Advances in Bridge Deck Overlays

Completing projects faster, with better performance, and less cost.

As the condition of U.S. bridges comes under increased scrutiny following a major collapse and a negative national bridge report card, state departments of transportation are focusing heavily on bridge repairs. The need for repairs is great, and many state DOTs have found that repairing their aging bridges with concrete deck overlays is the most cost effective solution. Today, new fast setting cement technology is allowing bridge deck overlays not only to be completed faster, but with better quality, long-term performance, and an in-place cost that's less than traditional Portland cement concrete. As a result, the coming years hold great opportunity for bridge deck overlay projects that will be aided by new cement technology.

Benefits of Low-P for Bridge Deck Overlays

- ❒ 2- to 3-hour 3,500- to 4,500-psi compressive strength
- ❒ 2- to 3-hour tensile strength
- ❒ 24-hour bond-adhesion
- ❒ Low cost
- ❒ Low permeability—improved resistance to attack from chlorides and de-icing salts
- ❒ Excellent freeze-thaw resistance
- ❒ Single component cement—just add water and aggregates
- ❒ Provides corrosion protection
- ❒ High sulfate resistance
- ❒ Easy to place, high slump, non-segregating formula
- ❒ Hydraulic cement based formula—provides excellent long life durability

Bridges across the country are in great need of repair. According to the American Society of Civil Engineers, 27 percent—or 160,000—of U.S. bridges are either structurally deficient or obsolete. When the bridge structure is sound and only the deck needs repairs, then a wearing surface overlay provides an economical and long-lasting solution. In a typical overlay project, the wearing surface has deteriorated to a condition that requires a new surface to be installed. This phenomenon occurs most often above the Mason-Dixon Line where deicing chemicals and freeze-thaw cycles are the primary causes for reinforcing corrosion and concrete deterioration. Concrete is porous and the surface experiences chloride intrusion, especially via cracks in the concrete and saturation to some depth. (Concrete can be cored and studied to determine depth of intrusion.)

Repairing bridge decks with concrete overlays is not a new practice in the U.S., where the application has been performed with success since the 1960s. Most of the Interstate highway system was relatively young. Bridge decks were just beginning to mature after 20 years when DOTs recognized the need for bridge decks to be repaired or replaced. History shows latex-modified Portland cement concrete (LMC) being used first in overlays in the early 1990s, then low slump and micro-silica fume concrete came on the scene.

Since then, the specification and use of low permeability, high durability concrete has increased for bridge repair projects across the country. Portland cement concrete is usually specified on low-traffic volume bridges because lane closure is not an issue. However, for high-traffic volume bridges when minimizing public disturbance is of great concern, fast-setting concrete is often the best repair solution. An additional performance characteristic of fast setting concrete is that it can develop early tensile strength that helps reduce cracking due to load vibration.

While the material cost of fast-setting cement may be more than traditional alternatives, this is often offset with lower in-place costs plus shorter lane closure time. Fast-setting concrete provides a critical advantage in high-traffic areas where crews may only have from 9 a.m. to 3 p.m. to close a lane for repairs.

New Advances in Cement Technology

Fast-setting cement products have provided advantages for infrastructure projects since their introduction in the early 1960s. Today, new technologies have greatly advanced fast-setting cement products, and the implications for bridge deck wearing surface overlays are significant. The most recent advanced cement technology for repairs and overlays in nearly 15 years is known in the industry as Rapid Set® Low-P™ (CTS Cement Manufacturing Corporation, www.ctscement.com) having the performance characteristics of latex modified concrete—early (LMC-VE), but with in-place costs comparable to LMC and micro-silica fume concrete.

Low-P is a fast-setting calcium sulfoaluminate (CSA) cement modified with specific components to develop the performance characteristics of LMC-VE concrete. Characteristics of this cement technology include low permeability, excellent freeze thaw durability, corrosion resistance, volume stability, and

very high early strengths for fast and ultra-durable concrete repairs and overlays. Perhaps the most significant benefit of Low-P is the wet cure lasts only two to three hours. Because it's faster, Low-P allows contractors to begin on adjacent work or open to traffic within hours, not four to seven days as with traditional concrete approved for similar applications. This quick placement time also reduces a contractor's safety exposure and costs for traffic control. This new cement technology produces a concrete with a 20- to 25-year lifespan.

What's more, Low-P has reduced equipment and staging requirements when compared to other similar concrete production. Much of the repair and overlay work is conducted in off hours. Fast setting concrete is not appropriate for mixer drums. These projects require a mobile volumetric mixer, a staging area, piles of rock and sand, a water source, and a cement silo. For latex modified concrete, an additional staging area is needed for a tractor-trailer loaded with latex or 400 gallon totes. This requires four steps to the loading process. But with Low-P, cleaning between loads is reduced and the reloading can be conducted in one location, thus reducing the overall cycle time by at least 15 minutes.

Applications in Missouri

Low-P was recently specified for bridge deck overlays in Missouri for seven overpasses at six locations on the heavily traveled stretch of Route 55 that passes through St. Louis, MO (total length of improvements was 1.364 miles), and bridge rehabilitation of the Lafayette Avenue overpass (0.038 miles of improvements). The Lafayette Overpass required concrete removal and overlay; however, the remaining seven bridge decks required extensive repairs in addition to a new wearing surface. The original contract required the use of a standard Missouri Department of Transportation (MODOT) Portland cement bridge concrete mix for the repairs and a latex modified concrete for the overlay.

An eight- to nine-in. slump was allowed at discharge, a seemingly high slump that produced a cohesive concrete that was easy to place.

Because of the necessity of maintaining traffic flow and the tight schedule, the selected contractor, Concrete Strategies, recognized the challenges in completing each bridge within the short 40- to 45-day timeframe and looked for a faster approved concrete material. Concrete Strategies submitted Low-P cement for use in both the patching and wearing surface overlay applications. Local construction engineers for MODOT realized all the constraint issues were valid and approved Low-P cement as a viable concrete solution.

The eight-bridge project began in May 2009 and six were completed in August 2009. The final two were completed in May/June 2010. The project involved the removal of existing 25-year old overlays, partial and full depth deck repairs, joint repairs, and the application of a new overlay wearing surface. Low-P cement provided the required structural strengths in as little as two hours (exceeding 3,500 psi).

Repair crews were able to start patching work in the next zone the same day. If they had used the traditional state approved Portland cement bridge concrete, they would have had to wait several days

The placement of wearing surface overlays on each of the decks allowed for an eight- to nine-in. slump at discharge. This seemingly high slump produced a cohesive concrete that was easy to place and the deck finisher worked well with the concrete. Further, the mix did not segregate and held well on sloped bridges without sagging.

"By using Low-P on this project, we were able to save time and get the roadway open in three hours instead of three to seven days, which would have been the timeline with other forms of concrete," said Steve Armstrong at Concrete Strategies, the contractor for the project.

MODOT conducted numerous field tests including early age compressive strengths, freeze-thaw (99-100), rapid chloride permeability (< 800 coulombs), and 24-hour bond pull off tests (>200 psi). In December 2009, this rehabilitation project was recognized for excellence and use of new technology with a "Quality of Concrete Award" from the St. Louis Concrete Council.

While funding for infrastructure projects is an issue of critical concern for many state DOTs, Low-P cement offers a viable solution for overlays. Fast, low-cost, and offering a long lifespan, Low-P can benefit numerous bridge deck overlays and structural repair projects across the country.

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