EUCON LiNX

Bridge Deck Overlay

Lyman County, South Dakota

CASE STUDY

Interstate 90 is the mainline through South Dakota. In 2000, the South Dakota Department of Transportation (SD-DOT) began repair work on a 13-mile stretch of the highway through Lyman County. The State decided to rehabilitate six bridges which had been protected with rigid concrete overlays in the late 1970's. The overlays were experiencing a fair amount of ASR and nearing the end of their service life, so they were removed and replaced with new two inch rigid concrete overlays. ASR contributes to premature concrete deterioration, and South Dakota has been a leader in the search to find techniques to solve the problem.

"The ASR creates micro-cracking and opens the concrete up to water intrusion and freeze-thaw damage. An overlay can have major freeze-thaw problems if there is a micro-cracking network at the interfacial region between the overlay and the existing deck."

Dan Johnston, Project Engineer
South Dakota DOT

SD-DOT's research highlighted one of the mechanisms through which ASR attacks bridge deck overlays. According to Dan Johnston, Project Engineer in the SD-DOT Research Office, ASR can be particularly detrimental to the bond between a bridge's existing concrete structure and the new concrete in the overlay. He says, "We have been looking at ASR occurring in existing substrate concrete and in the overlay itself. The evidence indicated that there might be a weak link at the bond between the two due, at least partially, to alkali silica reactivity."

Another reason for the heightened concern about interfacial region is that alkali in the new overlay could stimulate any ASR already occurring in the siliceous aggregates of the substrate. The low-slump (one inch) concrete used for the overlay required an especially high cement content, approximately 823 pounds of cement per cubic yard, creating an especially high exposure to alkali. Johnston says, "That's going to accelerate ASR because one of the fundamental things that causes it and makes it continue to happen is the alkali being available to support the reaction."

To avoid this problem, the project specifications called for stringent measures to assure ASR would not prematurely shorten the service life of the new overlay. Limits were placed on the reactivity of the aggregates and the alkali content of the cement. The grout used for bonding new concrete to old had to contain lithium nitrate admixture, an admixture proven to suppress alkali-silica reactivity. And, the overlay concrete had to have either a minimum of 15% of the cement replaced with Class F fly ash or, depending on the reactivity of the aggregates, between 1.5 to 3 gallons of lithium nitrate admixture per cubic yard.

Overlay subcontractor, Industrial Builders, Inc., Fargo, ND, chose the lithium option. John Pogorzelski, the project's superintendent explains that the choice was based on practicality and economics. He used a mobile mixer, basically a mini-batch plant, to mix the overlay concrete at the job site. The lithium nitrate

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contained Lifetime® Admixture Technology from FMC Corp.

"We would have needed a separate bulk storage bin and metering system to get the fly ash into the mix. Whereas the lithium comes in a liquid form and all we have to do is remove some of the water from the mix design and substitute the lithium for it."
John Pogorzelski, Project Superintendent

According to Johnston, mobile mixers are typical for South Dakota, because a lot of overlays are quite a few miles from the ready-mix plant. Plus, the mixing cycle of a typical mobile mixer is about 30 seconds, which is insufficient to mix fly ash properly. More important to the long-term success of the project is that, in Johnston's words, "the lithium is going to be available to the interfacial region substrate concrete as well as the overlay concrete." The lithium, he explains, "will migrate down into the existing substrate to protect the weak link at the interfacial zone between the bond line and just below it. We were seeing failures just below the bond line in the old substrate concrete, and we wanted to address this."

"Lithium did not interfere with the workability of the concrete. The concrete acted the same way that low slump concrete has always acted, as far as I was concerned. There was no adverse reaction at all."
John Pogorzelski, Project Superintendent

Not only was the concrete easier to put down, its more likely to stay down. By using lithium nitrate to mitigate its ASR potential, there is a better chance that the overlay will be able to meet the State's service life requirements.

MATERIAL DETAILS		
Cement	TYPE I-II	Low Alkali
Fly Ash	Class F	Intermediate CaO
Rock	Quartzite	Slowly Reactive
Sand		Highly Reactive
ASR Admixture	Lifetime®	1.5 gal/yd^3

NOTE: The Euclid Chemical Company acquired the Chemical Admixture and Fiber Division of Boral Materials Technologies, Inc. July 1, 2003.

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