A Continued Evaluation of the Urban Heat Mitigation Potential of the San Antonio Cool Pavement Pilot

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Final Report for 2023 Fieldwork

Abstract

The City of San Antonio, Texas, as part of its broader climate action and adaptation plan, began a cool pavement pilot program in collaboration with the University of Texas at San Antonio in 2023. The 2024 project evaluated the effectiveness of three different cool pavement treatments at five test sites across San Antonio during the summer. For each site, meteorological measurements were collected at the cool pavement installation as well as a representative control in the neighborhood. The findings indicated that the performance of the cool pavement installations varied across the products tested and were influenced by the characteristics of the control road.

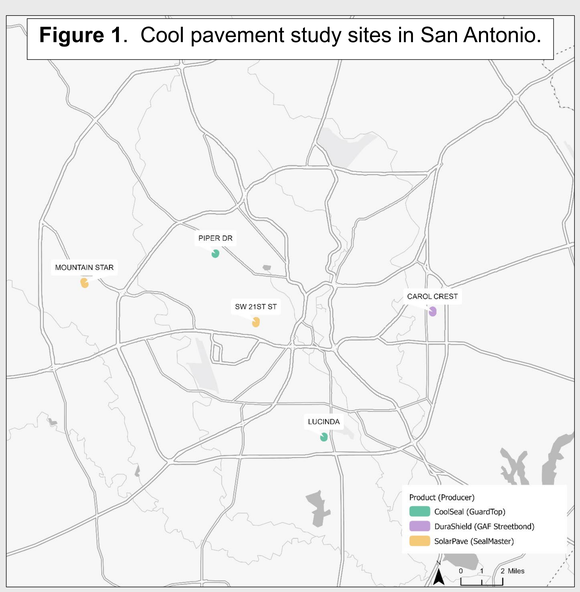
Background

A growing body of literature has focused on the efficacy of cool pavement. The findings have varied to some extent depending on the scale of the cool pavement installation, the specific cool pavement product utilized, the local geophysical setting, and the temperature metric analyzed. Generally, studies have documented that cool pavement can reduce street surface temperatures compared to controls (Cheng et al., 2019; Haselbach et al., 2011; Middel et al., 2020; Moretti et al., 2021; Santamouris et al., 2012; Schneider et al., 2023). However, this reduction in surface temperature has not always led to substantial decreases in ambient air temperature or an improvement of thermal comfort for pedestrians (Middel et al., 2020; Moretti et al, 2021; Schneider et al, 2023). Overall, due to the contrasting results of previous studies, particularly regarding air temperature and heat stress, this work aims to assess the performance of three different cool pavement products deployed throughout San Antonio, Texas.

Research Questions

1. How does cool pavement alter **surface temperature, air temperature and wet bulb globe temperature**?
2. How does cool pavement alter **albedo** and components of the **radiation budget**?

Figure 1. Cool pavement study sites in San Antonio.



Methods

In 2024, 16 days of fieldwork were performed from June 17th to September 13th. Two-sample t-tests were used to evaluate the statistical significance of the temperature differences between the cool pavement sites and controls.

Figure 2. Location of the Mountain Star cool pavement testing site and control testing site (left) as well as the fieldwork data collection schematic (right).

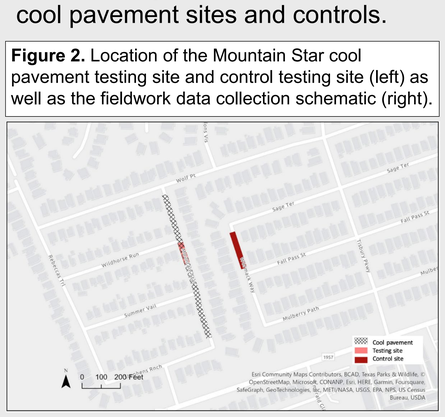
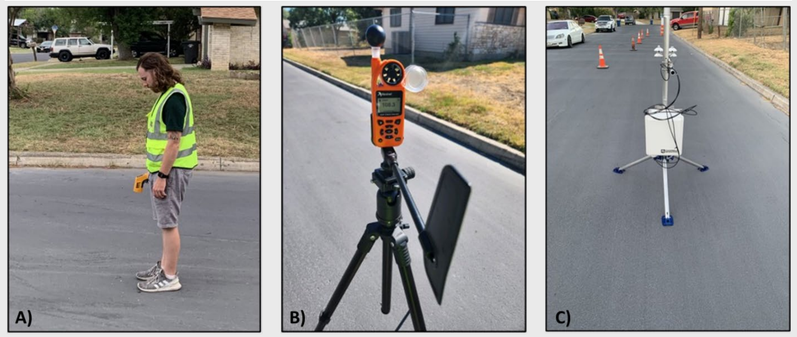


Figure 3. The a) FLUKE 572-2 infrared thermometer, b) Kestrel 5400 Heat Stress Tracker, and c) Hukseflux NR01 4-component net radiometer deployed in the field.



Results – Surface Temperature

Table 1. Differences in surface temperature between the cool pavement (CP) sites and control (CON) sites. The sample size (N) varied due to the exclusion of points influenced by shadows. Statistically significant differences are indicated by p-values in bold.

Product	Site Name	Avg. CP Surface Temp (°F)	CP N	Avg. CON Surface Temp (°F)	CON N	Difference	T-Value	P-Value
Morning (6:00 am - 7:00 am)								
Durashield	Carol Crest	88.98	24	89.79	24	-0.80	-1.36	0.18
CoolSeal	Lucinda	87.05	24	88.03	24	-0.98	-2.51	**0.02**
	Piper Dr.	88.23	24	89.18	24	-0.95	-2.76	**0.01**
SolarPave	Mountain Star	87.16	24	89.84	24	-2.68	-3.83	**0.00**
	SW 21st St.	86.55	24	88.45	24	-1.90	-2.84	**0.01**
Noon (12:00 pm - 1:00 pm)								
Durashield	Carol Crest	128.11	24	133.83	18	-5.72	-4.25	**0.00**
CoolSeal	Lucinda	130.58	19	128.74	24	1.84	1.49	0.14
	Piper Dr.	121.77	24	131.79	24	-10.02	-3.36	**0.00**
SolarPave	Mountain Star	119.48	24	131.73	24	-12.25	-7.62	**0.00**
	SW 21st St.	124.65	24	127.79	24	-3.13	-1.45	0.16
Afternoon (4:00 pm - 5:00 pm)								
Durashield	Carol Crest	138.51	24	145.59	17	-7.08	-3.10	**0.00**
CoolSeal	Lucinda	137.00	24	136.32	22	0.68	0.56	0.58
	Piper Dr.	130.51	24	141.15	24	-10.63	-3.79	**0.00**
SolarPave	Mountain Star	123.98	24	135.78	24	-11.79	-5.81	**0.00**
	SW 21st St.	128.41	24	135.47	24	-7.05	-2.96	**0.00**
Night (9:00 pm - 10:00 pm)								
Durashield	Carol Crest	102.94	24	105.00	24	-2.05	-1.81	**0.08**
CoolSeal	Lucinda	100.10	24	101.00	24	-0.90	-1.11	0.27
	Piper Dr.	98.75	24	100.22	24	-1.46	-1.24	0.22
SolarPave	Mountain Star	99.50	24	103.30	24	-3.80	-6.27	**0.00**
	SW 21st St.	98.66	24	102.32	24	-3.66	-2.15	**0.04**

Results – Air Temperature

Figure 4. Air temperature differences for the Carol Crest Durashield site by day and time. In the morning, the temperatures at the cool pavement were 0.4°F and 0.2°F lower than the control. These differences were statistically significant despite the small magnitude. During the noon and afternoon periods, no statistically significant differences were observed. Contrasts emerged again at night as the Carol Crest cool pavement was significantly cooler during both visits.



Results – Albedo

Table 2. Average albedo for each site calculated using the hourly averages of the incoming and outgoing shortwave radiation fluxes between noon and 4:00 pm. When available, values from 2023 are reported in parentheses.

	Mountain Star (SolarPave)	Piper Dr. (CoolSeal)	Carol Crest (Durashield)
Cool Pavement	0.29 (0.28)	0.20	0.15 (0.18)
Control	0.06 (0.22)	0.10	0.08 (0.16)

Conclusions

- The SolarPave product displayed the most consistent and statistically significant decreases in **surface temperature** with an average **reduction of 9.4°F** during the afternoon
- When combining the night and morning measurements, the **mean air temperature difference was -0.32°F**
- The average difference in the **mean wet bulb globe temperature** between the cool pavement and control sites during the daytime was **0.39°F**
- Cool pavement is **not a silver bullet** since it can reduce surface temperature but may not substantially impact air temperature or wet bulb globe temperature

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