AN ABSTRACT OF A THESIS

EXPERIMENTAL ANALYSIS OF INTERNAL CURING MATERIALS FOR THE MITIGATION OF AUTOGENOUS SHRINKAGE IN HIGH PERFORMANCE CEMENT-BASED MATERIALS

With the advent of high performance concrete containing low water-to-cement ratios and typically silica fume, early age shrinkage cracking of concrete has occurred with greater frequency. Early age cracking (primarily due to autogenous shrinkage) significantly compromises the durability of the concrete. Since the use of high performance concrete is increasing, there is a growing need for the mitigation of autogenous shrinkage. Autogenous shrinkage occurs after the onset of hardening when the porosity continues to increase and the internal relative humidity decreases due to the continued hydration. Reductions in the internal relative of humidity induce capillary tensions in the pore structure and bulk compression of cement paste, leading to autogenous shrinkage. The addition of water absorbent materials (i.e., internal curing) has been shown to minimize autogenous shrinkage and subsequent early age cracking. However, there is a lack of comprehensive experimental research in this area of internal curing.

This research program has investigated the effect of internal curing materials such as saturated lightweight aggregates and wood fibers on cement pastes, mortars, and concretes. Currently, internal curing materials have been evaluated for their shrinkage reducing capabilities in cement pastes and mortars at early and later ages. All internal curing materials used to date have been shown to reduce autogenous shrinkage and in some instances, expansion has been noted after several months. The effectiveness of the internal curing materials has been established based on the material protected paste volume, absorption capacity, desorption rate, reduction in paste and mortar autogenous shrinkage, and relative early age expansion. Solite has shown to be the most promising internal curing material investigated in this research.

While the addition of internal curing material appears to be effective at mitigating autogenous shrinkage, the compressive strength and modulus of elasticity of mortar and concrete tends to decrease, despite increases in the overall degree of hydration, as measured by loss on ignition. It is believed that these materials act as pre-existing defects in the microstructure.

The future of this research will be to investigate the movement of internal curing water in the cementitious microstructure at early ages. Analytical techniques are presently being considered to assess the distance and rate of water transport through the microstructure. These techniques include Time Domain Reflectometry (TDR), ^{1}H Nuclear Magnetic Resonance (NMR) and MRI imaging, Fourier Transform Infrared (FTIR) Spectroscopic Microscopy, and Neutron Imaging. Being able to determine an effective area of influence around internal curing materials would significantly improve the understanding of water movement through the refined pore structure.