JOINT TRANSPORTATION RESEARCH PROGRAM

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Best Practices for Patching Composite Pavements

Introduction

In pavement structures, base/subbase layers have many important functions, which include providing a stable construction platform, facilitating drainage, mitigating pumping of the subgrade fines, and protecting the pavement from the effects of frost. A range of designs, making use of unstabilized or stabilized aggregates and in some cases geosynthetics, are employed by different agencies to fulfill these functions. The performance of these layers is critical in achieving the desired pavement smoothness, and in extending the service life of the pavement.

This project was motivated by constructability and long term performance concerns with the existing design employed by INDOT for concrete pavements, as well as the desire to identify state of the art design solutions that could be applicable to both concrete and asphalt pavements. The primary objectives of the study were to: critically reexamine INDOT's existing design; perform a preliminary evaluation (based on aggregate compaction, hydraulic conductivity, strength and compatibility properties) of select unbound design options identified in collaboration with the Study Advisory Committee (SAC); explore the potential use of geotextiles as separator; and develop recommendations for base/subbase aggregate laboratory testing and evaluation.

Findings

- The work included a review of existing practices for base and subbase design in Indiana and in other states; laboratory evaluation of compaction and hydraulic conductivity (k) properties of select aggregates available in Indiana; collection of literature data for similar materials; analysis of the stability of the aggregates under the action of construction equipment; analysis of the compatibility between select aggregates using the software DRIP; assessment of the applicability of select geotextiles as separators.
- In general, the use of a drainage layer in combination with a separator layer seems to be the preferred design. Experience from other states also indicates design solution(s) that can be employed for both asphalt and concrete pavements.
- With regard to the drainage layer, use of a material such as #8 is found to be problematic due to the excessively high hydraulic conductivity and the inadequate stability for several of the loading cases examined in this study.
- Consistent with practice in other states, aggregates with particle size distribution falling within the band for Indiana #43 (or even #53), are better candidate materials for the drainage layer. Results from preliminary tests as well as literature data indicate that with appropriate gradation selection and compaction, values of k between 150 and 1000 ft/day (depending on gradation, aggregate source and level of compaction) can be achieved. Given the dependence of the hydraulic conductivity on particle size distribution, reference gradation bands may need to be further constrained to reliably achieve target values of hydraulic conductivity. At this time, specifications prescribing that the hydraulic conductivity of the compacted aggregate in the field fall within a narrow interval appear problematic to verify/enforce, due to the challenges in measuring k both in the field and in the laboratory.
- Selection of aggregates for the separator layer requires site specific consideration of the subgrade conditions, as the lack of compatibility with the subgrade at the lower interface is the primary reason for considering a material inadequate as a separator. Aggregates used for the separator layer in the states interviewed have gradations comparable to or finer than #53.
- Geotextile separators are an economic alternative to aggregate separator layers, with non-woven geotextiles being better candidates than woven fabrics in a number of situations. Their design requires consideration of the site-specific subgrade, and assessment of the construction condition severity for the survivability of the fabric. For the geotextiles examined in this project, survivability criteria were found to control the design.

- Compatibility analyses suggest that a separator may not always be necessary for pavements on cement-treated subgrades, but this conclusion requires additional validation.
- The stability of materials such as INDOT #43 and #53 requires density and frictional resistance that are achievable with thorough compaction. Static compaction alone is unlikely to be sufficient to this purpose. In the laboratory, the vibratory hammer method was confirmed as the most effective method for the compaction of all the aggregates examined, and should be used as laboratory reference. Similarly, in the field, vibratory compaction is highly desirable. An adequate procedure could include first passes of static compaction for gaining strength so that the material can sustain further passes in vibratory mode. Equally critical to the performance of materials such as #43 and #53, is controlling the placement water content and avoiding segregation (e.g., through the use of a spreader box).
- There are limitations in relying exclusively on the DRIP software for the design of drainage and separator layers, as it provides no assessment of the soundness/abrasion characteristics of aggregates, and does not include survivability criteria in the evaluation of geotextiles. Moreover, for all aggregates examined in this research predictions of hydraulic conductivity generated through DRIP yielded generally unreliable estimates.
- Only a few empirical relationships between strength parameters and aggregate characteristics emerge from this study, quantified by medium to high values of correlation coefficients, and which can be trusted after hypothesis testing. These are generally not strong enough to allow the development of empirical formulas applicable in engineering practice.

Implementation

The following primary recommendations for implementation emerge from the work performed:

- Indiana #8 should no longer be used for the base drainage layer.
- The use of geotextiles, including non-woven, should be encouraged for the separator layer. The design should rely on both survivability and filtration criteria, with consideration of the site-specific subgrade conditions.
- Construction methods to limit segregation of the aggregates in the field should be enforced.
- Compaction of aggregates in the field should be performed using vibratory rollers, with potentially early passes using static compaction to address stability problems.
- When placing materials such as #43 and #53 verification of the water content should be required.
- Where available, asphalt paving machines on track should be considered preferable to pavers on wheels.

The study also highlighted areas where additional research is warranted to improve predictions of the performance of the support layers, and support INDOT's move towards performance based specifications. It is suggested that future efforts be directed to:

- Obtaining shear strength and hydraulic conductivity data for aggregates of interest (e.g., #43 and #53) under a range of field-relevant testing conditions.
- Identifying/developing techniques for measuring the in situ hydraulic conductivity of compacted aggregates.
- Investigating the migration of fines through and from treated subgrades.
- Incorporating survivability and filtration criteria in a software that would be used for geotextile separator selection in place of DRIP.
- Extending the statistical analysis of shear strength data to a broader database.

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