



## BUYING TIME ON U.S. BRIDGE REPAIRS

New technologies and products can extend pavement life to help address the chronic pavement problems of the highway and bridge building industry.



Denver I-70 Bridge Repair



*When rapid-hardening cement combines with water (hydrates), it forms crystalline compounds much faster than does portland cement, getting traffic back on the road in less time.*

A number of problems have converged to create a perfect storm that threatens the condition of the United States' transportation infrastructure. Many U.S. interstate highways were built during the construction boom of the 1960s and 1970s, so a large percentage of those roads and bridges reached the end of their intended design lives at the same point in time. Most had experienced a greater than anticipated volume of traffic, which reduced their service lives. At the same time, the amount of funding available for repairs was not as great as had been originally anticipated and continues to be problematic, resulting in a large number of roads and bridges are being used past their design lives.

Departments of Transportation are tasked with deploying new techniques and new products that will extend pavement life until funding for more extensive road replacement becomes available -- and they are challenged to do so in timeframes that reduce traffic interruptions and lane closure times.

Rapid-hardening cement is helping to meet this challenge, as it sets and gains strength rapidly. When rapid-hardening cement combines with water (hydrates), it forms crystalline compounds much faster than

does portland cement, getting traffic back on the road in less time.

Here are some projects that are using state-of-the-art paving solutions to save taxpayer dollars, while providing more durable and safer road surfaces.

### Denver I-70 Bridge Repair

In the late 2000s, the I-70 bridge between State Highway 265 and State Highway 2 in Denver was one of 46 bridges in the metro Denver area that was being used past its intended design life. The Colorado Department of Transportation (CDOT) deemed it to be in imminent need of repair, since its 60 expansion joints had been corroded by water and salt and deterioration of the reinforcing steel and surrounding concrete had resulted. With bridge replacement being too costly, CDOT began a repair project to extend the life of the bridge an additional 10 to 15 years. Patching was completed in December 2010, and the whole bridge project was completed in Spring 2011.

Crews removed deteriorated concrete and sandblasted the newly exposed, undamaged surfaces, replacing reinforcing steel and adding galvanized wire mesh for structural reinforcement. This left areas up to 6 inches deep and 8 feet wide to be filled with concrete repair material, and a fast-setting product was needed to complete the work in a short timeframe. Rapid Set® Mortar Mix was selected for the project, as it was able to be applied 6-inches deep in a single application and reached initial set in 15 minutes. Final set was achieved in 35 minutes, with a 2500-psi compressive strength achieved one hour later, allowing crews to move to the next repair section. Rapid Set® Flow Control®, which increases the strength and reduces the shrinkage of the mix when used as a replacement for mixing water, was used to keep the repair material flowable while



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still retaining the same strength. Because of its superior speed and workability as well as its resistance to cracking, Rapid Set Mortar Mix was used to repair all of the bridge's horizontal and vertical overhead areas, covering 5,500 square feet of the substructure. Because Rapid Set Mortar Mix was able to be applied in a single application, the project saved an estimated 25 percent in labor costs and completion time.

### Route 95 Bridge Rehabilitation

Because of the high traffic volume on this 50-year-old interstate bridge in Foxboro, Massachusetts, the Massachusetts Department of Transportation (MassDOT) aimed to complete deck repairs throughout the course of two weekends.

Crews milled the existing asphalt concrete and removed deteriorated concrete. Those areas were then filled with a rapid-setting concrete that contained Rapid Set® Low-P® cement and fly ash. Rapid Set Low-P has low permeability and improved resistance to attack from chlorides and de-icing salts, and fly ash was added to eliminate any potential alkali silica reactivity problems. After patching, they placed a concrete overlayment; the 3-1/2 to 4-inch overlayment used the same rapid-setting concrete mix as the patched areas, a first for such a specification in Massachusetts. Concrete was mixed on site in mobile mixers, saving time and eliminating waste. This combination of techniques and materials demonstrated that bridge deck repair can be accomplished in a short period of time.

### I-55 bridges near St. Louis area

Like most states, Missouri wanted to reduce lane-closure times while its bridge decks were being repaired. Many of the state DOT's early experiments with materials offering fast cure times had proven to be non-durable. In 2008, the Missouri Department of Transportation (MoDOT) used Rapid Set® Low-P® Cement for the first time in one of its bridge overlays. Follow-up testing of the material indicated excellent compressive

strengths, low permeability, good bonding properties and minimal shrinkage.

Based on Low-P's earlier success, the St. Louis Area District approved its use. Concrete Strategies, the highway and bridge contractor on this project, performed work on a total of



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Route 95 Bridge Rehabilitation

six overpasses using Low-P; in every case, compressive strengths, permeability, and pull off tests were well within specified range.

### Highway J Bridge

The Highway J Bridge near Chillicothe, MO was scheduled for replacement as part of the state's Safe & Sound Bridge Improvement Program – a program that involved improvements to 802 of Missouri's worst bridges over the course of five years and is the largest bridge improvement project in the state's history.

During the reconstruction of the bridge, seven precast, prestressed concrete slabs were installed. High strength grout was needed to bond structural members and ensure load transfer. Rapid Set® Cement All®, high-strength, non-shrinking, fast-setting grout, was used to fill the keyways between the cored slab and box beam girders and in the holes where dowels connect the beams to the piers and abutments. It was also used to fill the 2- to 3-inch keyways to allow the individual cored slabs to operate as one unit.

Because the pour occurred in hot weather, Rapid Set® SET Control® additive was added to increase the working time for an additional 5 to 10 minutes. FLOW Control® was also used to produce a flowable mix which eliminated voids within the keyway.

Using fast-setting grout on the Highway J Bridge project achieved the strength required within the necessary time frame and helped keep the project on schedule; tests showed that it reached between 7000 to 10,000 psi within 18 to 24 hours.

### Lewis and Clark Bridge

In the summer of 2005, after 18 months of partial closures, the Lewis and Clark bridge connecting Rainier, Oregon to Longview, Washington re-opened -- six months ahead of schedule. The only bridge over the Columbia River for many miles, its closure time was restricted to late night and weekend hours and a financial bonus was awarded by the Washington State Department of



Highway J Bridge

Transportation (WSDOT) for using a minimal number of full-weekend closures.

To help meet these demands, Rapid Set® Cement, with a final set time of 35 minutes, was used for areas of the bridge that could be repaired by applying a new concrete overlay. 450 cubic yards of Rapid Set were used for the 1,575 foot length of overlay and the work was performed during one weekend. The overlay achieved a compressive strength of 4000 psi in four hours. Using Rapid Set saved at least nine days compared to a slower-setting concrete overlay.

### San Francisco-Oakland Bay Bridge

Seismic upgrades to the San-Francisco-Oakland Bay Bridge began in 2002. The west



Lewis & Clark Bridge

span (San Francisco side) was able to be retrofitted through reinforcement, but the east span (Oakland side) needed to be replaced entirely, with its new design including the world's longest self-anchored suspension span (SAS). The project took more than 10 years to complete and was one of the largest public works projects in U.S. history.

Because of the variety of materials being used to afford seismic safety, typical cement set times of 28 days were not practical. The steel suspension bridge can experience rapid expansion and contraction, so cement used at joints on the bridge needed to set within a 4 hour time window.

Rapid Set® Cement was used at the seismic joints on either side of the SAS so that



San Francisco-Oakland Bay Bridge

the concrete was able to set and achieve sufficient strength before bridge movement had time to occur. After construction was complete, concrete compression tests were performed at joint segments in time intervals of one, seven, and 56 days.

All of the test results proved that the concrete strengths, measured in PSI, exceeded performance requirements, and did so in a shorter time frame than was specified. A joint venture between American Bridge/Fluor was the bridge and highway contractor on this project.

### Walkway over the Hudson

Once touted as the world's longest bridge, the historic 6,768-foot-long Poughkeepsie-Highland Railroad Bridge in New York is again claiming distinction, this time as the world's longest pedestrian bridge. The not-for-profit organization known as Walkway over the Hudson assumed ownership of the abandoned structure in 1998 and turned it into a park that provides public access to the Hudson River's scenic landscape for pedestrians, hikers, joggers, bicyclists and people with disabilities.

The new walking surface is comprised of precast concrete panels; panel installation involved placement over vertical posts that had been welded to the bridge's girders and leveling and aligning the panels with leveling screws. Space between the panels and the bridge, as well as openings around the posts, were filled with Rapid Set® Cement All® grout, a specially formulated, flowable and fast-setting grout.

On this project, the closure pour openings were quite small, measuring approximately 6 inches long by 4 inches wide. The void underneath the closure pours measured 18 inches wide and 12 inches high, and the grout needed to be poured into this small opening with enough flowability to fill the entire void underneath. By using Rapid Set Cement-All pre-blended grout, in which the sand is pre-measured, work crews could ensure the quality required for the job. The



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Photo 1 – Walkway Over the Hudson

Rapid Set Cement-All grout offered a low-shrinkage, durable material for the closure pours that obtained the required strength within three hours.

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Photo 2 – Walkway Over the Hudson