A Faster Route to Long-Lasting Pavements

A Heavy Vehicle Simulator on State Route 14 near Palmdale

Researchers at the UC Berkeley Institute of Transportation Studies are helping the California Department of Transportation in its pursuit of the most cost-effective way to rebuild 3,000 lane-kilometers of the state's urban freeways while minimizing traffic disruption. As part of this search, the Berkeley researchers have developed a new way to analyze construction methods.

The planned reconstruction — mostly of concrete freeways in southern California — will be the largest such undertaking since the interstate highway system was completed in the mid-1970s and will ultimately affect millions of drivers. It will cost about $1 billion over the next ten years.

The Berkeley researchers' new construction productivity analysis system can be used to help engineers compare three choices for any particular stretch of worn-out pavement: constructing a new concrete pavement, constructing a new asphalt concrete pavement, or overlaying the existing pavement with asphalt concrete. The current work is part of a multi-year research effort for Caltrans at UC Berkeley's Pavement Research Center.

Build It Fast, Make It Last

The new pavements are to have a 30-year design life, compared to a 20-year design life for current pavement, and must be built on a fast-track schedule to minimize disruptions to the commuting public.

The Berkeley pavement researchers are studying both concrete and asphalt pavements. In 1998, a specially designed pavement testing site was constructed for their use on State Route 14 near Palmdale in Los Angeles County. A Heavy Vehicle Simulator (HVS) was sent there from Richmond Field Station to carry out on-site accelerated pavement testing, while a second HVS is being used to support lab analysis and field tests at the Richmond site.

Some of the new freeway pavements are to be built of concrete, and the UC Berkeley researchers are examining the best way to construct them quickly.

Fast-Setting Concretes

One option is to use fast-setting concretes. These include hydraulic cements not typically used for pavement lane replacement, or accelerated curing versions of traditional Portland Cement (type III with Modifiers). Instead of a 24- to 72-hour curing time for traditional Portland Cement, the new hydraulic cements can be opened to traffic in four to twelve hours. The modified type III Portland Cement can open to traffic after about 12 hours. However, laboratory tests at Richmond and experience at Palmdale suggest that cements with rapid setting properties must be checked for early age cracking in hot, dry climates such as that of Palmdale, which is typical of the regions where much of the concrete will be placed. Researchers also found that the extremely fast-curing concrete requires more vigilance on the job site. Pours, for example, must be scheduled precisely; otherwise the concrete could harden in the delivery trucks.

There are so many variables that can affect completion time that Pavement Research Center researchers developed the

A project manager can tell the public, "We can do it in 14 weekend days, and there will be orange 'road under construction' signs for months, or give us 10 straight days, and you won't see us again for 30 years."

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Pavements

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new construction productivity analysis system to compare them. For example, a sensitivity study evaluated the effect of curing time on the total construction time needed to replace existing concrete pavements with new concrete. The analysis showed that cutting curing time by two-thirds (66.6%) — from twelve hours to four hours — only reduced the project's duration by 19%.

Another approach is to change the logistics of construction. One option is to change the hours when lanes are closed; another is to close more lanes at one time.

If roads are closed only on weekends, analysis showed that the greatest time saving, 29%, came from shutting three lanes instead of two. The critical issue was found to be room for trucks to haul away demolition debris while concurrently placing the new concrete.

Using continuous closures instead of weekend closures gave the greatest productivity gain, 342%, because this approach eliminates duplicative start-up and shut-down operations, including downtimes at the end of each period while the newly laid sections cure.

This construction productivity analysis system is part of the doctoral thesis work of Eul-Bum Lee, a UC Berkeley student in Construction Engineering and Management (CEM). Professor William Ibbs is Lee's thesis chairman.

John Harvey, an adjunct professor and associate research engineer at the Institute, who is heading the CAL/APT project along with Professor Carl Monismith and post-doctoral researcher Jeff Roesler, said the productivity analysis system was a valuable new tool.

Public Knows What to Expect

"This way, a district engineer can show the public, 'We can do it in 14 weekend days (7 weekends), and there will be orange 'road under construction' signs for months, or give us 10 straight days, and you won't see us again for 30 years.'"

The next steps are to perform similar analyses for the asphalt concrete reconstruction and rehabilitation options, and to ask Caltrans district engineers and private contractors for other elements that should be added to the system's calculations. For instance, researchers have learned that the benefit of adding a third shift of workers may not be worth the added disruption and expense, since night shift work may be only 70% to 80% as efficient as daytime work.

The researchers also have plans to convert the productivity analysis system into a user-friendly software package.

More information can be found on the Web at <http://www.ce.berkeley.edu/~eblee/construct.htm>.

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