Project Summary

Texas Department of Transportation

0-5197-01: Continuing Research on Allowable Design Release Stresses for Prestressed Concrete

Background

In 2004, researchers investigated the feasibility of increasing the allowable compressive stress limit at prestress transfer. Initially, the live load performance of thirty-six specimens was evaluated. Later, forty-five Type-C beams and ten 4B28 box beams were tested to experimentally determine their cracking load. The Type-C beams were produced in four different fabrication plants using conventionally consolidated concrete. The ten 4B28 box beams were produced in two fabrication plants using concrete mixture designs of both self-consolidating concrete (SCC) as well as conventional concrete.

After testing the ten box beams, researchers reported that the beams fabricated using SCC had increased amounts of top flange cracking at release, substantially lower modulus of elasticity (along with increased deflections under live loading), slightly higher cambers near 28 days, and lower than expected flexural cracking loads under live loads. During and after beam fabrication signs of improper concrete consolidation was noted by TxDOT personnel and University of Texas researchers. However, these observations were not detailed to the point where the inferior performance of SCC box beams could solely be attributed to consolidation problems.

In an effort to explain the difference in performance between beams fabricated with SCC and those fabricated with conventional concrete, this investigation was carried out. Improper concrete consolidation and/or aggregate segregation could be two possible explanations for the observations made above. Hence, transverse cuts were deemed to be the most direct way to evaluate if any consolidation and/or segregation problem was present in the specimens tested.

What the Researchers Did

A diamond wire saw was used to produce twenty-five cuts in the box beams previously tested. For the purposes of this investigation, the majority of the cuts (21 out of 25) were done through box beams fabricated with SCC. In order to have a control sample that would allow the researchers to make a practical comparison, some cuts (4 out of 25) were made in box beams fabricated with conventional concrete.

Each cut surface was later pressure washed and examined visually for signs of aggregate segregation or any other concrete quality issue.

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Project Completed: 8-31-09

What They Found

After a meticulous examination of twenty-five cross sections exposed by cutting four specimens, it was found that the twenty-one cross sections of beams fabricated with self-consolidating concrete exhibited normal aggregate distribution with no noticeable segregation problems. Furthermore, the vertical distribution of coarse aggregate in the aforementioned SCC specimens was found to be comparable to that seen in the four cross sections of beams fabricated with conventional concrete.

Two differences were noticeable between the specimens made with different types of concrete. First, a lighter overall color was observed in specimens made with conventional concrete. This difference was solely because of the different aggregate type. The conventional concrete beams studied in this investigation were fabricated using limestone as coarse aggregate, whereas the beams fabricated with self-consolidating concrete studied herein used round river gravel. The second difference was the paste fraction. The examination of the cuts indicated that beams fabricated with SCC had a higher paste fraction. This was expected since the concrete mixture design for SCC requires the use of higher paste fraction and smaller coarse aggregate.

In addition, it was observed that the Styrofoam void placement was reasonably accurate within a 1/4” tolerance.

What This Means

Researchers concluded that the poor performance of the beams fabricated with SCC cannot be attributed to improper concrete consolidation or aggregate segregation.

Researchers also concluded that the quality of the self-consolidating concrete used in fabricating box beams for this project has minimum room for improvement, if any. Hence, the performance of beams fabricated with SCC is expected to be inferior to those beams fabricated with conventional concrete.

The advantages of using SCC in beam fabrication and the inferior overall performance observed in this project must be carefully weighed prior to the statewide implementation of SCC in bridge applications.

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