JOINT TRANSPORTATION RESEARCH PROGRAM

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Verification of the Enhanced Integrated Climatic Module Soil Subgrade Input Parameters in the MEPDG

Introduction

At the beginning of 2009, the Indiana Department of Transportation (INDOT) adopted the Mechanistic-Empirical Pavement Design Guide (MEPDG) method to study long-term pavement performance. The implementation of this new design approach led to difficulties for the pavement to pass the INDOT performance criteria: in particular, pavement roughness (International Roughness Index (IRI)) for hot-mixed asphalt (HMA) and faulting for jointed plain concrete pavement (JPCP) when A-6 or A-7-6 soils were considered as foundation soils.

This study focuses on investigating the influence of the soil input parameters in the Enhanced Integrated Climatic Model (EICM) on the prediction of the soil resilient modulus (M_R) in the MEPDG. A total of four sites located around the state of Indiana are used to propose/validate the observations and conclusions made in the research.

Findings

An investigation of the influence of EICM input parameters and other factors controlling the pavement performance led to the following conclusions:

- For the climatic conditions existing in Indiana, the location of the water table does not affect the value that the MEPDG uses for the subgrade resilient modulus. For A-7-6 soils, the degree of saturation throughout the pavement design life will always be above the optimal condition. Therefore, there will always be a reduction of the resilient modulus. For a water table located between 2 ft and 100 ft below the surface, the M_R reduction ranges between 36% and 45%, with the maximum reduction (45%)

observed when the water table is located at 2 ft (saturated condition).

- The gravimetric water content is the most influential parameter on the EICM since it is directly related to the optimum degree of saturation of the subgrade soil.
- For A-7-6 soils, the overall deformation of the pavement structure is controlled by the subgrade (~80% of total deformation). This is due to its relatively low stiffness compared to that of a lime or cement treated layer and of the asphalt layer.
- The treated layer plays an important role in the overall performance of the pavement. It controls the amount of stress and deformation in the foundation soil.

As part of this study, an assessment of the current subgrade modeling approaches was also conducted. The following observations were drawn:

- Current practice appears to produce a double reduction of the subgrade modulus used for pavement design, since the M_R values provided as input to MEPDG are not those obtained at optimum moisture content, but are reduced by the INDOT Geotechnical Office to account for the site conditions. A further reduction in M_R is performed within the EICM to account for the moisture conditions at the site.
- Laboratory measurements of the M_R for A-7-6 soils obtained at optimum moisture content provide average values ranging between 10,000 psi and 16,000 psi (e.g., see project SPR-3710 (SR-37, Mitchell, Lawrence County, Vincennes)). These values are higher than the reference value of 3,250 psi pro-

vided by the INDOT Geotechnical Office. Hence, it is necessary to define which condition (i.e., at optimum or reduced) is represented by the value of the resilient modulus given by the Geotechnical Office and/or used as input in the software.

- Current approaches for modeling treated soils neglect the changes in the nature of the soils that arise with treatment (i.e., an A-7-6 soil continues to be modeled as an A-7-6 soil, albeit with a higher modulus, and thus is susceptible to the same reduction in stiffness). Moreover, the values of M_R typically employed for treated A-6 and A-7-6 soils (~9,000 psi, provided by the INDOT Geotechnical Office) fall on the low end of the range reported in the literature.

Implementation

Three approaches for modeling the subgrade can be adopted:

1. Enable the EICM module and use as input a value of M_R that represents the optimum condition. This value will then be reduced within the EICM to reflect actual site conditions.
2. Disable the EICM module and introduce an input M_R that already accounts for moisture changes and reflects the in situ conditions.
3. Disable the EICM module and introduce an input M_R with seasonal reduction that reflects the in situ conditions.

Changes of the subgrade resilient modulus caused by the seasonal variations of the water table, modeled by placing it at 2, 4, 6, and 9 ft below the pavement surface, resulted in an average reduction of ~43%, which is nearly constant throughout the four seasons (winter, spring, summer, and fall). Thus, it appears that the third approach (i.e., using seasonal reduction) is less meaningful in Indiana and the first two approaches seem more practical.

Given that the fines content and plasticity of a chemically treated soil tend to decrease with treatment, the treated layer should be modeled with PI and P200 values that are representative of the soil after treatment. Moreover, the M_R input into the MEPDG for the treated layer should be a constant (i.e., not affected by EICM).

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