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Examining the Hydration and Mechanical Properties of Cement Paste Containing Cellulose Nanocrystals

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ABSTRACT

Cellulose nanocrystals (CNCs) are a nano-scaled particulae material that has been shown to improve strength in cementitious pastes. One advantage of CNCs compared to other nano-materials is that CNCs are renewable and sustainable. The objective of this investigation is to investigate the influence of additional alkali content on the behavior of CNCs in cement paste. This work evaluates flexural and compressive strength as a function of heat of hydration—which measures the extent of reaction. Previous mechanical tests on cement paste containing cellulose nanocrystals (CNCs) have shown CNCs to improve the flexural strength of cement paste by approximately 30%. Isothermal calorimetry testing showed that degree of hydration of the cement paste containing CNCs increases compared to the plain system. Since properties of cement composites are time dependent, specimens were tested at degree of hydration. The hypothesis of this work is that CNC will improve the strength gain as a function of hydration. In addition, CNC will improve in the degree of hydration. To evaluate this hypothesis, cement paste samples were prepared using CNC of 0%, 0.2%, and 1.0% by volume and alkali content of 0.19%, 0.61%, and 1.01% by weight. Heat of hydration quantities was related to specimen ages and mechanical properties at given ages.

Results showed that specimens containing CNCs with additional alkali content greatly increased strength at the same degree of hydration. Results indicate that CNCs are improving the strength of the cement paste by mobility of the microstructure.

KEYWORDS

Cellulose Nanocrystals, Degree of Hydration, Flexural Strength, Compressive Strength, Cement Pa