



Florida Department of Transportation Research

Role of Alkalis and Sulfates of Portland Cement on Durability of Florida Structures
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Among its various applications, Portland cement is used to construct bridges. The balance and interaction of chemical elements in Portland cement can have a significant effect on its strength and durability. Sulfur trioxide (SO_3), used to achieve set time, is a critical element that affects cement. Research has determined that there is an optimum SO_3 level for cement. A quantity of SO_3 , and alkali, is used to initiate chemical activity and provide early strength in the cement. However, raising the SO_3 and alkali content can result in sulfate attack on the concrete. Sulfate attack can cause concrete to expand, crack, or spall (flake away), eventually weakening it and making it susceptible to environmental attack.

The purpose of this study was to evaluate how different SO_3 and alkali levels affect Portland cement structures in Florida's environmental conditions. Researchers first performed chemical analyses of five types of Portland cement commonly used in Florida. Samples cast from the cements were evaluated for strength and durability under a variety of conditions. The researchers divided the samples into groups that were subjected to lime water solutions, continuous and intermittent salt water immersion, and high temperature and ambient temperature curing. They used scanning electron microscopy, x-ray diffraction, and optical microscopy to examine the test samples.

The study demonstrated that maintaining a low level of SO_3 and alkali is necessary to prevent overexpansion in concrete that will be subjected to high curing temperatures or to



Lime water immersion test tank

marine conditions. Increased levels of SO_3 and alkali did not invariably cause overexpansion in the concrete samples cured at ambient temperatures or exposed to lime solutions. All of the samples with higher alkali content showed lower strength measurements.

The researchers determined that replacing some of the Portland cement with fly ash in a concrete mix can reduce the tendency towards overexpansion. They recommend the use of fly ash in mass structures and precast elements. They also recommend that current standards for SO_3 and alkali limits in cement be continued. The results of this study show that monitoring the SO_3 and alkali content of Portland cement can result in stronger, more durable structures that potentially would provide longer service life with lower maintenance costs.

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