Modeling of Heated Pavement Systems for Resilient Communities

Iowa State University
Civil, Construction and Environmental Engineering

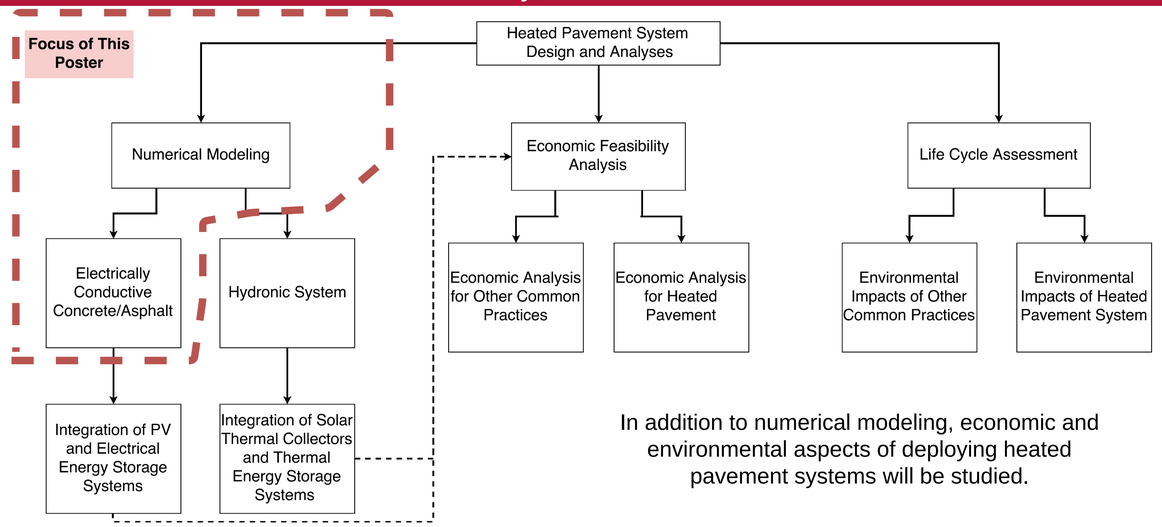
Midwest Big Data Hub
Omaha, NE, October 2, 2017

S.M. Sajed Sadati, Dr. Kristen Cetin, Dr. Halil Ceylan

Introduction

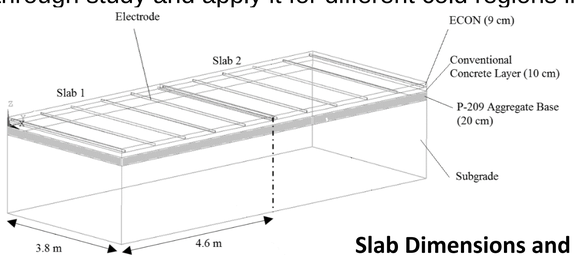
Confronting snowfall and pavement icing at airports in order to prevent long delays in scheduled flights has always been a challenge for airliners and the airport authorities. To address these concerns, electrically conductive asphalt and Portland cement concrete (ECON) is currently a focus area of pavement design, which applies a potential difference to a surface conductive concrete layer, heating up the pavement to melt the snow and ice. It is expected that if ECON system is feasible to be deployed and if comparing to conventional ice and snow removal methods has less impact on the environment, utilizing these types of heated pavement systems would be a step towards building resilient communities.

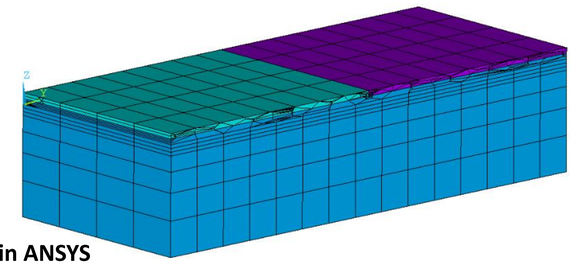
Project Overview



In addition to numerical modeling, economic and environmental aspects of deploying heated pavement systems will be studied.

This study develops a finite element (FE) model of ECON in ANSYS, validated through experimental data, for evaluating its thermal performance considering different climatic conditions. The sensitivity of the heat generation to material parameters of the ECON is investigated to determine the required accuracy for measuring each parameter and possible errors in the results. Initial results of the temperature increase on the top surface of FE model are consistent with the available experimental data which indicates that a FE model would be promising for performing feasibility studies and use in preliminary design and control strategy development of the conductive pavement systems. Each block shown in the diagram has a significant data collection to perform a through study and apply it for different cold regions in the US.



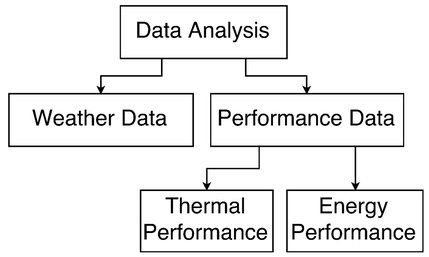


Slab Dimensions and FE Model in ANSYS

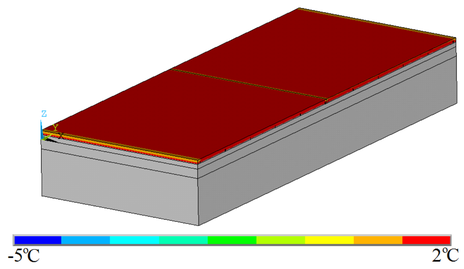
Data Collection, Modeling, and Results

There are different sources of data for studying the performance of heated pavement systems. All these data are with high time resolution and need processing to assure the accuracy of the measurements and find potential problems in the measurements.

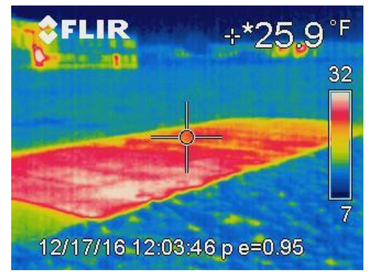
Weather data:
Weather conditions affect the performance of the system dramatically and the design parameters should be changed to design the system specific to each weather condition.
Weather data should be processed to find the
Typical weather data at each location of Interest.



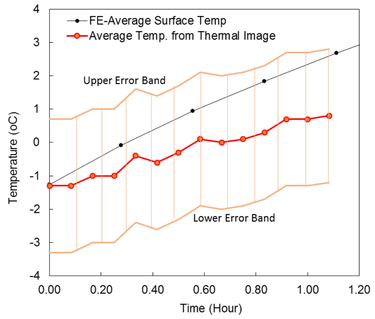
Performance Data:
Performance data collected using ~100 sensors for measuring temperature at different points of the pavement and electricity use of the system.



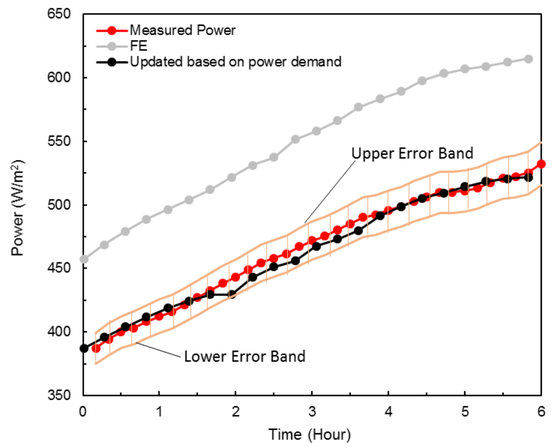
Temperature Distribution at the Surface of the ECON Model



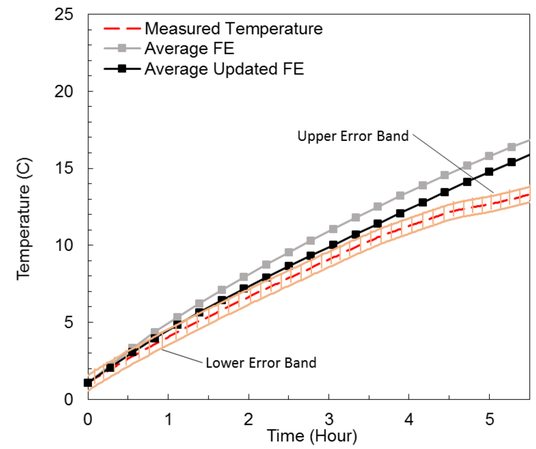
Thermal Image of ECON at DSM



Average Surface Temperature of ECON



Electric Power Drawn



Temperature Increase

Future Steps of Numerical Modeling

- Modeling the melting process of ice/snow
- Calculation of energy consumption for ice/snow removal process for a typical weather condition
- Validation of model with more experimental data from DSM airport
- Study the technical performance of the system for different scenarios

Tuan, C. Y. (2004). Concrete Technology Today: Conductive Concrete for Bridge Deck Deicing

Won, J. P., Kim, C. K., Lee, S. J., Lee, J. H., & Kim, R. W. (2014). Thermal characteristics of a conductive cement-based composite for a snow-melting heated pavement system. *Composite Structures*, *118*(1), 106–111. https://doi.org/10.1016/j.compstruct.2014.07.021

Wu, J., Liu, J., & Yang, F. (2015). Three-phase composite conductive concrete for pavement deicing. *Construction and Building Materials*, *75*, 129–135. https://doi.org/10.1016/j.conbuildmat.2014.11.004