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MIX DESIGN AND TESTING OF SELF-CONSOLIDATING CONCRETE USING FLORIDA MATERIALS

PROBLEM STATEMENT

Placement of concrete generally requires consolidation by vibration in the forms. Self-Consolidating Concrete (SCC), however, is "a highly flowable, yet stable concrete that can spread readily into place and fill the formwork without any consolidation and without undergoing any significant separation" (Khayat, Hu and Monty, Proceeding First International RILEM Symposium, SCC, Stockholm 1999). The composition of SCC must be designed in order not to separate, i.e., to create excessive bleedwater and settle out the coarse fraction (sedimentation). Further, air entrainment is a possible means for increasing SCC's resistance to frost or frost thawing salts.

SCC is increasingly being used as an excellent alternative to conventional concrete for high-density or intricate reinforced sections and placement in narrow molds. However, there currently are no ASTM or AASHTO test methods available for the evaluation and acceptability of SCC.

OBJECTIVES

The objective of this project is to evaluate the use, applicability, and performance of SCC in the fabrication of precast/prestressed concrete structures using locally available materials.

FINDINGS AND CONCLUSIONS

Self-Consolidating Concrete was produced using high powder content, viscosity modifying agents, or a combination of the two. Researchers investigated the flow characteristics and fresh concrete properties of the SCC, as well as the effect of sand-to-total aggregate ratio, fly ash, silica fume, slag, cement content, and the w/cm ratio. The research suggests that a minimum cementitious content of 825 lb/yd^3 should be used for w/cm ratio below 0.37 and a minimum of 900 lb/yd^3 for w/cm below 0.33.

Researchers found that the rheological tests (e.g., slump flow, L-box, U-box and V-funnel), although not standardized, are nevertheless sufficient to ascertain SCC attributes. Stability and segregation resistance of SCC mixes needs further study and development, and VSI rating may not be enough to distinguish a segregating concrete (VSI is subjective and, hence, prone to error). There was no statistical difference found in performing the slump-flow test using either an inverted cone or an upright cone. Silica fume and slag proved to be viable secondary cementitious material in SCC. The research suggested that no more than 6% silica and no more than 40% slag be replaced by mass in SCC; furthermore, a minimum of 10% fly ash is recommended with slag usage.

Because the technology for making SCC rests mostly in the hands of the ready-mix producer and because of local variations in properties of available materials, a performance-based specification should be employed rather than set specifications for the mix design.

BENEFITS

In general, the advantages of SCC include the following:

- simple placement in complicated formwork and tight reinforcement
- reduced construction times
- reduced noise pollution
- higher and more homogenous concrete quality across the entire concrete cross-section, especially around the reinforcement
- concreting deep elements in single lifts
- improved concrete surfaces and finishes
- typically higher early strength of the concrete (formwork can be removed quickly)
- Higher moisture retention may aid curing

The economic impact of switching to using SCC, however, should be analyzed at the plant. Trial batches should be performed in close relationship with the admixture supplier to identify the exact combination of admixtures and other concreting materials needed to optimize the element, in terms of both engineering performance and cost efficiency. It is well documented that the increase in raw material costs are easily offset with improvements in pouring productivity and reductions in vibrator cost and maintenance.

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