PORE SHIELD
Concrete Durability Revolutionized

RESEARCH SUMMARY

MITIGATING THE EFFECTS OF CAOXY FORMATION IN CONCRETE USING PORESHIELD

He, Farnam, Drexel University, 2021.

Introduction:

De-icing salts are often used to remove snow and ice on the surface of concrete pavements and bridge decks. The problem here is that the chemical reaction between moisture and salt can severely compromise the concrete by means of salt scaling, reinforcement corrosion, and the formation of destructive chemical phases such as calcium oxychloride (CAOXY). CAOXY is a chemical component that expands and forms cracks inside concrete, which can also be amplified by freezing and thawing cycles of the seasons.

How to Prevent The Formation of CAOXY in Concrete:

Several techniques have been developed to prevent the formation of CAOXY. These include using supplementary cementitious materials, modifying agents, and concrete durability enhancers such as soy methyl ester-polystyrene, otherwise known as SME-PS. SME-PS is the innovative durability enhancing technology behind PoreShield. PoreShield has not only proven itself to be a high performing, cost competitive way to add durability to bridge decks, and concrete pavement joints, but it has also shown to substantially reduce CAOXY formation.

Quantifying CAOXY Reduction Using Durability Enhancers:

Research by Wang, Monical, and Farnam, all suggest that the most feasible method to reduce CAOXY formation in concrete is to use applied sealers or protectants that provide physical or chemical barriers for the concrete to inhibit the seepage of water and de-icing salts, counteracting the harmful effects of CAOXY formation.

The study by Wang et al., found that SME-PS could reduce over 88% of CAOXY formation and reduce about 70% of the expansion caused by its formation in cement paste samples soaked in salt solution.

In another study by Monical et al., who compared the effectiveness of SME-PS at reducing the formation of CAOXY in cement paste with that of other topical treatments available on the market found that only one of the commercial products used in that study showed comparable performance to SME-PS.

Validating The Effectiveness of SME-PS Treatment to Reduce CAOXY Formation in Concrete:

To validate the effectiveness of SME- PS treatment, Farnam (Drexel University) developed a new modified method of characterizing the formed CAOXY in cementitious materials exposed to de-icing salts. The modified method developed in the study validated the effectiveness of SME-PS treated samples versus samples without it.

Farnam et al. quantified the formation of CAOXY in cured cement paste samples after being exposed to de-icing salt solution over time using Low-Temperature Differential Scanning Calorimetry (LT-DSC). LT-DSC is used to determine phase changes in materials, therefore, Farnam was able to determine the amount of CAOXY that had formed in the collected samples at different depths.

The study used Ordinary Portland cement with an SME-PS blend containing a 3% by mass polystyrene content. Four cement paste cylindrical samples with a water-to-cement (w/c) ratio of 0.5 and a size of 3 in × 6 in were prepared in the study. The four specimens were cut into eight halves, and a plastic dam was built on the cut surface to be used later for de-icing salt solution exposure. Four of the samples were identified as control specimens and exposed to solution, and the other four samples were treated with SME-PS, which was applied by brushing it onto the samples. After exposure to the salt solution, the solution was removed, and powder samples were collected at different depths using a mill grinder. Figure 1 illustrates the procedure of preparing the powder samples step by step for the LT-DSC test.

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ORDINARY PORTLAND CEMENT WITH AN SME-PS BLEND CONTAINING A 3% BY MASS POLYSTYRENE

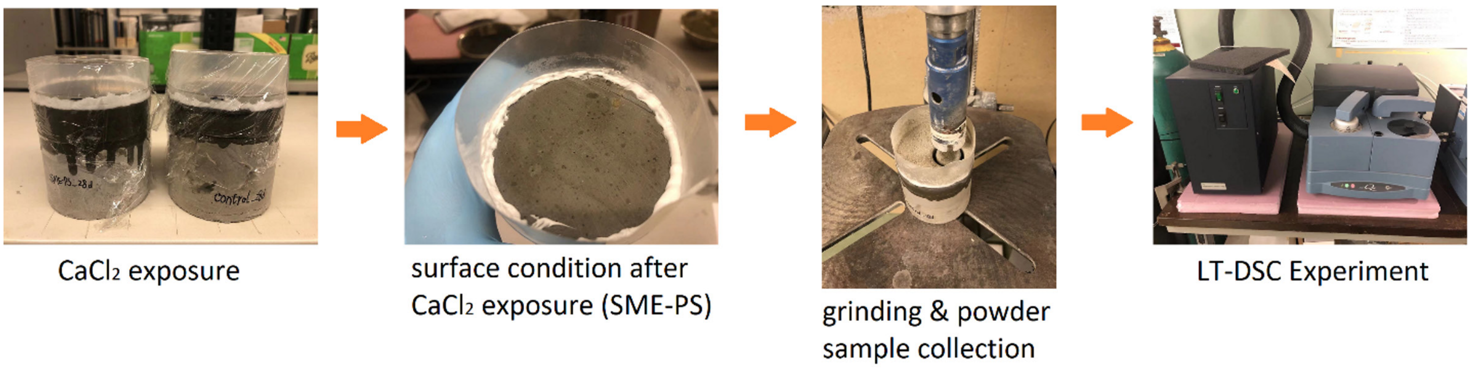

FIGURE 1 Procedure of preparing powder samples for LT-DSC test

Conclusion

The surface condition of cement paste samples with/without SME-PS treatment after 14-day and 28-day exposure to salt solution is shown in Figure 2. For control samples (a and c), the crystal-like CAOXY formation was observed along the crack pattern on the surface exposed to salt. Conversely, no crystal-like CAOXY was observed on the surface of cement paste samples treated with SME-PS (b and d) after 14 days.

SURFACE CONDITION OF CEMENT PASTE SAMPLES WITH/WITHOUT SME-PS TREATMENT

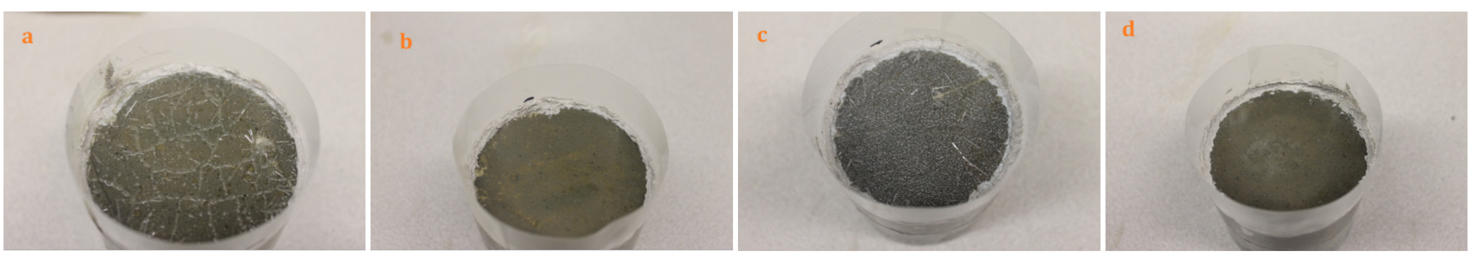

FIGURE 2 Surface condition of cement paste specimens after 14-day and 28-day exposure to 29.8% CaCl2 solution (a: control_14d, b: SME-PS_14d, c: control_28d, d: SME-PS_28d)

The reduction of CAOXY formation in cement paste was found to be greater than 90% for an exposure time of 28 days. Farnam et al. concluded that the modified model developed in the study, is verified to predict CAOXY profiles in cement paste after salt exposure and that due to the high level of CAOXY prevention that future research should be focused on the investigation of the protection mechanisms of SME-PS.

The authors acknowledge that this research was supported and funded by the United Soybean Board, 2021.

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