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Investigation of strength and hydration characteristics in nano-silica incorporated cement paste

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Abstract

A hydration model for Portland cement pastes modified with nano-silica in partial substitution is formulated based on the nucleation growth process from microstructural investigations over time. The model is calibrated against thermogravimetry, X-ray diffraction and calorimetry data for four different substitution rates from 0 to 12 wt% and is validated by backscattered electron microscopy. Finite element based compressive strength predictions using representative volume element analysis of the nano modified cement pastes agreed with the experimental values. The model predictions indicate that a rate of 8 wt% is the optimum replacement level of cement by nano-silica leading to a high density matrix promoting a maximum mechanical strength.

Keywords: cement paste, nano-silica, hydration modelling, compressive strength modelling, X-ray powder diffraction (XRPD), Thermal gravimetric analysis (TGA)

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