

UTC Project Information	
Project Title	MPC 486- Sustainable Heated Pavements for Infrastructure Longevity, Safety and Economic Competiveness
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Project Duration	September 30, 2013 to September 30, 2018
Brief Description of Research Project	Icing of pavements during the winter leads to problems affecting the majority of the USDOT's strategic goals. Icy roadways clearly pose a hazard to the <i>safety</i> of drivers and vehicle occupants. Icy roads also affect <i>economic competitiveness</i> as truck based transport of goods is slowed or interrupted. The use of de-icing agents, such as salt and Magnesium Chloride, can help prevent ice build-up on the roads, but bring with them significant initial and long term maintenance costs. Beyond the costs associated with purchasing and applying the materials, the application of chloride based agents to steel infrastructure (e.g. reinforced concrete pavements and bridge decks and steel bridge components) can lead to corrosion and possible premature failures. The American Society of Civil Engineers current grade of the U.S. roads is a D and bridges are a C+ (ASCE 2013). The deterioration caused by

corrosion raises technological and economic issues associated with the *state of good repair* goal including how to inspect, manage, and repair deteriorating transportation structures. The use of these chemicals to prevent icing also has environmental costs, relating to the goal of *sustainability*. The climate of the Region 8 states served by MPC means that icy roads are a national issue of great local significance.

Heated pavements offer a potential solution for the problems caused by icy roads. New research is investigating the application of heated pavements to keep airport runways clear and decision making tools to help airport managers decide when the heated pavements or other snow clearing solutions are viable (Vigar 2013). Heating a full network of roads is likely not viable at this point, but the targeted heating of particular safety trouble spots, critical freight routes, and heavily salted areas has the potential to make significant contributions to the quality of U.S. and regional transportation networks. These networks often include generous right-of-way areas that may lend themselves to supporting a distributed energy producing infrastructure; potentially decreasing costs in remote locations. The presence of ice in concrete pores is a fairly well-understood process (Penttala 1998, Kauffmann 2004) that can accelerate environmental degradation of pavements or other roadbases. A number of novel approaches have been attempted, including conductive concrete (Yehia and Tuan 1999, 2000, 2004, Tuan 2004), conductive asphalt (Chen and co-workers 2011), heated wiring (Tuan 2004, Zhao and co-workers 2010) and there has been at least one full bridge demonstration project reported in the literature (Tuan 2008). However, there are no broad-based design or implementation guidelines for use of this class of technology, nor is there a fixed approach for powering such methods.

Three key questions arise regarding the feasibility of a targeted heating approach:

- 1) How will locations where pavements will be targeted for heating be determined to make substantial contributions to improving safety, movement of goods, longevity of infrastructure and/or impact on the environment?
- 2) How will the appropriate source of energy necessary to heat the pavements be evaluated for each site in a sustainable manner (i.e. considering the triple bottom line)?
- 3) What type of paving technology can be effectively heated with the available energy or in a way that minimizes the energy demand?

Research Objectives:

The goal of this project is to investigate the feasibility and potential benefits of localized pavement heating using a prioritization tool that will target locations that are both high risk and located at sites compatible with novel off-grid power sources. To meet this goal, this project has the following research objectives:

1. Investigate characteristics of particular roads and sites that may make them attractive applications for this technology.
2. Investigate potential options for providing sustainable heating and associated costs.
3. Use site characteristics and heating solutions to develop an index for transportation decision makers to use in identifying sites that would most benefit from the heated pavement while simultaneously considering the most appropriate power source
4. Investigate pavement options that may provide a combination of durability and effective heat transmission and retention.

	5. Build numerical models that can characterize the heated materials, predict rates of heating/cooling, and be used as a design an analysis tool to modify pavement mixes or modifications in heating sources.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	
Impacts/Benefits of Implementation (actual, not anticipated)	

Web Links <ul style="list-style-type: none">• Reports• Project Website	