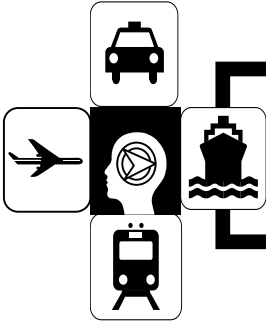


JERSEY DOT'S

"Turning Problems into Solutions"



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Tech Brief

SELF-CONSOLIDATING CONCRETE (PHASES I & II)

FHWA/NJ-2007- 021

April 2008

WHY WE ARE DOING THIS...

SCC can be defined as concrete that does not need compaction or vibration. It is a concrete that has high flowability without segregation. The material is able to flow under its self-weight into corners of formwork and through closely spaced reinforcement without vibration or compaction. This allows for a more industrialized production process, reduction of labor cost, and elimination of potential human error from vibrating the concrete. Hence, the use of SCC is spreading rapidly around the world, especially in Japan and Europe. However, the use of SCC in the United States is only limited to precast plants in a few states. Part of the reason is due to the limited knowledge and experience with the new material, lack of quality control and assurance, and no standard specifications for testing SCC.

In order to successfully develop SCC for highway structures, mineral and chemical admixtures such as pozzolans, lime stone filler, high-range water-reducing agent (HRWRA), and/or viscosity-modifying admixture (VMA) need to be added to the mix design. There are different methods to produce SCC that need to be evaluated for its proper use in construction projects in New Jersey. A number of SCC mixes has been identified and produced in the laboratory to understand their behavior. Before SCC can be incorporated in NJDOT projects, mix designs and specifications need to be developed and should reflect the state-of-practice in design of SCC while incorporating factors specific to New Jersey including the availability of SCC producers and expertise for various projects. Factors to be considered in developing specifications include: aggregate gradation requirements, maximum volume of coarse aggregates, appropriate filler materials and other admixtures, flow and segregation testing methods, durability, and material handling and placement requirements.

OBJECTIVES

The project consists of two Phases: Phase I – Testing of Field and Laboratory SCC mixes and Phase II – Instrumentation and Field Monitoring of SCC Drilled Shaft Application.

1. *The main objectives of Phase I of this project are to identify and develop SCC mix designs for both cast-in-place and pre-cast applications in New Jersey and other*

States and the effects of various parameters on the mechanical properties and durability of SCC mixes. Coordinate efforts with the local concrete producers to make sure that the selected SCC mixes can be produced in the plant and hauled to construction sites similar to regular concrete.

2. The main objectives of Phase II of this project are to evaluate the feasibility of SCC for drilled shaft construction. The evaluation process includes using various SCC field and laboratory testing methods and instrumentation and monitoring of drilled shaft cages with strain and temperature sensors.

HERE IS WHAT WE DID...

The project included two-phase research on Self-Consolidating Concrete (SCC) in New Jersey. Phase I involved collecting actual field SCC mixes that were used for casting non-structural concrete components such as tee walls and noise walls. In addition, laboratory mixes were also made to evaluate the mechanical properties and the durability of SCC with various pozzolanic materials.

In Phase II, the feasibility of using SCC in drilled shaft construction was evaluated on the new viaduct construction at the intersection of the GSP/I280 near Newark, NJ. Figure 1 through 4 show the various SCC tests performed on site for quality assurance. SCC was used in the drilled shaft foundations of this project as part of the NJDOT's SCC implementation plan with support from the Innovative Bridge Research and Construction Federal program. Fresh mix tests as well as visual inspection were performed; and specimens were collected to perform laboratory tests. All three shafts were instrumented with temperature sensors and cross-hole sonic logging (CSL) along the shaft length. Figures 5 and 6 show a typical vibrating wire strain gage and data logger installed on every drilled shaft instrumentation and data collection.



Figure 1. Slump Flow Test



Figure 2. J-Ring Flow Test



Figure 3. L-Box Test



Figure 4. L-Box Test Measurement h2

Figures 7 and 8 show the variation of strain in drilled shaft with time. Figure 8 shows the variation of temperature over the length of the drilled shaft.



Figure 5. Data Acquisition System

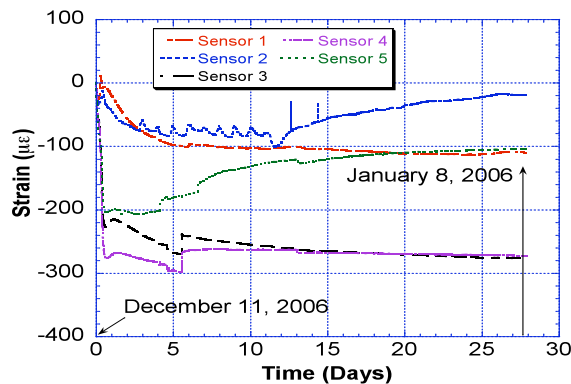


Figure 7. Strain Profile of the Demonstration Shaft

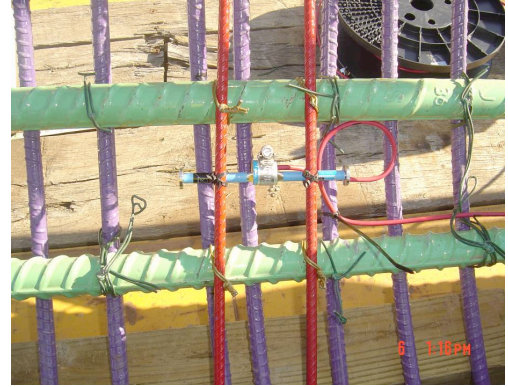


Figure 6. Model 4200 Concrete Embedment Gage

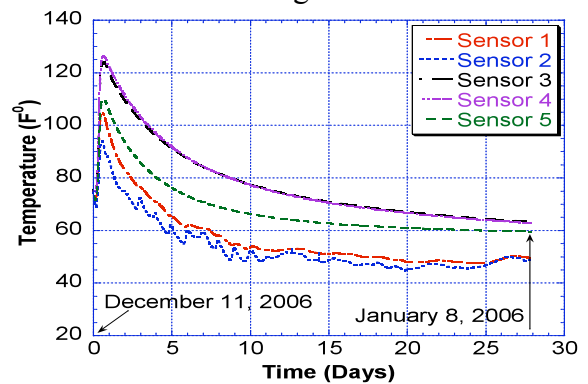


Figure 8. Temperature Profile of the Demonstration Shaft

Results from Phase I and II showed that SCC can be successfully made using viscosity modified admixture (VMA) or solely using super plasticizer (namely the polycarboxylate type) by properly adjusting the paste volume and coarse to fine aggregate ratios. SCC can also be made to equivalently match the mechanical properties and durability of high-performance concrete (HPC) by substituting Portland cement with pozzolans and other cementitious materials. Furthermore, based on the observations of the field mixes, more fundamental knowledge on SCC need to be disseminated to the contractor. It is recommended that the spread test be used in the field for classifying the fresh concrete properties of SCC as a screening test. For more quantitative results, it is recommended that the spread test be used in conjunction with other segregation tests, such as the J-ring test in order to determine the consistency of the mix.

FINDINGS.....

The following conclusions can be made:

1. There are no significant changes in compressive strength between SCC and normal/conventional concrete.

2. The modulus of elasticity of SCC is slightly lower than that of normal/conventional concrete but its tensile splitting strength was higher. The reduction in the elastic modulus was about 5% and the increase in the tensile splitting strength was about 10%.
3. The drying shrinkage of SCC was approximately 30% higher than that of normal/conventional concrete and approximately 40 % higher than that of HPC. In addition, fly ash is the best overall pozzolans for controlling the drying shrinkage of SCC with a 10 % reduction over normal SCC.
4. The performance of SCC under rapid chloride permeability testing (ASTM C1202) is greatly enhanced with the addition of fly ash and silica fume especially at 56 and 90 days. There is a 70% reduction in the amount of charged passed with the addition of silica fume and fly ash.
5. Performance of the SCC obtained from the drilled shafts in Phase II was found satisfactory. However, for the Demo shaft, the slump flow measured was over the upper specified limit of 28 inches. Additionally, it is also observed that there is a need to examine various mixes for segregation by applying the Visual Stability Index (VSI) as a screening tool.
6. ASTM Standard J-Ring Test (C1621/C1621M-06 Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring) was successfully used to test the passing ability of SCC. It is suggested that this test be used as a part of quality control measure (along with the regular slump flow test) when a more quantitative result is needed. This is especially true for mixes with superplasticizer only and high coarse aggregate content where the slump flow maybe within the limits of the slump flow test but may segregate when passing through the J-ring.

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A final report is available online at

<http://www.state.nj.us/transportation/research/research.html>

If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Division@dot.state.nj.us and ask for:

Self-Consolidating Concrete (Phases I & II)

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