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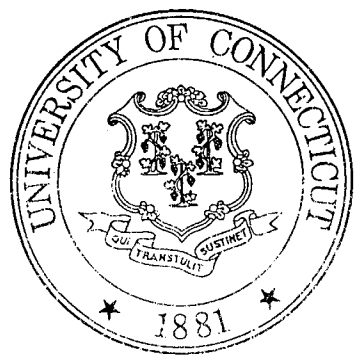
Comparison of AASHTO Moisture Sensitivity Test (T-283) with Connecticut Department of Transportation Modified Test Method

Final Report

August 1999

James Mahoney and Jack E. Stephens



SCHOOL OF ENGINEERING
UNIVERSITY OF CONNECTICUT
STORRS, CONNECTICUT

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16. Abstract

Several different interpretations of AASHTO's Moisture Sensitivity test exist. The official AASHTO interpretation of this test method does not account for water which has been absorbed into the test specimen while determining the specific gravity for the specimen. The modified Connecticut DOT method accounts for all of the water which the specimen has absorbed. Because of this difference in the calculation of the percent saturation, the test results for each method are quite different. This report looks at the differences in test results obtained using the two different test methods.

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Problem Statement:

The Superpave mix design system requires many different properties of the materials used to make Hot Mix Asphalt (HMA) to be tested. This includes a test to predict the mix's long-term stripping susceptibility. This test is an accelerated conditioning test which is performed on compacted bituminous mix specimens. After performing this test for a Superpave mix design, it was apparent that much of the HMA produced in Connecticut would have trouble passing this test even though most of the mixes have had very little history of stripping problems.

The AASHTO Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage (T283) contains wording which is unclear as to its interpretation. The interpretation of this Test Standard can have a great effect upon the results. Because of this unclear wording the Connecticut Department of Transportation (ConnDOT) has adopted a modified version of the AASHTO T283 test method. The major difference between the ConnDOT version and the official AASHTO method is the level of saturation of the conditioned specimens

This project was initiated to investigate the effects the modification of the test method would have on the test results. The results of this study will help determine if the modifications made to AASHTO T283 will give test results matching the minimal history of stripping experienced by these mixes.

Test Materials

HMA samples were obtained from the various mix plants that supply Connecticut Class 1 mix to the Connecticut Department of Transportation. This sampling of material was performed by either ConnDOT personnel or CAP Lab personnel. Materials used in this study were collected in the Fall of 1997 and during the Summer of 1998. Some of the HMA had Recycled Asphalt Pavement (RAP) in them.

HMA was sampled during the Fall of 1997 from the following HMA Plants:

Balf – Newington
O & G – Southbury
O & G – Woodbury
Suzio – Meriden
Tilcon – North Branford
Tilcon – Wallingford
Tilcon – Wauregan

HMA was sampled during the Summer of 1998 from the following HMA Plants:

Balf – Manchester
Balf – Newington
Galasso – East Granby
Lane – Sheffield MA
O & G – Stamford
O & G – Torrington
O & G – Woodbury
Palmer Paving – Palmer MA
Soneco – Groton
Soneco – Montville
Suzio – Meriden
Tilcon – Danbury
Tilcon – New Britain
Tilcon – North Branford
Tilcon – Wallingford
Tilcon – Wauregan

Methodology:

The first set of moisture sensitivity tests were performed on a limited number of HMA samples from the Connecticut HMA Plants. This testing was performed in accordance with AASHTO T283. 5-1 gallon pails of HMA were collected from each mix plant tested. The samples were collected and returned to the CAP Lab. The material was stored at room temperature in the sealed containers prior to testing.

The second set of moisture sensitivity tests were performed on a larger number of HMA samples. This testing was performed in accordance with Connecticut DOT's modified version of AASHTO T283. Appendix C contains the ConnDOT modified test method. 2-5 gallon pails and 1-1 gallon pail of HMA were collected from each mix plant. Extra material was collected for the ConnDOT modified test method based upon the experience of the first set of tests. The samples were collected and returned to the CAP Lab. The material was stored at room temperature in the sealed containers prior to testing. A sample of glasphalt was also acquired for testing during the ConnDOT version testing. Several sets of samples were made out of this material. Unfortunately, it was not possible to fabricate specimens that had the required air void content.

Due to space limitations in the forced draft oven as well as the length of time required to perform the test, only two samples could be tested per week.

Test Results:

A summary of the data from the official AASHTO T283 tests specified by Superpave is presented in Table 1. The individual test specimen data for the

official AASHTO T283 test can be seen in Appendix A. These results indicate that none of the mixes pass the tensile strength ratio (TSR) requirement for Superpave. The minimum acceptable TSR for Superpave mixes is 80%.

Table 1 – Results of Interpretation of AASHTO T283 Official Method

HMA Plant ID	Average of Conditioned Specimens, psi	Average of Unconditioned Specimens, psi	Tensile Strength Ratio (TSR)
Balf – Newington	47.5	67.5	70.3%
O & G Woodbury	45.4	77.2	58.9%
Tilcon N. Branford*	46.8	61.4	76.2%
Suzio – Meriden	33.7	57.8	58.4%
Tilcon Wallingford	47.9	80.7	59.4%
Tilcon Wauregan	46.2	69.6	66.4%
O & G Southbury	44.8	78.3	57.3%

* Contained RAP

The summary for the results from the ConnDOT Modified version of AASHTO T283 makes up Table 2. The individual test specimen data for the ConnDOT Modified version of AASHTO T283 can be seen in Appendix B. The results show that 10 of the 15 HMA samples tested had TSRs greater than 80%. There is no precision or bias statement for the modified ConnDOT T-283 method, but two of the failing results are probably within one standard deviation of the minimum 80% TSR for the test method.

Table 2 – Results of ConnDOT Modified AASHTO T283

HMA Plant ID	Average of Conditioned Specimens, psi	Average of Unconditioned Specimens, psi	Tensile Strength Ratio (TSR)
Balf Manchester	81.8	104.8	87.1%
Soneco Groton	56.2	88.2	63.7%
Tilcon Danbury	65.0	81.3	79.9%
Galasso E. Granby	77.5	77.3	100.4%
Balf Newington	88.4	90.8	97.3%
Soneco Montville*	94.6	107.3	88.1%
O & G Woodbury	112.8	117.8	95.7%
Tilcon N. Branford*	-	-	Sample Damaged
O & G Stamford	101.5	100.1	101.3%
Tilcon Plainville	88.3	96.6	91.4%
Lane Sheffield	122.0	130.7	93.3%
Suzio Meriden	84.8	115.9	73.2%
O & G Torrington	82.2	120.7	68.1%
Tilcon Wallingford*	113.2	136.8	82.7%
Tilcon Wauregan	91.6	102.5	89.4%
Palmer Paving*	79.7	91.5	78.1%
Glassphalt	-	-	Sample Damaged

* Contained RAP

Conclusions:

The modified ConnDOT version of AASHTO T283 allowed a majority of the material to achieve a TSR greater than 80%. The difference in the degree of saturation is probably the largest factor in the variation in the test results. Four of the five materials tested in both the official AASHTO version and the ConnDOT version of the test passed the ConnDOT modified version of T283 while failing the official AASHTO test. The only material to fail both sets of tests came much closer to the minimum acceptable TSR of 80% in the ConnDOT modified version of the test.

The largest difference between the ConnDOT modified version of T283 and the official AASHTO version of T283 is the computation of the amount of water absorbed by the specimen. The official AASHTO method states the amount of water absorbed into the specimen is calculated by:

(VSSD-SSD)/Volume of voids

Where: VSSD is the vacuum saturated surface dry weight

SSD is the saturated surface dry weight

The ConnDOT modified version of T283 calculates the amount of water absorbed by the specimen as:

(VSSD – Dry Weight of Specimen)/Volume of Voids

Where: VSSD is the vacuum saturated surface dry weight

The two procedures define water of saturation differently. The official AASHTO procedure results in a higher degree of saturation as the water required to achieve 55-80% saturation is in addition to the amount of water required to reach the saturated surface dry condition. The modified ConnDOT method uses all of the water absorbed by the specimen towards saturation of 55-80%. The increased volume of water in the official AASHTO method may be causing the specimen to be damaged excessively when it is frozen thus decreasing the TSR values.

Based upon these test results it is apparent that the official AASHTO test is more severe than the ConnDOT modified version. There are still some issues regarding the use of either of these tests as to their ability to predict the future

stripping potential of HMA. There are also some questions in regard to the use of either of these test methods on plant made mixes.

Appendix D contains the data from the collection of the second set of samples. From this data, it can be seen that materials collected from O & G Torrington and O & G Woodbury contained coarse aggregates from the same quarry. The fine aggregates were from different sources for these two mixes. The TSRs for both mixes were quite different. O & G Torrington had a TSR of 68.1% and the mix from O & G Woodbury had a TSR of 95.7%. There are several possible causes for this vast discrepancy in the TSRs. The differences in fine aggregate may have contributed to the differences. Another possible source of the discrepancy could have been the asphalt binder. The sources and lot numbers of the asphalt binder used, were not available. It is likely that the asphalt binder was not the same for both mixes. The other source of difference could be the test itself. In the AASHTO test procedure, there is no precision and bias statement provided for this procedure. It is not clear as to why there is no such statement provided for this procedure.

The testing protocol does not address the effects of performing this testing on HMA produced by mix plants. The mixes used for this testing were made in mix plants. The effects of the production and storage of these mixes prior to testing on the results is unclear.

It is recommended that the effectiveness of the moisture sensitivity testing to predict the HMA's likelyhood of having moisture induced damage be tracked

over time. The project numbers for the materials used in the ConnDOT modified method are included in Appendix D along with the aggregate information.

Reference

AASHTO, "Standard Specifications for Transportation Materials and Methods of Sampling and Testing", 19th Edition, 1998.

Appendix A

Official AASHTO T283 Specimen Data

AASHTO T-283

Balf - Newington
ConnDOT Class 1- Sampled 10-23-97
% AC by weight 5.74%

	Conditioned			Unconditioned		
Specimen Number	E1	E2	E5	E3	E4	E6
Diameter, mm	150	150	150	150	150	150
Height, mm	94.7	94.7	94.9	94.8	95.0	94.9
Dry Wt, g	3963.8	3958.7	3959.2	3956.0	3959.4	3957.7
SSD Wt, g	3986.4	3977.1	3979.1	3973.4	3978.1	3977.5
Wt. in Water, g	2342.5	2338	2338.2	2336.8	2335.7	2337.5
Vol.	1643.9	1639.1	1640.9	1636.6	1642.4	1640
Bulk Gravity	2.411	2.415	2.413	2.417	2.411	2.413
Max. Theor. Gravity	2.608	2.608	2.608	2.608	2.608	2.608
% Air Voids	7.55%	7.39%	7.48%	7.32%	7.56%	7.47%
Vol. Air Voids	124.0	121.2	122.8	119.7	124.2	122.5
After Vacuum Saturation						
SSD Wt, g	4070.3	4060.4	4061.4			
Wt. in Water, g	2432.9	2426.4	2425.4			
Water Gained	83.9	83.3	82.3			
% Saturation	67.6%	68.7%	67.0%			
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1440	1650	1840	2230	2270	2520
Tensile Strength, psi	41.64	47.71	53.09	64.41	65.43	72.71
Average	47.48			67.52		

TSR	70.3%

AASHTO T-283

O & G - Southbury
ConnDOT Class 1
% AC by weight 6.19%

	Conditioned			Unconditioned		
Specimen Number	Q2	Q5	Q8	Q3	Q6	Q4
Diameter, mm	150	150	150	150	150	150
Height, mm	95.1	95.1	95.0	95.0	95.0	95.1
Dry Wt, g	3970.7	3959.8	3951.3	3963.1	3953.7	3963.4
SSD Wt, g	3982.8	3976.4	3969.8	3976.7	3970.8	3976.0
Wt. in Water, g	2331	2325.2	2325.8	2326.5	2321.6	2322.9
Vol.	1651.8	1651.2	1644	1650.2	1649.2	1653.1
Bulk Gravity	2.404	2.398	2.403	2.402	2.397	2.398
Max. Theor. Gravity	2.593	2.593	2.593	2.593	2.593	2.593
% Air Voids	7.29%	7.52%	7.31%	7.38%	7.55%	7.54%
Vol. Air Voids	120.5	124.1	120.2	121.8	124.4	124.6
After Vacuum Saturation						
SSD Wt, g	4078.8	4068.2	4062.5			
Wt. in Water, g	2429.9	2421.0	2421.0			
Water Gained	96.0	91.8	92.7			
% Saturation	79.7%	74.0%	77.1%			
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1660	1630	1380	2740	2510	2900
Tensile Strength, psi	47.80	46.93	39.775	78.97	72.34	83.50
Average	44.83			78.27		

TSR	**57.28%**

AASHTO T-283

O & G - Woodbury
ConnDOT Class 1
% AC by weight 6.57%

	Conditioned			Unconditioned		
Specimen Number	G1	G2	G6	G3	G4	G8
Diameter, mm	150	150	150	150	150	150
Height, mm	94.9	94.8	94.8	94.9	94.8	94.9
Dry Wt, g	3962.1	3952.4	3960.8	3961.8	3959.2	3962.7
SSD Wt, g	3976.5	3970.3	3976.1	3975.9	3969.1	3977.3
Wt. in Water, g	2328.0	2330.0	2335.5	2335.8	2326.4	2336.7
Vol.	1648.5	1640.3	1640.6	1640.1	1642.7	1640.6
Bulk Gravity	2.403	2.410	2.414	2.416	2.410	2.415
Max. Theor. Gravity	2.569	2.569	2.569	2.569	2.569	2.569
% Air Voids	6.44%	6.21%	6.02%	5.97%	6.18%	5.98%
Vol. Air Voids	106.2	101.8	98.8	97.9	101.6	98.1
After Vacuum Saturation						
SSD Wt, g	4059.7	4048.4	4049.9			
Wt. in Water, g	2412.5	2410.0	2411.8			
Water Gained	83.2	78.1	73.8			
% Saturation	78.3%	76.7%	74.7%			
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1580	1490	1650	2670	2880	2470
Tensile Strength, psi	45.59	43.04	47.658	77.04	83.18	71.27
Average	45.43			77.16		

TSR	58.87%

AASHTO T-283

Suzio - Meriden
ConnDOT Class 1- Sampled 10-23-97
% AC by weight 5.99%

	Conditioned			Unconditioned		
Specimen Number	L2	L6	L7	L3	L4	L5
Diameter, mm	150	150	150	150	150	150
Height, mm	95.1	95.0	94.9	94.9	95.0	95.0
Dry Wt, g	3940.7	3939.0	3942.2	3944.7	3945.9	3947.1
SSD Wt, g	3966.0	3962.2	3964.9	3971.1	3969.0	3968.8
Wt. in Water, g	2326.0	2317.3	2321.2	2322.7	2322.7	2326.4
Vol.	1640.0	1644.9	1643.7	1648.4	1646.3	1642.4
Bulk Gravity	2.403	2.395	2.398	2.393	2.397	2.403
Max. Theor. Gravity	2.615	2.615	2.615	2.615	2.615	2.615
% Air Voids	8.11%	8.43%	8.28%	8.49%	8.34%	8.10%
Vol. Air Voids	133.0	138.6	136.2	139.9	137.4	133.0
After Vacuum Saturation						
SSD Wt, g	4061.9	4058.6	4061.6			
Wt. in Water, g	2382.3	2411.6	2423.2			
Water Gained	95.9	96.4	96.7			
% Saturation	72.1%	69.6%	71.0%			
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1190	1040	1280	1980	2060	1970
Tensile Strength, psi	34.26	29.98	36.932	57.13	59.37	56.78
Average	33.72			57.76		

TSR	58.38%

AASHTO T-283

Tilcon - North Branford
ConnDOT Class 1
% AC by weight 5.75%

	Conditioned			Unconditioned		
Specimen Number	H1	H2		H3	H4	H5
Diameter, mm	150	150		150	150	150
Height, mm	94.6	94.5		94.6	94.5	94.7
Dry Wt, g	3938.9	3942.8		3939.1	3938.4	3912.3
SSD Wt, g	3955.3	3957.9		3959.7	3958.5	3937.2
Wt. in Water, g	2321.1	2318.2		2329.8	2323.5	2301.1
Vol.	1634.2	1639.7		1629.9	1635	1636.1
Bulk Gravity	2.410	2.405		2.417	2.409	2.391
Max. Theor. Gravity	2.588	2.588		2.588	2.588	2.588
% Air Voids	6.87%	7.09%		6.62%	6.92%	7.60%
Vol. Air Voids	112.2	116.2		107.8	113.2	124.4
After Vacuum Saturation						
SSD Wt, g	4042	4049.5				
Wt. in Water, g	2410.4	2414.4				
Water Gained	86.7	91.6				
% Saturation	77.3%	78.8%				
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1690	1540		2220	2040	2100
Tensile Strength, psi	48.92	44.62		64.26	59.11	60.72
Average	46.77			61.36		

TSR	**76.2%**

AASHTO T-283

Tilcon - Wauregan
ConnDOT Class 1
% AC by weight 5.84%

	Conditioned			Unconditioned		
Specimen Number	O1	O2		O4	O5	
Diameter, mm	150	150		150	150	
Height, mm	94.9	94.7		94.9	94.8	
Dry Wt, g	3860.2	3861.0		3857.2	3859.6	
SSD Wt, g	3893.3	3890.0		3886.2	3883.1	
Wt. in Water, g	2261.1	2264.8		2267.7	2249.8	
Vol.	1632.2	1625.2		1618.5	1633.3	
Bulk Gravity	2.365	2.376		2.383	2.363	
Max. Theor. Gravity	2.537	2.537		2.537	2.537	
% Air Voids	6.78%	6.36%		6.06%	6.86%	
Vol. Air Voids	110.6	103.3		98.1	112.0	
After Vacuum Saturation						
SSD Wt, g	3967.2	3964.1				
Wt. in Water, g	2344.8	2340.0				
Water Gained	73.9	74.1				
% Saturation	66.8%	71.7%				
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1540	1660		2440	2380	
Tensile Strength, psi	44.43	48.00		70.40	68.74	
Average	46.22			69.57		

TSR	66.43%

AASHTO T-283

Tilcon - Wallingford
ConnDOT Class 1- Sampled 10-23-97
% AC by weight 5.61%

	Conditioned			Unconditioned		
Specimen Number	N1	N2	N3	N4	N5	N6
Diameter, mm	150	150	150	150	150	150
Height, mm	95.0	95.0	95.0	95	94.9	95
Dry Wt, g	3981.1	3988.3	3986.2	3984.2	3990.2	3985.9
SSD Wt, g	3993.9	3999.4	3999	4000.5	4001.1	3996.6
Wt. in Water, g	2348.2	2354.7	2348.4	2360.9	2351.3	2350.6
Vol.	1645.7	1644.7	1650.6	1639.6	1649.8	1646
Bulk Gravity	2.419	2.425	2.415	2.430	2.419	2.422
Max. Theor. Gravity	2.614	2.614	2.614	2.614	2.614	2.614
% Air Voids	7.46%	7.23%	7.61%	7.04%	7.48%	7.36%
Vol. Air Voids	122.7	119.0	125.7	115.4	123.3	121.2
After Vacuum Saturation						
SSD Wt, g	4085.8	4088.4	4086.6			
Wt. in Water, g	2442.1	2444.7	2437.6			
Water Gained	91.9	89.0	87.6			
% Saturation	74.9%	74.8%	69.7%			
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water						
Load - lb	1610	1680	1700	2710	2900	2790
Tensile Strength, psi	46.40	48.42	48.998	78.11	83.67	80.42
Average	47.94			80.73		

TSR	59.38%

Appendix B

Connecticut DOT Modified Version of AASHTO T283 Specimen Data

AASHTO T-283 (CT Modified)

Balf - Manchester
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned				
Specimen Number	a2	a3	a7	a1	a4	a5	a6	a8
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3980.2	3976.2	3972.2	3967.3	3973.6	3977.1	3969.4	3979
SSD Wt, g	4003	3993.1	3989.9	3991.6	3995	3993.9	3985.9	3997.3
Wt. in Water, g	2365.8	2352.2	2359.9	2362.1	2359.5	2362.5	2366.7	2370.1
Vol.	1637.2	1640.9	1630.0	1629.5	1635.5	1631.4	1619.2	1627.2
Bulk Gravity	2.431	2.423	2.437	2.435	2.430	2.438	2.451	2.445
Max. Theor. Gravity	2.616	2.616	2.616	2.616	2.616	2.616	2.616	2.616
% Air Voids	7.07%	7.37%	6.85%	6.93%	7.13%	6.81%	6.29%	6.53%
Vol. Air Voids	115.7	120.9	111.6	112.9	116.5	111.1	101.8	106.2
	After Vacuum Saturation							
SSD Wt, g	4052.9	4040.8	4035.9					
Wt. in Water, g								
Water Gained (SSD-Dry	72.7	64.6	63.7					
% Saturation	62.8%	53.4%	57.1%					
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	2740	2690	3000	3280	3200	3200		
Tensile Strength, psi	77.73	76.31	85.11	93.05	90.78	90.78		
Average	79.72			91.54				

TSR	**87.1%**

AASHTO T-283 (CT Modified)

Balf - Newington
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			Test	Test
Specimen Number	e2	e3	e7	e1	e5	e6	e4	e9
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3970.8	3988.6	3969.8	3987.9	3978.8	3969.5	3973.2	3965.8
SSD Wt, g	4009.8	4021.6	4004.9	4014	4015	4003.6	4008.9	3999.4
Wt. in Water, g	2379.5	2387.4	2381.6	2385	2385	2372.3	2382.6	2367
Vol.	1630.3	1634.2	1623.3	1629	1630	1631.3	1626.3	1632.4
Bulk Gravity	2.436	2.441	2.446	2.448	2.441	2.433	2.443	2.429
Max. Theor. Gravity	2.632	2.632	2.632	2.632	2.632	2.632	2.632	2.632
% Air Voids	7.46%	7.27%	7.09%	6.99%	7.26%	7.55%	7.18%	7.70%
Vol. Air Voids	121.6	118.8	115.0	113.8	118.3	123.1	116.7	125.6
	After Vacuum Saturation							
SSD Wt, g	4052.9	4055.9	4041				4037.4	
Wt. in Water, g	2418.4	2422.2	2417.1				2412.1	
Water Gained (SSD-Dry	82.1	67.3	71.2				64.2	
% Saturation	67.5%	56.7%	61.9%				55.0%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	2880	3440	3025	3200	3250	3150		
Tensile Strength, psi	81.70	97.59	85.82	90.78	92.20	89.36		
Average	88.37			90.78				

TSR	97.3%

AASHTO T-283 (CT Modified)

Galasso - East Granby
ConnDOT Class 1
% AC by weight 6.08%

	Conditioned			Unconditioned			Test
Specimen Number	d1	d2	d5	d4	d6	d7	d3
Diameter, mm	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95
Dry Wt, g	3843.2	3850.2	3849.3	3968.5	3839.2	3835.3	3947.1
SSD Wt, g	3882.1	3872.1	3887.3	3973.2	3876.6	3870.5	3968
Wt. in Water, g	2253.9	2251.9	2256.4	2346.6	2259.8	2242.8	2344.7
Vol.	1628.2	1620.2	1630.9	1626.6	1616.8	1627.7	1623.3
Bulk Gravity	2.360	2.376	2.360	2.440	2.375	2.356	2.432
Max. Theor. Gravity	2.5465	2.5465	2.5465	2.5465	2.5465	2.5465	2.5465
% Air Voids	7.31%	6.68%	7.32%	4.19%	6.75%	7.47%	4.52%
Vol. Air Voids	119.0	108.3	119.3	68.2	109.2	121.6	73.3
	After Vacuum Saturation						
SSD Wt, g	3925.3	3924.2	3934.4				
Wt. in Water, g	2303.5	2305.3	2311.2				
Water Gained (SSD-Dry	82.1	74	85.1				
% Saturation	69.0%	68.3%	71.3%				
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water							
Load - lb	2550	2750	2900	2750	2600	2820	
Tensile Strength, psi	72.34	78.01	82.27	78.01	73.76	80.00	
Average	77.54			77.26			

TSR	100.4%

AASHTO T-283 (CT Modified)

Lane - Sheffield, MA
ConnDOT Class 1
% AC by weight 6.11%

	Conditioned			Unconditioned			Test	Test	Test
Specimen Number	k3	k6	k7	k1	k2	k4	k5	k8	k9
Diameter, mm	150	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95	95
Dry Wt, g	3891.7	3888.1	3889.6	3894.5	3890.8	3889.9	3894.2	3890.8	3912.3
SSD Wt, g	3920.1	3914.9	3921.6	3919.9	3909.2	3921.9	3917.9	3914.8	3933
Wt. in Water, g	2303.6	2294.7	2298.4	2295.5	2293.7	2300.7	2295.8	2289.2	2315.7
Vol.	1616.5	1620.2	1623.2	1624.4	1615.5	1621.2	1622.1	1625.6	1617.3
Bulk Gravity	2.407	2.400	2.396	2.398	2.408	2.399	2.401	2.393	2.419
Max. Theor. Gravity	2.5754	2.5754	2.5754	2.5754	2.5754	2.5754	2.5754	2.5754	2.5754
% Air Voids	6.52%	6.82%	6.96%	6.91%	6.49%	6.84%	6.78%	7.07%	6.07%
Vol. Air Voids	105.4	110.5	112.9	112.2	104.8	110.8	110.0	114.9	98.2
	After Vacuum Saturation								
SSD Wt, g	3959.1	3970.2	3966.9				3953.9		
Wt. in Water, g	2347.6	2347.7	2348.7				2334.7		
Water Gained (SSD-Dry	67.4	82.1	77.3				59.7		
% Saturation	63.9%	74.3%	68.4%				54.3%		
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water									
Load - lb	4450	4300	4150	4650	4720	4450			
Tensile Strength, psi	126.24	121.99	117.73	131.91	133.90	126.24			
Average	121.99			130.69					

TSR	**93.3%**

AASHTO T-283 (CT Modified)

O & G - Stamford
ConnDOT Class 1
% AC by weight 5.69%

	Conditioned			Unconditioned			Test	Test
Specimen Number	i4	i6	i7	i1	i2	i3	i5	i9
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3979.1	3980	3981.1	3983	3983.5	3983.6	3982.3	3920.1
SSD Wt, g	4002.9	3998.7	3997.8	4007.9	4007.3	3998.8	4005.6	3957.8
Wt. in Water, g	2366.4	2362.4	2356.1	2370.8	2363.5	2360.4	2372.2	2314
Vol.	1636.5	1636.3	1641.7	1637.1	1643.8	1638.4	1633.4	1643.8
Bulk Gravity	2.431	2.432	2.425	2.433	2.423	2.431	2.438	2.385
Max. Theor. Gravity	2.6096	2.6096	2.6096	2.6096	2.6096	2.6096	2.6096	2.6096
% Air Voids	6.83%	6.79%	7.07%	6.77%	7.14%	6.83%	6.57%	8.62%
Vol. Air Voids	111.7	111.2	116.1	110.8	117.3	111.9	107.4	141.6
	After Vacuum Saturation							
SSD Wt, g	4045.6	4042.6	4046				4048	
Wt. in Water, g	2416.6	2406.1	2406.2				2416.3	
Water Gained (SSD-Dry	66.5	62.6	64.9				65.7	
% Saturation	59.5%	56.3%	55.9%				61.2%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	3600	3580	3550	3350	3540	3700		
Tensile Strength, psi	102.13	101.56	100.71	95.04	100.43	104.96		
Average	101.47			100.14				

TSR	101.3%

AASHTO T-283 (CT Modified)

O & G - Torrington
ConnDOT Class 1
% AC by weight 5.21%

	Conditioned			Unconditioned			Test	Test
Specimen Number	M1	M4	M5	M2	M3	M6	M7	M9
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3849.9	3850.5	3836.9	3851.8	3850.4	3856.7	3866.5	3838.9
SSD Wt, g	3865.9	3872.2	3854	3865.6	3870	3871.1	3881.9	3856.2
Wt. in Water, g	2225.2	2237.2	2222.4	2227	2234	2239.4	2247.2	2215.4
Vol.	1640.7	1635.0	1631.6	1638.6	1636.0	1631.7	1634.7	1640.8
Bulk Gravity	2.346	2.355	2.352	2.351	2.354	2.364	2.365	2.340
Max. Theor. Gravity	2.53633	2.53633	2.53633	2.53633	2.53633	2.53633	2.53633	2.536328
% Air Voids	7.48%	7.15%	7.28%	7.32%	7.21%	6.81%	6.74%	7.75%
Vol. Air Voids	122.8	116.9	118.8	119.9	117.9	111.1	110.3	127.2
	After Vacuum Saturation							
SSD Wt, g	3925.2	3944.3	3928				3940.6	
Wt. in Water, g	2286.2	2306.4	2294				2304.2	
Water Gained (SSD-Dry	75.3	93.8	91.1				74.1	
% Saturation	61.3%	80.3%	76.7%				67.2%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	2900	3070	2720	4200	4200	4360		
Tensile Strength, psi	82.27	87.09	77.16	119.15	119.15	123.69		
Average	82.17			120.66				

TSR	68.1%

AASHTO T-283 (CT Modified)

O & G - Woodbury
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			Test	Test
Specimen Number	g1	g2	g6	g3	g5	g7	g4	g9
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3942	3953.5	3946.4	3942.9	3943.3	3947.9	3950.6	3963.2
SSD Wt, g	3967.7	3979.7	3975.5	3967	3959	3974.4	3976.1	3979.8
Wt. in Water, g	2332.6	2339.8	2333	2331.6	2313.2	2338	2342.3	2334.1
Vol.	1635.1	1639.9	1642.5	1635.4	1645.8	1636.4	1633.8	1645.7
Bulk Gravity	2.411	2.411	2.403	2.411	2.396	2.413	2.418	2.408
Max. Theor. Gravity	2.5703	2.5703	2.5703	2.5703	2.5703	2.5703	2.5703	2.5703
% Air Voids	6.20%	6.21%	6.52%	6.20%	6.78%	6.14%	5.92%	6.31%
Vol. Air Voids	101.4	101.8	107.1	101.4	111.6	100.4	96.8	103.8
	After Vacuum Saturation							
SSD Wt, g	4007.5	4020	4017.6				4012	
Wt. in Water, g	2377.8	2380.2	2369				2382	
Water Gained (SSD-Dry	65.5	66.5	71.2				61.4	
% Saturation	64.6%	65.3%	66.5%				63.4%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	3900	4050	3980	4600	4380	3480		
Tensile Strength, psi	110.64	114.89	112.91	130.50	124.25	98.72		
Average	112.81			117.82				

TSR	**95.7%**

AASHTO T-283 (CT Modified)

Palmer Paving - Palmer, MA
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			Test	Test	Test	Test
Specimen Number	p2	p4	p7	p1	p5	p6	p3	p8	p9	p10
Diameter, mm	150	150	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95	95	95
Dry Wt, g	4001	4001	3999.3	3999.8	3995.1	3995.4	3997.2	3775	3994.1	3691.1
SSD Wt, g	4022.7	4016.5	4024.4	4018.6	4019.1	4019.4	4017.4	3816.9	4016.9	3742.3
Wt. in Water, g	2398.9	2389.7	2380	2388.1	2386.1	2396.2	2382.1	2221.8	2387.4	2170.8
Vol.	1623.8	1626.8	1644.4	1630.5	1633.0	1623.2	1635.3	1595.1	1629.5	1571.5
Bulk Gravity	2.464	2.459	2.432	2.453	2.446	2.461	2.444	2.367	2.451	2.349
Max. Theor. Gravity	2.6418	2.6418	2.6418	2.6418	2.6418	2.6418	2.6418	2.6418	2.6418	2.6418
% Air Voids	6.73%	6.90%	7.94%	7.14%	7.39%	6.83%	7.48%	10.42%	7.22%	11.09%
Vol. Air Voids	109.3	112.3	130.5	116.5	120.7	110.8	122.2	166.2	117.6	174.3
	After Vacuum Saturation									
SSD Wt, g	4068	4068.8	4071.4							
Wt. in Water, g	2447.3	2440.9	2424.5							
Water Gained (SSD-Dry	67	67.8	72.1							
% Saturation	61.3%	60.4%	55.2%							
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water										
Load - lb	3020	3050	2580	3930	3600	3550				
Tensile Strength, psi	85.67	86.52	73.19	111.49	102.13	100.71				
Average	81.80			104.78						

TSR	**78.1%**

AASHTO T-283 (CT Modified)

Soneco - Groton
ConnDOT Class 1
% AC by weight 6.27%

	Conditioned			Unconditioned			test	test	test
Specimen Number	B-2	B-4	B-5	B-3	B-6	B-7	B-1	B-8	B-9
Diameter, mm	150	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95	95
Dry Wt, g	3849.5	3851.8	3861	3840.2	3844	3863.4	3955.8	3859.6	3807.9
SSD Wt, g	3871.9	3869.3	3880.9	3865.4	3858.3	3882.4	3969.3	3877.8	3826.4
Wt. in Water, g	2231.8	2232.5	2250.2	2229.2	2225.7	2249.7	2326.5	2240.5	2204.6
Vol.	1640.1	1636.8	1630.7	1636.2	1632.6	1632.7	1642.8	1637.3	1621.8
Bulk Gravity	2.347	2.353	2.368	2.347	2.355	2.366	2.408	2.357	2.348
Max. Theor. Gravity	2.522	2.522	2.522	2.522	2.522	2.522	2.522	2.522	2.522
% Air Voids	6.93%	6.69%	6.12%	6.94%	6.64%	6.18%	4.52%	6.53%	6.90%
Vol. Air Voids	113.7	109.5	99.8	113.5	108.4	100.8	74.3	106.9	111.9
	After Vacuum Saturation								
SSD Wt, g	3917.8	3922.3	3922.3					3947.8	
Wt. in Water, g									
Water Gained (SSD-Dry	68.3	70.5	61.3					88.2	
% Saturation	60.1%	64.4%	61.4%					82.5%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water									
Load - lb	1845	1930	2165	3160	2980	3185			
Tensile Strength, psi	52.34	54.75	61.42	89.65	84.54	90.35			
Average	56.17			88.18					

TSR **63.7%**

AASHTO T-283 (CT Modified)

Soneco - Montville
ConnDOT Class 1
% AC by weight 5.78%

	Conditioned			Unconditioned			Test
Specimen Number	f1	f2	f4	f3	f5	f6	f7
Diameter, mm	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95
Dry Wt, g	3751.4	3756.1	3758.6	3749.9	3752.9	3755.4	3756.4
SSD Wt, g	3785.9	3785.1	3785.5	3775.2	3775.3	3782.7	3782.9
Wt. in Water, g	2158.3	2146.7	2159.2	2147.4	2151.7	2158.9	2159.2
Vol.	1627.6	1638.4	1626.3	1627.8	1623.6	1623.8	1623.7
Bulk Gravity	2.305	2.293	2.311	2.304	2.311	2.313	2.313
Max. Theor. Gravity	2.4787	2.4787	2.4787	2.4787	2.4787	2.4787	2.4787
% Air Voids	7.01%	7.51%	6.76%	7.06%	6.75%	6.70%	6.67%
Vol. Air Voids	114.1	123.0	109.9	114.9	109.5	108.7	108.2
	After Vacuum Saturation						
SSD Wt, g	3827.6	3832.7	3826.2				3842
Wt. in Water, g	2202.9	2197.2	2203.2				2222
Water Gained (SSD-Dry	76.2	76.6	67.6				85.6
% Saturation	66.76%	62.25%	61.49%				79.10%
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water							
Load - lb	3350	3300	3350	3750	3900	3700	
Tensile Strength, psi	95.04	93.62	95.04	106.38	110.64	104.96	
Average	94.56			107.33			

TSR **88.1%**

AASHTO T-283 (CT Modified)

Suzio - Meridan
ConnDOT Class 1
% AC by weight 6.86%

	Conditioned			Unconditioned			Test	Test
Specimen Number	L3	L4	L7	L1	L5	L6	L2	L9
Diameter, mm	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95
Dry Wt, g	3929.6	3932.8	3934.8	3938.3	3929.9	3936.5	3939.2	3228.7
SSD Wt, g	3959	3955	3950.6	3951.5	3948.7	3957.1	3944.9	3940.5
Wt. in Water, g	2316.1	2317.6	2307.4	2307.2	2313.2	2311.5	2299.2	2293.1
Vol.	1642.9	1637.4	1643.2	1644.3	1635.5	1645.6	1645.7	1647.4
Bulk Gravity	2.392	2.402	2.395	2.395	2.403	2.392	2.394	1.960
Max. Theor. Gravity	2.5995	2.59952	2.5995	2.5995	2.5995	2.5995	2.5995	2.5995
% Air Voids	7.99%	7.60%	7.88%	7.86%	7.56%	7.98%	7.92%	24.61%
Vol. Air Voids	131.2	124.5	129.5	129.3	123.7	131.3	130.3	405.4
	After Vacuum Saturation							
SSD Wt, g	4021.2	4013.7	4014.7				3996	
Wt. in Water, g	2380.9	2381.5	2376.1				2352.3	
Water Gained (SSD-Dry	91.6	80.9	79.9				56.8	
% Saturation	69.8%	65.0%	61.7%				43.6%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water								
Load - lb	2750	3100	3120	3720	4270	4270		
Tensile Strength, psi	78.01	87.94	88.51	105.53	121.13	121.13		
Average	84.82			115.93				

TSR **73.2%**

AASHTO T-283 (CT Modified)

Tilcon - Danbury
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			Test
Specimen Number	c1	c2	c3	c4	c5	c7	c6
Diameter, mm	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95
Dry Wt, g	3814.6	3815	3841.4	3816.4	3812.5	3815.9	3815.3
SSD Wt, g	3877.1	3860.6	3864.2	3873.2	3868	3864.9	3882.6
Wt. in Water, g	2264.7	2234.9	2245.5	2251.2	2260.1	2251	2251.2
Vol.	1612.4	1625.7	1618.7	1622.0	1607.9	1613.9	1631.4
Bulk Gravity	2.366	2.347	2.373	2.353	2.371	2.364	2.339
Max. Theor. Gravity	2.5303	2.5303	2.5303	2.5303	2.5303	2.5303	2.5303
% Air Voids	6.50%	7.26%	6.21%	7.01%	6.29%	6.56%	7.57%
Vol. Air Voids	104.8	118.0	100.5	113.7	101.1	105.8	123.5
	After Vacuum Saturation						
SSD Wt, g	3911.8	3902.8	3905.3				3940.8
Wt. in Water, g	2294.6	2278.9	2285.4				2319.9
Water Gained (SSD-Dry	97.2	87.8	63.9				125.5
% Saturation	92.7%	74.4%	63.6%				101.6%
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water							
Load - lb	Bad	2380	2200	2800	2950	2850	
Tensile Strength, psi		67.52	62.41	79.43	83.69	80.85	
Average		64.96			81.32		

TSR	79.9%

AASHTO T-283 (CT Modified)

Tilcon - Plainville
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			
Specimen Number	j2	j3	j7	j1	j4	j5	j6
Diameter, mm	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95
Dry Wt, g	4009.4	4011.8	4015.3	4008.4	4011.2	4009.5	4009.3
SSD Wt, g	4039.2	4047.5	4047.2	4030.5	4039.3	4041.6	4046.5
Wt. in Water, g	2409.8	2424.4	2417.6	2410.3	2414	2406.8	2403.1
Vol.	1629.4	1623.1	1629.6	1620.2	1625.3	1634.8	1643.4
Bulk Gravity	2.461	2.472	2.464	2.474	2.468	2.453	2.440
Max. Theor. Gravity	2.656152	2.6562	2.6562	2.6562	2.6562	2.6562	2.6562
% Air Voids	7.36%	6.94%	7.24%	6.86%	7.08%	7.66%	8.15%
Vol. Air Voids	119.9	112.7	117.9	111.1	115.1	125.3	134.0
	After Vacuum Saturation						
SSD Wt, g	4079.1	4081.2	4093.6				4076.3
Wt. in Water, g	2452.4	2461.3	2469.9				2458.9
Water Gained (SSD-Dry	69.7	69.4	78.3				67
% Saturation	58.1%	61.6%	66.4%				50.0%
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water							
Load - lb	3170	3120	3050	3450	3520	3250	
Tensile Strength, psi	89.93	88.51	86.52	97.87	99.86	92.20	
Average	88.32			96.64			

TSR	**91.4%**

AASHTO T-283 (CT Modified)

Tilcon - Wallingford
ConnDOT Class 1
% AC by weight

	Conditioned			Unconditioned			Test	Test	Test
Specimen Number	N1	N7	N8	N2	N3	N4	N5	N6	N9
Diameter, mm	150	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95	95
Dry Wt, g	4009	4013.7	4014.1	4008.5	4008.8	4012	4009.1	3999.4	4005.1
SSD Wt, g	4037.9	4039.1	4039.3	4035.7	4030.9	4039.8	4034.7	4030	4033.5
Wt. in Water, g	2415.9	2414.4	2408.9	2409.4	2408.5	2417	2415.7	2402.1	2405
Vol.	1622.0	1624.7	1630.4	1626.3	1622.4	1622.8	1619.0	1627.9	1628.5
Bulk Gravity	2.472	2.470	2.462	2.465	2.471	2.472	2.476	2.457	2.459
Max. Theor. Gravity	2.6397	2.6397	2.6397	2.6397	2.63974	2.6397	2.639743	2.6397	2.6397
% Air Voids	6.37%	6.41%	6.73%	6.63%	6.40%	6.34%	6.19%	6.93%	6.83%
Vol. Air Voids	103.3	104.2	109.8	107.8	103.8	103.0	100.3	112.8	111.3
	After Vacuum Saturation								
SSD Wt, g	4078.8	4081.4	4087.8				4076.3		
Wt. in Water, g	2353.4	2453.4	2448.9				2452.8		
Water Gained (SSD-Dry	69.8	67.7	73.7				67.2		
% Saturation	67.6%	65.0%	67.1%				67.0%		
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water									
Load - lb	4200	4000	3770	4600	5050	4820			
Tensile Strength, psi	119.15	113.47	106.95	130.50	143.26	136.74			
Average	113.19			136.83					

TSR	82.7%

AASHTO T-283 (CT Modified)

Tilcon - Wauregan
ConnDOT Class 1
% AC by weight 5.74%

	Conditioned			Unconditioned			Test	Test	Test
Specimen Number	O-2	O-6	O-7	O-4	0-5	O-8	O-1	O-3	O-9
Diameter, mm	150	150	150	150	150	150	150	150	150
Height, mm	95	95	95	95	95	95	95	95	95
Dry Wt, g	3815.3	3817.7	3814.6	3814	3816	3811.8	3913.1	3814.2	3823.7
SSD Wt, g	3843.4	3847.3	3838.8	3843.4	3842.8	3841.9	4931.7	3840.8	3843.5
Wt. in Water, g	2230.7	2234.2	2229.4	2233.3	2228.6	2234.4	2311.4	2238.2	2235
Vol.	1612.7	1613.1	1609.4	1610.1	1614.2	1607.5	2620.3	1602.6	1608.5
Bulk Gravity	2.366	2.367	2.370	2.369	2.364	2.371	1.493	2.380	2.377
Max. Theor. Gravity	2.5236	2.5236	2.5236	2.5236	2.5236	2.5236	2.5236	2.5236	2.5236
% Air Voids	6.26%	6.22%	6.08%	6.14%	6.32%	6.04%	40.82%	5.69%	5.80%
Vol. Air Voids	100.9	100.3	97.9	98.8	102.1	97.1	1069.7	91.2	93.3
	After Vacuum Saturation								
SSD Wt, g	3878.2	3886.6	3884.3					3877.9	
Wt. in Water, g	2269.1	2273.2	2272.2					2271.6	
Water Gained (SSD-Dry	62.9	68.9	69.7					63.7	
% Saturation	62.4%	68.7%	71.2%					69.8%	
After 24 Hours Soaking in 60° C Water and 2 Hours in 25° C Water									
Load - lb	3220	3400	3070	3600	3550	3690			
Tensile Strength, psi	91.35	96.45	87.09	102.13	100.71	104.68			
Average	91.63			102.51					

TSR	**89.4%**

Appendix C

Connecticut DOT Modified Version of AASHTO T283

MOISTURE SUSCEPTIBILITY

AASHTO T 283 MODIFICATIONS

(1998)

For Section 9.2

Delete first sentence, and insert the following sentence:

The dry subset shall be tested immediately.

For Section 9.3.2

Delete first paragraph and insert the following:

9.3.2 Determine bulk specific gravity by AASHTO T 166. Calculate total volume of absorbed water using the following formula:

Water Pickup = I - A

where: I = Vacuum saturated-surface Dry Mass, and
A = Specimen Dry Weight.

For Section 9.3.3

Delete first sentence, and insert the following:

Determine degree of saturation by dividing volume of absorbed water with volume of air voids. Refer to Table 1, M, % Sat. (R/H x 100).

After Section 9.3.7

Delete Note 2 after Section 9.3.7, and insert Table 1

For Section 11

Add the following formulas:

Tensile Strength kPa (psi)	$S_1 = \frac{2P}{\pi t D}$

Tensile Strength Ratio	$\frac{\text{ATS CS}}{\text{ATS UCS}} \times 100$

S_1 = tensile strength (kPa) (psi)
P = maximum load (Newton) (lb_f) x 4.448 = Newtons
t = specimen thickness, mm (in)
D = specimen diameter, mm (in)
ATS CS = Average Tensile Strength of Conditioned Specimens
ATS UCS = Average Tensile Strength of Unconditioned Specimens

TABLE 1 - MOISTURE SUSCEPTIBILITY - AASHTO T 283

Mixture		Date:
AC by Weight: %		

			CONDITIONED SPECIMENS			UNCONDITIONED SPECIMENS		
		TRIAL MOLD						
Diameter: mm (in.)	a							
Thickness: mm (in.)	b							
Weight: Dry	A							
Weight: SSD	B							
Weight: Under Water	C							
Volume: B-C	D							
Bulk Gravity: A/D	E							
Maximum Gravity:	F							
Air Voids: % = (100) (F-E/F)	G							
Air Voids, Volume: (GD/100)	H							
After 2-5 min 508 mm (20 in.) Hg Vacuum Saturation in 25 °C (77 °F) Water								
Weight: SSD	I							
Weight: Under Water	J							
Volume: I-J	K							
Bulk Gravity: A/K	K1							
Water Pickup: I-A	L							
Saturation %: L/H x 100	M							
Swell %: K-D/D x 100	N							
After soaking 24 hours in 60 °C (140 °F) Water & 2 hours in 25 °C (77 °F) Water								
Average thickness mm								
Weight: Under Water	O							
Weight: SSD	P							
Volume: (P-O)	Q							
Water Pickup: P-A	R							
Saturation %: R/H x 100	S							
Swell: %: Q-D/D x 100	T							
Load: Newton (lb_f).								
Tensile Strength kPa (psi) (1)								
Avg. Indirect Tensile Strength								
Tensile Strength Ratio (2) Conditioned/Unconditioned								
Std. Indirect Tensile Strength								
Relative Variation in Strength								
Coarse Aggregate Stripped: %								
Fine Aggregate Stripped: %								

(1) Tensile Strength kPa (psi) $S_1 = \frac{2P}{\pi t D}$

(2) Tensile Strength Ratio $\frac{\text{ATS CS}}{\text{ATS UCS}} \times 100$

S_1 = tensile strength (kPa) (psi)
P = maximum load (Newton) (lb_f) x 4.448 = Newtons
t = specimen thickness, mm (in)
D = specimen diameter, mm (in)
ATS CS = Average Tensile Strength of Conditioned Specimens
ATS UCS = Average Tensile Strength of Unconditioned Specimens

SUGGESTIONS ON PERFORMING
AASHTO T 283 (Modified)
with
SUPERPAVE MIXTURES

1998

SCOPE:

The scope of these suggestions is twofold: to assess AASHTO T 283 moisture susceptibility testing of Superpave Gyratory Compactor (SGC) specimens and to outline a work plan for performing this testing.

OBJECTIVE OF TESTING:

The objective of this testing is to have six (6) SGC specimens compacted to contain 6-8 percent air voids.

Three (3) of the specimens are conditioned to 55-80 percent water saturation and subjected to a freeze-thaw cycle, and three (3) are used as control specimens. The six specimens are split and their tensile strength ratios (TSR) calculated. They are then analyzed for evidence of stripping.

OUTLINE OF WORK PLAN

MIXTURE PREPARATION:

- Obtain representative samples of coarse and fine aggregates.
- Dry materials and perform gradations.
- Calculate specific gravities on all individual components.
- Determine G_{sb} of mixture.
- Blend portions of material to fit Superpave mix design criteria.
- Run experimental blend of materials and AC (mix approximately 90 seconds).
- Mix one portion of approximately 2000 grams to be used as a "butter" batch and for maximum theoretical gravity.
- Mix one portion of approximately 4000 grams to be compacted by SGC (see Notes 1 and 2).

  Note 1: Sample height for Gyratory mold specimen should be set to 95 mm on SGC to maintain same ratio as with Marshall method. Larger molds may be too large to fit in Lottman head assembly for tensile strength testing.

  Note 2: To obtain a yield of approximately 6-8 percent air voids, use the following formula:

Mass = Volume of specimen x Theoretical gravity x (0.90)*

*The mass desired is one that will yield 7 percent air voids or 93 percent density. To compensate for surface voids and different mixture characteristics, an additional 3-5 percent may have to be deducted from density; therefore, the (0.90) may vary between (0.88) to (0.93).

EXAMPLE: $\pi \cdot r^2 \cdot h \cdot G_{mm} \cdot (\pm 0.90)(0.001) = 3.14 \cdot 75^2 \cdot 95 \cdot 2.633 \cdot (\pm 0.90) \cdot (0.001) = 3976.2$ g

- Compact Gyratory mold specimen and compute voids obtained.
- Verify that percent of air voids are within the 7 ± 1 percent range, proceed with testing.

WATER SUSCEPTIBILITY TESTING

STEP 1

- Start mixing of samples on either Tuesday or Wednesday to allow time to form specimens and prepare for curing on Friday of the same week (as specified in Step 6).
- Dry all materials necessary to make eight (8) gyratory molds and one (1) theoretical gravity.
- Place the individual pans, 30.5 cm x 50.8 cm (12 in x 20 in), of proportioned blends, the AC, mixing bowl and paddle into the oven and heat to mixing temperature 10 ^{0}C higher than what is determined by the viscosity chart, typically 162-167 ^{0}C (323.6-332.6 ^{0}F).
- With proper mixing temperature obtained, start with maximum theoretical specific gravity sample by mixing a mass based on the aggregate nominal maximum size as a butter batch and continue with the next eight (8) samples (approximately 4000 grams each).

Step 2

- Cool mixtures at room temperature for 2 to 2 1/2 hours in flat pans 30.5 cm x 50.8 cm (12 in x 2 in).

Step 3

- Place in oven at 60 ^{0}C (140 ^{0}F) for 16 hours.
- Be sure pans have airflow above and below.
- Preheat mold collars in separate oven set at compaction temperature of the design HMA, typically 145 °C (293 °F).

Step 4

- Age material for 2 hours at 135 ^{0}C (275 ^{0}F).

Step 5

- Place material in oven set at compaction temperatures of the design HMA, typically 145 ^{0}C (293 ^{0}F) for 1/2 hour.
- Compact specimens.

Step 6

- Extract specimens.
- Allow to remain at room temperature for 72-96 hours.

Step 7

- Test specimens to determine bulk specific gravities and percent air voids.

Step 8

- Select two groups of three specimens each so that both groups have the closest average of percent voids possible.
- Determine which group will be conditioned and which will be unconditioned.
- The conditioned specimen group will be saturated and subjected to a freeze-thaw cycle.
- The unconditioned specimen group will be tested immediately, as specified in Step 13 and 14.
- Save two additional molds for determining saturation in Step 9.

Step 9

- To determine proper saturation, vacuum and time, place one of two additional test molds not selected for either group into a bowl, elevating it 25.4 mm (1 in) above the bottom by wire mesh.
- Fill the bowl with distilled water, covering the mold by approximately 25.4 mm (1 in) above the surface.
- Apply vacuum at 20 inches Hg for 2-5 minutes.
- Allow mold to remain in water for 5-10 minutes, then weigh mold in water and weigh in the SSD state. This enables you to determine the percent saturation. (If saturation is not 55-80 percent, adjust vacuum or time duration as needed. If specimen has been saturated beyond 80 percent, it cannot be used because it has been damaged.)

Step 10

- Saturate the subset to be conditioned as determined in Step 9.
- Compute both bulk specific gravity and percent saturation.
- Wrap with plastic, tape and place into freezer bag containing 10 ml water.

Step 11

- Place conditioned specimens into freezer 17.7 ^{0}C ± 3 ^{0}C (0 ^{0}F ± 5 ^{0}F) for a minimum of 16 hours.
- Heat hot water baths to 60 ^{0}C (140 ^{0}F) temperature prior to completion of the 16-hour cycle above.

Step 12

- Immerse conditioned specimens in bags directly into 60 ^{0}C (140 ^{0}F) bath for approximately 10 minutes to facilitate removal of plastic wrap.
- Remove bags and wrapping and return specimens to bath for 24 hours.
- Before leaving for the day, check to be sure water levels are above molds.

Step 13

- Immerse conditioned specimens into 25 ^{0}C ± 6 ^{0}C (77 ^{0}F ± 1 ^{0}F) bath for 2 hours (ice may be necessary to stabilize temperature).
- Place unconditioned specimens into 25 ^{0}C ± 6 ^{0}C (77 ^{0}F ± 1 ^{0}F) bath for 2 hours.

Step 14

- Re-adjust height on Marshall stability tester to accommodate larger Lottman head to determine tensile strength, if necessary.
- Apply loading to specimens until failure.
- Continue loading until you can split molds in half to determine magnitude of stripping present, if any.
- Calculate all 6 tensile strengths using formula shown on data sheet.
- Calculate two tensile strength ratios by using the following formula:

$$\text{Tensile Strength Ratio} = \frac{\text{ATS CS}}{\text{ATS UCS}} \times 100$$

ATS CS = Average Tensile Strength of Conditioned Specimens
ATS UCS = Average Tensile Strength of Unconditioned Specimens

STEP	TIME AND TEMPERATURE	TIME FRAME (suggested)	DAY
1 *	Mix sample 162-167 ^{0}C (323.6-332.6 ^{0}F) 90 seconds mix time.	12:30 p.m. - 1:00 p.m.	1
2	Cool to room temperature in flat pans (12 in x 20 in) for 2 to 2 1/2 hours.	1:00 p.m. - 3:00 p.m.	1
3	Place in oven at 60 ^{0}C (140 ^{0}F) for 16 hours.	3:00 p.m. - 7:00 a.m.	2
4	Age for 2 hours at 135 ^{0}C (275 ^{0}F).	7:00 a.m. - 9:00 a.m.	2
5	Place molds in oven at compaction Temperature 145 ^{0}C (293 ^{0}F) for 1/2 hour.	9:00 a.m. - 9:30 a.m.	2
6	Extract molds and place at room temperature for 72-96 hours.	9:30 a.m.-9:30 a.m.	2
7	Test molds for bulk specific gravity and % Air Voids	9:30 a.m.-3:30 p.m.	5
8	Select 3 specimens for conditioning and 3 for unconditioning.	9:30 a.m.-3:30 p.m.	5
9	Determine saturation time on extra molds.	9:30 a.m.-3:30 p.m.	5
10	Saturate subsets to be conditioned.	9:30 a.m.-3:30 p.m.	5
11	Place conditioned specimens in freezer 17.7 ^{0}C ± 3 ^{0}C (0 ^{0}F ± 5 ^{0}F) for a minimum of 16 hours.	3:30 p.m.-8:00 a.m.	6
12	Immerse conditioned specimens in hot water bath 60 ^{0}C ± 1 ^{0}C (140 ^{0}F ± 1.8 ^{0}F) for 24 hours.	8:00 a.m.-8:00 a.m.	7
13	Immerse conditioned and unconditioned specimens in water bath 25 ^{0}C ± 6 ^{0}C (77 ^{0}F ± 1 ^{0}F) for 2 hours.	8:00 a.m.-10:00 a.m.	7
14	Tensile Test specimens.	10:00 a.m.-3:00 p.m.	7

*Temperature must reach at least 162 ^{0}C (323.6 ^{0}F) before 12:30 p.m. to meet chart time and temperature.

Appendix D

HMA used for ConnDOT Modified Version Aggregate Sources and Placement Locations

Material Producer	ConnDOT Project Number
Balf – Manchester	Unknown
Balf – Newington	118-140
Galasso – East Granby	174-269D
Lane – Sheffield, MA	174-269P
O & G – Stamford	173-312F
O & G – Torrington	174-269J
O & G – Woodbury	174-262N
Palmer – Palmer, MA	171-272C
Soneco – Groton	94-183
Soneco – Montville	172-300G
Suzio – Meriden	79-183
Tilcon – North Branford	173-311F
Tilcon – Danbury	34-287
Tilcon – New Britain	88-147
Tilcon – Wallingford	151-276
Tilcon – Wauregan	172-299H

Class 1 Hot-mix samples for CAP Lab

Date: 7/14, 1998

Sampler: ANTONIAK & MUSZYNSKI

Company Operating Plant: GALASSO

Plant Location: EAST GRANBY

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate GALASSO E. GRANBY

Source of Manufactured Fines GALASSO E. GRANBY

Source of Natural Sand: GALASSO SOUTHWICK

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 318

Location: BARKHAMSTED

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 8/12, 1998

Sampler: M. CRUESS

Company Operating Plant: LANE SA

Plant Location: SHEFFIELD

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate LANE WESTFIELD MA

Source of Manufactured Fines LANE W. STOCKBRIDGE MA.

Source of Natural Sand: LANE LENOX DALE MA

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 44

Location: SALISBURY

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/23, 1998

Sampler: R. DEMATTIES

Company Operating Plant: O & G

Plant Location: STAMFORD

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate TILCON NO. BRANFORD

Source of Manufactured Fines N.Y. TRAP & CLINTON POINT N.Y.

Source of Natural Sand: COW BAY N.J.

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 123

Location: NEW CANAAN.

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 8/3, 1998

Sampler: S. MANN

Company Operating Plant: O&G

Plant Location: TORRINGTON

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate O&G WOODBURY

Source of Manufactured Fines _____

Source of Natural Sand: O&G TORRINGTON

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 63

Location: GOSHEN

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/23, 1998

Sampler: M. ANTONIAK

Company Operating Plant: O&G

Plant Location: WOODBURY

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate O&G WOODBURY

Source of Manufactured Fines O&G WOODBURY

Source of Natural Sand: SCANIA BRISTOL

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 6

Location: BETHEL

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 9/02, 1998

Sampler: J. MUSZYNSKI

Company Operating Plant: PALMER

Plant Location: PALMER MA.

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate LANE WESTFIELD

Source of Manufactured Fines LANE WESTFIELD

Source of Natural Sand: PALMER MA

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 20%

Site where material is to be used: Route # RT 31

Location: COVENTRY

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7 / 14 , 1998

Sampler: D NOTO

Company Operating Plant: SONECO

Plant Location: GROTON

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate NE I MONTVILLE

Source of Manufactured Fines NE I MONTVILLE

Source of Natural Sand: NE I GRISWOLD

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # RT. 32

Location: NEW LONDON

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/14, 1998

Sampler: DOUGHTY / BAUER

Company Operating Plant: SONECO

Plant Location: MONTVILLE

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate NE 1 MONTVILLE

Source of Manufactured Fines NE 1 MONTVILLE

Source of Natural Sand: NE 1 GRISWOLD

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 20%

Site where material is to be used: Route # 49

Location: VOLUNTOWN

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 8/21, 1998

Sampler: PROJECT INSP.

Company Operating Plant: SUZIO

Plant Location: MERIDEN

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate YORK HILL MERIDEN

Source of Manufactured Fines YORK HILL MERIDEN

Source of Natural Sand: EARTH PRODUCTS DEEP RIVER

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # EAST MAIN ST.

Location: MERIDEN

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/14, 1998

Sampler: R. DEMATTIES

Company Operating Plant: TILCON

Plant Location: DANBURY

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate TILCON WALLINGFORD & N. BRANFORD

Source of Manufactured Fines TILCON WALLINGFORD & N. BRANFORD

Source of Natural Sand: SCALIA - BRISTOW

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 7

Location: DANBURY

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/30, 1998

Sampler: M. ANTONIAK

Company Operating Plant: TILCON

Plant Location: NEW BRITAIN

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate NEW BRITAIN TILCON

Source of Manufactured Fines NEW BRITAIN TILCON

Source of Natural Sand: SOUTHINGTON TILCON

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # MAIN ST.

Location: NEW BRITAIN

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/23, 1998

Sampler: D. NOTO

Company Operating Plant: TILCON

Plant Location: NO. BRADFORD.

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate TILCON NO. BRADFORD

Source of Manufactured Fines TILCON NO. BRADFORD.

Source of Natural Sand: KOBYLUCK

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 15-0%

Site where material is to be used: Route # 114

Location: ORANGE

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/28, 1998

Sampler: S DOUGHTY

Company Operating Plant: TILCON

Plant Location: WALLINGFORD

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate TILCON WALLINGFORD

Source of Manufactured Fines TILCON WALLINGFORD

Source of Natural Sand: MACCLAIN GLASTONBURY

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 25%

Site where material is to be used: Route # I 84

Location: WATERBURY

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 9 / 2, 1998

Sampler: J. DOUGHTY

Company Operating Plant: TILCON

Plant Location: WAUKEGAN

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate TILCON WAUKEGAN

Source of Manufactured Fines TILCON WAUKEGAN

Source of Natural Sand: TILCON WAUKEGAN

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # 14

Location: CANTERBURY

Comments:

Class 1 Hot-mix samples for CAP Lab

Date: 7/16, 1998

Sampler: R. DEMATTIES

Company Operating Plant: BALF

Plant Location: NEWINGTON

Plant QC Lab Technician: _____

Plant Lab. Phone: ( ) _____ - _____

Quarry source of Coarse Aggregate BALF NEWINGTON

Source of Manufactured Fines BALF NEWINGTON

Source of Natural Sand: BALF MANCHESTER

Binder Grade: _____

Binder Source: _____

What % Rap in mix? 0

Site where material is to be used: Route # I-91

Location: ROCKY HILL

Comments: