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Research Notes

New Performance Approach to Evaluate ASR in Concrete [TPF-5(521)]

Advancing new test methods and predictive tools for assessing alkali–silica reaction (ASR) susceptibility in concrete mixtures.

Pavement

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Project Title:
New Performance Approach to Evaluate ASR in Concrete [TPF-5(521)]

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WHAT IS THE NEED?

Alkali–Silica Reaction (ASR) is a harmful chemical reaction in concrete that causes expansion, cracking, and long-term durability problems. Traditional ASR test methods are either too slow, inconclusive, or lack the sensitivity to reliably predict ASR risk in field structures. Recent advances by the Turner-Fairbank Highway Research Center (TFHRC) have produced two new test methods: American Association of State Highway and Transportation Officials (AASHTO) TP-144 (T-FAST) for identifying reactive aggregates and AASHTO T 416 (ATT) for determining the alkali threshold (AT) of aggregate combinations. While promising, these methods require validation within performance-based frameworks and real-world mixture designs. There is also a need to better understand how supplementary cementitious materials (SCMs) influence alkali loading (AL) in concrete and to develop practical mitigation strategies when reactive aggregates cannot be avoided.

WHAT ARE WE DOING?

The work is organized into three main tasks:

- **Selection and characterization of aggregates using TFHRC toolkit tests.** Aggregates are tested using AASHTO TP 144 (T-FAST) to identify reactive phases and AASHTO T 416 (ATT) to determine alkali thresholds, both individually and in combined mix designs.
- **Characterization of supplementary cementitious materials (SCMs).** A full chemical analysis of SCMs is conducted using X-ray fluorescence (XRF) and Raman spectroscopy to assess their effects on alkali loading and potential to mitigate ASR in concrete.

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- **Preparation and evaluation of concrete samples.** Concrete mixtures are batched using selected aggregates, binders, and SCMs. A protocol for preparing samples for scanning electron microscopy (SEM) has been established, with samples collected for ongoing microstructural analysis.

WHAT IS OUR GOAL?

The goal of this study is to evaluate a wide selection of concrete mix designs to validate the use of the new AASHTO TP-144-21 (T-FAST) and alkali threshold test (ATT) methods in conjunction with mix design data, cement mill reports, and SCM properties to determine the likelihood of ASR gel formation in concrete.

WHAT IS THE BENEFIT?

Alkali-silica reaction (ASR) is one of the major degradation causes of concrete. This research will substantiate the method of detecting potential ASR in concrete. The results of this study will be used to design an ASR mitigation test like T-FAST. It is necessary to expand T-FAST capabilities to evaluate ASR mitigation strategies. Guidelines for effective mitigation methods to limit the occurrence of ASR in future concrete are required to protect the long-term investment in California.

WHAT IS THE PROGRESS TO DATE?

The research team has made the following progress:

- Aggregate selection and testing: Continued measurements of combined alkali thresholds (ATMX) for nine distinct concrete mixes from South Dakota.
- SCM characterization: Raman spectra from SCM samples embedded in epoxy were processed and analyzed. The challenge of fluorescence interference in the Raman spectra was investigated and mitigated using potassium bromide as an alternative embedding medium. Moreover, several pellets of Class C fly ash were prepared using potassium bromide as the flux to determine the optimal sample-to-flux ratio.
- Concrete sample preparation: Concrete cylinders were casted for pore solution analysis and paste cylinders were embedded with resistivity sensors for three ordinary portland cement mixes with varying compositions. Moreover, paste reactivity was continuously monitored for all specimens from the three mixes.