National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Strategies for Design and Construction of High-Reflectance Asphalt Pavements

RESEARCH SYNOPSIS–TRB REPORT 2098

Problem Statement

Government agencies and private business are increasingly focusing on green construction practices in order to achieve Leadership in Energy and Environmental Design (LEED) certification. Cool asphalt pavements are an important part of meeting LEED standards for new construction. Architects and designers need guidelines for the design and construction of high-reflectance asphalt pavements.

Objective

The objective of this study was to identify and validate high-reflectance asphalt pavement surface treatments that (a) are suitable for parking lots and other large paved surfaces (20,000 to 50,000 ft2), (b) have a solar reflectance index (SRI) of at least 29 percent, the LEED minimum requirement, and (c) are economical (less than $3/ft2 in place). This study examined several options for improving the solar reflectance index of asphalt pavements and provides useful guidelines on the effectiveness and typical costs of the options.

Background

Several factors influence the temperature of a pavement surface, but specifically, solar reflectance (albedo) and thermal emissivity are used to determine the SRI of a pavement. SRI represents surface temperature relative to that of standard white (SRI=100) and standard black (SRI=0) surfaces. Solar reflectance refers to how well a surface color reflects light (e.g., light colors have high reflectivity), and emissivity is a measure of the ability to radiate absorbed heat. Higher reflectance and/or higher emissivity corresponds to a higher SRI value.

When first constructed, conventional asphalt pavements generally have low SRI values due to the low reflectivity of the black asphalt binder and limited exposure of the aggregate after construction. However, the SRI increases as the binder weathers and the aggregate becomes more exposed. In contrast, portland cement concrete (PCC) pavements have higher SRI values initially, but the SRI value decreases over time.

Description of Study

For this study, eight technologies for improving the reflectance of asphalt pavements were evaluated:

1) Surface gritting using light-colored aggregate
2) Chip seals with light-colored aggregate
3) Sand seals (also known as scrub seals) with light-colored aggregate
4) Shot blasting – provided by Blastrac®
5) Synthetic binder with light-colored aggregate – a natural color of CS-Phalt™ provided by Toda America, Inc.
6) Light-colored surface paint – two shades of StreetBond™ provided by Integrated Paving Concepts, Inc.
7) Micro-surfacing using light-colored materials – E-Krete™ provided by PolyCon Manufacturing
8) Grouting of open-graded mix with cementitious materials – Densiphalt® produced by Euco Densi LLC

Figure 1 Measuring solar reflectance with a pyrometer according to ASTM E 1918.

Technologies one through seven were evaluated using small test sections built on a storage area adjacent to the National Center for Asphalt Technology test track. Two methods were employed to measure the solar reflectance of each surface treatment. First, solar reflectance measurements using a pyrometer were taken within the sections at different times of day over a two-month period according to ASTM E 1918. Due to the varying position and angle of the sun during these times, this allowed measurements of six different areas within each test section. Second, two cores from each section were sent to the PRI Construction Materials Laboratory to determine solar reflectance and thermal emissivity according to ASTM C 1549 and ASTM C 1371, respectively. SRI values were then calculated according to ASTM E 1980. To evaluate the eighth technology, the researchers identified an existing surface to test Densiphalt® and obtain SRI results.

Conclusions and Recommendations

The following conclusions were drawn from this study:

1) Six of the eight technologies exhibited SRI values of 29 or higher, including StreetBond™ coating by IPC, E-Krete® micro-surfacing by PolyCon, synthetic binder by Toda America, Densiphalt® by Euco Densi, and chip seals and sand seals with light-colored aggregate.
2) Surface gritting using light-colored aggregate probably would have exhibited SRI values of 29 or higher if the aggregate had properly adhered to the asphalt mat.
3) SRI values calculated based on the solar reflectance measured according to ASTM E 1918 or ASTM C 1549 can be very different (up to 11 percent in this study), particularly if the tested surface is rough or irregular.

Figure 1 Installation of E-Krete® test section.

The following recommendations are made on the basis of these conclusions:

1) Six technologies exhibiting an SRI value of 29 or higher can be used for constructing high-reflectance asphalt pavements. These factors should be considered before choosing a method:
   a. StreetBond™ and E-Krete® micro-surfacing are applied in a thin layer and do not enhance pavement structural capacity. These technologies can be used over general-purpose parking lot pavements.
   b. When using light-colored binders such as CS-Phalt™, the production and paving equipment must be cleaned in advance to preserve the light color of the mix. These binders can be used in constructing an overlay or a new pavement.
   c. Densiphalt® can be used to protect against fuel spillage and also offers resistance to abrasion and rutting.
   d. Use of sand and chip seals should be carefully considered, as these technologies may not be durable enough for parking lot conditions.
2) Cost comparisons of the recommended technologies should be conducted on a case-by-case basis because the construction costs can vary significantly based on project location, size and scope.

Further Research

While gritting may be a viable technology for improving pavement reflectivity, the construction process should be further investigated to determine if the uncoated or lightly coated aggregate will adhere to the mat.

Acknowledgements and Disclaimer

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