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16. Abstract Quality materials are necessary for good performance of products used in transportation construction. Inspection during any process is critical to performance. Although some laboratories have improved the quality of testing in the last few years, the need to become more efficient and apply automated testing procedures remains a challenge for laboratory engineers. The objective of this project was to identify problems relating to materials testing and search for existing solutions in other disciplines, thus using technology transfer. The higher ranked materials identified during the project were concrete, asphalt, aggregates, ash, and bridge materials. Technology transfer could offer a means to improve testing procedures at a lower cost. The researchers encountered much resistance for change. The main websites used as resources during this project were provided by National Aeronautic and Space Administration, Knowledge Express Data, Federal Highway Administration, Sacramento California, state of Pennsylvania, and Strategic Highway Research Program.			
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**IMPROVEMENT OF LABORATORY TESTING:
A SUMMARY OF THE FEASIBILITY STUDY
Project Summary Report 1789-S**

Project 0-1789: Applications of State-of-The-Art Technology in Electronics/Semiconductor
Engineering

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Quality materials are necessary for good performance of transportation systems. Because of this importance, the selection and testing process for materials has always required special attention from construction engineers and laboratory technicians. However, general laboratory testing, and more importantly, testing in concrete, asphalt, aggregate, cement and ash have not changed much over the years. Although laboratory engineers have implemented some improvements in the last few years, the need to make laboratory testing of materials used in construction of the transportation system more efficient continues to be a challenge.

In addition, the amount of material Texas Department of Transportation (TxDOT) uses in the construction and maintenance of Texas roadway infrastructures is astronomical, so ensuring that highway materials users provide the quality of service required is also an immense task. An application of state-of-the-art technology in electronics/semiconductor engineering encompasses a broad range of possible exchanges for new technology.

What We Did ...

Researchers conducted a survey to help set the direction of this project. The survey was sent to the TxDOT personnel identified by the project director and program coordinator. TTI researchers

interviewed and collected surveys from 16 individuals at TxDOT. Areas of expertise of the respondents included research, asphalt, chemical, precast concrete, calibration, bituminous material, bridge construction, coatings, traffic material, steel bridge fabrication, soils, aggregates, pavement management, concrete/cement, bridge inspection, and structures inspection and test. The interviewees were informative and very helpful in identifying difficulties they had experienced. From the problem areas identified by the survey responses, researchers focused on finding technological exchanges or other useful improvements. The searching methods included interviews with technology transfer experts and technology transfer agencies, web searches, and other resources.

The survey and interviews of the 16 TxDOT personnel allowed the researchers to identify specific test methods that should be improved. Also, researchers identified trouble spots within these procedures that could use improvement. They classified the information collected into five characteristics: 1) frequently performed and needing changes, 2) time-consuming task, 3) difficult-to-train personnel, 4) difficult-to-run procedure, or 5) no improvement needed. Once they had identified the higher ranked problems, the researchers investigated the test procedures and searched for technologies and applications that could be transferred to the identified test methods.

The following specific testing procedures were included in the search:

- concrete testing,
- alkali-silica aggregate (ASTM C1260),
- change in length of concrete due to alkali silica reaction (ASR) (ASTM C1293),
- pavement and asphalt testing,
- testing epoxy,
- bridge testing,
- data management of bridge information,

- frequency of inspection for steel bridges,
- measurement of prestressed concrete beams in excess of 100 feet,
- thermoplastic testing, and
- Fiber-Optic Sensors.

What We Found ...

Researchers actively searched for advances in current procedures, and much information was obtained, with some possibilities presenting themselves. For example, two of the possibilities are detailed below. Others are detailed in the research report.

A direct implementation is in the area of Alkali-Silica Reaction (ASR) in testing concrete specimens.

The actual standard to determine potential alkali reactivity of aggregates, ASTM C1260, takes around 16 days for detection in a process made in mortar bars. Another standard, ASTM C1293 “Change in Length of Concrete due to Alkali Silica Reaction,” which determines the susceptibility of an aggregate sample for expansive alkali-silica reaction involving hydroxide ions associated with alkalies, requires extensive personnel training.

Sometimes the core surface can reflect alkali-silica reaction presence, allowing an expert eye to determine its presence. Because it is known that ASR produces a kind of damage in concrete life, it is important that the owner, constructor, design engineer, and technicians know the ASR level that aggregates would have in concrete before these materials are used.

The researchers found a developed process for quicker detection of ASR. The use of the dark short-wavelength (254 nanometer) ultraviolet light allows engineers to see the alkali-silica gel inside the concrete core. The process involves first applying uranyl acetate solution to the concrete core

surface. The uranyl ion effect substitutes alkali in the gel and imparts a characteristic yellow–green glow. This color is only seen through the ultraviolet light.

The photograph (figure 1) shows a sample of a concrete core. In this small part of the core, we can see particular zones (as indicated by points 1, 2 and 3) located on a stone border. These small dark gray zones show the presence of ASR that the technicians or engineers cannot recognize with the naked eye. With the same core using the ultraviolet light and uranyl acetate, we can determine the presence of ASR regardless of the level of expertise of engineers or technicians.

This finding means that in less than one day personnel could know whether or not there is an alkali-silica reaction in a tested sample. With this automation TxDOT could get better results in a minor amount of time. Engineers can reduce the presence of ASR damage in the field with faster identification of ASR.

The second possibility identified in this project is the use of fiber-optic sensors as a weight-in-motion (WIM) device. Fiber-optic sensors were starting to be used in 1990—an offshoot from the optical communication industry and laser optics industry. The fiber-optic sensor as a WIM device would have a wide latitude in measuring weight as demonstrated by Blue Road Research. They instrumented a bridge and were able to measure the wide latitude of forces from a man walking across the bridge to a minivan driving across the bridge. Other tests were done measuring a loaded dump-truck on the bridge. As seen in Figure 2, Blue Road Research has ongoing WIM testing. Along with other companies, Sensor Line also is working on fiber-optic WIM systems. The price of a fiber-optic WIM should be close to that of a piezo-electric system, as well as have increased longevity and increased accuracy.

The Researchers Recommend...

- While the researchers looked for the best current technological changes, technology continues to change, and TxDOT should consider this search an ongoing process.
- Technology transfer offers a vast amount of potential changes, and TxDOT should continue to search for improvements.
- A quicker test to determine the reaction of alkali-aggregate is available through the application of an ultraviolet light device and uranyl acetate solution.
- TxDOT should achieve old paper documents, such as the 80 years of bridge plans, in digital format with a “knowledge-based system,” for easier and widespread access.
- More research is needed for using fiber-optic sensors as a WIM system.

For More Details...

The research is documented in Report 1789-2, *Improvement of Laboratory Testing: Feasibility Study of Electronics/Semiconductor Engineering Materials Testing*

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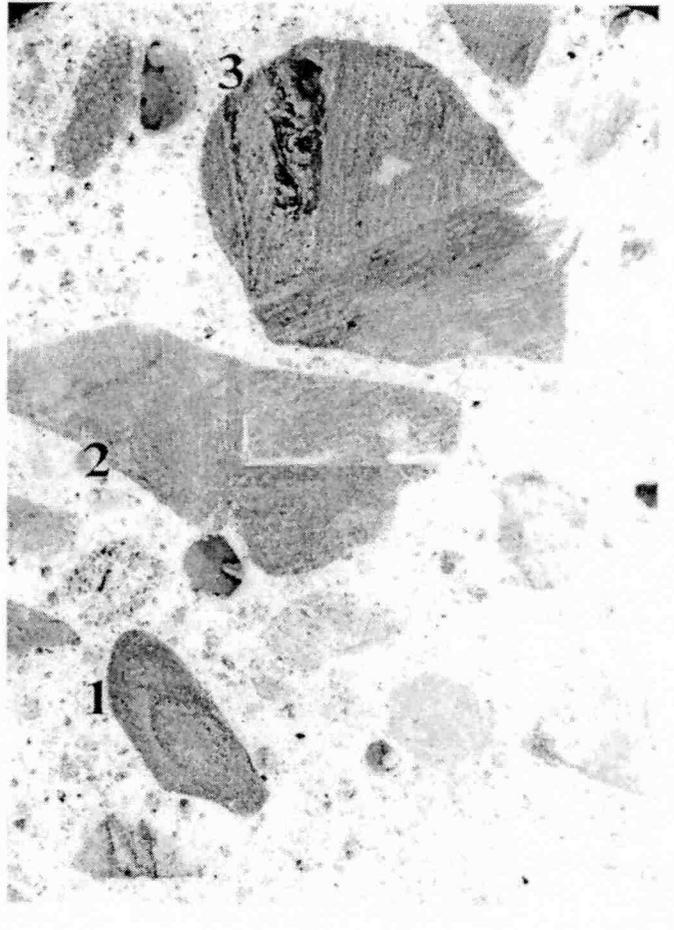


Figure 1. Gray Zones at Aggregate/Concrete Interface Showing ASR.



Figure 2. Blue Road Research Laboratory WIM Test Site.