the project also demanded rock-solid coordination between Granite’s own plant and paving crews.

“It requires a lot of coordination when you’re putting out as much as the plant can handle and putting it down as fast as the crew can handle,” Mihal said.

“We had 55-hour lane closures, where we’d pave for 55 hours straight,” Curtis added. “We swapped day and night crews and to refuel, but otherwise, the paver never stopped.” With its continuous paving operation, Granite put down its record highest tonnage: more than 19,000 tons from a single plant in a single weekend.

Most of the paving on the I-5 job was performed with Granite’s Cat AP1055F track paver and Cedar Rapids 522 track paver, with a variety of Sakai, Hamm, and Cat rollers.

The project team and the team at the plant talked every day leading up to those weekends to ensure they ran smoothly, Mihal said. Curtis added how important it was that the plant did all preventive maintenance ahead of those weekends so the plant would run smoothly throughout the 55 hours.

“Kudos to our plant teams for having all preventive maintenance done ahead of time, and the aggregate stockpiled and ready to go, so the plant would purr all weekend long,” Curtis said. “The benefit of those

55-hour weekends is once the plant is up, as long as you don't let it stop, you can get it up to optimum efficiency and keep it cruising along."

When issues did arise, the staff was quick to fix minor issues right away. For example, one weekend the plant had an electrical issue but the staff was able to resolve it quickly and keep the plant running.

The project also required the Granite paving crew to be equally prepared. Although most of the paving was performed by one paving train at a time, Curtis said Granite had a lot of backup equipment available in case of breakdowns.

The mix was produced at Granite's Astec double drum plant in Sacramento, which was roughly 15 miles away from the project, an average 30-minute truck drive depending on traffic and which side of the job the crews were working on.

To streamline communication between the paving crew and the plant, Granite began using HaulHub to track trucks throughout the project. "Having up-to-the-minute locations of trucking throughout the job was particularly important on those big weekends, where there was more traffic on the roads during the day," Curtis said.

"As soon as the truck was ticketed, we were able to see it on our phones out in the field," Mihal said, adding that this was particularly important given the different types of mixes they were working with. "Some nights, we'd have three different types of mixes. By using GPS tracking on trucks, we were able to guarantee the right mix ended up in the right location."

Engineering Value

Communication with Caltans was also key to the success of the project. “We had a great partner relationship with Caltrans throughout the project,” Mihal said. “We could make changes through value engineering proposals, which was a key aspect to save money for Caltrans.”

Through value engineering, the contractors were able to add four additional HOV miles to the project through a change order. “We were able to allow the public back on the road sooner than originally anticipated, and opened 5 miles of southbound HOV a year in advance of what we anticipated,” Mihal said.

The largest value engineering impact was when the contractors suggested modifying the original plans for the project’s structural transitions. The plan originally called for the crews to pave a 300-foot-long 400:1 wedge of asphalt to taper the roadway, now 9 inches higher, down to the original grade of the bridge transitions. They were then supposed to tear out the asphalt transition in nightly closures and replace it with precast concrete panels in order to open it to traffic the following day.

“That would be a time consuming, expensive, and elaborate method,” Curtis said. But, Caltrans already had developed the perpetual pavement design to widen the roadways and the contractors thought that design could be used to create the transitions. “During the 55-hour lane closure, we tore out the existing concrete and built a full-depth asphalt section that tied it into our overlay.”

As the crews paved the overlay, they tapered it over the full-depth asphalt pavement section as they approached the transition sections. “When all was said and done, we didn’t throw away nearly as much

material and were also able to utilize a more efficient construction method using perpetual asphalt pavement as opposed to precast concrete," Curtis said.

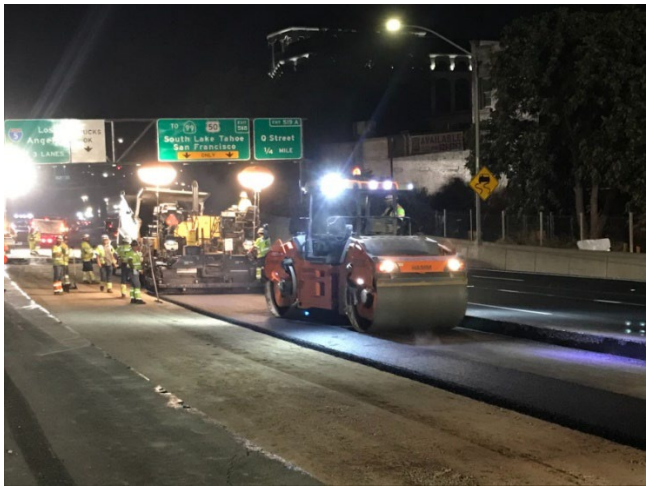
"By building it entirely out of asphalt, we saved $19 million through a reduction of material and change of material type," he added. "We also reduced staging and were able to open it earlier."

Another aspect of the project's complexity was keeping traffic open and flowing while adding a 9-inch overlay to the project. "Getting traffic through there without reducing lanes required a lot of planning," Mihal said, "especially when you're raising the grade of the entire roadway through the project. You have to make sure to keep drop-offs low enough for traffic to go through there. We had to make sure we understood the area and plan that out in advance of each day of work."

Although the contractors weren't involved in the initial design strategy, both contractors were heavily involved in the mix design process and were integral to the further development of Caltrans' long life pavement specification.

"Even on our project, Caltrans was still adjusting the method for its long life asphalt," Curtis said. For example, the specification required a beam test where you make a beam out of asphalt and flex it at a high rate, which requires millions of individual flexes, over the course of several days. "Had that test remained in the performance specifications to perform every night, we don't know how that project would have moved forward with those requirements."

"You have to be cautious of tests with long lead time for performance based specifications," Mihal said. "Some tests work great in the initial design phase, but aren't practical for a field environment because of the time it takes to do them. In a basic paving operation, if it takes three days to get results, you've already placed 10,000 tons of asphalt before you've got results from previous tests."



“UCPRC and Caltrans recognize that they can have certain requirements in the job mix formula phase, but need analogous testing methods that can be done each night that allow the contractor to react to changes in the mix and build a better product,” Mihal said. “That’s still being figured out.”

“In our experience, and what we heard in collaborations with Caltrans and UCPRC, is that they’re still in the stage of gathering information and determining what works and what doesn’t,” Curtis said, adding that they expect additional changes to the spec and testing requirements. “But, they’re moving toward what works and what doesn’t to make high performing asphalt.”

Historical Project, Future-Focused

Granite and Teichert began work on the project in July 2019 and are expected to finish the job in the fall of 2022. The project, which is 80 percent complete, is waiting for warmer weather to complete the last step, paving the OGFC.

However, traffic is already riding on the surface course. “We’ve already had a lot of good feedback from the public who say it’s like riding on a brand new freeway,” Curtis said, adding that Granite passed the job’s tight smoothness requirement. “So, it went from a failing concrete highway to being as smooth as a freeway can get.”

Both companies achieved more than 100% pay factor bonus for the project

Mihal said both companies achieved more than 100% pay factor bonus for the project, since the long life mix (not the OGFC) was the only component with an associated bonus.

“It was impressive to see what both plants and paving crews were capable of doing, with two of the largest paving contractors doing their full effort, night after night, at that quantity,” Mihal said. “I’ve never been a part of a paving job of this scale, and few can claim they have.”

Ultimately, this was the largest paving job in District 3 in Caltrans history and the largest ever in Sacramento. But this job, more than most, is focused on the future: the future of long life asphalt in the state of California.