Quantifying Asphalt Emulsion-Based Chip Seal Curing Times Using Electrical Resistance Measurements

Introduction

The quality and performance of chip seal treatments during their service life are driven primarily by the construction phase. Chip seals are typically constructed by spraying an asphalt emulsion film on the surface of an existing pavement, spreading a layer of cover aggregate, rolling the aggregate into the fresh asphalt emulsion’s surface to firmly seat the aggregate chips into the emulsion, brooming the surplus aggregate particles, and opening the pavement to unrestricted traffic. To a great extent, the timing of this construction sequence determines the success or failure of the surface treatment.

Although rapid-set emulsions are used for chip seals, these emulsions still require some amount of time to sufficiently cure. The actual curing time is jobsite-specific and depends on several factors, including the types of emulsion and aggregate, ambient and pavement temperatures, humidity, wind speed, and cloud cover, as well as several less quantifiable factors. Sometimes, uncontrollable variables that affect the chip seal curing process can make the seal coat performance unpredictable and may even lead to surface treatment failures, such as aggregate loss and bleeding, and to vehicle damage.

The objective of this research was to develop an electrical measurement technique that can consistently determine when a chip seal system has sufficiently cured and, therefore, decide when a chip seal can safely be broomed and opened to unrestricted traffic.

Findings

• An electrical resistance measurement can be used to quantify chip seal curing times. The approach takes into account the factors that affect the electrical resistance measurements, such as material cross-sectional area, distance between probes, and asphalt emulsion and cover aggregate properties. Also, the approach is capable of capturing the factors (i.e., compaction, climatic conditions) that are associated with variable curing times within chip seal projects.

• A normalized resistance index (NRI) is proposed as a quantifiable tool to determine when a fresh chip seal can withstand the forces of brooming and be opened to unrestricted traffic. The NRI approach provides quantitative measurements that can be used to evaluate the chip seal curing process in a consistent and repeatable fashion.

• The field and laboratory experimental results agree that when the NRI value exceeds 10, a chip seal system has sufficiently cured and ample mechanical strength gains have been achieved to allow for brooming and opening to traffic.

• Use of the methodology for full-scale chip seal systems shows that the curing time for the chip seal projects ranges from 3.5 to 4.0 hours. These curing times are in good agreement with chip seal construction guidelines that suggest that brooming generally can be performed within 2 to 4 hours after sealing (under favorable climatic conditions).
Implementation

- This research has demonstrated that an electrical measurement technique can provide a rapid, non-destructive indication of the amount of curing that has occurred in a chip seal. An Indiana Test Method (ITM) has been written and is proposed for use in implementing the measurement technique. The application of this methodology will result in more accurate, robust, and timely decisions with regard to when a chip seal has gained sufficient mechanical strength to allow brooming or opening to unrestricted traffic without undue loss of cover aggregate.
- Implementation of this measurement technique as a quality control tool can ensure quality of materials used on the project, prevent minimal windshield claims and chip seal repair work, prevent unnecessary construction delays, provide safety for the public and construction workers, and ensure a successful chip seal project.
- Implementing this construction technique could positively impact chip seal construction quality as well as extend the service life of the chip seal. Future studies should be performed to assess the impacts of this construction technique on the long-term performance of chip seals and life-cycle benefits.
- The findings of this study can be extended to various other asphalt emulsion applications. Electrical resistance measurements show great potential to serve as a quality control and early life performance assessment tool for asphalt emulsion paving applications (i.e., tack coat, cold mix asphalt, etc.).

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