Summary Report 490-1S

Implication of Aggregates in the Frictional Performance of Seal Coat Overlays

Highway personnel apply a seal coat pavement overlay. Researchers investigated the effects of various aggregate types on pavement friction and are preparing draft specifications for optimizing the friction performance of seal coat overlays.

Problem Statement

Wet weather skidding accidents on streets and highways are a continuing concern to officials and highway engineers. Causes of these accidents include variables such as reduced pavement friction, poor drainage properties of the surface, and driver inexperience.

Reduced friction between a vehicle's tire and the pavement surface in wet weather is a contributing factor in many of these accidents. Improving pavement friction is a challenging problem to highway engineers because it requires the identification and application of construction materials and techniques that produce non-deteriorating, skid-resistant pavement surfaces.

Historically, research has shown that it is neither physically possible nor economically feasible to construct an asphalt concrete pavement surface that provides skid resistance at an adequate level throughout the pavement's service life. Consequently, engineers utilize a seal coat maintenance technique as one way of improving friction performance on roadways. This maintenance technique consists of applying asphalt to a roadway surface followed by an overlay of cover aggregates.

Since sources for aggregates of known high-frictional performance are depleted in many areas of the country, highway engineers must increasingly rely on the use of aggregates for which the performance record is unknown. Successful design and construction of a high-friction pavement surface requires specific guidelines and procedures for the proper selection of aggregates.

Objectives

Center for Aggregates Research (CAR) researchers at the Center for Transportation Research (CTR) conducted Study 03-6-86-490, Implication of Aggregates in the Construction and Performance of Seal Coat Pavement Overlays, in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The objective of this study was to investigate the effects of various aggregate types on pavement friction, and to develop statistical models that produce design criteria for optimizing friction performance of seal coat pavement.
overlays.

To investigate the effect of aggregate type on pavement friction, researchers used Texas as a test model and constructed 59 seal coat test sections 1,000 feet (304 m) long in the four climatic regions of the state. The environmental characteristics of these four regions included: wet and no freeze; wet and freeze-thaw cycling; dry and no freeze; and dry and freeze-thaw cycling.

Researchers used many of the aggregate types that are common to each region, and economically available, in the design mixture for each seal coat section. These aggregate types included:

- limestone;
- limestone rock asphalt;
- sandstone;
- siliceous gravel;
- rhyolite;
- trap rock; and
- lightweight aggregate.

Researchers used the TxDOT research skid trailer following the American Society for Testing and Materials (ASTM) E-274 procedure to measure frictional performance. The research team utilized the British pendulum method to determine if the results correlated with the friction results. They measured the "macrotexture," the large-scale texture at the surface caused by the size and shape of the coarse aggregate particles of the test sections, with the ASTM sand patch test. The research team also conducted laboratory evaluations on section samples to determine the physical properties of the aggregates and their mineralogy and petrographic characteristics.

Comparisons between aggregate properties, construction variables, traffic volume, and environmental variables enabled researchers to determine the correlation between the lab tests and field tests. These comparisons gave the researchers what they needed to pinpoint variables that might affect frictional performance.

**Findings**

Researchers, using ASTM methods (or TX modification), found that several aggregate properties, traffic volume, and seasonal conditions are important factors affecting the frictional resistance of pavement surfaces. For example, aggregates with a high resistance to both polish and breakdown during freeze-thaw cycles, or low soundness loss, performed better than aggregates demonstrating a high polish resistance and high soundness loss.

This performance characteristic was dependent on the level of average daily traffic combined with changes in the fine-scale roughness, or "microtexture," of the exposed aggregate particles. The microtexture changes resulted from polishing during long, dry periods and roughening caused by the rejuvenating effects of long, wet periods.

Researchers also found that porous aggregates, particularly lightweight and limestone rock asphalt, maintained better friction performance in areas that experienced freeze-thaw cycling. Additionally, low polish value aggregates that possessed some porosity, or had high contents of non-carbonate minerals, performed better than other low polish value aggregates.

Through photomicrographs, researchers found that two aggregates in the same category and with approximately the same percentages of hard mineral may have different grain sizes. Aggregates that are more angular and have larger mineral grains produce better skid resistance. In addition, researchers found a high skid resistance from coarse, angular hard mineral grains more uniformly distributed in the softer mineral matrix.

Construction variables also play an important part in skid resistance. High aggregate spread rates (square yard/cubic yard of aggregate) and low asphalt distribution rates gave the best results.

From the data collected in the field test sections and through laboratory studies, researchers are developing prediction
models for each of the major aggregate categories: limestone, sandstone, siliceous gravel, lightweight, and limestone rock asphalt. The frictional performance estimate comes from the modeling of aggregate properties, traffic volume, and climate conditions. The models produce frictional performance estimates of seal coat pavements for a specific service period. Additionally the models can assist in the selection of the type and quality of aggregates during the design phase to obtain a desired friction performance within a certain time limit.

**Recommendations**

Researchers are preparing draft specifications for consideration by TxDOT to define the aggregate properties which will provide the desired frictional resistance as a function of the average daily traffic. The specifications are based on the results of up to nine years of field observations.

The information in this summary is detailed in CTR research reports on study 03-6-86-490, Strategic Research Plan for Achieving Adequate Pavement Friction. The contents of this summary do not necessarily reflect the official views or policies of TxDOT or the FHWA.