Accelerated Sulfate Attack Testing for Concrete

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Lead Institution:

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Tran-SET

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$ 106,000

Testing concrete for accelerated sulfate attack

Deterioration of concrete caused by sulfate attack is typically a long-term process influenced by type and concentration of sulfate solution, exposure conditions, and groundwater conditions. Depending on the severity of exposure, ACI 201.2R provides prescriptive recommendations to mitigate deterioration from sulfate attack. However, the requirements are often based on durability characteristics that are not representative of modern concrete and may hinder the use of new and emerging cementitious materials. To accept new cementitious materials combinations, ACI recommends performance testing using ASTM C1012. However, ASTM C1012 requires measurements that may last as long as 18 months for mixtures containing supplementary cementitious materials (SCMs), which serves as a deterrent for adopting new cementitious materials. State departments of transportation, such as New Mexico, that are experiencing a rapid transition from using fly ash as the primary SCM to adopting a broad range of other SCMs for use in concrete need to be able to evaluate new cementitious materials combinations much more quickly. Consequently, new accelerated laboratory tests are needed that accurately reflect long-term performance and durability for concrete exposed to sulfate rich environments, while obtaining results within a reasonable timeframe. This research project is intended to further the development of an accelerated acceptance test for cementitious materials combinations exposed to sulfate rich environments.

Problem Statement

Deterioration of concrete caused by sulfate attack is typically a long-term process influenced by factors that include type and concentration of sulfate solution, exposure conditions, and groundwater conditions. Depending on the severity of the sulfate exposure, ACI 201.2R, Guide to Durable Concrete, provides recommendations to mitigate deterioration from sulfate attack by limiting parameters such as water-tocementitious materials (w/cm) ratio, compressive strength, and cement type. However, prescriptive requirements are often based on durability characteristics that do not accurately reflect durability of modern concrete and may hinder adoption of new cementitious materials. ACI permits use of other combinations of cementitious materials in sulfate environments provided that performance testing using ASTM C1012 demonstrates that established expansion limits are not exceeded. ASTM C1012 accelerates the attack mechanisms by immersing mortar bars in a sodium sulfate solution (5% Na2SO4) while monitoring length changes over time. ASTM C1012 often requires monitoring for up to a year, and as long as 18 months if mixtures contain supplementary cementitious materials (SCMs), which serves as a deterrent for adopting new cementitious materials. However, state departments of transportation, such as New Mexico, experiencing a rapid transition from using fly ash as the primary SCM to adopting a broad range of other SCMs for use in concrete need to be able to evaluate new cementitious materials combinations much more quickly. Consequently, an accelerated laboratory test is needed that accurately reflects long-term performance and durability for concrete exposed to sulfates, while obtaining results within a reasonable timeframe.

Objectives

The purpose of this research project is to further the development of an accelerated acceptance test for cementitious materials combinations exposed to sulfate rich environments. The accelerated test proposed for this work utilizes a procedure to impregnate mortar bar specimens with sulfate solution in a manner that can be easily adapted to test concrete specimens. The goals of this project focus on assessing the repeatability of the test for mortar and concrete, the ability of the test to reliably identify acceptable combinations of cementitious materials, and establishing correlations with ASTM C1012 results.

Figure 1. Sulfate impregnation chamber prior to introducing sulfate solution.

Intended Implementation of Research

Workforce Development, Education, and Outreach: The goal of the research team is to ensure that results of this project are published in archival form to provide lasting impact on the transportation industry. NMSU's research team intends to disseminate the research results to the research community, state DOTs, and other transportation related organizations.

Anticipated Impacts/Benefits of Implementation

This project is expected to produce meaningful contributions by: a) Reducing the time required to approve new cementitious materials for use in high sulfate environments; b) Improving sustainability and durability through by allowing new cementitious materials to be used in sulfate rich environments. Additionally, new SCMs will produce sustainability benefits by reducing usage of portland cement and fly ash; c) Provide a performance test method that can be adopted by other agencies (e.g., ASTM, DOTs, etc.) to assess sulfate resistance in a timely manner.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.