

# High-Albedo Pavements May Have Environmental Benefits



By Yetkin Yildirim, P.E.

**H**eat energy behaves differently depending on the color of the surface that it comes into contact with. Light, white colored surfaces tend to reflect heat energy, while dark, black-colored surfaces absorb much of this energy. The degree to which a surface reflects this energy is called its *albedo*, which can be expressed as a numerical value from 0 to 1 (where 1 means 100 percent reflectance, and 0 means total absorption).

Asphalt materials have traditionally been black, and thus, the majority of our world's roadways are dark in shade. As a result, the earth's natural surface has become extensively covered by dark roadways. The solar reflectance of a freshly installed asphalt pavement is about 0.05; this means that

fresh asphalt absorbs 95 percent of the sun's energy. Slightly lighter, aged asphalt pavements have a solar reflectance between 0.10–0.18, depending on the type of aggregate used in the asphalt mix.

## URBAN HEAT RETENTION

As pavements cover approximately 35–40 percent of populated areas, this process of heat retention has contributed to an increase of urban temperatures relative to rural areas in the same climatic zone. The resulting temperature-increasing phenomenon has been coined the *Urban Heat Island (UHI)* effect.

Growing UHIs made by covering the earth's surface in heat-absorptive structures is said to contribute to presumed

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global warming. Heat that would otherwise be reflected is instead being stored on the earth's surface, only to be later released as a form of energy that gets trapped in the earth's atmosphere.

### HIGHER ALBEDO = LOWER TEMPS

There are many factors that contribute to a pavement's heat-retention properties, including pavement thickness, pavement density, and type of material used. However, the most influential factor on a surface's temperature is its albedo. All else being equal, a surface with a low albedo will absorb far more heat than a high albedo surface.

Independent of the type and thickness of the pavement, it is clear that a higher albedo results in a lower maximum daily surface temperature, as well as a lower minimum daily temperature. Regardless of the thickness or density of a pavement, increasing surface reflectance will result in less heat absorption.

Approximately 2.4 percent of the earth's surface is covered by urban areas. If all of the black surfaces in these areas were turned white, it's calculated that it would result in 0.03 percent more of the sun's energy being reflected, rather than being absorbed. This number may appear negligible, but this seemingly small change results in enough UHI reduction to account for 44 billion tons of CO<sub>2</sub>.

It is difficult to imagine how much of an impact such a huge amount of CO<sub>2</sub> offset would bring, but there is a more

relatable way to conceptualize these calculations: if the albedos of all urban surfaces are raised to offset 44 billion tons of CO<sub>2</sub>, the impact would be equivalent to removing all cars from the entire globe for 11 years.

### PERFORMANCE BENEFITS

Not only can increasing roadway albedo have positive environmental effects, but more reflective roadways also can be less costly and more durable than their black-colored counterparts.

Flexible pavements are constructed using elastic materials that are susceptible to temperature changes. The structural capacity of a flexible pavement decreases as the temperature of the pavement increases. Laboratory and field testing has shown that the resilient modulus of an asphalt pavement increases as a result of lower pavement temperature.

The more resilient a pavement, the better the pavement is at resisting gradual deformation such as rutting. Because a higher albedo results in a lower maximum pavement temperature, light-colored pavements can be thinner than dark-colored pavements while achieving the same durability. A higher albedo means that less material is necessary for construction which translates into lower material costs. 

*Yildirim is director, Texas Pavement Preservation Center. Opinions expressed are those of the author*



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