

at AUBURN UNIVERSITY

Pavement Friction

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Topics

- TWPD (NCAT Three Wheel Polishing Device)
- DFT (Dynamic Friction Tester)
- DOT Mix Lab Study
- High Friction Surface Treatment (HFST)
- NCAT Test Track Results



TWPD Development Problem Statement

- Friction aggregate is the costly, premier aggregate product in the mix.
- Early research assessed the coarse friction aggregate independent of the mix.
- Specification criteria are based on conservative engineering judgment from a limited number of field trials.
- Friction studies require lengthy field trails



NCAT Three Wheel Polishing Device



Preparing Mix Slabs



Test Protocol

- Test two replicate slabs
- 0-0.5-1-2-5-10-20-40-60-100K cumulative polishing cycles







Dynamic Friction Tester (DFT)

- Tests conducted at specific intervals during polishing (0,0.5, 1, 2, 5, 10....100k cycles).
- Three replicate measurements.
- Friction values are measured at 0, 20, 40, 60 and 80 km/h.
- Test Procedure ASTM E 1911





DFT Output

Project Name Measurement Site	FHWA Friction NCAT Laboratory	Measurement Loca Pavement Surface	tion Type SMA
Weather Date Memo	2010 / 01 / 30 Time 13 : 41	Moving Average Operator	Srikanth Erukulla
(u) 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1	Measurement Result	Raw Data	ile Name Slab 13 4000 ontrol Number Average Run out of I Runs 5 Coefficient of Friction at 20 km/h 40 km/h 60 km/h 80 km/h 0 0.646 0.594 0.570 0.148 0.784

Use of Test Track Mixtures

FHWA Friction Study - Test Track Field Performance



Friction Ranking Based on Lab & Track Results

	Ranking based on				
Mix Type	Laboratory Results	Test Track Results			
E1	1	1			
W7	2	2			
N4	3	3			
W3	4	4			





Lab and Test Track Data Correlation

Mix Type	Model	ANOVA Table		R-square,	Pearson's Correlation
		F-Statistic	P-value	%	Coefficient
E1 mix	$SN64 = 20.3 + 0.582 \text{ DFT}_{60}$	59.34	0.016	96.7	0.984
W7 mix	$SN64 = -4.6 + 0.878 DFT_{60}$	7.93	0.106	79.9	0.894
N4 mix	$SN64 = -0.3 + 0.927 DFT_{60}$	2.65	0.245	57.0	0.755
W3 mix	$SN64 = -44.0 + 1.97 \text{ DFT}_{60}$	2.00	0.293	50.0	0.707



MS DOT Study Objective

Use the NCAT rapid laboratory friction evaluation test protocol with the TWPD conditioning and DFT testing devices to better understand the influence of friction aggregate in a typical gravel-limestone 9.5 mm surface mixture and in an ultra-thin surface mixture (4.75 mm).



9.5 mm Mixture and Aggregate Substitutions

- 1. Identify 9.5 mm mixture
 - 65% crushed gravel (50% +No.8)
 - 24% limestone (8% +No.8)
 - 10% sand
- 2. Determine the coarse aggregate substitutions (+No.8)
 - 33% & 60% slag
 - 33 % & 60% granite
- 3. Screen the source gradations for blending (split on No.8)
- 4. Prepare three replicate test slabs of each mix with PG 67 -22 binder compacted to 7% air voids



9.5 mm Mixture Results - DFT

Average Fn @ 40 kph



Ultra-thin Mixture and Aggregate Substitution

1. Identify ultra-thin mixture

- 70% limestone
- 10% natural sand
- 19% manufactured sand
- 2. Determine the total aggregate substitutions
 - 25% & 50% crushed gravel
- 3. Screen the source gradations for blending (split on No.16)
- 4. Prepare three replicate test slabs with PG67 -22 binder compacted to 7% air voids



Ultra-thin Mixture Results - DFT





HFST Research Program

Lab-1 Study (8 aggregates)

- TWPD conditioning, DFT/CTM measurements
- Field Study (8 aggregates, extended for 3 aggrs)
 - Test Track truck conditioning
 - DFT/CTM measurements
 - Skid Trailer measurements
- Lab-2 Study (4 aggregates)
 - Aggr Size? #8 & #12, some #6 & #16
 - TWPD conditioning, DFT/CTM testing
 - British Pendulum
 - Micro-Deval, AIMS

Lab Polishing







W9F - Taconite, MN W9E - Al-Fe Oxide, OR W9D - Slag, PA W9C - Silica, OH W9B - Basalt, WA W9A - Chert, OK W8B - Bauxite, China W8A - Granite, WI







Field DFT Measurements (Extended Conditioning)

Asphalt Technology NCAT at AUBURN UNIVERSITY















Test Track Friction Results

Test variation

- SMA mixes
- Asphalt binder comparison
- PFC mixes







SMA Comparison







at AUBURN UNIVERSITY

SBS-GTR Comparison



Sep-12 Jan-13 May-13 Sep-13 Jan-14 May-14 Sep-14









Thank you. Questions?

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