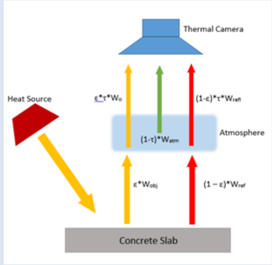
Heat-Reflective Coating for Reduction of Urban Heat Island

Nicholas W. Moore[1], Aidin J. Golrokh[2], Dr. Yang Lu*
Macalester College[1], Boise State University[2]*

I. Introduction

Nearly a third of urban areas are covered by paved surfaces, adding to the Urban Heat Island (UHI), found to create a 1 to 3 °C annual air temperature increase in cities [1]. Heat-reflective coatings are commonly used to increase paved surfaces albedo, reducing surface temperature in asphalt and concrete by 13 and 4°C respectively [2, 3]. The aim of this study is to examine temperature performance of a coating using thermal imaging.



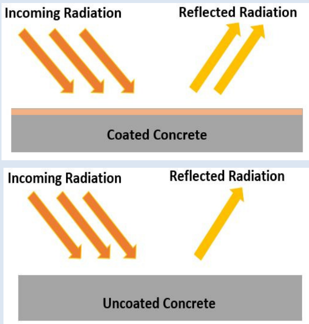


Figure 2.

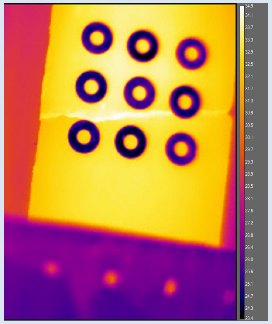


Figure 3.

Figure 1. Conceptual model of experiment with thermal camera.

Figure 2. The difference in radiation reflected between uncoated and coated pavement

Figure 3. Example of point set up using a thermal camera before data collection.

II. Traditional Pavements vs Coated Pavements

Traditional Concrete:

- Absorbs about 90% of radiation
- Contributes to Climate Change
- Higher water runoff temperature
- Increases UHI in cities
- Decreases human comfort
- Cooler night temperatures

Coated Concrete:

- Reflects 50% of radiation
- Offsets Climate Change
- Increases driver safety
- Reduces street lighting
- Better air quality
- Longer lifetime

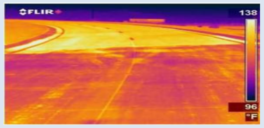


Figure 4. Thermal image of coated and uncoated surface temperature gradient

III. Methods

- Six layers of coating at 3 mm thickness applied to 6 x 6 x 20 inch concrete slab
- Heated with halogen lamp under varying conditions (heat, wind and humidity)
- Temperature is measured at surface with infrared camera and depths of 2in, 3in, and 4in with thermocouples

Figure 5. Various steps in the experimental setup, including coating application, point selection and data collection for the wind environment.

IV. Results

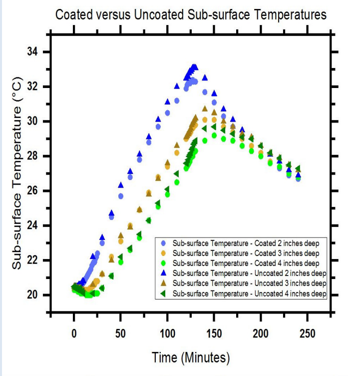


Figure 6. Data from three subsurface depths of 2 inches, 3 inches and 4 inches during normal heating for coated and uncoated samples.

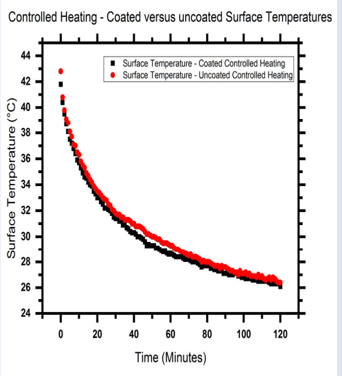


Figure 7. Surface temperature data from both uncoated and coated samples during the normal heating conditions.

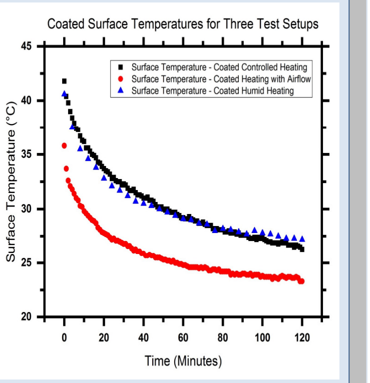


Figure 8. Surface temperature data for the coated concrete in all three environmental conditions; normal, wind and humidity.

V. Conclusion & Future Study

Conclusion:

- In both normal and humid conditions, the coating was found to reduce surface temperature by 1-2°C, however it was not as drastic for humid testing. This shows that heat-reflective coating could help mitigate UHI.
- No cooling effects were noticed for wind heating.
- Normal and humid conditions typically rose to the same peak temperature during the heating phase, whereas the addition of windy conditions reduced the peak temperature.
- The subsurface temperatures decreased as depth increased during the heating phase, however they re-converged quickly during the cooling phase.
- The subsurface temperatures were slightly cooler with the coated sample.

Future Study:

- Study the effects of heat-reflective coatings on asphalt pavement, expecting to see higher temperature anomalies.
- Perform a similar study outdoors for both concrete and asphalt at the same time in order to compare the results.
- Record air temperature difference above coated and uncoated sections of pavement at increasing heights.

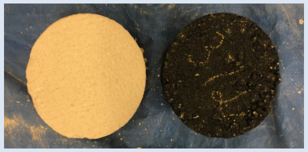


Figure 9. Future work includes the similar experiment but with asphalt cylinders rather than concrete.

VI. References

1. Wong E., Akbari H., Bell R., Cole D.,"Reducing Urban Heat Islands: Compendium of Strategies", Environmental Protection Agency.
2. Yang J., Wang Z., Kaloush K. E., "Effect of Coating on Thermal Performance of Different Pavements", Arizona State University, 2016.
3. Synnefa A., Santamouris M., Livada I., "A Study of the Thermal Performance of Reflective Coatings for the Urban Environment", Solar Energy, 80, 968-981, 2006.