

**Bi-Monthly Progress Report:**

**Project Number and Title:** *URI Project 1.11 Energy Harvesting and Advanced Technologies for Enhanced Life*

**Research Area:** *Devotement of Improved Road and Bridge Monitoring and Assessment Tools*

**PI:** *K. Wayne Lee, University of Rhode Island (URI), Civil and Environmental Engineering*

**Co-PI(s):** *Michael L. Greenfield, URI, Chemical Engineering and Sze Yang, URI, Chemistry*

**Reporting Period:** *April – May 2019*

**Date:** *5/31/2019*

**Overview:**

*Provide overview and summary of activities performed during previous two months....*

A test apparatus was built for measuring temperature as a function of depth within a full-size asphalt concrete pavement core. An embedded pipe allows water to circulate through the pavement to provide heat transfer from pavement into water. Thermocouples in the new system enable computer monitoring of 16 temperatures each second. An incandescent light bulb acts as a heat source to mimic the effects of sunlight.

Design on a setup to measure the Seebeck effect between a hot pavement and a cold sink in the ground was initiated. Parts are being ordered.

Modeling efforts were initiated to predict the temperature within an asphalt concrete pavement as a function of depth into the surface and incoming heat intensity. Preliminary results show a temperature distribution in the presence of a heat source.

*Provide context as to how these activities are helping achieve the overarching goal of the project...*

The project goal is to extract energy from a pavement that experiences heating due to incoming solar radiation. Warm water and small voltages are two possible ways to extract this experimentally. The first two activities relate to testing this extraction experimentally. The third activity relates to evaluating the feasibility and success of these steps by using parameterized physics- and chemistry-based models.

*Describe any accomplishments achieved under the project goals...*

Setting up the pavement core model with an embedded water pipe equipped with thermocouples, and it is a necessary first accomplishment to carry out the project.

*Describe any opportunities for training/professional development that have been provided...*

The graduate students working on the project are both in the non-thesis Civil Engineering master's program. They are receiving training that is not usually available to non-thesis students regarding conducting research and actively participating in the research process.

*Describe any activities involving the dissemination of research results (be sure to include workshops, seminars, and conferences attended/held for dissemination of information regarding this project) ...*

David Schumacher made a presentation at CVE601 Graduate Seminar course on May 1, 2019.

K. Wayne Lee, David Schumacher, Austin Decotis and Sze Yang submitted a paper, entitled "Infrastructure Assessment through Solar Energy Harvesting" at the 4<sup>th</sup> Renewable Energy Sources - Research and Business Conference (RESRB) which will be held in Wroclaw, Poland on July 8-9, 2019.

*Encouraged to add figures that may be useful (especially for semi-annual reporting by the project manager and management team) ...*



Figure 1: *A Test Apparatus to Measure Temperature*

### **Participants and Collaborators:**

*What organizations have been involved as partners on this project?*

University of Rhode Island, Dept of Civil Engineering, Dept. of Chemical Engineering and Department of Chemistry

*Have other collaborators or contacts been involved? If so, who and how?*

**Name of Technical Champion:** Steven Cascione

**Title:** Programming Services Officer

**Organization:** RIDOT

**Phone number:** 401-734-4803

**Email:** Steven.Cascione@dot.ri.gov

*What students have participated in the project? (Include class standing, major, role in the research)*

David Schumaker, CVE non-thesis MS student, setting up experiments on heat extraction using water

Austin Decotis, CVE non-thesis MS student, begun design of the experimental setup on Seebeck effect

Mason Hyde, CHE junior, initiated modeling of heat extraction

### **Changes:**

*Discuss any actual or anticipated problems or delays and actions or plans to resolve them...*

A computer that was planned for use with the water experiments had suffered a hardware failure that was not previously identified. An alternate machine was found for use on a short-term basis.

*Discuss and changes in approach and the reasons for the change...*

It was not possible to use a prior setup (from research by Lee and Correia in 2012) for measuring temperatures in an asphalt pavement core. It appears that the thermocouple wires became broken when the apparatus was relocated to Pastore Hall from Bliss Hall prior to building renovations.

**Planned Activities:**

*Description of future activities over the coming months.*

Experiments on heat extraction using water will be conducted using the asphalt pavement core that is instrumented with new thermocouples and a water pipe.

Modeling will represent the asphalt pavement core in software for heat transfer calculations. Models will be used to interpret the experimental data on effectiveness of heat transfer.

Experiments on Seebeck effect between a hot pavement and a cold sink in the ground will be conducted in the lab.

Very preliminary results will be shared at the TIDC annual meeting in Maine in early June.