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Maryland Tests Extended-Life Pavements

The Salisbury Bypass is serving as a test bed for extended-life pavement.

By Michael Boyette, Al Paul Lefton Inc.

Vacationers and day-trippers headed to Maryland's Eastern Shore beaches are noticing a big improvement in their ride lately. Until recently, the trip included an unwanted stop-and-go tour of downtown Salisbury. The new U.S. Route 50 Salisbury Bypass makes life a little easier for travelers and townspeople alike, rerouting that traffic away from the downtown onto a divided, four-lane, 7-mile highway connecting U.S. Routes 13 and 50.

What drivers aren't as likely to notice, however, is that they're taking part in a long-term research study that could yield dividends for the next 75 years. The Maryland Department of Transportation's State Highway Administration (MDSHA) is using the bypass as a test bed to evaluate extended-life pavements, which are projected to double the life of highways throughout the state.

Beneath the new pavement, sensors collect information on three segments of the highway: a control segment using a traditional pavement mix and two test segments using high-performance concrete. The data, to be collected over a two-year period and analyzed at the Civil Engineering Department of the University of Maryland, will provide estimates of how long these high-performance pavements will last under actual conditions.

Vicki Stewart, statewide chemical/concrete/cement team leader for the State Highway Administration, said, "The potential savings to the state from extended-life pavements are enormous. These data will allow us to develop solid life cycle cost analyses of these pavements. We'll be able to quantify the benefits in real dollars. And, they'll allow us to evaluate and compare the performance of different approaches."

Longer life = lower cost

A pavement that lasts an extra 35 to 40 years appears to be an increasingly attractive investment to highway engineers and administrators. Even with higher first costs, high-performance materials generate big savings over the long term. Materials costs are small compared with labor and engineering costs for a repaving project and indirect costs such as financial hardships for area businesses and countless hours of lost time to commuters.

That analysis makes sense not only to MDSHA, but also the Federal Highway Administration (FHWA), which helped fund the pilot project, and to

Top: The Salisbury Bypass.

Center and bottom: Beneath the new pavement, sensors collect information on three segments of the highway.

Lafarge North America, which supplied the cement and technical assistance for the study.

Lafarge sees a growing role for high-performance concrete in roadways, says Greg Daderko, product manager of specialties and blends for Lafarge North America's Cement Division. "More and more of our DOT customers are asking about the long-term benefits of extended-life pavements. The data from the Salisbury Bypass study will help them build better roads."

High performance doesn't necessarily mean exotic. These concretes are modifications of proven mix designs. The Lafarge NewCem brand slag cement used in the pilot project, for example, has been used in road construction for more than three decades.

Extended-life pavements are projected to double the life of highways throughout the state.

Project scope

One of the key determinants of the life expectancy of concrete pavement is cracking. If the tensile stresses due to shrinkage or an applied load exceed the tensile strength of the concrete, the concrete will develop cracks. Cracks can disrupt the integrity of the slab and allow moisture and other contaminants into the concrete, which can lead to disintegration of the concrete.

One test section uses low-shrinkage concrete (LSC), reducing the potential for random cracking and curling. The other test section uses fatigue-resistant concrete (FRC). Small synthetic fibers are added to the mix during batching to provide additional tensile strength to the slab. These fibers have been shown to reduce cracking by 80 percent to 100 percent. MDSHA and the FHWA turned to technology to shorten the learning curve, using embedded sensors to monitor the pavement's performance under actual traffic conditions.

The test pavement consists of approximately 2,400 feet of straight, level highway, extending across both eastbound lanes of traffic. The pavement is divided into three 800-foot sections – one control section and two test sections – so they are exposed to precisely the same traffic and weather conditions.

Except for the concrete mix, design criteria are identical for all three sections. The pavement is 10 inches thick, over a sub-base of 8 inches of Graded Aggregate Base. Epoxy-coated dowels are used to tie pavement sections together.

The control section uses MDSHA PCC Mix #7, the standard mix specified by MDSHA for concrete pavements.

One test section uses the FRC mix, which conforms to the standard Maryland mix but contains synthetic fibers, added to the mix at the batch plant at the rate of one pound per hundredweight.

The LSC also conforms to the standard mix, but uses a larger-sized coarse aggregate – Maryland #357 – in place of the standard Maryland #57 aggregate. The larger aggregate size helps stabilize the size of the slab and control shrinkage.

All three mixes used NewCem slag cement, supplied by Lafarge. "The portland-slag blend was used primarily to mitigate alkali-silica reactions with the aggregates used in the concrete," said Stewart. Alkali-silica reactivity (ASR) can occur between the alkalis in portland cement and silica aggregates. In the presence of water, these reactions can form an expansive gel, leading to cracking. The slag cement in the NewCem blend reacts with the alkalis in portland cement, keeping them from reacting with the silica aggregates.

Other characteristics of slag cement contribute to extended pavement life. It provides higher ultimate compressive and flexural strength when combined with standard portland cement. It also reduces the concrete's permeability to water, chlorides, and other aggressive agents, reducing the potential for pavement deterioration.

More ways to extend life

In addition to materials used in the test sections, the entire project includes additional measures to extend the life of the project:

- The pavement employs 15-foot joint spacing. By reducing the size of the slabs, tensile stress is reduced.
- The project is the first in the United States to require a warranty from the contractor for concrete joint performance for a period of three years.
- The shoulders, which were originally specified as hot mix asphalt, were upgraded to concrete at the recommendation of the contractor, Cherry Hill Construction, Inc. Concrete shoulders are expected to reduce maintenance and last longer.

Preliminary data are undergoing analysis. The analysis uses software developed by the American Concrete Institute to estimate the life of the pavement.

"We recognized the potential for high-performance concrete to extend the life of roadways," said Stewart. "What's been missing, however, are field results to support a solid cost-benefit analysis. We believe the results of these tests will help highway engineers across the country to make better decisions about when and where to use high-performance mixes." ■

Top: Materials costs are small compared with labor and engineering costs for a repaving project.

Bottom: There is a need for high-performance concrete to extend the life of roadways.