ABSTRACT

Yogini Deshpande. PhD., Purdue University, August 2006. Development of Rapid Setting Self-Compacting Concrete. Major Professor: Jan Olek

When dealing with the issue of repair of infrastructure, especially bridge deck and concrete pavements, the desire to minimize the traffic delays and inconvenience to the traveling public often leads to the use of rapid hardening repair materials. Frequently, the repairs need to be performed in confined spaces where repair materials are placed around the existing or newly installed reinforcement. As a result, it is very desirable for the repair material to have high fluidity that can ensure good compaction and facilitate flow to tight spaces, preferably without the use of a vibrator. Also, typically such repair concretes are prepared in small (~25-30 L) batches using low-capacity mortar mixers.

This research project consisted of two phases. In the first phase, an in-depth evaluation of commercial rapid setting materials (CRSM) was carried out. Four CRSMs were evaluated at three different casting temperatures for slump/slump flow, setting time, rate of development of compressive strength, slant shear bond strength, freeze-thaw resistance, air-content of hardened concrete, drying shrinkage and cracking potential. It was observed that not all the CRSMs met the requirements of ASTM C 928. Most CRSMs tested exhibited low resistance to freezing and thawing.

In the second phase of the project, rapid-setting self-consolidating concrete (RSSCC) was developed using a ternary blend of Type-III cement, silica fume and micro-fine flyash, high-range water reducer (HRWR) and accelerators. The maximum size aggregate used in production of RSSCC was 9 mm, which was similar to that used in CSRMs. A five minutes mixing sequence involving a 2 Step addition of HRWR was developed for production of RSSCC in the mortar mixer. The results of the study indicate that it is possible to develop a small aggregate size based self-consolidating repair concrete that achieves a compressive strength of 19 MPa at the end of 6 hrs, has good bond characteristics and excellent freezing and thawing durability (DF>90%).

The existing literature on self-consolidating concrete (SCC) clearly indicates that its stability, in terms of flowability and segregation resistance, can be significantly influenced by the quantities as well as by physical and chemical properties of the

component materials. In the second phase a laboratory investigation on the sensitivity of rapid-setting self-consolidating concrete (RSSCC) to material and production variables that included: aggregate gradation, aggregate moisture content and the type of the mixer, remixing was also carried out. All mixtures were prepared using the same general proportions but the "as-mixed" aggregate moisture condition varied from dry (0% moisture) to twice the saturated surface dry (SSD) value. The aggregate gradation was also varied by using aggregates with different fineness modulus. Remixing was carried out at 10, 17 and 25 minutes of rest time. It was observed that variation in aggregate moisture content and aggregate gradation resulted in noticeable changes in fresh concrete properties such as the slump flow, stability and V-funnel flow values. While changes in moisture content and gradation of aggregates had an impact on the early (6 h) compressive strength, the compressive strength at the end of 24 hours was not significantly affected.