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Advancements

New LowP Bridge Overlays Performing Well in St. Louis Area

Business Issue

Closing bridge decks for rehabilitation is an inconvenience for Missouri motorists. MoDOT is aggressively pursuing alternate materials to speed up this process to provide a smooth pavement with minimal traffic interruptions. Unfortunately, many materials that offer faster cure rates are not very durable. A new product, called LowP, is a combination of the CTS Rapid Set Cement and proprietary add mixtures. LowP offers high early strength, low permeability, with the added benefit of corrosion protection.

Approach

As an alternative to using latex modified concrete for a bridge deck overlay, the St. Louis Area District used CTS Rapid Set LowP Concrete (LowP).

The LowP was placed in the St. Louis area using modified specifications for latex modified concrete:

- Ambient and deck temperatures were 85˚ F or below.
- Once the previous overlay was removed and all patching completed, the entire deck was sandblasted followed by an air blast. This was done within 24 hours prior to placing concrete.
- On some occasions, the deck was water blasted instead of sandblasting.
- Citric acid was used as a retarding admixture.
- The deck was thoroughly wetted for a minimum of three hours and covered with polyethylene sheeting until time for concrete placement.
- The finished surface was covered with wet burlap immediately behind the tiner. The burlap must be kept saturated for a minimum of three hours. It should be noted that LowP concrete requires a significant amount of water during the curing process to avoid cracking.
- Due to the fast setting characteristics of this product, the fresh concrete should not be placed too far ahead of the paver.
- Pre-deck pour meetings with a manufacturer's representative are also suggested.

The first bridge to receive a LowP overlay was Chestnut Street over I-70. MoDOT employees performed this pour. This overlay was placed on October 25, 2008.

Follow-up testing indicated excellent compressive strengths, low permeability, good bonding properties, and minimal shrinkage.

Several overlays were awarded by contract to Concrete Strategies on overpasses along I-55. Concrete strategies requested a change from using Latex Modified Concrete overlay material to CTS Rapid Set LowP Cement Concrete. Concrete Strategies cited schedule constraints, higher performing material, and a no-cost adjustment as justification for the change. Encouraged by the results from the Chestnut Bridge, St. Louis Area staff approved the substitution of LowP cement concrete.

Completed Lafayette Bridge using LowP concrete.

Results

Lafayette Bridge

The first bridge to be overlaid by Concrete Strategies was Lafayette over I-55. The bridge was 180 feet long and 36 feet wide (6,480 ft.^{2}). Concrete Strategies elected to place the overlay in two sections. The first side was overlaid on May 14, 2009, and the second side was placed on May 16. The surface was sandblasted, wetted, and covered within 24 hours prior to each placement. The use of a Bidwell bridge deck finisher was used, followed by a bull-float and tined finish. Wet burlap was placed immediately behind the tiner and kept wet for three hours. The concrete was produced by using two mobile volumetric International brand mixers. The trucks were immediately reloaded adjacent to the end of the bridge. Reloading took approximately 30 minutes and discharge usually took 35 minutes.

The approved mix design contained 658 lbs. of LowP cement, 1500 lbs. of ½-inch MoDOT approved bridge Class "E" crushed limestone, 1,473 lbs. of MoDOT approved sand, and a water/cement, ratio of 0.44. The slump at discharge was nine inches, five inches after five minutes, and three inches after 15 minutes. This allowed plenty of time to place, bull-float, hand float, and tine the concrete surface. A total of 65 cubic yards was placed for the deck. Follow-up testing indicated three-hour compressive strength in excess of 6,000 psi, permeability in the very low category, and pull off tests were comparable to the previous bridges with the bond loss being between the concrete surface and the test equipment.

Pestalozzi Bridge

Concrete Strategies poured the overlay on Pestalozzi Street over I-55 on May 21and 22. This box girder structure is 244.5 feet long and 36 feet wide (8,803 ft.^{2}). Milling was used to remove the old low slump overlay and some of the suspected poor concrete under the overlay. Once milling was completed, jackhammers were used to remove the rest of the unsound concrete. A total of 3,029 ft.^{2} of patching on the original deck was completed using LowP concrete. The deck was prepped according to specifications and a total of 94 yds.^{3} was used to complete the overlay. Compressive strengths, permeability, and pull off tests were comparable to the results from the Lafayette Bridge.

Bidwell bridge deck finisher.

Results (cont'd)

Utah Bridge

The Utah Street overpass was the third bridge scheduled for rehabilitation. Milling was used to remove the old low slump overlay and hydro-demolition was used to remove the unsound concrete. Patching totaled about 875 $ft.^2$ and was all partial depth. Again, the deck prep was according to specifications and a total of 75 $yds.^3$ of LowP was used to complete the overlay. The mix design for the patching was changed to 572 lbs. of LowP cement, 1500 lbs. of ½-inch Class "E" MoDOT approved limestone, 1,610 lbs. of MoDOT approved sand, and a water/cement ratio of 0.43. This bridge presented a challenge because it was built on a noticeable incline. Even though the slump of the concrete was nine inches, it did not sag or segregate when placed on the steep grade because of the concrete's rapid slump loss characteristics.

Arsenal Bridges

The westbound and eastbound Arsenal Street Bridges are each about 240 feet long with a total of 14,891 $ft.^2$ of deck surface. The existing overlay was removed by milling followed by hydro-demolition. A total of 538 $ft.^2$ of patching was performed before the deck was prepared for the overlay. With the success of the new 6.5-bag mix design, it was decided that the patches and the overlay would use the new mix design. Overlay in the westbound lane was placed on June 29 and the eastbound lanes were overlaid on August 6 and 7. Even with the lower amount of cement content in the new mix design, the compressive strengths were averaging 4,300 psi in three hours. Pull off tests were comparable to the previous bridges with the bond loss being between the concrete surface and the test equipment.

Sidney Bridge

The Sidney Street overpass is a 237-foot long 8,515 $ft.^2$ bridge. After the old low slump overlay was removed, it revealed an area of about 2,178 $ft.^2$ that needed partial depth repair and 227 $ft.^2$ needed full depth repair. The Sidney Street Bridge has a pub and five-star restaurant on the north end of the bridge. The restaurant and pub caused some problems with the delivery of the concrete. Because patrons of these two establishments often park on and sometimes in the street, the contractor had to deliver the concrete from the east end of the bridge, which meant pouring downhill. This caused some concern because the water used to keep the burlap wet tended to run onto the fresh concrete being placed. The westbound lane was overlaid on July 16 and the eastbound was placed on July 17. The compressive strengths were still in the 4,500-psi range after three hours.

I-44 Meramec River Bridge

The westbound I-44 Bridge over the Meramec River was the latest bridge to receive the LowP overlay. On this bridge, hydro-demolition was used to remove the overlay and any exposed unsound concrete. Additional areas of bad concrete were removed using jackhammers, but instead of patching these areas, it was decided to pour the patches and overlay at the same time. The lanes that received the overlay and patching were over 1,300 feet long and 37 feet wide. The contractor performed hydro-demolition on one lane at a time and overlaid half of the lane per night. One of the major hurdles facing the contractor on this bridge pour was the time constraints for lane closure. Any additional lane closures for placing the concrete could not begin before 10:00 p.m. and had to be opened by 5:30 a.m. Freeze/thaw beams were molded on the sixth night of pouring and after 300 cycles, the durability factor was 99 percent. A flexural strength beam was broken after 14 days with a flexural strength of 708 psi. The three-freeze/thaw beams were broken after 300 cycles with a flexural strength average of 937 psi. Three-hour compressive strengths on all pours averaged 4,515 psi. The first pour on the bridge was on August 13 and the seventh and final pour was placed on the night of October 19.

Recommendations

Due to the success and ease of placement of the LowP concrete overlay, more bridges are being scheduled for this type of overlay in the future. Follow-up visual surveys will be performed periodically.