South Carolina
Department of Transportation

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# Field and Laboratory Assessment of Flowable Fill Performance in South Carolina

The South Carolina Department of Transportation (SCDOT) makes widespread use of controlled low-strength materials, also known as flowable fill, in highway construction and maintenance. SCDOT estimates that approximately 15,000 cubic yards of flowable fill are placed annually at a cost of about $73 per cubic yard. It is primarily used as a very low-strength and excavatable material for backfilling around pipes and culverts and also as a higher strength material to fill under pavement patches and other cuts directly under pavement. SCDOT specifies two standard mix designs to handle these two applications. The mix designs are similar in all aspects except for the water requirement. The higher strength CLSM requires less water, which decreases the water-to-cement ratio and thus contributes to more strength development.

The performance of flowable fill in South Carolina has been unsatisfactory at times. Some of the problems encountered include controlling the delivered mix quality of fill and determining the setting time necessary for sufficient strength gain to continue backfilling. Unfortunately, there are no current quality assurance methods in place to address these problems. The performance of flowable fill therefore needs to be assessed in the field as well as in a controlled laboratory environment. Thus this project has two aims: 1) to observe and quantify material performance as placed in the field and 2) to compare the measured field properties to those measured in an extensive laboratory program.

Current practices for placing CLSM were observed at six sites in South Carolina. At each of these sites, CLSM was sampled and tested in the field and laboratory for flowability, bleeding, air content, fluid density, setting and hardening time and unconfined compressive strength. Observations were made at these sites with respect to placement, quality assurance methods and product performance. It was found that CLSM properties of each SCDOT standard mixture vary from site to site and from truck to truck. One of the reasons for the significant variation appears to be the uncontrolled addition of water to mixtures prior to placement. It was observed that neither one of the two standard mixtures meets flowability criteria when tested per ASTM D 6103. As a result, water was often added on site to improve flowability. This water addition decreased the long-term strength of the flowable fill, which was consistently less when compared to specimens produced in the laboratory. Even with extra water, the flowable fill required some manual placement to spread and level the material, which should not be necessary if the CLSM is proportioned correctly to meet flowability criteria.

## SUMMARY REPORT

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Based on mixtures produced in the lab, standard SCDOT mixtures set and harden within three to four days when measured per ASTM D 6024. These tests were not conducted in the field, but it is suspected that the setting and hardening process will be slower when CLSM is produced and placed with extra water. Since this is one of the critical problems associated with CLSM performance in South Carolina, the setting and hardening behavior in the field needs to be investigated further. A pocket or field penetrometer should be explored as simpler tools (as compared to ASTM D 6024) to make this assessment.

Although the two standard SCDOT mixtures were designed to be excavatable, both of them are considered to be non-excavatable based on criteria published in the literature. By increasing the water content, a flowable and excavatable mixture can be developed for construction and maintenance applications where such properties are required, such as for pipeline bedding and cover.

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