

Cracking and fracture of cement exposed to calcium leaching

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Abstract:

Calcium leaching occurs when water in the environment penetrates the concrete, reach the cement matrix, react with calcium hydroxide (CH) and calcium silicate hydrate (CSH), and leach out calcium-rich compounds. Calcium leaching thrives when concrete serves in high humidity or is submerged underwater. With increasing extreme events due to climate change (e.g., hurricanes, tornados, etc.), there are concerns regarding degradation of concrete structures subjected to extreme events while serving in high humidity conditions (e.g., submerged). It is critical to understand the cracking and fracture behavior of cement experiencing calcium leaching.

In this paper, 3-point bending tests of notched and unnotched cement specimens that experienced calcium leaching is performed. The tests allowed observing cracking and fracture characteristics of cement exposed to varying time periods of calcium leaching (1 week, 4 weeks, and 12 weeks) and levels of relative humidity (16%, 50%, and 99%). The experimental observations are used to support a state-of-the-art peridynamic model, which aims to simulate the fracture behavior of cement in extreme environments. The combined experimental and computational observations shed light on the significance of calcium leaching on cement cracking and fracture behavior.