Quality Assurance Procedures for Chip Seal Operations Using Macrotexture Metrics

Introduction

The Indiana Department of Transportation (INDOT) has implemented a comprehensive and proactive pavement preservation program to formalize preventive maintenance activities such as thin surface treatments, crack seal, and chip seal (seal coat) and to determine the optimum balance between preventive maintenance expenditures and capital expenditures. It is anticipated that in FYs 2017–21, INDOT’s six districts will altogether perform approximately 1,500 lane miles of chip seal work each year. It has been recognized that the quality of chip seal relies to a great extent on the qualities of binder and aggregate, proper application rate, construction, and existing pavement condition. To ensure successful chip seals, INDOT has implemented special quality assurance (QA) procedures, i.e., Activity 2050 Mainline Seal Coat Quality Assurance Evaluation (MSQA) that allows INDOT maintenance engineers to assess the quality of a new chip seal based on visual inspection of two 1,000-foot sections selected from a chip seal project.1

However, concerns associated with the MSQA procedures have been identified by INDOT maintenance engineers. First, the quality of visual inspection by human eye relies on the vision, experience, and level of training of the inspector. Issues may arise over the reliability and validity of visual inspection. Two randomly selected 1,000-foot-long sections may not fully represent the overall quality of the chip seal project. Second, each district usually performs approximately 250 lane miles of chip seal work every year, which may encompass ten to twenty different roads. INDOT is currently able to inspect three to five roads per district per year. Third, visual inspection may become labor intensive, inefficient, and prone to errors as the current MSQA requires two visual inspections performed, respectively, one month and twelve months after construction. In addition, traveling vehicles may pose a threat to the inspector’s safety during visual inspection.

In response to the growing concerns about chip seal quality and consequence and the need to enhance the efficiency of QA inspection, this study aimed to develop novel concepts and provide innovative solutions to enhance the current QA practices over chip seal jobs. Extensive testing was conducted to validate the concept of using macrotexture measurements to provide a cost-effective solution to assuring the quality of chip seal construction. The setup of a texture testing system was evaluated and verified on both test tracks and actual chip seal projects. Macrotexture metrics were determined by taking into account the performance measures for pavement construction. A field test protocol was developed to implement the QA for chip seal. There is no doubt that this study will not only ensure alignment between specifications, performance, and quality of end product, but also improve customer satisfaction, reduce life-cycle cost, and enhance operational efficiency.

Findings

Ride quality and safety are two critical performance measures that have been widely used to evaluate the quality of new pavement. The former is defined in light of pavement smoothness; the latter is defined in light of pavement friction. Pavement smoothness does not change much before and after placing chip seal, in particular single chip seal. However, chip seal premature or early failure is commonly accompanied by excessive aggregate loss or bleeding, or both, which will undoubtedly affect the surface frictional characteristics of chip seal. The surface of a failed chip seal tends to become slippery, leading to very low surface friction. Therefore, surface friction can be utilized as a performance-focused measure for assessing the quality of new chip seal.

INDOT conducts pavement friction testing in

accordance with ASTM E274 (2015). This test requires intermittent acceleration or braking to adjust the speed of the test vehicle, which may impose significant impacts on traffic flow conditions and safety. In addition, this test cannot provide a seamless coverage of the road. Nevertheless, pavement friction varies with surface texture, test tire, presence of water, and test speed. When conducting friction testing at standard test conditions, surface texture becomes the dominant factor affecting pavement friction. Technologies are currently available to provide continuous texture measurements. It is advisable to use surface texture instead of friction for quality assessment or assurance.

Texture depth, spacing, and shape may be used to fully characterize the geometrical properties of a texture profile. To predict wet pavement friction, however, the mean profile depth (MPD) of macrotexture was found to be the best depth parameter. Field test results indicate a strong exponential relationship between MPD and friction exists, and MPD and friction variations follow a similar trend. It is evident that MPD is the best macrotexture metric to assess the surface friction, and therefore the quality of chip seal.

Field visual inspection revealed that bleeding and tracking are commonly found in the wheel paths, either in one wheel path or two wheel paths. Nevertheless, there are evident differences between the texture characteristics in the right and left wheel paths, due to the spatial variability of texture or the nature of pavement surface. Cumulative frequency distribution (CFD) provides an easy way to visualize large texture data sets and detect the small differences in the distribution of texture measurements.

**Implementation**

The following recommendations are made for future implementation:

- Use of two point lasers, one for each wheel path, is needed and anticipated to acquire the necessary information for evaluating the characteristics of texture profiles and capturing the spots of bleeding or tracking in both wheel paths.

- It is rational to perform texture testing in both directions for the quality assurance of chip seal. However, texture measurements made in one direction can provide sufficient information for the quality assurance of chip seal, which may be justified if resources are limited.

- Chip seal in the driving lane may experience higher variability than that in the passing lane. Therefore, the texture depths in the driving lane may yield more strict standards for the quality assurance of chip seal.

- The current two QA inspections performed after one month and twelve months of service can be combined into a single, one-time QA inspection that should be conducted after the first snow season and can ensure both safety and quality. However, visual inspection is still necessary to identify problems earlier when corrective actions can still be taken and to avoid the consequence due to immediate and dramatic loss of surface friction. It is recommended that visual inspection should be conducted before applying fog seal.

- Chip seal QA can be measured in terms of the macrotexture metrics such as MPD and attribute percentile values. Although three equations have been developed to accomplish this, the equation below may yield the best estimation.

\[
MSQA = 78.023 + 13.602 \times MPD - 0.011 \times Truck - 0.1716 \times Length
\]

**Recommended Citation for Report**


View the full text of this technical report here: https://doi.org/10.5703/1288284316779

Published reports of the Joint Transportation Research Program are available at http://docs.lib.purdue.edu/jtrp/.