Kansas Department of Transportation

TECHNICAL SUMMARY

Utilization of Laser Induced Breakdown Spectroscopy (LIBS) for Real-Time Testing and Quality Control Monitoring of Aggregate Materials used in Highway Construction

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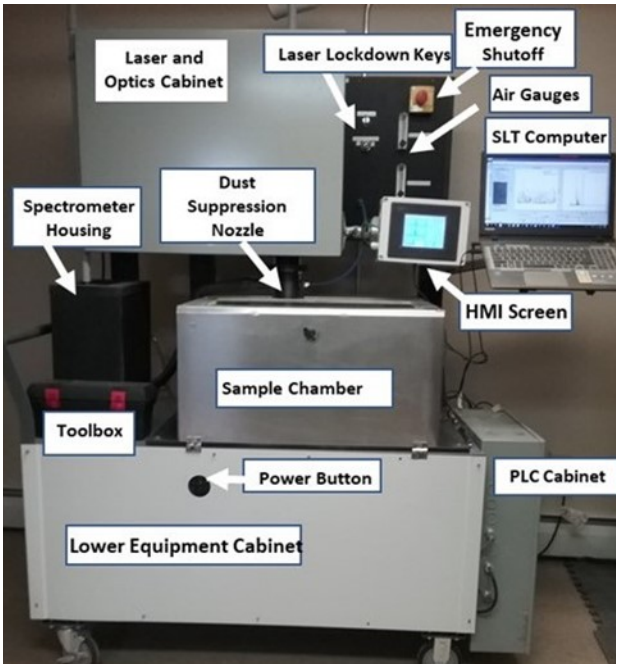
A Transportation Pooled Fund Study - TPF-5(364)



The Sample Laser Targeting (SLT) System

Introduction

Laser scanning of transportation aggregate materials provides a means to identify aggregate types, sources, and quality in near real-time. The Transportation Pooled Fund (TPF) effort described in this report began as a sequel to a TRB IDEA Program proof of concept laboratory study in 2012, and culminated in the development of the first commercial laser scanning system for transportation aggregate. This system is currently in operation at the Kansas Department of Transportation materials testing laboratory in Topeka, Kansas. The technology employed is based on a process referred to as Laser Induced Breakdown Spectroscopy (LIBS). In this process, a high-powered laser pulse is used to excite atoms that make up the minerals of the aggregate. This excitation results in the emission of light over a range of unique wavelengths (spectrum) that can be used to identify or fingerprint the targeted material. Pattern matching and modeling spectral fingerprints provides the means to identify aggregate types and their engineering properties.

Project Description

The wide applicability of the laser scanning technology was demonstrated by the analyses that were performed for the four state transportation agencies that participated in this TPF study: Kansas, New York, Ohio, and Maryland. The focus of the Kansas effort was to determine whether laser scanning could be used to predict D-cracking aggregate susceptibility, and whether production blends could be evaluated to ensure

that the source aggregate materials were all derived from approved sources. The focus of the New York effort was to determine whether laser scanning could be used to predict acid insoluble residue test results. The focus of the Ohio effort was to determine whether laser scanning could be used to predict the percentage of reactive chert and shale in a parent aggregate material. The focus of the Maryland effort was to determine whether laser scanning could be used to identify the quarry source of unknown aggregate materials, and whether laser scanning could be used as a surrogate to predict British Pendulum Number and Dynamic Friction Value test methods used to quantify aggregate friction properties.

Project Results

The results of this TPF effort demonstrate that laser scanning technology can provide new rapid testing quality control and assurance procedures (not possible using classical aggregate testing methods), thereby enhancing the overall quality of the aggregate resources used in products that make up the transportation infrastructure. The findings and conclusions presented in this report illustrate the untapped potential of the laser scanning process. In addition to the properties focused on in this report, there seems to be little reason why other material properties could not be simulated. The realization of laser scanning as a transportation agency quality control tool, however, will require a major effort in the development of a spectral database to classify and associate the geochemical properties of a state's aggregate resources with known engineering properties. This is a substantial undertaking that could potentially require years of sample collection, scanning, and traditional testing to characterize aggregate quality from its quarry resources. Those agencies with the resources to pursue the development will be at the forefront of aggregate QC/QA programs in the 21st century.

Project Information

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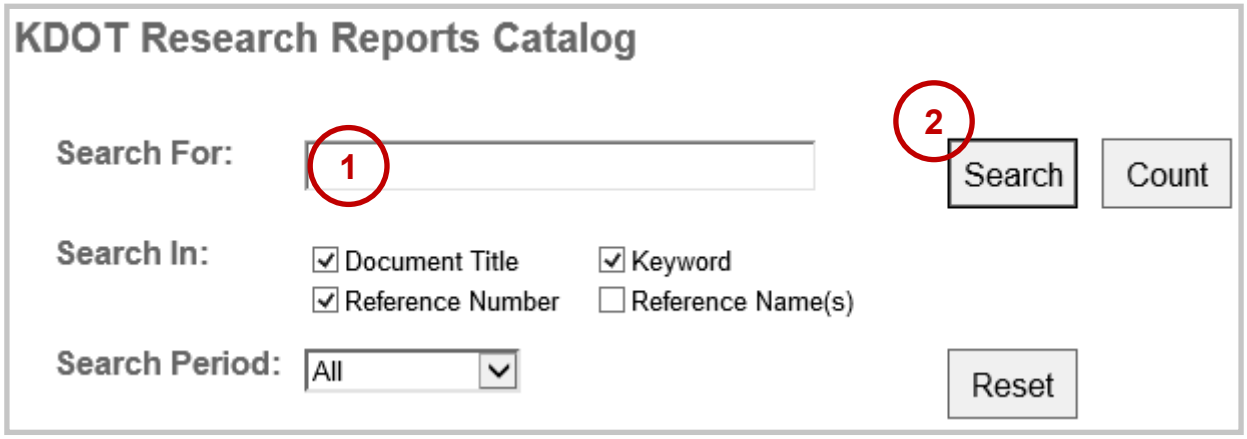

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