National Concrete Pavement Technology Center

Feasibility of Slip-Form Paving with Self-Consolidating Concrete

tech transfer summary

Balancing flowability and "green" strength in SCC pavement mixtures can result in increased freeze-thaw pavement durability and can eliminate the need for vibrators in slip-form paving.

Objectives

- Develop a new type of self-consolidating concrete (SCC) for slip-form paving to produce more workable concrete and smoother pavements, better consolidation of the plastic concrete, and higher rates of production.
- Investigate essential concrete material components (such as superplasticizer, viscosity modifying agent, mineral filler, and other new admixtures) and their roles in SCC used for slip-form paving.
- Develop mix design methodology, acceptance criteria, and mix proportions for the new SCC slip-form paving.
- Conduct a preliminary field investigation for new mixes of SCC to be used in slip-form paving, and evaluate the properties of the SCC in the field when slip-form paving techniques are used.

Problem Statement

Over-consilidation is often visible as longitudinal vibrator trails in the surface of concrete pavement. The use of vibrators in slip-form concrete pavement construction results in a concrete air loss which significantly reduces concrete freeze-thaw durability. In addition, regular vibration is especially difficult to properly apply to thin concrete pavement sections (such as ultrathin overlays, two-lift, and curb paving).

Concrete research and practice have shown that concrete material selection and mix design can be tailored to provide a sufficient self-compaction in slip-form paving without the need for vibration. However, in developing SCC for slip-form paving, the challenge is that it needs to possess not only excellent self-compactibility and stability prior to extrusion, but also sufficient "green" strength after extrusion, while the concrete is still in a plastic state. Such "green" strength ensures that the fresh concrete can sustain its self-weight, or hold the slab in shape, without having support from any framework.

Research Description

In this phase, essential material components and potential mix proportions of SCC for slip-form paving were invesgitated. A mini-paver was developed to simulate field paving using new self-consolidating concrete in the laboratory. X-ray computed tomography (CT) tests were performed to monitor aggregate segregation and void distribution in selected cylinder samples of SCC used in slip-form paving.

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RESEARCH PROJECT TITLE
Self-Consolidating Concrete—Applications for Slip-Form Paving

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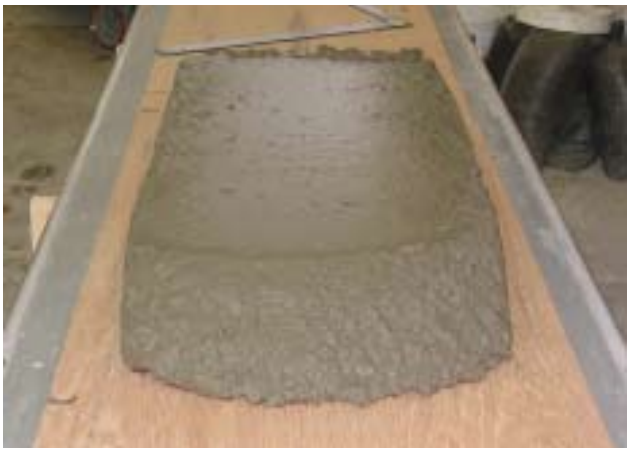
Based on the results of the feasibility study, the SCC concrete mix designed for slip-form paving will be modified for use in small-scale field trials in phase II. The field performance of the new SCC for slip-form paving will be evaluated.

Key Findings

- Well-designed SCC mixtures used in slip-form paving can attain a desirable balance between flowability and self-consolidation by tailoring concrete materials and mix design.
- Successful mixtures can maintain adequate "green" strength, holding their shape sufficiently after extrusion from a paver.
- The SCC developed for slip-form paving will not be as fluid as the conventional SCC, but it will be workable enough for machine placement, at the same time allowing self-compaction with minimum segregation.
- The use of fine materials (such as supplementary cementitious materials) and appropriate chemical admixtures (such as plasticizer and viscosity modifying agent) could significantly improve fresh concrete flowability.
- The resulting SCC for slip-form paving will have performance properties (set time and strength) compatible with current pavement concrete.

Comparison of concrete mixes and purposes

Concrete Type		Characteristics
Conventional concrete for slip-form paving		Slump: 1-2" Good shape stability Requires vibration
Conventional SCC		Slump >10" Self-flowing Self-leveling Self-consolidating Requires formwork
New SCC for slip-form paving		Slump: 5-8" Self-leveling Self-consolidating Good shape stability No vibration required



Test section of SCC extruded from mini-paver

Implementation Benefits

- The need for vibration required by conventional concrete during slip-form paving is eliminated.
- Concrete quality is improved due to elimination of vibrator trails and a more uniform air void system.
- A concrete paving technique without the use of vibration succeeds in reducing problems—such as segregation and air loss—which result from inconsistent vibration of concrete.
- Smoothness of pavement is improved by minimizing hand surface-finishing requirements.
- SCC for slip-form paving boosts production efficiency by increasing construction speed and decreasing costs for labor and machine energy consumption.
- The noise disturbance generated by vibrators is avoided.

Mini-paver with section of SCC pavement slab