ABSTRACT

Tabares, Juan D.. M.S.C.E., Purdue University, December 2016. The Influence of Alkalinity of Portland Cement on the Absorption Capacity of Superabsorbent Polymers (SAP) to Develop Internally Cured Concrete. Major Professor: Jan Olek.

The concrete industry increasingly emphasizes advances in novel materials that promote construction of more resilient infrastructure. As a potential solution to improve concrete durability, internal curing (IC) of concrete by means of superabsorbent polymers (SAP) has been identified as one of the most promising technologies of the 21st century. The inclusion of superabsorbent polymers into a cementitious system promotes further hydration of cement, by providing internal moisture during the hardening and strength development periods, and limits self-desiccation, shrinkage, and cracking. This thesis presents work performed to provide a better understanding of how (1) the absorption capacity of SAP is influenced by the chemistry of the pore solution (i.e. alkalinity and type of ionic species), and (2) the SAP´s contribution (as an internal curing agent) to the degree of hydration of cement paste depends on its absorption capacity. The research work was divided into materials characterization, absorption capacity of SAP in synthetic pore solutions, and evaluation of SAP in cement pastes as an internal curing agent.

In the first stage, ***Materials Characterization***, cement pastes were prepared using cements with three different levels of alkalinity. After mixing, fresh cement paste was stored in plastic sealed containers, and at the age of 5 minutes of hydration, pore solution was extracted from the fresh cement paste by means of a Millipore^{TM} pressure filtering system and was stored in sealed glass vials. Chemical analysis of the extracted pore solution was performed by means of titration and pH-meter (hydroxyl ions and pH), ion chromatography (sulfates and chlorides), Atomic Absorption (AA) and inductively coupled plasma optical emission spectrometry (ICP) (sodium, potassium and calcium). In addition, physical properties of the polymer such as shape and size were studied by means of image analysis using an optical microscope and Image J analysis software.

During the second stage, the ***absorption capacity of SAP*** at different levels of alkalinity was tested. Different synthetic solutions resembling the extracted pore solutions were prepared and used to investigate the swelling behavior and absorption capacity of SAP by means of optical microscope and the tea bag method. It was found that different absorption isotherms are obtained due to the influence of chemical composition of the pore solution on the absorption mechanism of the SAP investigated.

In the third stage, the inclusion of **SAP in cement pastes for internal curing** purposes was evaluated. Mix proportions were defined based on the absorption capacity of the SAP studied. Later, powders (cement and SAP) were mixed in dry state using a FLAKTECK mixer to ensure homogeneous distribution of SAP throughout the volume. Cement pastes were prepared and samples were collected to test set times, isothermal calorimetry, and chemical and autogenous shrinkage.