TECHSUMMARY February 2016

State Project No. 30000609 / LTRC Project No. 12-5P

Evaluation of DOTD Aggregate Friction Rating Table by Field Measurements

INTRODUCTION

Currently, the Louisiana Department of Transportation and Development (DOTD) uses the aggregate friction rating table based on polished stone value (PSV) of coarse aggregates as the friction guidelines for wearing course. However, PSV only considers the frictional characteristic of coarse aggregates and is just one of many factors that affect the field friction performances. Therefore, there is a need to modify the current aggregate friction rating table by using the indices that can reflect the real field friction performance with proper threshold values. In this way, the Department will have the flexibility to specify aggregates for asphalt mixtures with various qualities to achieve better cost-benefit ratios and enhance the use of locally available aggregates.

OBJECTIVE

The objective of this research was to evaluate the current DOTD coarse aggregate friction rating table and provide a recommendation of friction guidelines for wearing course based on traffic, aggregate, and mixture properties.

SCOPE

To achieve the objective, the surface friction characteristic of selected Louisiana asphalt pavements covering typical aggregates and mixture types were assessed using friction and texture measuring devices. Dynamic friction tester (DFT), circular texture meter (CTM), locked wheel skid trailer (LWST), and laser profiler (LP) tests were performed on the selected 22 pavement surfaces covering statewide. In addition, Pavement Management System (PMS) skid measurement data were also used to assist analysis.

METHODOLOGY

Each selected road sections for the tests were at least 0.5-mile long without a sharp curve, steep grade, or intersection. The wearing course mixtures of the selected pavement sections contained DOTD commonly used aggregate sources and four typical mix types: 12.5-mm and 19-mm Superpave, stone mastic asphalt (SMA) and open graded friction course (OGFC). In addition, traffic volume and geographic location were also considered in the selection of test sections. Field tests include the friction measurements using LWST, DFT, CTM, and LP at the beginning (0 ft.), mid-point (500 ft.), and end (1000 ft.) on each selected test section.

A comprehensive statistical analysis was performed on the data collected. First, a number of necessary statistical correlations were developed, such as correlations among different friction numbers (e.g. skid number, DFT, and F60) and surface textures and correlation between ribbed and smooth tire. The relationship between the laboratory- and field-compacted asphalt mixtures were established by comparing previous LTRC report 09-2B DFT and CTM data with field DFT and CTM test results data. Second, the degradation of pavement friction and texture due to traffic

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polishing were evaluated. The results were used to evaluate the current DOTD friction rating table. Finally, the aforementioned correlations and analysis results were used to develop an end-of-pavement-life skid resistance prediction procedure (Figure 1). The procedure considers the design traffic, aggregate blend polish stone value, and gradation parameter as input. In such a way, the existing friction rating table could be replaced by a new mix design friction table, such as Table 1 and Table 2. In general, Table 1 indicates the PSV requirement to achieve the design field skid number (SN40S = 20) based on traffic level and mixture types at the end of 15 years. Similarly, Table 2 is benchmark DFT20 value after 100,000 polishing cycles (polished under three wheel polishing device) for four typical mixtures, which can be used to evaluate the friction resistance of the new aggregate sources. DFT20 values in Table 2 were determined based on the design life of 15 years and SN40S equal to 20.

CONCLUSIONS

The friction performance of OGFC mixture was higher among the mixture type. The data analysis result showed that the mean profile depth (MPD) is strongly related with mixture type and DFT20 related with aggregate type and traffic index (a wear factor considering both ADT and service years). As expected, the SN40R was found to be more sensitive to the micro-texture, while the SN40S was sensitive to both micro- and macro-textures. Several correlation analyses were performed to develop a correlation between friction/texture measuring devices. A regression model was developed to predict the SN40R based on SN40S and MPD, and a non-linear relationship was regressed to predict the SN40S based on DFT20 and MPD. A nonlinear regression analysis was performed to develop a DFT20 degradation model based on the PSV and the traffic index. Thus established correlations led to the development of a procedure for predicting pavement end-of-life skid resistance based on the design traffic, aggregate blend polish stone value, and gradation parameters.

RECOMMENDATIONS

It is recommended that the Materials and Testing Section implement the developed end-of-pavement-life skid resistance procedure by considering the design traffic, aggregate polished stone value and gradation parameters in routine wearing course mix design in order to fulfill the desired skid resistance. The existing friction rating table –Table 502-3 in the current DOTD's Road and Bridges Specifications may be replaced by a new wearing course mix design friction table , such as Table 1 or 2.

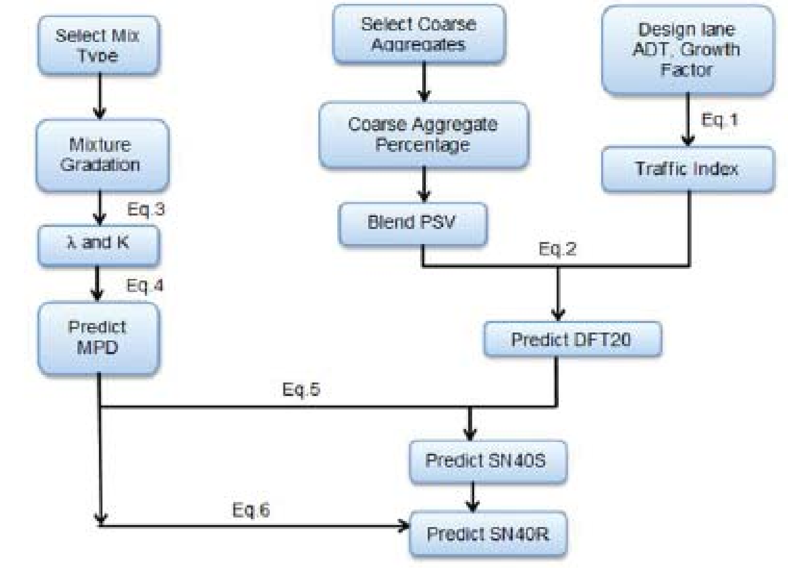

Figure 1 Prediction of skid numbers

$$\text{Traffic Index (T.I.)} = \frac{\text{ADT @design lane} \times \text{Growth rate factor} \times 365}{10^6} \quad (1)$$

$$\text{DFT20} = 0.13 \times exp^{(-0.056 \times T.I.)} + 2.6 \times \text{PSV} - 0.5 \times exp^{(PSV)} \quad (2)$$

$$F(x; K, \lambda) = 1 - exp^{(-\frac{x}{\lambda})^K} \quad (3)$$

$$\text{MPD} = 0.14 \times \lambda + 0.09 \times K - \frac{0.041}{K^4} \quad (4)$$

$$\text{SN40S} = 2.15 \times \text{DFT20} \times exp^{(-\frac{0.54}{MPD})} \quad (5)$$

$$\text{SN40R} = 0.93 \times \text{SN40S} - 0.16 \times \text{MPD} + 0.26 \quad (6)$$

Figure 1
Prediction of skid numbers

Table 1
PSV requirements

Mixture	For 15-year design life			
	ADT @ design lane			
	0-3000	3000-7000	7000-10000	>10000
	PSV	PSV	PSV	PSV
OGFC	18	25	30	32
SMA	20	27	32	33
19-mm Superpave	22	30	34	36
12.5-mm Superpave	24	31	36	37

Table 2
DFT20 requirements

Mixture	DFT20 requirement at 100,000 cycles				
	For 15-year design life				
	ADT @ design lane				
	<1000	1000-3000	3000-5000	5000-7000	>10000
12.5-mm SP LS	0.246	0.301	0.326	0.337	0.343
19-mm SP LS	0.241	0.298	0.321	0.331	0.337
SMA LS	0.204	0.266	0.303	0.321	0.333
OGFC LS	0.195	0.265	0.294	0.307	0.314