

Low Temperature Calorimetry Study of Freeze and Thaw Behavior in Cementitious Materials Exposed to NaCl Salt

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A low-temperature longitudinal guarded comparative calorimeter was used to perform cyclic freeze-thaw testing on mortar samples saturated with NaCl solutions. Heat flow activity was monitored during the freeze-thaw experiment to detect ice formation and cracking. While the conventional water-NaCl phase diagram would suggest that no freezing or damage would occur in samples saturated with 15 % and 23.3 % NaCl solution by mass within the applied freeze-thaw temperature range, damage was observed. For these samples, an additional heat flow peak accompanied by acoustic activity was detected at a temperature greater than the expected freezing point. To better understand the source of this damage, a low temperature differential scanning calorimeter was used to investigate the influence of NaCl on freeze-thaw behavior of water, two pore solutions, hydrated cement powder, and calcium hydroxide powder. The results showed that the pore solution alters the freeze-thaw behavior slightly; however, it does not exhibit the additional phase change at higher concentrations. The samples made with hydrated cement powder showed the unexpected phase change in high concentrations of NaCl solution in a temperature range between 0 °C and 8 °C. While the exact nature of this phase change is currently not definitively known, it appears that it results in a premature damage development during freeze-thaw when high concentration salt solutions are used, even if freezing of the solution is not occurring.