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Development of a Laboratory Test Procedure to Evaluate Tack Coat Performance

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Abstract

A laboratory testing procedure is presented, the results of which may be used for determining the best combination of tack coat type, mixture type, and application rate to be applied in the field for optimum performance. Tack coat related performance results were determined from Hamburg wheel tracking and simple shear tests on laboratory prepared specimens. This study was undertaken to evaluate the shear strength performance of tack coats under laboratory-controlled conditions. The performance of thin asphalt concrete (AC) overlays on concrete (PCC) pavements was evaluated. In practice, problems with these types of structures are often related to the interface interaction between the AC and PCC and consequently the performance of the tack coat. The experiment presents a methodology to examine the performance of tack coats used to bond AC and PCC structures in the laboratory. This paper presents the results of the lab tests and a statistical analysis of the results.

Key words: Asphalt, Tack coat, Hamburg wheel tracking device, Shear test, Asphalt overlays.

Introduction

In this study, research was done to identify the factors that contribute to the performance of thin asphalt concrete (AC) overlays on concrete (PCC) pavements. Problems identified include debonding, slippage cracks, and stripping (due to the influence of moisture). The source of these problems is often the interface between the AC and PCC and consequently the performance of the tack coat. A laboratory experiment with simple shear testing and Hamburg wheel tracking tests was developed to investigate the performance of tack coats.

The objective of this study was to determine important factors affecting the performance of tack coats in order to be able to evaluate their performance in laboratory conditions. The proposed laboratory test procedure could be used in determining the best combination of tack coat material, mixture type, and application rate to be applied in the field for optimum performance. The experiment could further be used to develop a strategy towards evaluating the potential of tack coats prior to use in the field.

As part of the experiment, 150 mm gyratory compacted asphalt specimens were tacked onto concrete disks, the preparation of which is discussed later. A major benefit of this approach is that tack coat related performance results may be obtained from laboratory prepared specimens.

Four influence factors were investigated as part of the experiment mix type, tack coat type, tack coat application rate and trafficking. The last factor was addressed in terms of Hamburg wheel tracking. These factors that influence tack coat performance were investigated at 2 levels. These are shown in Table 1. Hamburg tests were done at 50 °C. Shear tests were done at 20 °C. Six specimens were tested at each of the factor combinations.

Table 1. Experimental factors and levels.

Mix type	Tack type	Application rate	Hamburg cycles
Type D	SS1	0.1132 l/m^2	0
CMHB	CSS-1H	0.2264 l/m^2	5000

Previous Research

Reported research on the shear performance of tack coats has focused primarily on the interface characteristics between asphaltic layers. Uzan et al. (1978) evaluated the direct shear resistance of a neat asphalt binder (Pen 60/70) tack coat. Direct shear tests at a constant shearing rate of 0.1 in/min (2.5 mm/min) were done at 77 °F (25 °C) and 131 °F (55 °C) and optimum tack coat application rates were identified to maximize shear resistance at these temperatures.

Mrawira and Damude (1999) report shear testing at a constant rate of 0.04 in/min (1 mm/min) and 72 °F (22 °C) to investigate the influence of an emulsion grade SS-1 tack coat between freshly paved asphalt layers. Contrary to expectations, they found that non-tacked overlays exhibited slightly higher maximum shear strengths than tack-coated overlays.

Mohammad et al. (2002) recently reported on the influence of asphalt tack coat materials on the shear strength of interfaces between asphaltic layers. They investigated the influence of different emulsions and 2 PG grade binders used as tack coats, 5 different tack coat application rates ranging from 0 gal/yd^2 to 0.2 gal/yd^2 (0.9 l/m^2), and test temperatures of 77 °F (25 °C) and 131 °F (55 °C). Simple shear tests using the Superpave shear tester (SST) were done by applying a shearing load at a constant rate of 50 lb/min (222.5 N/min). Their results indicated that the CRS-2P emulsion evaluated was the best tack coat type and 0.02 gal/yd^2 (0.09 l/m^2) was the optimum application rate at which the maximum interface shear strength was measured for both test temperatures.

Scope

A factorial design at 2 levels was developed to limit the total number of tests required. The experimental factors and levels considered are shown in Table 1. Asphalt mixes with Type D and open coarse matrix high binder (CMHB) gradations with limestone aggregate were used. It was anticipated that the open gradation would be more susceptible to the influence of moisture, particularly with Hamburg trafficking. Two emulsion tack coats were tested and 2 application rates were considered. The minimum residual tack coat application rate specified in Texas is 0.226 l/m^2. The experiment considers the influence of cutting this rate in half. Finally, the experiment considers the combined influence of trafficking and moisture as part of the Hamburg wheel tracking tests. Given the variable nature of asphaltic materials, 6 specimens were tested at each factor combination. This amounts to a total of 96 tested specimens.

The tack coat materials used in the study include 2 slow setting emulsions (SS1 and CSS-1H). Rheological properties of the tack coats are shown in Table 2. The gradations of the AC mixes are shown in Table 3 together with other relevant mix design information.

Table 2. Tack coat properties.

Property	Emulsions		SS-1 TxDOT Spec		CSS-1H TxDOT Spec	
	SS-1	CSS-1H	Min	Max	Min	Max
Viscosity, Saybolt Furol @ 25 °C, s	22	26	20	100	20	100
Residue by distillation, % by weight	62	62	60	-	60	-
Pen @ 25 °C, 100 g, 5 s	134	104	120	160	70	110
Ductility @ 25 °C, 5 cm/min, cm	124	70+	100	-	80	-

Table 3. HMA mix design information.

Sieve size, mm	Type D	CMHB
0.075	3.8	4.7
0.18	8.4	8.2
0.425	20	12
2	37	18.4
4.75	63	37.2
9.5	91.8	60
12.5	100	99.3
Rice density	2.432	2.453
Binder grade	PG64-22	PG64-22
Binder content, % by total mass	5.7	3.8

Specimen Preparation

Asphalt mixtures were collected from the plant and were stored at room temperature before use. The asphalt mixtures were reheated to 126 °C, typically over a 4-h period, and gyratory compacted to a fixed height of 50 mm and a diameter of 150 mm. The mass of material required to achieve this height was determined beforehand using a trial and error procedure to ensure that all specimens had voids of 7% in the mix (VIM). As part of this procedure the maximum theoretical or Rice's density of the mixes was determined. In addition, duplicate samples at 4 different masses were compacted and the bulk densities of the compacted specimens determined. Compacted specimens were allowed to cool overnight after which densities were measured. Only specimens with an air void content of 7% ± 1% were selected for testing purposes.

The asphalt specimens had to be sawn for the Hamburg test configuration, in which 2 specimens are placed side-by-side. The sawed specimens were tacked to concrete disks having a height of 25 mm, also sawed as indicated. The concrete disks were obtained by sawing 150 mm diameter PPC concrete cores. The surface finish of the sawed concrete cores was relatively smooth. The mass of tack coat required to obtain the required application rate was determined by taking into account the needed binder content of the emulsions and the surface area to be coated, calculated as shown in Figure 1. The emulsion tack coat was spread evenly over a concrete disk and allowed to break before the asphalt specimen was attached. Thereafter, the composite specimen was loaded by applying a pressure of 690 kPa using a Texas gyratory compactor and maintaining this pressure on the specimen for 5 min to improve the bond between the asphalt and the concrete. These specimens were then placed within an environmental chamber set at 20 °C for at least 48 h before Hamburg and/or shear testing.

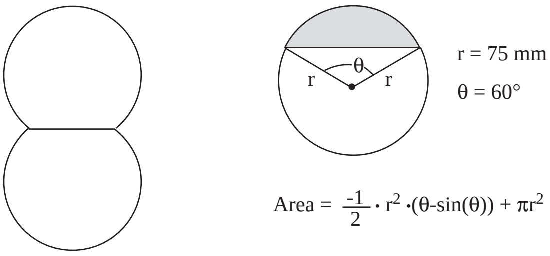

Figure 1. Specimen configuration for Hamburg testing and associated surface area calculations.

Hamburg and Shear Testing

Hamburg tests using the Texas Department of Transportation approach, Tex-242-F (2004), were done at a temperature of 50 °C applying 5000 cycles to the composite specimens. Figure 2 shows a Hamburg wheel tracking device. The HWTD test is conducted on a pair of samples simultaneously. The cylindrical specimens are 150 mm in diameter and about 40 mm thick (Yildirim and Thomas, 2001). Cylindrical specimens were compacted with the aid of the Superpave gyratory compactor.

Shear tests were done using a Marshall press modified to allow vertical shearing of the composite specimens along the asphalt-concrete interface. Figure 3 shows the representation of the shear test. These tests were done within the environmental chamber at 20 °C. The specimens were sheared at a constant displacement rate of 50.8 mm/min. The data acquisition system included a National Instruments controller to which the load cell was connected. The load signal was sampled every 0.05 s using software timing and the LabView data acquisition system. This setup allowed a continuous force-displacement response to be captured.

Figure 2. Hamburg wheel tracking device.

Test Results

Shear stress was computed based on the shearing load (P) and the tacked area as follows: $\tau = P/Area$. Figure 1 shows the ticketed area of a trimmed Hamburg wheel tracking specimen. The edges of the specimens were trimmed to allow 2 specimens to be aligned. The shear stress versus displacement curve was plotted for each specimen. The test results showed that the shear response varies in terms of force and displacements depending on the resistance offered by the tack coat. Typical curves are shown in Figure 4.

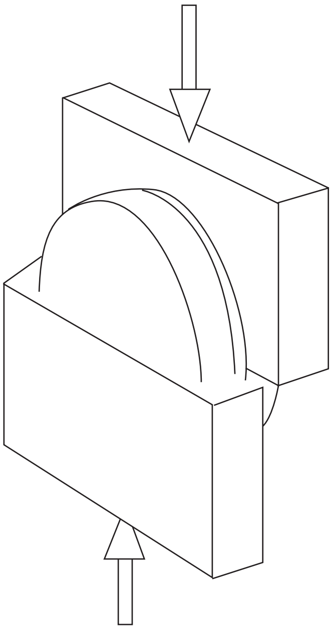

Figure 3. Direct shear testing configuration.

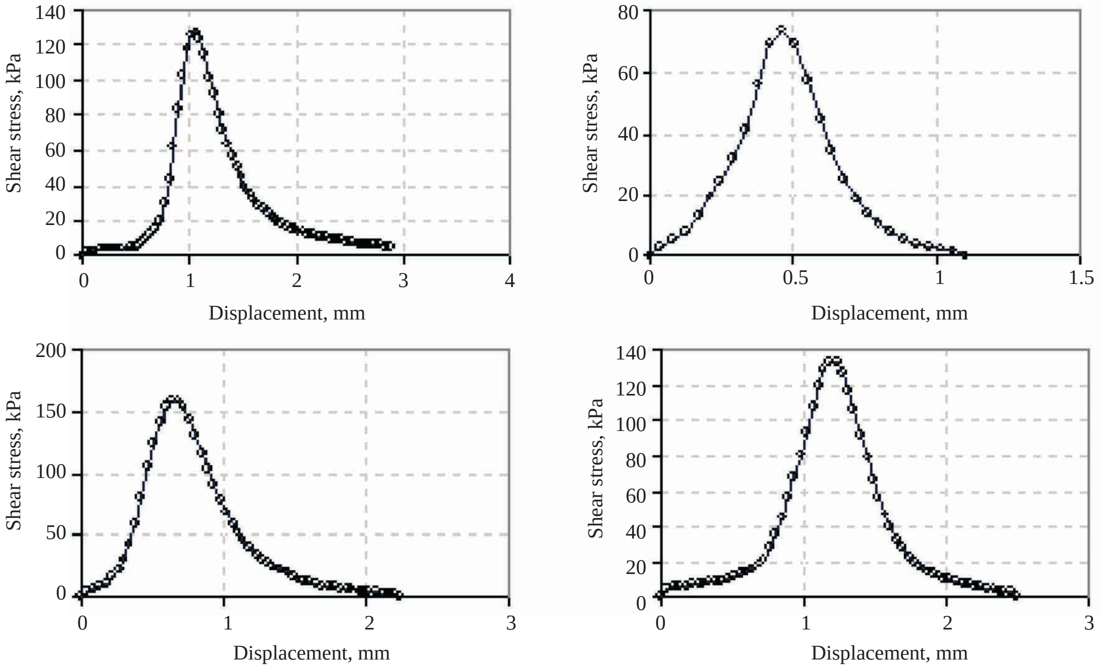

Figure 4. Shear stress - displacement curves.

The maximum shear stress was determined from the graph's peak. In addition to the maximum shear stress, a number of other parameters were determined from the curves including the displacement at maximum shear stress, the area beneath the force displacement curves up until the displacement at maximum shear stress (Area 1) and the total area beneath the force displacement curves (Area 2). These parameters are defined as shown in Figure 5.

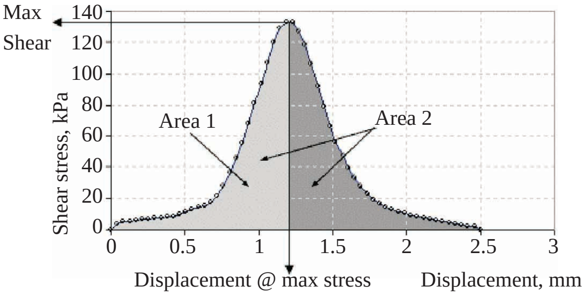

Figure 5. Shear stress parameters.

Statical analyses

The results from the shear tests were used to investigate the influence of the experimental factors on the shear parameters including maximum shear strength, displacement at maximum shear strength and area beneath the stress-displacement curves. Six specimens were tested at each factor combination of mix type, tack coat type, application rate and Hamburg cycles. The data from the factorial experiment were analyzed using the STATLETS statistical software package. Fischer's least significant difference (LSD) procedure was used to analyze the data.

The multiple comparison statistical procedure known as Fischer's LSD was selected with a 95% confidence interval. Results of the LSD analyses are shown in Table 4 through Table 7 for each of the responses including maximum shear stress, and displacement at maximum shear stress in Area 1 and Area 2. The tables show the mean for each level of the factors. They also show means for different combinations of the factors and the standard error of each mean, which is a measure of its sampling variability defined as (population standard deviation) / sqrt(n). The tables show limit ranges or intervals around each mean. The intervals are constructed in such a way that if 2 means are the same, their intervals will overlap 95.0% of the time. No overlap indicates a statistical significant difference in means. Table 8 shows the significant effects and interactions for response variables.

Discussion of Test Results

Maximum shear stress

The Type D specimens show higher maximum shear stress compared to the CMHB specimens. This may be related to the difference in aggregate structure of the mix gradations, i.e. with the Type D mixes, the surface finish is finer and less porous, which results in a higher contact area between the AC and PCC. Emulsion type does not significantly influence shear stress. A higher tack coat application rate gives significantly higher shear stress, although the influence and interaction of mix type also need to be taken into account. The shear stress of the Type D mixes was considerably higher than that for the CMHB specimens regardless of application rate, but for the CMHB specimens, higher shear stresses were apparent at the lower tack coat application rate. Trafficking with the Hamburg wheel tracking device improved maximum shear stress (for the CMHB specimens). This was unexpected since it was anticipated that the Hamburg wheel tracking would lead to stripping of the tack coat. CMHB specimens performed better with SS1 emulsion. The shear stress results indicate that the performance of the CMHB specimens were influenced by Hamburg trafficking. One reason for this could be that the CMHB specimens rutted more. This would increase the vertical compressive stress on the interface, improving the strength thereof. Overall it appears that the CMHB specimens were more sensitive to changes in the influence factors.

Shear stresses determined as part of the experiment compare favorably with those reported by Mohammed et al. (2002) as part of a study to investigate the interface shear strength of tack coats. In their study, asphalt mixes were gyratory compacted upon a tacked lower AC layer within the compaction mold. This suggests that the approach adopted in the present study may be feasible to investigate interface shear strength.

Displacement at maximum shear stress

The following factors and interactions have P-values below 0.05 and are thus statistically significant at the 95.0% confidence level:

Table 4. Means with 95.0% LSD intervals for maximum shear stress (kPa).

	Count	Mean	Stnd. Error	Lower limit	Upper limit
Total	96	143.7			
Mix Type					
CMHB	42	104.5	7.8	93.5	115.5
Type D	45	182.9	7.4	172.4	193.3
Tack Type					
CSS-1H	44	138.0	7.2	127.8	148.1
SS1	43	149.4	8.0	138.1	160.6
Application Rate (l/m^2)					
0.2264	43	160.8	7.3	150.6	171.1
0.1132	44	126.5	7.9	115.3	137.7
Hamburg Cycles					
0	46	127.2	7.4	116.8	137.6
5000	41	160.2	7.8	149.1	171.2
Mix Type by Tack Type					
CMHB by CSS-1H	21	92.8	10.1	78.5	107.1
CMHB by SS1	21	116.2	11.8	99.5	132.8
Type D by CSS-1H	23	183.1	10.2	168.7	197.5
Type D by SS1	22	182.6	10.8	167.4	197.8
Mix Type by Application Rate (l/m^2)					
CMHB by 0.2264	22	92.8	10.1	78.5	107.1
CMHB by 0.1132	20	116.2	11.8	99.5	132.8
Type D by 0.2264	21	183.1	10.2	168.7	197.5
Type D by 0.1132	24	182.6	10.8	167.4	197.8
Mix by Hamburg Cycles					
CMHB by 0	22	92.8	10.1	78.5	107.1
CMHB by 5000	20	116.2	11.8	99.5	132.8
Type D by 0	24	183.1	10.2	168.7	197.5
Type D by 5000	21	182.6	10.8	167.4	197.8
Tack Type by Application Rate (l/m^2)					
CSS-1H by 0.2264	22	92.8	10.1	78.5	107.1
CSS-1H by 0.1132	22	116.2	11.8	99.5	132.8
SS1 by 0.2264	21	183.1	10.2	168.7	197.5
SS1 by 0.1132	22	182.6	10.8	167.4	197.8
Tack Type by Hamburg Cycles					
CSS-1H by 0	23	92.8	10.1	78.5	107.1
CSS-1H by 5000	21	116.2	11.8	99.5	132.8
SS1 by 0	23	183.1	10.2	168.7	197.5
SS1 by 5000	20	182.6	10.8	167.4	197.8
Application Rate (l/m^2) by Hamburg Cycles					
0.2264 by 0	24	92.8	10.1	78.5	107.1
0.2264 by 5000	19	116.2	11.8	99.5	132.8
0.1132 by 0	22	183.1	10.2	168.7	197.5
0.1132 by 5000	22	182.6	10.8	167.4	197.8

Table 5. Means with 95.0% LSD intervals for displacement at max. shear (mm).

	Count	Mean	Stnd. Error	Lower limit	Upper limit
Total	96	0.91			
Mix Type					
CMHB	42	0.89	0.06	0.81	0.98
Type D	45	0.93	0.05	0.86	1.01
Tack Type					
CSS-1H	44	0.89	0.05	0.82	0.96
SS1	43	0.94	0.06	0.85	1.02
Application Rate (l/m^2)					
0.2264	43	0.93	0.05	0.85	1.00
0.1132	44	0.90	0.06	0.82	0.98
Hamburg Cycles					
0	46	0.70	0.05	0.62	0.77
5000	41	1.13	0.06	1.05	1.21
Mix Type by Tack Type					
CMHB by CSS-1H	21	0.84	0.07	0.74	0.95
CMHB by SS1	21	0.94	0.09	0.82	1.07
Type D by CSS-1H	23	0.94	0.08	0.83	1.04
Type D by SS1	22	0.93	0.08	0.82	1.04
Mix Type by Application Rate (l/m^2)					
CMHB by 0.2264	22	0.84	0.07	0.74	0.95
CMHB by 0.1132	20	0.94	0.09	0.82	1.07
Type D by 0.2264	21	0.94	0.08	0.83	1.04
Type D by 0.1132	24	0.93	0.08	0.82	1.04
Mix Type by Hamburg Cycles					
CMHB by 0	22	0.84	0.07	0.74	0.95
CMHB by 5000	20	0.94	0.09	0.82	1.07
Type D by 0	24	0.94	0.08	0.83	1.04
Type D by 5000	21	0.93	0.08	0.82	1.04
Tack Type by Application Rate (l/m^2)					
CSS-1H by 0.2264	22	0.84	0.07	0.74	0.95
CSS-1H by 0.1132	22	0.94	0.09	0.82	1.07
SS1 by 0.2264	21	0.94	0.08	0.83	1.04
SS1 by 0.1132	22	0.93	0.08	0.82	1.04
Tack Type by Hamburg Cycles					
CSS-1H by 0	23	0.84	0.07	0.74	0.95
CSS-1H by 5000	21	0.94	0.09	0.82	1.07
SS1 by 0	23	0.94	0.08	0.83	1.04
SS1 by 5000	20	0.93	0.08	0.82	1.04
Application Rate (l/m^2) by Hamburg Cycles					
0.2264 by 0	24	0.84	0.07	0.74	0.95
0.2264 by 5000	19	0.94	0.09	0.82	1.07
0.1132 by 0	22	0.94	0.08	0.83	1.04
0.1132 by 5000	22	0.93	0.08	0.82	1.04

Table 6. Means with 95.0% LSD intervals for Area 1 (mm^2).

	Count	Mean	Stnd. Error	Lower limit	Upper limit
Total	96	38.2			
Mix Type					
CMHB	42	27.5	2.3	24.3	30.7
Type D	45	48.9	2.2	45.9	52.0
Tack Type					
CSS-1H	44	37.9	2.1	34.9	40.9
SS1	43	38.5	2.3	35.2	41.8
Application Rate (l/m^2)					
0.2264	43	45.1	2.1	42.2	48.1
0.1132	44	31.2	2.3	28.0	34.5
Hamburg Cycles					
0	46	30.1	2.2	27.0	33.1
5000	41	46.3	2.3	43.1	49.5
Mix Type by Tack Type					
CMHB by CSS-1H	21	26.6	3.0	22.4	30.7
CMHB by SS1	21	28.3	3.4	23.5	33.2
Type D by CSS-1H	23	49.2	3.0	45.0	53.4
Type D by SS1	22	48.6	3.1	44.2	53.1
Mix Type by Application Rate (l/m^2)					
CMHB by 0.2264	22	26.6	3.0	22.4	30.7
CMHB by 0.1132	20	28.3	3.4	23.5	33.2
Type D by 0.2264	21	49.2	3.0	45.0	53.4
Type D by 0.1132	24	48.6	3.1	44.2	53.1
Mix Type by Hamburg Cycles					
CMHB by 0	22	26.6	3.0	22.4	30.7
CMHB by 5000	20	28.3	3.4	23.5	33.2
Type D by 0	24	49.2	3.0	45.0	53.4
Type D by 5000	21	48.6	3.1	44.2	53.1
Tack Type by Application Rate (l/m^2)					
CSS-1H by 0.2264	22	26.6	3.0	22.4	30.7
CSS-1H by 0.1132	22	28.3	3.4	23.5	33.2
SS1 by 0.2264	21	49.2	3.0	45.0	53.4
SS1 by 0.1132	22	48.6	3.1	44.2	53.1
Tack Type by Hamburg Cycles					
CSS-1H by 0	23	26.6	3.0	22.4	30.7
CSS-1H by 5000	21	28.3	3.4	23.5	33.2
SS1 by 0	23	49.2	3.0	45.0	53.4
SS1 by 5000	20	48.6	3.1	44.2	53.1
Application Rate (l/m^2) by Hamburg Cycles					
0.2264 by 0	24	26.6	3.0	22.4	30.7
0.2264 by 5000	19	28.3	3.4	23.5	33.2
0.1132 by 0	22	49.2	3.0	45.0	53.4
0.1132 by 5000	22	48.6	3.1	44.2	53.1

Table 7. Table of means with 95.0% LSD intervals for Area 2 (mm^2).

	Count	Mean	Stnd. Error	Lower limit	Upper limit
Total	96	70.0			
Mix Type					
CMHB	42	49.3	4.0	43.6	54.9
Type D	45	90.7	3.8	85.3	96.0
Tack Type					
CSS-1H	44	67.1	3.7	61.9	72.3
SS1	43	72.9	4.1	67.1	78.7
Application Rate (l/m^2)					
0.2264	43	89.1	3.7	83.9	94.4
0.1132	44	50.8	4.1	45.1	56.5
Hamburg Cycles					
0	46	68.4	3.8	63.1	73.8
5000	41	71.5	4.0	65.9	77.2
Mix Type by Tack Type					
CMHB by CSS-1H	21	41.3	5.2	34.0	48.6
CMHB by SS1	21	57.2	6.1	48.7	65.8
Type D by CSS-1H	23	92.8	5.2	85.4	100.2
Type D by SS1	22	88.5	5.5	80.7	96.3
Mix Type by Application Rate (l/m^2)					
CMHB by 0.2264	22	41.3	5.2	34.0	48.6
CMHB by 0.1132	20	57.2	6.1	48.7	65.8
Type D by 0.2264	21	92.8	5.2	85.4	100.2
Type D by 0.1132	24	88.5	5.5	80.7	96.3
Mix Type by Hamburg Cycles					
CMHB by 0	22	41.3	5.2	34.0	48.6
CMHB by 5000	20	57.2	6.1	48.7	65.8
Type D by 0	24	92.8	5.2	85.4	100.2
Type D by 5000	21	88.5	5.5	80.7	96.3
Tack Type by Application Rate (l/m^2)					
CSS-1H by 0.2264	22	41.3	5.2	34.0	48.6
CSS-1H by 0.1132	22	57.2	6.1	48.7	65.8
SS1 by 0.2264	21	92.8	5.2	85.4	100.2
SS1 by 0.1132	22	88.5	5.5	80.7	96.3
Tack Type by Hamburg Cycles					
CSS-1H by 0	23	41.3	5.2	34.0	48.6
CSS-1H by 5000	21	57.2	6.1	48.7	65.8
SS1 by 0	23	92.8	5.2	85.4	100.2
SS1 by 5000	20	88.5	5.5	80.7	96.3
Application Rate (l/m^2) by Hamburg Cycles					
0.2264 by 0	24	41.3	5.2	34.0	48.6
0.2264 by 5000	19	57.2	6.1	48.7	65.8
0.1132 by 0	22	92.8	5.2	85.4	100.2
0.1132 by 5000	22	88.5	5.5	80.7	96.3

Table 8. Significant effects and interactions for response variables.

Effect of interaction	MAX	DISP	A1	A2
Mix type	X	X	X	X
Application rate	X		X	X
Hamburg cycles	X	X	X	
Mix type by application rate	X		X	X
Mix type by Hamburg cycles		X	X	X
Mix type by tack type				X
Application rate by Hamburg cycles	X		X	X
Tack type by application rate				X
Tack type by Hamburg cycles			X	
Mix type by application rate by Hamburg cycles	X		X	X
Mix type by tack type by application rate by Hamburg c		X		

- Mix type
- Hamburg cycles
- Mix type by Hamburg cycles
- Mix type by tack type by application rate by Hamburg cycles

For displacement at maximum shear stress, fewer main effects and interaction are significant compared to maximum shear stress. Displacement at maximum shear stress was significantly influenced by mix type and Hamburg cycles. Type D specimens exhibit higher displacement at maximum shear stress, which may again be related to the contact area on the interface. The displacement at maximum shear stress increased with Hamburg testing of the CMHB specimens. As before, the CMHB specimens appear more sensitive to factor level.

Area 1

The following factors and interactions have P-values below 0.05 and are thus statistically significant at the 95.0% confidence level:

- Mix type
- Application rate
- Hamburg cycles
- Mix type by application rate
- Mix type by Hamburg cycles
- Tack type by Hamburg cycles
- Application rate by Hamburg cycles
- Mix type by application rate by Hamburg cycles

More interactions are significant when evaluating the area beneath the stress-displacement curves. Area is a multiplicative effect of both maximum shear stress and displacement at maximum shear stress. The same trends are apparent as with the previous 2 response variables, although CMHB does not stand out as being as sensitive to changes in the influence factors as noted with maximum shear stress and displacement at maximum shear stress.

Area 2

The following factors and interactions have P-values below 0.05 and are thus statistically significant at the 95.0% confidence level:

- Mix type
- Application rate
- Mix type by tack type
- Mix type by application rate
- Mix type by Hamburg cycles
- Tack type by application rate
- Application rate by Hamburg cycles
- Mix type by application rate by Hamburg cycles

The same trends are apparent as with the other response variables. In contrast to the Area 1 analysis, the Area 2 analysis indicates that CMHB (as before) appears to be more sensitive to changes in factor level.

Conclusions

In this study, the shear strength performance of tack coats serving to bond AC and PCC specimens was investigated using a shear test developed as part of the study. The apparatus applies a shear load to the interface of composite specimens at a constant displacement rate of 50 mm/min. Shear tests were done at 20 °C. Four influence factors were investigated as part of the experiment: mix type, tack coat type, tack coat application rate and Hamburg wheel tracking. Tack coat performance influence factors were investigated at 2 levels. Hamburg tests were done at 50 °C by applying 5000 cycles. Six specimens were tested at each of the factor combinations.

As part of the experiment, 150 mm gyratory compacted asphalt specimens are tacked onto concrete disks. A major benefit of this approach is that tack coat related performance results may be obtained from laboratory prepared specimens. Results from the present study indicate that this approach may be feasible to investigate the interface shear strength of tack coats between AC and PCC.

Statistical analyses (LSD at the 95% confidence level) of the shear test results indicated that the (main effect) factors that significantly influence tack coat performance include mix type, tack coat application rate and Hamburg trafficking. Given that only 2 emulsions were used as tack coats, tack type was not identified as having a significant influence. Of the 2 mix types evaluated, the Type D mix specimens performed considerably better than the CMHB mix specimens, owing to the nature of the interface contact, which is in turn is related to the aggregate structure of the AC. Tack coat performance was generally better at the higher application rate. It was found that Hamburg trafficking improved the shear strength response, in contrast to expectations. Therefore, it can be concluded that 5000 cycles as applied are not enough to cause expected tack coat failure. Based on this finding it is recommended that the number of cycles should be increased to investigate the effect of trafficking. Interactions between the main effects were found to be significant. In particular it was found that the CMHB mix specimens were generally more sensitive to changes in factor level.

Four response variables were investigated: 1) maximum shear stress, 2) displacement at maximum shear stress, 3) partial area beneath the shear stress-displacement curve until the displacement at maximum shear stress and 4) total area beneath the stress-displacement curve. The area beneath the stress-displacement curve was found to be a better discriminating factor to determine the significance of main effects and interactions. This factor not only considers the maximum shear strength of the interface but also the energy required to fail the bond between the AC and the PCC.

It is recommended that the experiment be expanded to investigate the influence of temperature and that more than 2 be investigated for specific factors. Since tack type was not identified as a significant factor influencing interface shear strength it is recommended that an asphalt binder (PG 64-22) and/or modified tack coat be used as alternatives to emulsions alone. To better investigate the influence of moisture and the potential of debonding it is recommended that Hamburg tests be done at a lower temperature (25 °C) and that more cycles (20,000) be applied to investigate the influence of trafficking. The factorial experiment should be expanded to allow determination of optimum tack coat application rates.

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