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# SELF-CONSOLIDATING CONCRETE (SCC) STRUCTURAL INVESTIGATION

## PROBLEM STATEMENT

Self-consolidating concrete (SCC) is a relatively new approach to making concrete, and it is characterized by its high flowability and resistance to aggregate segregation in the plastic state. SCC has become a popular alternative for commercial precast elements in Florida. In response to producer requests to use SCC, the Florida Department of Transportation (FDOT) recognized the need to perform a study in which full-scale precast, pretensioned AASHTO Type II beams were constructed using SCC and tested.

## OBJECTIVES

SCC trial mix designs were developed by the FDOT State Materials Office in conjunction with the participating precast producer. These trial mixes included extensive plastic property testing of the SCC trial mixes. Three beams were constructed using SCC, and three using a conventional FDOT approved mix. The major tasks included performing plastic and hardened property tests, constructing SCC beams without vibrating, determining the prestress transfer length, monitoring the camber, and, finally, testing the beams in such a manner as to produce flexure and shear dominated failure modes.

## FINDINGS AND CONCLUSIONS

This program did not encounter any issues that might render the use of SCC imprudent. The structural performance of the SCC test beams was very similar to that of the standard mixes. There are a number of methods that can be used to make concrete that has self-compacting qualities. Some of these methods are sensitive to the mixing procedures and conditions that make close quality control very important to a successful outcome. Consequently, in the current state of practice, it is recommended that SCC only be used in precast plant environment under carefully controlled conditions. The sensitivity of the plastic properties to the mixing procedures and environment make quality control indispensable. The same quality control that is usually exhibited in the precast plant environment may not be apparent under difficult field conditions. This may result in plastic property variation that can cause problems with concrete placement and quality. The following were among the findings and conclusions reached by the researchers:

- The use of SCC to construct the beams reduced construction time, improved labor efficiency, reduced noise, and improved safety.
- In general, the compressive strength of SCC is expected to be higher than that of a corresponding conventional concrete. This was found to be true in one of the two trial mixes prepared during the mix design phase. The other trial mix SCC compressive strengths were

lower. SCC used to fabricate the beams was also found to have lower early age compressive strength than the conventional concrete. Compressive strengths of the two concretes converged to approximately 8,800 psi at 56 days. Cylinders tested at the time of the beam tests indicated higher compressive strengths for the SCC in most cases. It was not clear why these differences in compressive strengths were noted, although variation in cylinder curing conditions may have been a contributing factor. In addition, the cement supplier was changed between the trial mix and beam construction, which may have contributed to the variation.

- No notable differences were found in prestress transfer length, mean camber growth, flexural capacity, shear capacity, or observed web cracking (during load testing) between the SCC and standard beams. One exception was the fully bonded strand slip in SS2-SCCF2, which resulted in a 15% lower ultimate capacity for SCC. It is believed that, based on the transfer length measurements, the abrupt prestress transfer conditions may have contributed to the early slip. Indeed, the prestress transfer conditions may have accounted for more variation in the beam performance than the difference in the type of concrete.

- Total deflections measured during the load tests indicated that the standard mix had slightly better ductility than SCC with the standard beams reaching an average of 17.1% more deflection than the SCC beams at the ultimate load.

- For flexure dominated failure modes, analytical models for flexure (both ACI and AASHTO approach, which are nearly identical) compare very well with the measured capacities with no more than 4% difference. Flexural failure modes consisted of some strand slip and yielding followed by a compression failure and sudden loss in capacity.

- Shear dominated failure modes were observed to consist of either a compression failure in the top of the section (either the top of the precast or topping, depending on the test specimen) near the point of applied load or, in one case, strand slip at the support. This is typical strut and tie behavior that has been commonly observed in previous research.

- Some aggregate segregation was noted in one of the SCC beams, but there was no indication of widespread problems.

## BENEFITS

This research has provided information necessary to determine if SCC may be used on FDOT projects, particularly for precast members. Final approval will be a policy issue decided by the Materials Office and others based on this research and other information. The benefits of using SCC are that (1) it should save money, since the precaster will need fewer people to place concrete with this product, and (2) if segregation of the aggregate is not a problem, then the product will be better since voids, bug holes, and honeycombing will be eliminated or reduced.

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