Kansas Department of Transportation

TECHNICAL SUMMARY

Preliminary Investigation of Laser Induced Fluorescence Spectroscopy to Predict Limestone Aggregate Freeze-Thaw Susceptibility

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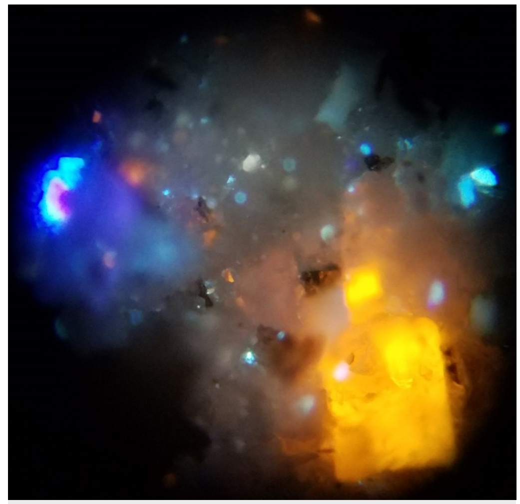

Fluorescence image of a siliceous aggregate sample

Introduction

Qualifying concrete aggregates for resistance to freeze-thaw damage is a critical step to prevent concrete pavement deterioration in Kansas. Currently, Kansas Department of Transportation (KDOT) practice involves two laboratory tests for qualifying concrete aggregates: KTMR-21, *Soundness and Modified Soundness of Aggregates by Freezing and Thawing*, and KTMR-22, *Resistance of Concrete to Rapid Freezing and Thawing*. Unfortunately, both tests are time consuming and thus cannot provide near real-time quality control nor assurance. KTMR-22 takes approximately six months to complete, for example. Thus, aggregate sources are prequalified for use in on-grade concrete. Even with prequalified quarries, natural geologic variability has led to continued pavement degradation associated with non-durable concrete aggregates. For these reasons, a significantly faster test for screening concrete aggregates is proposed in this study based on the principle of material fluorescence.

Project Description

This study evaluated the Laser Induced Fluorescence Spectroscopy (LIFS) technique as a potential predictive tool for freezing and thawing durability of concrete aggregates. A low-powered red laser and wide band spectrometer proved to work best for the aggregates tested. A partial least squares (PLS) for one variable modeling approach was used to correlate test results from KTMR-21 and KTMR-22 with the LIFS spectra.

Project Results

The LIFS spectra were divided into calibration and evaluation data sets. The PLS predictive model showed the ability to predict KTMR-21 Loss Ratio (Soundness) but was not predictive of KTMR-22 results. The technique can be applied for screening during aggregate production due to the very short duration of the LIFS test. It is likely that a larger study involving more aggregate types will improve predictive capacity by lowering the uncertainty associated with only having a few samples from which the PLS-1 model was calibrated. Furthermore, it is worth noting that the final instrumental components used for this research were relatively inexpensive when compared to the originally planned system requirements. The LIFS technology could be very impactful if employed in aggregate quarries by enabling production operations to avoid benches or seams that include potentially non-durable aggregates.

Project Information

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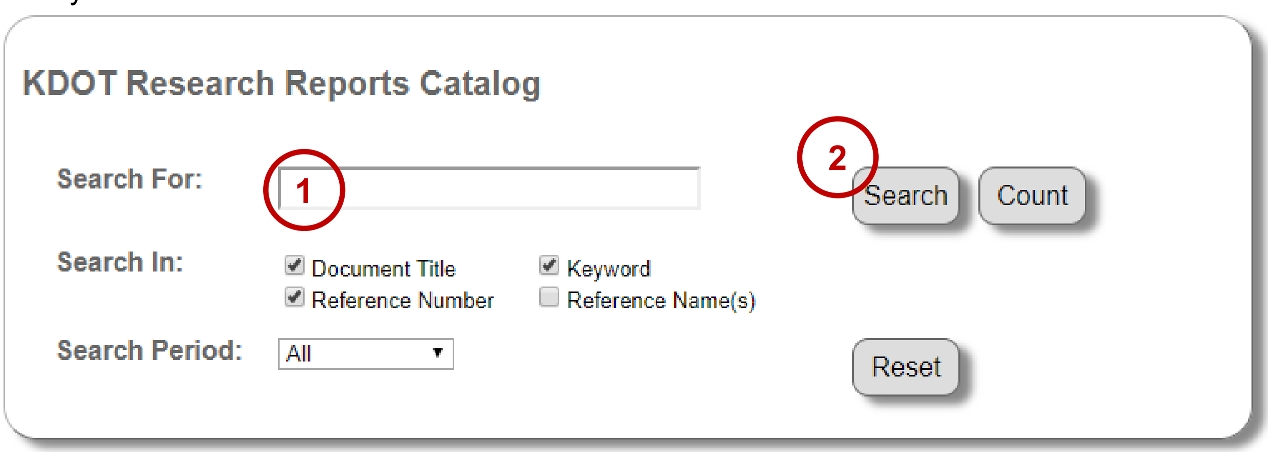

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