EFFECT OF GRADATION ON STIFFNESS AND FLOW BEHAVIOR OF AGGREGATE BASES: A LABORATORY AND FIELD STUDY

CEES Master’s Thesis Defense
Hasan Kazmee
Friday, July 23, 2010, 2:30 pm in Room CEC 100

ABSTRACT

Aggregate base is an important structural component of a pavement. It is constructed by spreading and compacting larger grade aggregates beneath the asphalt concrete (AC) layer(s). Aggregate base acts as a support for the AC layer as well as reduces the traffic-induced stresses by distributing over a wider area on the underlying layers. It also functions as a drainage layer. Permeability (k) of aggregate bases is used frequently to characterize flow behavior. Historically, gradation specifications used by the Oklahoma Department of Transportation (ODOT) have led to aggregate bases with very low permeability. Variations in permeability within the same gradation envelope are observed frequently. To this end, a combined study was undertaken to generate relevant laboratory and field data on permeability and stiffness of aggregate bases for different gradations.

The present study emphasizes on the effect of gradation, compaction energy and shape properties on permeability and modulus of aggregates from three commonly used sources in Oklahoma, namely Anchor Stone, Dolese and Martin Marietta. Three gradations were selected for this study namely: AASHTO #57, OKAA Type M and ODOT Type A. In the laboratory component, both lower (LL) and upper (UL) limits were used and specimens were prepared using two different levels of compaction, namely standard Proctor and modified Proctor. Specimens having AASHTO #57 and OKAA Type M gradations were compacted with standard Proctor effort to simulate open graded and medium dense graded base conditions, respectively; whereas, specimens with modified Proctor compaction was applied on ODOT Type A gradations to replicate dense graded base conditions. Permeability (k) was measured using the falling head approach. In the field component, in-situ drainage and strength characteristics of representative gradations were evaluated and compared. Accordingly, a 152.4 m (500–ft) long test section was constructed on Timberdell Road in Norman with the above mentioned gradations. Field tests (falling weight deflectometer (FWD), and permeability) were conducted periodically after the test section was opened to traffic.

Laboratory test results show that permeability decreases with the increase in compaction level, percent fines (passing #200 sieve) and dry density, as expected. Lower limit of AASHTO #57 is the only gradation that satisfies the minimum drainage requirement suggested by the FHWA guideline. A parametric study was conducted with Partial Least Squares (PLS) regression method to evaluate the influence of governing parameters such as gradation characteristics and shape indices. The PLS regression analyses revealed that effective diameter of aggregate bases is the most dominant factor to influence permeability. From aggregate imaging system (AIMS) test results, among the shape indices, composite gradient angularity and composite sphericity indices can be well correlated to permeability. Field data reveal that traffic-induced compaction can lead to an increase in FWD moduli and decrease in permeability.