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Final Report
November 11, 1998

Ruggedness Evaluation of
AASHTO TP7 and TP9: Phase 1
Indirect Tensile Strength Test (TP9)
Executive Summary
Federal Highway Administration
National Asphalt Training Center II
Task J

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Purpose of Ruggedness Testing

Engineers believe that results from a test method should not be subject to extreme variability caused by very minor differences in equipment or operator technique. When a test method is still early in its development, ruggedness testing evaluates whether minor variations in test parameters cause major variations in test results. A ruggedness experiment is aimed at evaluating a proposed test procedure so that potential sources of variability can be identified. According to ASTM C1067, "...ruggedness testing has as its purpose the detection and control of sources of testing variation prior to programming an interlaboratory study. One of the most productive uses of a ruggedness or screening evaluation is the elimination of those test methods shown to have poor precision even after making vigorous efforts to reduce the variation." Thus the goal of the experiment is to identify sources of variation in the AASHTO TP9 (Indirect Tensile Strength) test procedure and to propose necessary changes such that variability is reduced to tolerable levels.

Participating Laboratories

Labs involved in the ruggedness experiment evaluating the Indirect Tensile Strength test (ITS) include those shown in Table 1 below:

Table 1: Participating Labs in AASHTO TP9 (ITS) Ruggedness Evaluation

Test Method	Laboratory	Equipment
	Penn State University[1] (Northeast Superpave Center)	Instron IDT
AASHTO TP9	Purdue University (North Central Superpave Center)	Instron IDT
	Turner-Fairbank Highway Research Center	Instron IDT
	Asphalt Institute (National Asphalt Training Center)	Interlaken IDT

1 - Originating laboratory.

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Experimental Conditions

A 12.5-mm nominal Superpave coarse mixture (using a PG 64-22 asphalt binder) was selected as the experimental asphalt mixture. ASTM C1067 recommends that seven main experimental factors be evaluated for each procedure. Table 2 provides a description of the seven main factors and their associated levels for the Indirect Tensile Strength test (ITS).

Table 2: Main Factors and Levels for Indirect Tensile Strength Test

	Level	
Main Factor	Low	High
Air Void Content	6.5%	7.5%
Pre-Load	5 N	15 N
Test Temperature	-9.5° C	-10.5° C
Temperature Preconditioning Time	2 hours	4 hours
Temperature Equilibration Time	15 minutes	45 minutes
Deformation Rate	45 mm/min.	55 mm/min.
Specimen Orientation[1]	top of specimen - left	top of specimen - right
[1] This is a dummy main factor added to achieve the seven main factors required by ASTM C1067 analysis.		

The tests in the experimental matrix were conducted in accordance with AASHTO TP9 except as noted in Table 2.

Results

Table 3 presents F-values calculated following the ASTM C1067 analysis procedure. The critical F-value was determined to be 5.59 for this set of experimental data. Table 4 is a summary of the statistical significance of the main factors for the ITS ruggedness experiment.

Table 3: F-Values for ITS Ruggedness (ASTM C1067 Analysis)

	Main Factor						
Lab	Air Voids	Pre-Load	Test Temp	Temp PreCond	Temp Stab.	Load Rate	Spec. Orient.
TFHRC	1.61	0.04	0.93	0.49	4.36	0.01	3.92
NESC	5.68	0.08	0.00	0.09	1.23	0.56	0.02
AI	0.01	0.45	0.33	0.72	0.01	0.00	0.65
$F_{critical}$ = 5.59							

Table 4: Summary of Statistical Significance for ITS Ruggedness (ASTM C1067 Analysis)

	Main Factor						
Lab	Air Voids	Pre-Load	Test Temp	Temp PreCond	Temp Stab.	Load Rate	Spec. Orient.
TFHRC	NS	NS	NS	NS	NS	NS	NS
NESC	**5.68**	NS	NS	NS	NS	NS	NS
AI	NS	NS	NS	NS	NS	NS	NS
$F_{critical}$ = 5.59 "NS" = Non-significant							

Of the seven main factors in the ITS ruggedness experiment, only one of 21 comparisons appeared significant (air voids at NESC). Considering the acceptable repeatability of the test results, it appears that the main factors selected are overwhelmingly insignificant.

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Conclusions and Recommendations

The following conclusions and recommendations can be made based on the data obtained from the ITS Ruggedness Experiment. None of the main factors produced a significant effect on indirect tensile strength test results. Recommended tolerances on test temperature (± 0.2° C) and temperature preconditioning time (3 ± 1 hour) appear reasonable based on the analysis of the test data. Temperature equilibration time was not considered significant for this data, but was important for the SSCH test. Since the test specimens are the same size, it is recommended that wording similar to that proposed in Note 14 of AASHTO TP7 (requiring 45 minutes equilibration time unless data indicates a lesser time as acceptable) be used.

Specimen preparation variables also were generally insignificant. The specimen orientation, a dummy variable, did not have an effect on the test results. Also, the percentage of air voids within the specimen did not have a significant effect on the test results for the tolerance selected. As such, it appears acceptable to require performance test specimens to have 7.0 ± 0.5 percent air voids. Additional experimentation may indicate that this tolerance should be increased further.

Finally the rate of loading (50 ± 5 mm/min.) and initial pre-load (10 ± 5 N) did not indicate an effect on the indirect tensile strength at -10° C.

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