UTC Project Information

Project Title	Feasibility of Developing a Chemical Sensor for Asphalt Aging
University	Michigan State University
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Total Project Cost	$185,428
Agency ID or Contract Number	DTRT13-G-UTC44
Start and End Dates	October 1, 2014 to September 30, 2016
Brief Description of Research Project	The oxidation of binders in asphalt pavements has been a subject of interest for a significant number of years given that oxidative aging constitutes a primary cause of binder hardening in pavements, thus contributing to various forms of pavement surface distresses. The action of oxygen is one of the principal factors responsible for the occurrence of aging phenomena. When asphalt is exposed to atmospheric oxygen, a slow autoxidation occurs, the chemical nature of which depends to a very large extent upon the temperature. As binders oxidize, carbonyl groups are formed increasing the polarity of their host compounds and making them much more likely to associate with other polar compounds. As they form these associations, they create less soluble asphaltene materials, which behave like solid particles. This composition change, results in orders-of-magnitude increases in both the asphalt's viscous and elastic properties. The end result is a material that increases its stress greatly with deformation and simultaneously cannot relieve the stress by flow, leading to a pavement that is very brittle and susceptible to fatigue and thermal cracking. Current techniques do not allow for the detection of asphalt aging levels in the field. Most of the experimental

techniques are limited to laboratory settings, thus leading to inaccurate aging predictions compared to actual observed degradation levels in the field. The objective of this project is to design and implement a low cost aging sensing system which is easy to install, and implement in the field. The process is based on the inclusion of chemical compounds that exhibit similar oxidation kinetics properties to asphalt binders. These engineered compounds will also contain fluorescent elements which exhibit a varying fluorescence emission spectrum depending on levels of concentration of surrounding reactants (such as oxygen). The system will characterize the levels of oxidation in a particular location where the engineered compounds have been added, and will be investigated by using remote imaging analysis (detection of emission spectrum). The successful development of this technique would allow for: (1) evaluating different levels of field oxidative aging of asphalt; (2) improving aging models by considering discrepancies between laboratory and filed observations.

Describe Implementation of Research Outcomes (or why not implemented)	N/A
Impacts/Benefits of Implementation (actual, not anticipated)	Successful proof-of-concept for the proposed installation procedures could dramatically transform the economics of pavement preservation. The system will consist of a network of installed material patches containing the modified material with the added fluorescent aging-dependent engineered compounds. Each patch (sensor node) is capable of continuously monitoring the level of aging at the specific location. The information can be periodically uploaded wirelessly to a central database. The sensor can be read through standard camera sensitive to fluorescence emission spectrum that is either manually operated or mounted on a moving vehicle. The roads can be frequently monitored to detect changes indicative of the onset of surface aging, allowing for automated early detection. The investigators recognize that any existing technology will have to go through major improvements before its wide acceptance into practice. The work proposed in this project will constitute a step forward toward eliminating several key hurdles.
Web Links • Reports • Project website	<www.chpp.egr.msu.edu>