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# DOTs See Benefits in Internally Cured Concrete Bridge Decks

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**Charged with maintaining critical infrastructure while conserving taxpayer dollars, state Departments of Transportation are on the lookout for ways to improve the performance of roads and bridges. Deteriorated pavements irritate drivers and damage vehicles, while the need for frequent repairs wastes both time and money.**

Because they're exposed to weathering from above and below, bridge decks are particularly vulnerable. And bridges that are unsafe to use or are undergoing repairs can severely restrict normal traffic flow. Several state DOTs, including New York, Illinois, Indiana, and Louisiana, have begun using internally cured concrete for bridge decks, and they are already reaping some benefits.

## What internal curing does

Internal curing is produced by incorporating pre-wetted lightweight aggregates (LWA) into a concrete mixture. Pores in the LWA function hold, then readily release, water needed for hydration or to replace moisture lost through evaporation. By maximizing cement hydration throughout the interior of concrete, internal curing can contribute to increased strength while reducing autogenous stresses and strains.

By reducing moisture differentials through the depth of a slab, internal curing results in smaller, tighter shrinkage cracks at the surface, and less curling and warping at the slab edge. Less cracking means that less water and deicing salts penetrate the surface, reducing corrosion of steel reinforcement and extending the useful life of the deck. And for jointed concrete slabs, less warping at slab edges makes for a smoother pavement and a more comfortable ride.

## A mandate for internal curing

In 2015, the Louisiana Transportation Research Center (LTRC) undertook a project to evaluate the properties and performance of internally cured concrete (ICC) for bridge decks, as compared with that of conventional concrete. Two test projects were constructed: one bridge on US Route 80 in Ada, La., and one on West Congress Street on the Acadia/Lafayette Parish line. Each project included trial sections of ICC as well as control sections constructed of conventional concrete.

LTRC Associate Director Tyson Rupnow discussed the test program: "We saw less cracking with the internally cured material. The Route 80 Bridge, in the northern part of the state, has been in place for almost 2 years, and the reduction in cracking is clearly evident. And that's even true for the last 22 feet of the deck, which received no external curing at all because the contractor ran out of curing compound."

In its summary technical report on the research, LTRC research recommended that the Louisiana Department of Transportation and Development (DOTD) incorporate ICC into its specifications where appropriate. Rupnow says, "I anticipate that DOTD will require internally cured concrete at some future time. At this point, we've completed the research project, we've published a report, and we continue to monitor the pilot bridges, going back periodically to do crack surveys."

Meanwhile, the Lafayette [Parish] Consolidated Government (LCG), impressed by the pilot project results, began requiring ICC for bridge deck construction in late 2016. Rupnow says the LCG has built a couple more bridges using ICC since the pilot project, and currently has several more in the works. He says they're very happy so far with the results they've got. They've also established some protocols to reassure the ready-mix producers and contractors who are new to the material.

"For the US Route 80 pilot project, the local ready-mix supplier was somewhat hesitant to try ICC, so LTRC

engineers assisted with trial batches with them present. They were pleased—they said it just looks like regular concrete.

"Initially, LTRC also sent personnel to the ready-mix producers to assist with the moisture correction for the batching for them to produce ICC, until they were able to train a technician to do it properly. Now Lafayette Consolidated Government has a testing lab they contract with to do all the quality control and quality assurance testing for them," Rupnow says.

## Incremental steps in the Midwest

Though neither state has begun requiring ICC for bridge decks, both Indiana and Illinois DOTs have initiated trial projects and have developed "special provisions" to govern the mix design and placement of internally cured concrete for bridge decks.

Tony Zander is currently an Area Engineer in INDOT's Pavement Division and formerly served as a concrete engineer with the department of materials manager. Zander describes the impetus behind Indiana's efforts: "Based on research that came out of Purdue University, we decided to do some pilot projects using a lightweight fine aggregate to provide internal curing. This would be for a high-performance concrete. We set some jobs up, but the FHWA considered it a new type of material and so required us to write a research plan in order to get permission to use it.

"The plan was to set up three projects with internally cured, high-performance concrete and create a unique special provision for those. They would be built, put in service and then in 3 years, we'd evaluate how the decks are performing with regard to cracks and chloride penetration. During the next construction season, one or two more bridges were done under the special provision.

"One of our pilot projects was a twin structure—a bridge on Interstate 69 over Little Black Creek in the Fort Wayne district—that was a true test project, in that the northbound structure was done with internally cured high-performance concrete and the southbound structure with our conventional Class C concrete as a control. We also tried to vary the types of structures: one was a three-span reinforced concrete slab bridge; others included steel-beam single-span structures and three-span bulb-tee concrete structures. We wanted to see the performance of more rigid structures as compared with maybe a multiple-span steel-beam structure. We finished up the 3 years on the newest ones in 2016," Zander says.

So far, INDOT has accumulated a lot of data but, according to Zander, would need further research before deciding to require the use of ICC. Among the still unanswered questions, he says, are:

- **Where are we seeing the biggest improvement in crack reduction?**

- **What types of structures should we be targeting—e.g., long-span bulb-tee bridges that are difficult and expensive to repair if damaged?**

- **Who would be responsible for testing and approving the concrete, and who would pay for the testing and/or equipment?**

Illinois DOT began a research project in 2010, to investigate ways to mitigate shrinkage cracking of bridge decks. Internally cured concrete is one of several options being studied; others include the use of shrinkage-reducing admixtures and shrinkage compensating cementitious materials like Type K and Type G additives. IDOT became interested in ICC through presentations by Dr. Jason Weiss at the National Concrete Consortium and an Illinois Ready-Mixed Concrete Association meeting.

James Krstulovich, Concrete Technology Engineer with IDOT's Central Bureau of Materials, says "We ultimately hope to provide our Districts a toolbox of options for mitigating shrinkage-related cracking to suit their particular circumstances. Based both on Dr. Weiss's extensive research and on seemingly successful implementation by INDOT and NYSDOT, we prepared two special provisions and associated test methods for their immediate use, even though our research results were still pending. The two special provisions essentially mirror the different approaches that INDOT and NYSDOT have taken: INDOT's is the 'technical' approach involving calculations to determine the volume of pre-wetted lightweight fine aggregate needed, and NYSDOT's is the 'simplified' approach that just specifies a flat 30% by volume substitution. My thought was that the 'technical' approach might appeal to certain Districts, but the 'simplified' approach could help a District break the ice, so to speak, without scaring off their contractors/concrete suppliers."

"At this time, four of our nine Districts have requested the special provisions for possible implementation, and so far, two of the four have completed one bridge project each using internal curing. Both used the 'simplified' special provision. One project is 1-1/2 years old, and the other is just about 1 year old. I hope to check out the older project in the near future; very recently I heard it is 'looking good.' A third District is hoping to have a project on an upcoming letting," Krstulovich says.

He says the producers and contractors that have worked with ICC have not encountered any real difficulty with it. "One of the points we've been making is that you shouldn't see any significant difference in what you're used to doing with a bridge deck and what you're doing [with internally cured concrete]. Every benefit it provides happens in the background. You're going to get the benefits, but your finishers shouldn't be complaining about anything. You'll just do what you normally do and it'll be fine."

Krstulovich anticipates the use of ICC for bridge decks will grow in Illinois as those who have experienced good results inspire other Districts to try it out.