

Modeling of Sulfate Resistance of Fly ash Blended Cement Concrete Materials

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ABSTRACT:

Test procedures were developed to analytically and experimentally correlate the service conditions of concrete with variable flyash/cement proportions subjected to external sulfate attack. Expansion tests were conducted according to ASTM C1012 for different class C and class F flyashes with up to 30% cement replacement by weight. Effect of specimen size and aggregate contents on the expansion behavior of mortars exposed to sulfate solution was measured. In addition the microstructure of materials was studied using Scanning Electron Microscopy (SEM) for evaluating the compositional changes and crack patterns due to sulfate exposure.

One of the main challenges in this area is in the parameter evaluation, estimation, and the interpretation of experimental results. A model based on the diffusion-reaction approach for external sulfate attack of concrete was used. Fick's second law is assumed for diffusion of the sulfate ions, and a second order chemical reaction between reacting calcium aluminates and penetrating sulfates takes place resulting in formation of ettringite from various sources of calcium aluminates. According to the proposed model, the crystallization pressure of products of reaction result in a bulk expansion of the solid. The constitutive response of the matrix and the expansive stresses are calculated from the imposed volumetric strain. Microcracks are initiated when the strength of the matrix is reached, leading to changes in the diffusivity and a reduction in elastic properties of the matrix. The model solutions based on a simplified diffusivity approach is used. The theoretical expansion-time responses are obtained and compared with a range of experiments conducted. Applicability of this model to interpret experimental data using a variable range of calcium aluminates and blended cements is investigated.

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