Cool Pavement Strategies for Mitigating Heat Island: Do They Help Reduce Energy Use?

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Introduction

- With the process of urbanization, more of the urban surface is, or will be, paved with asphalt or concrete pavements. Pavements contribute to local Urban Heat Islands (UHI) in hot regions by creating an impermeable surface and by absorption and later transmission of solar energy.
- Cool pavements, with lower temperatures, have been identified by the US Environmental Protection Agency (EPA) as a major strategy to mitigate heat island effect, with one of the main benefits being that they could lower air temperatures and consequently reduce cooling related energy use and associated greenhouse gas emissions.
- On the downside, cool pavements can also potentially increase energy use and greenhouse gas emissions if more heating is required during cold periods.

Objective & Methodology

- This study is to develop a preliminary model for evaluating impacts of pavement strategies on building energy use, which can be used to provide a first-order preliminary estimate of the effectiveness of cool pavements on helping reduce building energy use.
- The primary pavement data needed for the model are Cooling and Heating Degree Hours (thermal load) near the intake to the Heating, Ventilation, and Air Conditioning (HVAC). Data measured from the nine test sections in Davis, California were used to calculate the thermal load on an annual basis and provide a preliminary indication of pavement type effect.
- The results from this type of study can provide insights for designers and policymakers on the effectiveness of applying cool pavement strategies for mitigating near-surface heat island effects, from the viewpoint of building energy demand.
- The preliminary model is a simplified one based on near-surface air temperatures assuming that they are controlled by the pavement surrounding the building, and did not consider the thermal radiation interaction between building and pavements.

Field Measurement on Different Pavements

- Test Sections for Cool Pavement Study
- Pavement Temperatures of Test Sections
- Test Sections for Cool Pavilion Study
- Field Measurement on Different Pavements

Thermal Load (for HVAC Energy Use)

- Cooling and Heating Degree Hours
- Near-Surface Air Temperature
- Example Monthly Thermal loads (CDH, HDH & Total-CDH+HDH)

Summary & Discussion

- Example thermal load was calculated from the measured data of near-surface air (5 in [12.5 cm] above) temperatures on the nine test sections built for this study.
- The CDH is high in summer and low in winter; the HDH is higher in winter and lower in summer, as expected. The total thermal load (CDH + HDH) is generally higher in summer and slightly lower in winter in Davis, California. Different pavement types have influence on the thermal load (CDH and HDH), but not very significant.
- Moreover, the influences on the thermal load of pavement types are not constant (for example, positive on CDH and negative HDH, positive in summer and negative in winter). The correlation of annual thermal load and albedo was examined. The increased albedo reduces the CDH but increases slightly the HDH, and reduces the total thermal load on an annual basis. All these impacts are not very significant for the test site in the open area in Davis, California.