Investigating the Need for Drainage Layers in Flexible Pavements

Introduction

Moisture can significantly affect flexible pavement performance. As such, it is crucial to remove moisture as quickly as possible from these pavements to avoid allowing moisture into the pavement subgrade. In the 1990s, the Indiana Department of Transportation (INDOT) adopted an asphalt pavement drainage system consisting of an open-graded asphalt drainage layer connected to edge drains and collector pipes to remove moisture. Since that time asphalt pavement materials and designs in Indiana have dramatically changed. Today, in-place field densities achieved during construction make asphalt mixtures less susceptible than their 1990s counterparts to moisture intrusion. Additionally, producing and placing open-graded asphalt drainage layers poses challenges: these layers can potentially increase costs, and they tend to have lower strength than traditional dense-graded asphalt pavement layers.

The objective of this research was to evaluate the effectiveness of INDOT’s current flexible pavement drainage systems given the changes to pavement cross-sections and materials since the open-graded drainage layer was adopted. Additionally, the effectiveness of the filter layer and edge drains was examined. Laboratory experiments were performed to obtain the hydraulic properties of field-produced asphalt mixture specimens meeting INDOT’s current specifications. The results were used in finite element modeling of moisture flow through pavement sections. Modeling was also performed to investigate the rutting performance of the drainage layer in flexible pavements under various traffic loads and subgrade moisture conditions in combination with typical Indiana subgrade soils. The results were used to develop a design tool that helps the pavement designer to more accurately assess the need for a pavement drainage system in any given flexible pavement.

Findings

The following are the specific findings from this project:

1. INDOT’s current flexible pavement drainage system, which combines an open-graded drainage layer with edge drains, can be an effective tool in preventing pavement subgrade from staying saturated for extended periods of time.

2. The use of a dense-graded granular filter layer beneath the open-graded drainage layer more effectively prevents the pavement subgrade from
reaching fully saturated levels than does a dense-graded asphalt filter layer.

3. The use of edge drains in flexible pavements can lower pavement layer and subgrade moisture levels, especially when no drainage layer is included in the pavement.

4. Despite recent improvements in materials and construction methods, the pavement drainage layer in INDOT’s current flexible pavement specification continues to effectively reduce moisture content throughout the pavement layers, including the subgrade, thus providing improved moisture protection to pavement systems.

5. A design tool was developed to assess the need for a drainage layer in flexible pavements. This tool indicates when flexible pavement drainage layers are needed and when they can be safely eliminated. It is based on pavement deformation, not on economics.

Implementation

Given the study findings, the following are recommended for implementation:

1. In areas with a higher rainfall or high-water tables, the use of a dense-graded granular filter layer should be considered, rather than a dense-graded asphalt filter layer, as the granular filter appears more effective.

2. The design tool should be used on a supplemental basis. While the design tool recommendations should not be implemented until after a thorough field validation, data gathered from supplemental use will help to improve the design tool in the future.

3. A field validation study, as outlined in Chapter 8 of this report, should be completed in order to verify the study findings and calibrate the design tool. Instrumenting flexible pavement field sections will provide data to lend additional guidance to the findings of this study.

Deliverables

The project deliverables are as follows:

1. A final report explaining project objectives, scope, findings, and implementation recommendations.
2. A design tool to assess the need for a drainage layer in flexible pavements.
3. A suggested field experiment to validate the project findings and calibrate the design tool.

Expected Benefits

By using the results of this research study to better determine when flexible pavements need drainage layers and when such drainage layers can be left out, the following benefits are anticipated:

1. Without the need for a drainage layer, more easily constructed asphalt mixtures can be used in flexible pavements, thus improving flexible pavement construction methods.
2. The elimination of added costs for modified binders typically needed in the drainage layer, thus resulting in lower costs.
3. The elimination of an additional asphalt mixture (drainage layer) that would otherwise need to be designed and placed, again resulting in reduced construction costs.

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