LOUISIANA TRANSPORTATION RESEARCH CENTER

Technical Summary

LTRC Report 707

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Assessment of Laboratory Friction Testing Equipment and Validation of Pavement Friction Characteristics with Field and Accelerated Friction Testing

Introduction

The current DOTD aggregate friction rating system relies solely on the Polished Stone Value (PSV) of coarse aggregates. However, significant variability in PSV values is frequently observed between aggregate shipments from the same quarry. Even when tests are conducted on samples from the same batch, discrepancies in PSV values may arise due to actual variations in the produced aggregates or the type of testing equipment used. This variability often leads to questions and concerns from aggregate suppliers, particularly when their aggregates fail to meet the PSV targets set by DOTD, resulting in a reduced Friction Rating and a lower classification. To address this issue, there is a need to formalize the use of aggregate polishing tests to optimize aggregate utilization and ensure a desirable skid resistance value over the pavement's service life.

Objective

The primary objectives of this project were: (1) to assess variations of PSV test results; (2) to evaluate a new TWPD-based aggregate friction testing procedure; (3) to validate and update previously developed harmonization correlations for different field friction measurements; and (4) to determine threshold friction design values (i.e., DFT and mean profile/texture depth values) for commonly used wearing course mixtures in Louisiana.

Methodology

Seven aggregate sources were selected for this project, including three sandstone types, three limestone types, and one rhyolite type. These aggregates are commonly used in wearing course mixtures for DOTD roadway projects. Only aggregates passing through a 1/2-inch sieve and retained on a 3/8-inch sieve were used in the preparation of laboratory polishing samples.

Two laboratory polishing methods: the polished stone test (see Figure 1a), using British Wheel Polisher (BWP) and British Pendulum Tester (BPT), and the three-wheel polishing test (see Figure 1b), using a Three-Wheel Polishing Device (TWPD) and the Dynamic Friction Tester (DFT), were employed to evaluate the polishing resistance of the selected aggregates. These methods simulated traffic conditions to assess the durability of the aggregates' microtexture.

Additionally, the surface friction characteristics of eight Louisiana asphalt pavements, incorporating typical aggregate and mixture types, were evaluated using various in-situ friction and texture measuring devices. Each of the selected road sections was at least 1/2 mile long without a sharp curve, steep grade, or intersection. Field tests included the friction measurements using the Dynamic Friction Tester (DFT), Circular Texture Meter (CTM), Locked Wheel Skid Trailer (LWST), British Pendulum Tester (BPT), and laser profiler (LP) at the beginning (0 ft.), mid-point (500 ft.), and end

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(1000 ft.) of each selected test section. Statistical analyses, including ANOVA, t-test, regression and k-mean cluster methods, were performed on lab and field measurement results to determine if there was any significant difference or relationships among different aggregates and friction measurement devices.

Additionally, a new F(60) prediction model was developed. This model incorporates aggregate polishing resistance measured by DFT, mixture mean profile depth (MPD), and polishing cycles to predict in-situ pavement friction and also enable the determination of threshold aggregate friction design values during an asphalt wearing course mix design under different traffic polishing.

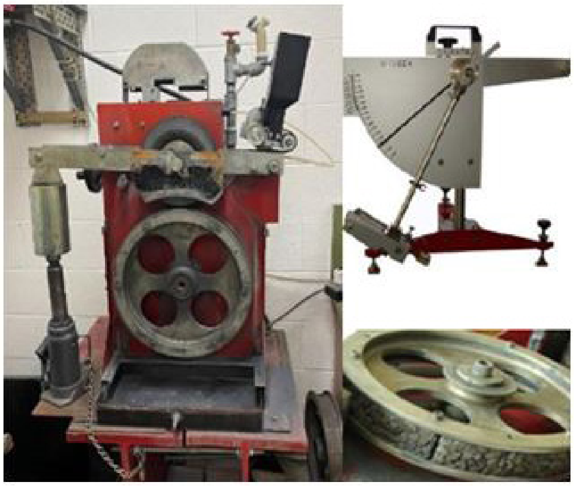

Figure 1a. BWP/BPT

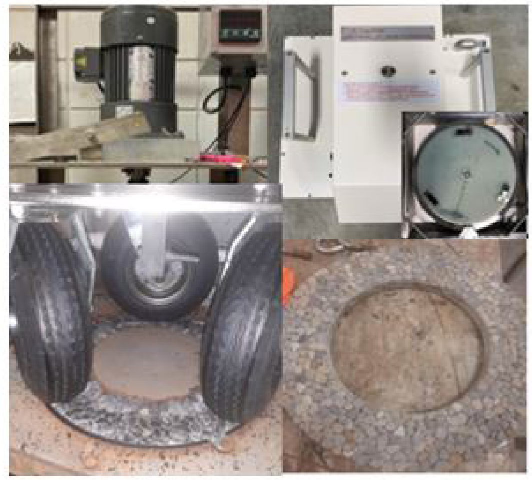

Figure 1b. TWPD/DFT

Conclusions

- The laboratory BWP/BPT test results revealed high variability among the tested aggregate samples, which can be attributed to factors such as differences in source materials due to aggregate production processes and shipment timing, variations in sample preparation, and the sensitivity of the polishing and measurement devices.
- By contrast, the TWPD/DFT test results provided distinct and consistent polishing resistance data compared to the BWP/BPT results. Variability analysis of the TWPD tests combined with DFT measurements considered factors such as aggregate type, DFT speed, 90° sample rotation, sample duplication, and operator differences. These analyses demonstrated that DFT20 (i.e., DFT measurement at 20 km/hr) showed no statistically significant variation across different measurements, confirming its reliability as a metric for aggregate polishing resistance.
- Moreover, the DFT20 @ 100,000 polishing values closely aligned with the chemical composition of the tested aggregates. Aggregates with higher silica (SiO_2) content and lower calcium oxide (CaO) content exhibited superior friction performance. However, the PSV results obtained from the BWP/BPT tests did not correspond to the friction resistance rankings observed in the TWPD tests, even when the same aggregate materials were used. This discrepancy underscores the limitations of the PSV test compared to the TWPD procedure.
- Additionally, DFT measurements offered a broader range of values for different aggregate sources than the PSV values measured using the BPT, further indicating that the TWPD method is a more consistent and repeatable approach for evaluating laboratory aggregate polishing resistance.

Recommendations

- It is recommended that DOTD adopt and implement the AASHTO PP103 polishing test procedure, which combines the Three-Wheel Polishing Device (TWPD) with the Dynamic Friction Tester (DFT), as a replacement for the previous method utilizing the British Wheel Polisher (BWP) and British Pendulum Tester (BPT).
- The developed F(60) prediction model provides valuable guidance for asphalt engineers in determining the friction requirements of blended coarse aggregates during the design of wearing course mixtures.
- Given the limited number of aggregate sources tested in this project, it is recommended that additional aggregate sources be evaluated using the TWPD/DFT protocol. The results can then be utilized to establish new friction rating criteria based on DFT20 @ 100,000 for DOTD's initial aggregate source friction approval process.