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Implementing SCC Technology in Nebraska—All About Working Together

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Self-consolidating concrete with a compressive strength of 12,000 psi (83 MPa) was used in the beams of the Harris Overpass, Lincoln, NE.

In October 2001, Concrete Industries, Inc. (CI) was working with its admixture supplier to improve our form finish for precast concrete products. They brought us a new product and before long the concrete slump became a 26-in. (660-mm) diameter circle. Obviously, this generated a lot of excitement with our production personnel, but we also had to consider what it would take to get architects and engineers comfortable with using it.

Two significant changes happened between then and now. First, the admixture and cement companies promoted the advancement of self-consolidating concrete (SCC). Second, CI—through the Prestressed Concrete Association of Nebraska (PCAN)—developed a strong partnership with the University of Nebraska and the Nebraska Department of Roads. Looking back, this partnership was the key to getting things done quickly. By mid-January 2002, in addition to studying a vast amount of information from Japan and Europe, we had determined that, by going to a smaller limestone coarse aggregate and finer sand, we could make a more consistent concrete. The smaller aggregate size and the use of a viscosity modifying admixture (VMA) allowed us to use a smaller cementitious materials content. The final cementitious materials content, water-cementitious materials ratio, and air content were not significantly different from our conventional slump concrete. This was a very important consideration for us. Because the final hardened concrete looked the same as our conventional slump concrete, it reduced concerns about the use of SCC. It allowed us to focus on segregation, the issue everyone (including CI) was concerned about. All we needed to do was make sure we had no segregation and we would be successful.

From Parking Structures to Bridges

Our first commercial project using SCC was a 275,000 ft^2 (25,500 m^2), five-level, totally precast, concrete parking structure with nine different precast products totaling more than 6300 yd^3 (4810 m^3) of concrete. We approached the contractor and architect with a proposal to use SCC. We attended a jobsite meeting to explain the technology, show our development data, and answer any questions. At the end of this meeting, it was stated that the concrete specification for this project was performance based. As long as the concrete performed per the specifications, CI could use this new material. In order to meet the delivery schedule, we had started this project by casting prestressed concrete double tees with conventional slump concrete. However, on February 28, 2002, we switched all production to self-consolidating concrete.

From the very beginning, we knew we wanted to use SCC in Nebraska bridge girders, so PCAN approached Lyman Freemon, the Nebraska State Bridge Engineer. After reviewing what CI had learned up to that point and considering any issues that might impact bridge design, Freemon gave PCAN his department's support. Each precaster would need to develop its own mix design and get the Nebraska Department of Roads (NDOR) approval. We then started working with the NDOR Materials and Testing Division. NDOR set up the design framework and had oversight of all phases of concrete production and placement. During this time, NDOR personnel would make unannounced inspections, do comparison tests, and review our concrete mixing and testing procedures.

We started testing SCC mixtures in January 2002. By March, CI had approval for initial testing of concrete in non-NDOR products. We needed to gather information about properties such as modulus of elasticity, shrinkage, and flexural strength. We knew the compressive strength and durability were going to be satisfactory, so we used our commercial projects to facilitate this testing. Towards the end of April, we had gathered enough data to settle on a final mix design. Once that happened, we started our work with Dr. Maher Tadros at the University of Nebraska at Lincoln (UNL). In addition to segregation, the biggest NDOR concern was strand bond. UNL verified the strand bond by doing full-scale testing for transfer and development length using NU Girders with many strands. They also used the Moustafa pullout test. We finished in May 2002, with NDOR giving CI approval to use SCC in all bridge products.

Our first project was a single-span bridge north of Crofton, NE. This bridge consisted of five NU1100, 43-in. (1100-mm) deep girders that were 104 ft (31.7 m) long. The design called for forty-four 0.6-in. (15-mm) diameter strands and concrete compressive strengths of 7500 psi (52 MPa) at release of the strands and 8500 psi (59 MPa) at 28 days. We made our first casting on May 13, 2002. Our actual concrete strengths were 7870 psi (54.3 MPa) at release of the strands and 9230 psi (63.6 MPa) at 28 days. From that time, the use of SCC for NDOR precast products became standard practice for CI. Our best performing mix shown in the table below achieved an average strength of 8800 psi (61 MPa) at 14 to 16 hours after casting and 12,000 (83 MPa) at

28 days. The admixture quantities were selected within the ranges listed to achieve the proper set control, slump flow, and cohesion.

Further Information

For further information about this article, contact the author at markl@concreteindustries.com or 402-441-4407.

Material[(1)]	**Quantities (per yd^3)**	**Quantities (per m^3)**
Cement, Type III	800 lb	475 kg
Fly Ash, Class C	150 lb	89 kg
Fine Aggregate	1295 lb	768 kg
Coarse Aggregate [(2)]	1431 lb	849 kg
Water	292 lb	173 kg
Retarding Admixture	0 to 5 fl oz	0 to 193 mL
High-Range Water-Reducing Admixture	2 to 14 fl oz	77 to 542 mL
Mid-Range Water-Reducing Admixture	4 to 8 fl oz	155 to 309 mL
Viscosity Modifier	2 to 10 fl oz	77 to 387 mL
Water-Cementitious Materials Ratio	0.31	0.31

1. An air entrainment admixture was also used to achieve a total air content of 2 to 5%.

2. 1/2 in. (13 mm) maximum size limestone.

The above table lists the concrete mix proportions for the Harris Overpass beams as 800 lb of Type III cement, 150 lb of Class C fly ash, 1295 lb of fine aggregate, 1431 lb of coarse aggregate, 292 lb of water, 0 to 5 fl oz of retarding admixture, 2 to 14 fl oz of high-range water-reducing admixture, 4 to 8 fl oz of mid-range water-reducing admixture, and 2 to 10 fl oz of viscosity modifier for a total water-cementitious materials ratio of 0.31.