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Early Age Microstructural Analysis of Cement-Polymer Composite Paste Cured at High Temperature

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Abstract : As a preliminary investigation on the control of microcracking in composite cement pastes, this study explores and compares the compatibility of Tetraethyl Orthosilicate (TEOS), Ethylene Glycol (EG) and Silicone Resin (SIL) in cement pastes cured at high temperature. Pastes were prepared by incorporating ordinary Portland cement (OPC) into an additive solution, using a solution/cement ratio of 0.45. Specimens were molded for 24h at 21 ± 2°C, then cured in deionized water for another 24h at 74 ± 1°C. TEOS and EG influence on fresh paste properties were similar to the reference OPC paste yet disintegration was observed in EG and SIL specimens after the first 12h of curing. X-Ray Diffraction analysis (XRD) coupled with thermogravimetric analysis (TGA/DTG) verified that SIL addition impedes portlandite formation significantly. Backscatter Scanning Electron Microscopy (SEM) techniques were therefore performed on selected areas of each sample to investigate the morphology of the hydration products detected. Various morphologies of portlandite crystals were observed in pastes with EG and TEOS addition, as well as dense morphologies of calcium silicate hydrate (C-S-H) gel and fibers, and ettringite needles. However, the formation of portlandite aggregate and clusters of C-S-H was highly favored by TEOS addition. Furthermore, the microstructural details of composite pastes were clearly visible at low magnifications i.e. 500x, as compared to the OPC paste. The results demonstrate accelerated hydration within composite pastes, a uniform distribution of hydration products, as well as an adhesive interaction with the products and polymer additive. Overall, TEOS demonstrated the most favorable influence, which indicates the potential of TEOS as a compatible polymer additive within the cement system at high temperature.

Keywords : accelerated curing, cement/polymer composite, hydration, microstructural properties, morphology, portlandite, scanning electron microscopy (sem)
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