

New Jersey Department of Transportation  
Bureau of Research

## Technical Brief



### Laser Scanning Aggregates for Real Time Property Identification

*Laser Induced Breakdown Spectroscopy (LIBS) technology is used to identify the mineral composition of aggregate used for road construction. This is important to know the quality of aggregates provided by various aggregate manufacturing companies which will affect the durability of the highways/roads.*

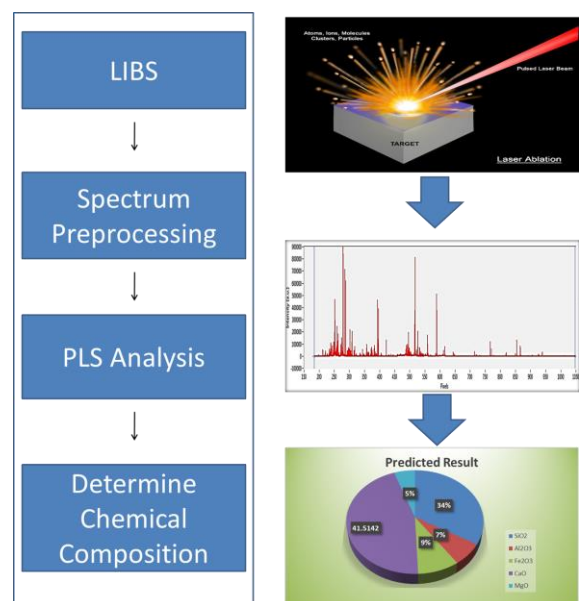
#### Background

This research study utilizes laser technology for real time property determination of an aggregate that can be performed in the field to yield relevant data quickly, so that aggregate quality control can be undertaken in a timely and cost efficient manner. Currently, NJDOT uses X-Ray Fluorescence analysis (XRF) and petrographic examination to identify the minerals present in the aggregate. This process requires more time and careful sample preparation. LIBS involves firing a laser pulse at a sample to determine its composition from light spectra emitted and interpreted using a spectrometer and a custom program, was chosen to be the basis of the portable system. The results obtained from the LIBS system was compared with XRF data provided by the NJDOT.

#### Research Objectives and Approach

This study focused on the development of a portable tool for the in-situ characterization and quality control of aggregates using laser analysis. The primary objectives of this research are as follows:

- To obtain the characteristic laser spectra models for various aggregate sources from New Jersey and surrounding areas
- To calibrate the model using laser spectrums of newly added rocks to identify real time aggregate properties such as mineralogy
- To determine if the field and laboratory setup produce consistent results
- To develop a user-friendly program for rapid analysis of laser spectra with batch capability and for future refinement of the models as new stones are added
- To determine the feasibility and affordability of laboratory based laser technology applications for field use
- To demonstrate the use of laser technology in the field for aggregate property determination and as a



- means of quality control
- To develop a user-friendly manual for operation and regular maintenance of the portable laser setup
- To train New Jersey Department of Transportation (NJDOT) personnel in the use of the laser technology

## Findings

A portable equipment is built to identify the mineralogy of aggregate and tested for the durability and resiliency of the equipment under field conditions. The conclusions derived from this research is as following:

- Laser Induced Breakdown Spectroscopy can be used to quantify the chemical composition of aggregate stone samples.
- Partial Least Square Regression Analysis can be used to develop predictive models to predict the aggregate composition.
- Split Training with Y-Scaling using a Three-Way Split classification is found to be the best model with an overall accuracy of 90%.
- A user-friendly GUI program is developed for easy analysis of LIBS data.
- No sample preparation is needed for this testing. Testing for a single stone type takes less than an hour to collect the LIBS spectrum, analyze the data and predict the result.
- The portable equipment is built to handle the vibrations and the impact caused by poor roadway and driving conditions.
- The portable equipment gives reliable test results at 60<sup>0</sup>F or above.
- The aggregate samples with high moisture content were also tested with no impact on the accuracy of the results obtained.
- This equipment is also tested with a low cost, temperature controlled, lower resolution spectrometer and found producing similar results with the same accuracy. Thus, the equipment can be made 50% more affordable in the future.
- A manual is developed for the end users that includes the safety precautions, operation and maintenance of the equipment and trained the NJDOT personnel to equip them to use the equipment.

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A final report is available online at: <http://www.state.nj.us/transportation/refdata/research/>. If you would like a copy of the full report, send an e-mail to: [Research.Bureau@dot.state.nj.us](mailto:Research.Bureau@dot.state.nj.us).

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