The Performance and Economic Benefits of Thick Granular Base for Flexible Pavement Design in Ohio

Problem

ODOT typically constructs asphalt pavements on a 4” or 6” dense graded aggregate base (DGAB). Pavement constructed with a thick granular base (12”+) is common practice for many foreign countries (i.e. South Africa, New Zealand, Australia, etc.) and some states in the United States (i.e Washington, Idaho, etc.). These designs take advantage of the stress-hardening characteristics of confined granular material, reduce cost by incorporating more lower cost granular material and less stabilized material, and move the weaker and frost susceptible subgrade material further down in the pavement structure where stress, strain, and frost penetration are lower. The bases are usually surfaced with a chip seal or asphalt concrete to protect the base from the climate and traffic. The thick bases in Northwest United States, called rock caps, are used as a capillary block. These bases consist of an 18” thick layer with a 3” nominal maximum size aggregate. These bases are usually overlaid with a dense graded aggregate base and an asphalt surface. These nations/states are not in the same climatic zone as Ohio or have the same types of materials.

The purpose of this study is to investigate from the performance and economic aspects, the feasibility of using thick granular base for flexible pavement design in the State of Ohio. Special local issues such as weather, ground conditions, materials supplies were investigated for implementing in Ohio.

Objectives
1) Identify the state of practice in foreign countries and peer states
2) Analyze LTTP data to evaluate the effects of pavement base design on its structural performance (reducing the pavement deflection and increasing the uniformity in responses)
3) Employ ME-Pavement Design Guide for pavement performance prediction

Description

This study considered the performance criteria and life cycle economic analyses for implementing thick granular base under flexible pavement. The performance of different types of base layer design was compared using the LTTP database. The focus was on the ability of achieving uniform dynamic deflections using Falling Weight Deflectometer (FWD) data. Based on FWD record from the LTTP database, the relative merits of different base type design were compared.

The pavement performance was also predicted using version 0.99 of the MEPDG design software. A sensitivity study was conducted on the effects of granular base layer parameters on the pavement performance. From the relative improvement in terms of pavement distress reduction, an optimal base layer thickness of 12 in to 15 inch was identified. The use of thicker granular base (from the current 4 in to 6 in granular base currently used in Ohio to 12 inch thick granular base) was predicted to increase the pavement service life around 30% using the criteria for common types of distresses. A life cycle analyses were conducted using a simplified economic model. The model indicated that for the typical Ohio flexible pavement sections, doubling the thickness of base layer, while causes higher initial construction cost, would still result in life cycle cost savings. Thus performance prediction using MEPDG and life cycle economic analyses both supported positively the use of granular base in flexible pavement design in Ohio.

It was also found in this study that the climate model of the existing MEPDG design software does not adequately account for the regional climate conditions (such as freeze-thawing effects) on pavement performance. Recommendations were made to further analyze field performance data to validate the MEPDG model predictions.

Finally, preliminary criteria for material specifications were proposed to select materials for granular base construction.

Conclusions & Recommendations

Based on the results of this study, the use of thick granular base, while might cause higher initial construction cost, will offset the initial cost by extending the pavement service life. The use of thick granular base has economic advantages with regard to the reduction of life cycle construction cost. An optimal thickness of granular base of 12 inch is recommended.

Since the MEPDG was used with calibration factors based on only a few sections in Ohio, it is recommended test sections be built to verify the actual performance is predicted accurately by the MEPDG. These would also provide an opportunity to validate and calibrate the Integrative Climate Model, one of the key components of MEPDG.
Implementation Potential

This study can be implemented by 1) incorporating the recommended optimal granular base layer thickness into ODOT Pavement Design and Rehabilitation Manual to reduce the life cycle cost of flexible pavement for Ohio; 2) validating the recommended criteria for granular base materials selection and incorporating into ODOT Materials Specifications.