The Advanced Characterization Testing of the Port Authority of NY/NJ's Hot Mix Asphalt Materials

- Rosphalt Material Test Results -

Submitted to:

The Port Authority of NY/NJ, Materials Engineering Division
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Conducted by:

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SCOPE OF WORK

The scope of work encompasses the advanced characterization of the Rosphalt 50 hot mix asphalt material for the Port Authority of NY/NJ's. The advanced characterization is comprised of using the Repeated Load Permanent Deformation test as described by NCHRP 465, and the Flexural Beam Fatigue device. The Repeated Load was used to evaluate the rutting potential of HMA, while the Flexural Beam Fatigue was used to evaluate the fatigue properties of the HMA materials.

MATERIALS TESTED

The Rosphalt 50 hot mix asphalt (R-50) was evaluated for both permanent deformation and flexural fatigue properties. The PANYNJ provided two different mix designs proposed for use with the Rosphalt material. The first design was conducted to a design air void level of 1%, while the second design was conducted to a design air void level of 3%. The PANYNJ requested testing conducted at the design air void level and 2.0% above design air void level for the flexural fatigue tests. Permanent deformation testing was only conducted on the 1% design air void level mix.

For the flexural fatigue testing, a Flexural Beam Fatigue device described by AASHTO 321, was used to evaluate the fatigue properties of the R-50 designed and compacted in four different manners; 1) R-50 designed at 1% air voids and tested at 1% air voids, 2) R-50 designed at 1% air voids and tested at 3% air voids, 3) R-50 designed at 3% air voids and tested at 3% air voids, and 4) R-50 designed at 3% air voids and tested at 5% air voids. The fatigue testing was conducted under a constant-strain test mode at a test temperature of 15^{o}C (59^{o}F). A haversine waveform was applied at a rate of 2 Hz (2 loads per second) and a magnitude of 900 micro-strains. The loading type described was supposed to simulate the typical loading and bending action on the orthotropic steel decks on the George Washington Bridge.

For the Repeated Load Permanent Deformation testing, the permanent deformation properties of the HMA samples were measured by applying a 20 psi cyclic stress on a cylindrical sample that had been heated to 140^{o}F. The testing specifications followed those outlined in NCHRP 465. Permanent deformation testing was only conducted on the R-50 designed at 1% air voids and tested at 1% air voids and also the R-50 designed at 1% air voids and tested at 3% air voids, as requested by the PANYNJ.

Flexural Fatigue Test Results

All samples were tested at a test temperature of 15^{o}C. The test specimens were tested until approximately 3,000,000 loading cycles, or until the specimen's flexural strength reached a pre-determined minimum value. Samples that were tested out until 3,000,000 cycles lasted 17 days due to the slower loading frequency (2 Hz or 2 loads per second). Testing was only conducted at 900 μ-strains due to the extremely, high fatigue resistance of the Rosphalt 50 material.

Throughout the test, the flexural stiffness of the samples was calculated and recorded. The stiffness of the beams was plotted against the load cycles and the resulting data was fitted to an exponential function as follows (AASHTO T321):

$$S = S_O e^{bN} \quad (1)$$

where,

S = flexural stiffness after the n load cycles;
S_O= initial flexural stiffness;
e = natural algorithm to the base e
b = constant from regression analysis
N = number of load cycles

Equation (1) was then modified to determine the number of loading cycles to achieve 50% of the initial flexural stiffness

The test results for the four different Rosphalt 50 HMA mixes are shown in Figure 1 and Table 1. The flexural beam fatigue results show that as long as the compacted air voids are less than 3% air voids, the R-50 material will provide excellent fatigue resistance.

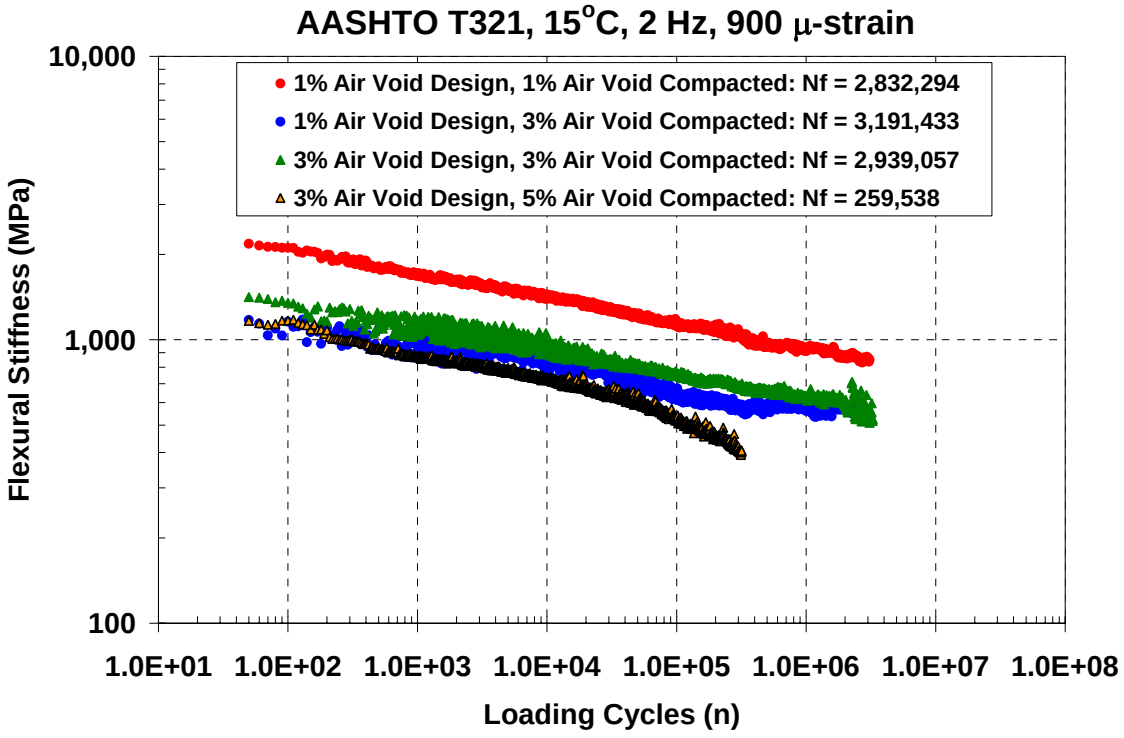


Figure 1 – Flexural Beam Fatigue Test Results for the Rosphalt 50 Material

Table 1 – Flexural Beam Fatigue Test Results for Rosphalt 50 Material

Sample Type	Air Voids (%)	Initial Stiffness, S_O (MPa)	Exp. Constant, b	Fatigue Life, $N_{f, 50\%}$ (cycles)
1% Air Void Design, 1% Air Void Compacted	1.4	1,347,7	-2.45E-07	2,832,294
1% Air Void Design, 3% Air Void Compacted	2.7	782.9	-2.17E-07	3,191,433
3% Air Void Design, 3% Air Void Compacted	3.1	891.4	-2.36E-07	2,939,057
3% Air Void Design, 5% Air Void Compacted	4.5	766.6	-2.67E-06	259,538

Repeated Load Permanent Deformation Testing of Rosphalt HMA (R-50)

Three samples each of the 1% design/tested at 1% air voids and 1% design/tested at 3% air voids were tested using the Repeated Load Permanent Deformation test. The permanent deformation properties used for evaluation/comparison, and outlined in NCHRP Report 465, were:

1. Flow Number (F_N) – The larger the flow number, the more resistant the HMA mix is to permanent deformation;
2. Slope of the Linear Portion of the Permanent Strain vs Cycles Plot (b) – The larger the slope, the greater the potential for rutting in the field and the faster the rutting accumulates; and
3. Accumulated Permanent Deformation at 1,000 Loading Cycles (ε_P (%) @ N = 1,000) – The larger the e_P (%) @ 1,000 cycles, the greater the potential for rutting in the field.

These three parameters were shown to provide the best correlation to measured field rutting (NCHRP 465) when conducting the repeated load permanent deformation test. The correlation results determined in NCHRP 465 are shown in Table 2.

The table clearly shows that at the test temperature of 130^{o}F, the R^2 values for the 3 parameters when compared to measured field rutting were all greater than 0.86. This should also correspond to the requested test temperature of 140^{o}F used in this study.

Table 2 – Results of Test Parameter Correlation to Field Rutting (NCHRP 465)

Unconfined Repeated Load	Model	100°F				130°F			
		R^2	Se/Sy	Rational	Rating	R^2	Se/Sy	Rational	Rating
Flow Number (F_N)	Power	0.96	0.229	Yes	Excellent	0.90	0.359	Yes	Good
Slope (b)	Linear	0.59	0.743	Yes	Fair	0.87	0.393	Yes	Good
Permanent Strain	Linear	0.95	0.256	Yes	Excellent	0.86	0.410	Yes	Good
Resilient Strain	Linear	0.90	0.362	Yes	Excellent	0.66	0.652	Yes	Fair
Resilient Modulus at Flow	Linear					0.72	0.548	Yes	Good
$\varepsilon_p/\varepsilon_r$ Ratio	Linear	0.83	0.472	Yes	Good	0.59	0.676	Yes	Fair
Mu (μ)	Linear	0.79	0.530	-	Good	0.25	0.881	-	Poor
Intercept (a)	Linear	0.30	0.964	Yes	Poor	0.13	1.055	Yes	Very Poor

A summary of the permanent deformation parameters are shown in Table 3 and the permanent deformation plots are shown in Figure 2 and Figure 3. Samples #1 and #2 were not used in the calculation of the average values. During the sample preparation process, coring in particular, both Sample #1 and #2 witnessed extreme bleeding of the asphalt binder and almost seized the core barrel during coring. It is believed that during this coring process, as well as the extraction process of the samples from inside the core barrel, Sample #1 and Sample #2 may have been damaged. This is in agreement with the permanent deformation results shown in Table 3, Figures 2 and 3. A resolution to the excessive bleeding and seizing problem was quickly found by freezing the samples overnight prior coring.

Table 3 - Summary of Test Results from the Repeated Load Permanent Deformation Test for Rosphalt HMA

Sample Type	Sample ID	Air Voids (%)	Flow Number (FN)	Permanent Strain (%)		Slope (b)
				@ 1,000 Cycles	@ 10,000 Cycles	
1% Air Void Design, 1% Air Void Compacted	#1	1.2	> 20,000	0.958	1.484	0.184
	#3	0.5	> 20,000	0.268	0.372	0.143
	#6	0.7	> 20,000	0.234	0.325	0.14
	Average	***0.6***	***> 20,000***	***0.251***	***0.349***	***0.142***
1% Air Void Design, 3% Air Void Compacted	#2	2.9	6,500	0.725	2.267	0.302
	#4	2.7	> 20,000	0.315	0.474	0.18
	#8	2.5	> 20,000	0.205	0.272	0.122
	Average	***2.6***	***> 20,000***	***0.260***	***0.373***	***0.151***

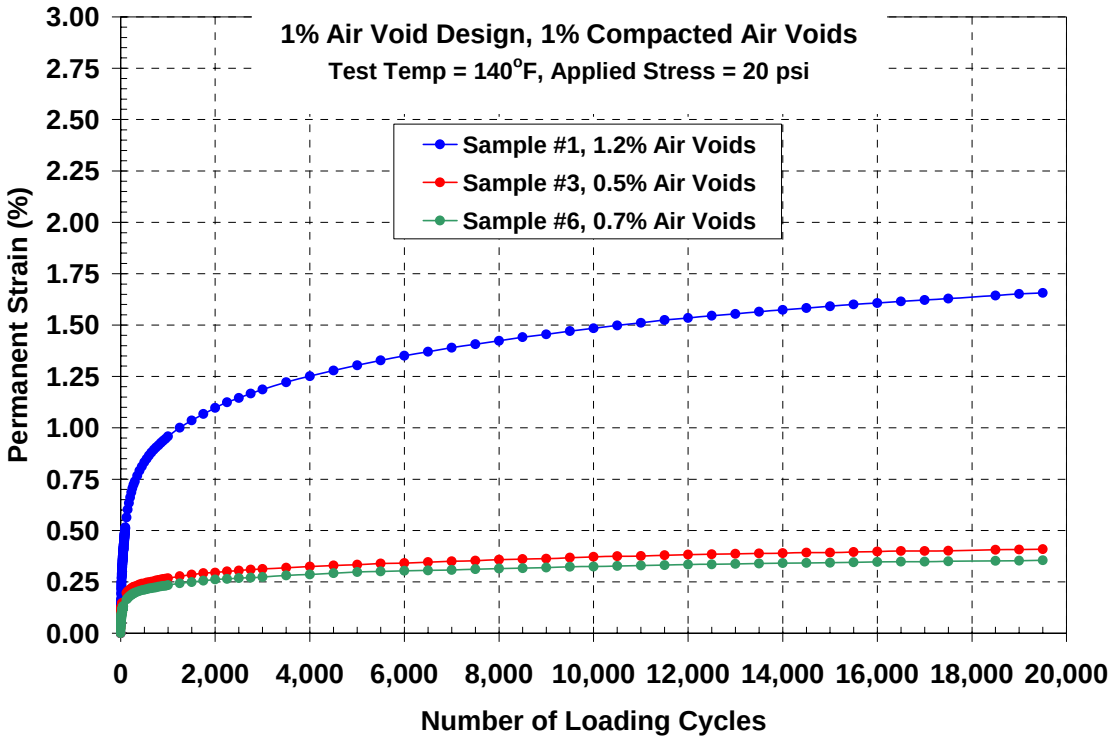


Figure 2 – Permanent Deformation Plots of 1% Air Void Design and 1% Air Void Compacted

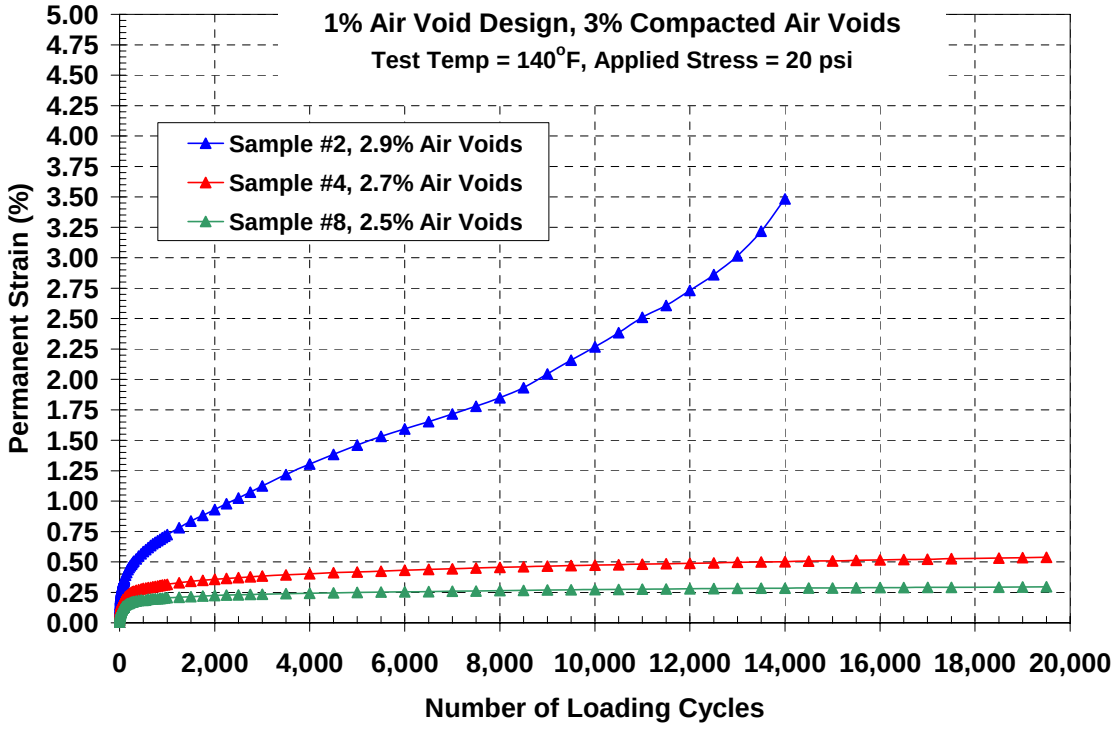


Figure 3 – Permanent Deformation Plots of 1% Air Void Design and 3% Air Void Compacted

The results of the permanent deformation testing indicated that:

- The flow number (F_N) of the 1% Air Void Compacted mix and 3% Air Void Compacted mix were shown to both be >20,000 loading cycles. It should be noted that the testing procedure used in the study was held to a maximum of 20,000 loading cycles.
- The slope of the permanent strain curve (b) for the 1% Air Void Compacted mix was found to be slightly less than that of the 3% Air Void Compacted mix. This would indicate that the 1% Air Void Compacted mix would accumulate permanent deformation at a lesser rate when compared to the 3% Air Void Compacted mix.
- The permanent deformation measured at the 1,000th loading cycle for the 1% Air Void Compacted mix was slightly lower than the 3% Air Void Compacted mix. This would indicate that the 1% Air Void Compacted mix would accumulate a lesser amount of permanent strain than the 3% Air Void Compacted mix.

Asphalt Pavement Analyzer Test Results

Although not part of the testing plan, the Asphalt Pavement Analyzer (APA) was also used to determine the rutting potential of the Rosphalt HMA. The APA is a loaded wheel testing unit that tests the rutting potential of HMA by running a loaded wheel over a pressurized hose which lies directly on the HMA samples. The testing was conducted using a 100 psi pressurized hose with a 100 lb wheel load being applied to the hose. All testing was conducted at 147^{o}F (64^{o}C).

To compare the test results, the APA rutting at 8,000 loading cycles is typically used by industry for comparative purposes. All Rosphalt 50 samples tested were compacted to the same target air voids as the Repeated Load Permanent Deformation tests. The APA tests results are shown in Figure 4. The results indicate that the 1% Air Void Design, 1% Air Void Compacted samples is slightly less susceptible to rutting than the 1% Air Void Design, 3% Air Void Compacted samples.

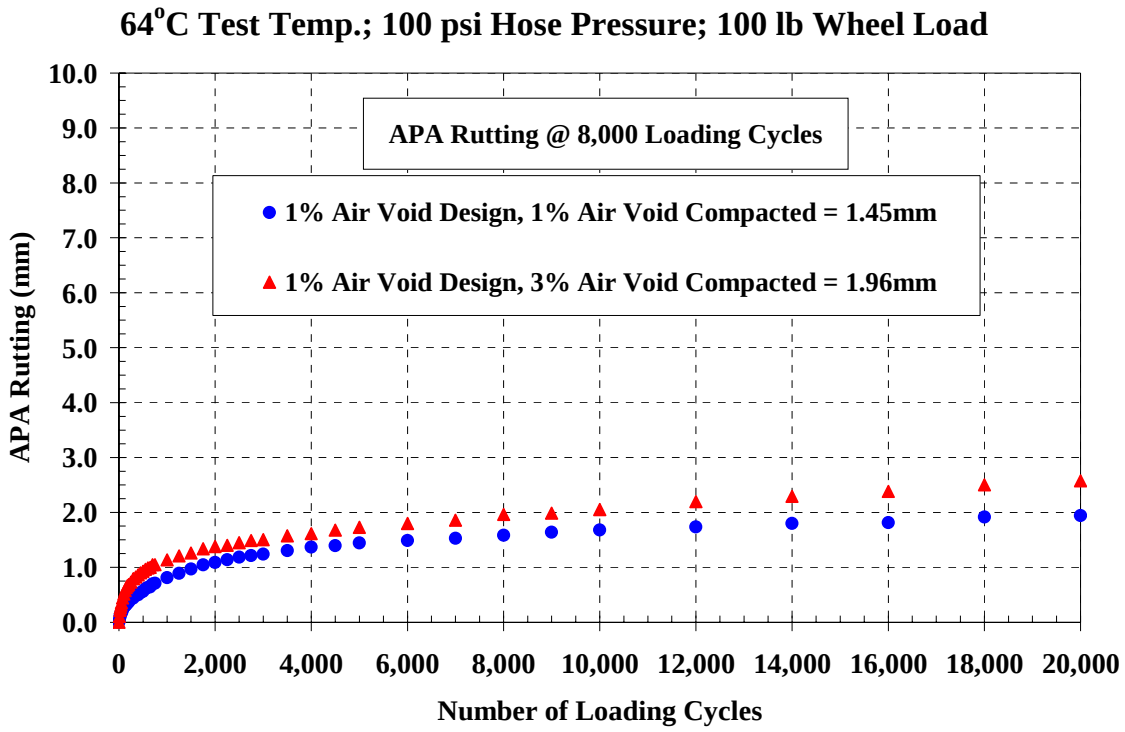


Figure 4 – Asphalt Pavement Analyzer Test Results for Rosphalt 50 Samples

Summary of Performance Testing

The permanent deformation and fatigue resistance properties of the Rosphalt 50 materials were determined using advanced material characterization testing procedures. The permanent deformation properties were evaluated using the Repeated Load Permanent Deformation test procedure as described by NCHRP 465, as well as the Asphalt Pavement Analyzer. The flexural fatigue properties were evaluated using the Flexural Beam Fatigue device and test procedure described in AASHTO T321.

Based on the performance testing, the following conclusions were drawn:

- The Flexural Beam Fatigue test results showed that the Rosphalt 50 material should provide excellent fatigue resistance when the compacted air voids are less than 3% for the mixes evaluated in this study. The one sample, 3% Air Void Design, 5% Air Void Compacted, had the lowest fatigue life of 259,538 cycles, while the other three samples had a **fatigue life one order of magnitude greater.**
- The Repeated Load Permanent Deformation testing showed that 1% Air Void Design, 1% Air Void Compacted had a slightly better rutting resistance than the 1% Air Void Design, 3% Air Void Compacted samples. The same conclusion was drawn from the Asphalt Pavement Analyzer testing.
- A summary of all the samples that have been tested to date regarding the rehabilitation of the George Washington Bridge is provided.

Table A – Summary of Flexural Beam Fatigue Tests Conducted at 900 μ-strains

Sample Type	Air Voids (%)	Initial Stiffness, S_o (MPa)	Exp. Constant, b	Fatigue Life, $N_{f, 50\%}$ (cycles)
R-50 1% Air Void Design, 1% Air Void Compacted	1.4	1,347,7	-2.45E-07	2,832,294
R-50 1% Air Void Design, 3% Air Void Compacted	2.7	782.9	-2.17E-07	3,191,433
R-50 3% Air Void Design, 3% Air Void Compacted	3.1	891.4	-2.36E-07	2,939,057
R-50 3% Air Void Design, 5% Air Void Compacted	4.5	766.6	-2.67E-06	259,538
Epoxy HMA	1.4	7,917.20	-4.17E-08	16,626,222
I-5, PG76-22, 5.9% AC	5.8	3,568.50	-6.00E-05	11,558
I-5, PG76-22, 6.3% AC	5.1	2,803.70	-3.91E-05	17,712

Table B – Summary of Repeated Load Permanent Deformation Tests

Sample Type	Sample ID	Air Voids (%)	Flow Number (FN)	Permanent Strain (%)		Slope (b)
				@ 1,000 Cycles	@ 10,000 Cycles	
R-50 1% Air Void Design, 1% Air Void Compacted	#3	0.5	> 20,000	0.268	0.372	0.143
	#6	0.7	> 20,000	0.234	0.325	0.14
	Average	***0.6***	***> 20,000***	***0.251***	***0.349***	***0.142***
R-50 1% Air Void Design, 3% Air Void Compacted	#4	2.7	> 20,000	0.315	0.474	0.18
	#8	2.5	> 20,000	0.205	0.272	0.122
	Average	***2.6***	***> 20,000***	***0.260***	***0.373***	***0.151***
Epoxy HMA	# 2	1.3	> 20,000	0.034	0.041	0.059
	# 7	1.8	> 20,000	0.02	0.024	0.054
	# 8	1.9	> 20,000	0.015	0.015	0.032
	Average	***1.85***	***> 20,000***	***0.018***	***0.020***	***0.043***
I-5, PG76-22, 5.9% AC	A	5.6	1,410	0.699	> 2.0	0.212
	C	5.8	1,961	0.629	> 2.0	0.192
	E	5.8	1,243	0.761	> 2.0	0.209
	Average	***5.8***	***1,538***	***0.695***	***> 2.0***	***0.200***
I-5, PG76-22, 6.3% AC	B	4.7	1,460	0.78	> 2.0	0.246
	C	5.3	1,703	0.819	> 2.0	0.232
	D	5.1	1,414	0.762	> 2.0	0.222
	Average	***5.2***	***1,526***	***0.791***	***> 2.0***	***0.227***

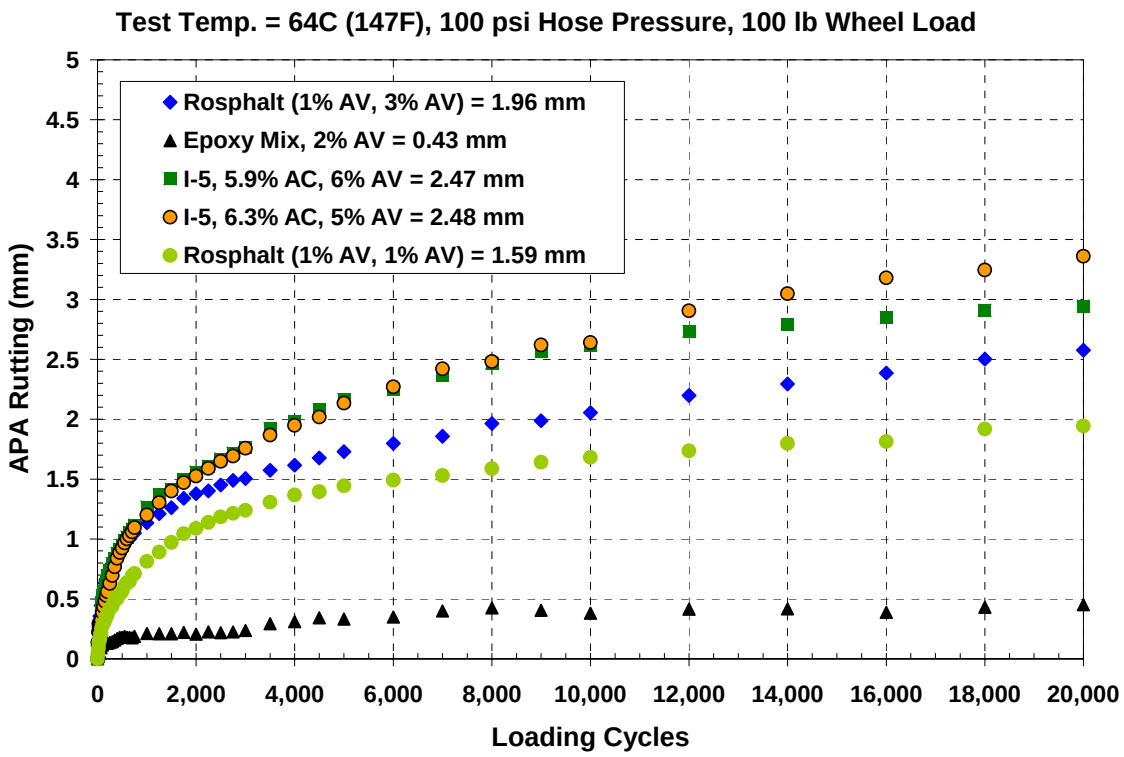


Figure A – Asphalt Pavement Analyzer Test Results

RELATED REFERENCES

Witczak, M.W., K.E. Kaloush, T. Pellinen, M. El-Basyouny, and H. Von Quintus, 2002, *Simple Performance Test for Superpave Mix Design, NCHRP Report 465.*

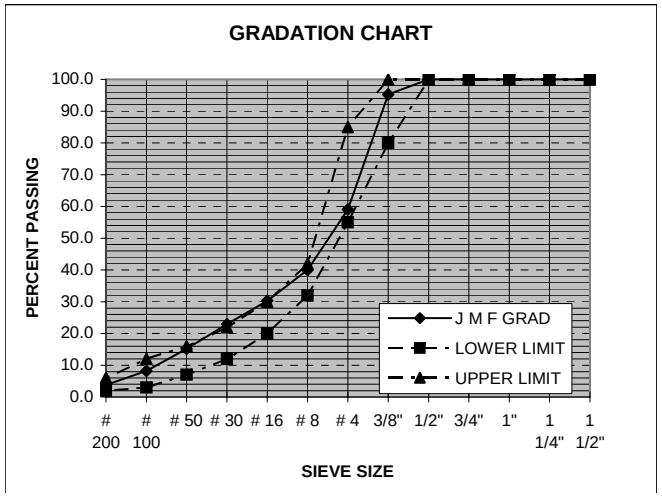
APPENDIX A – Mix Design for Rosphalt-50 1% Air Void Design

THE PORT AUTHORITY OF NY & NJ
MATERIALS ENGINEERING DIVISION
COMBINED BIN GRADATION ANALYSIS

Sieve	Bin 5			Sieve	Bin 4			Sieve	Bin3			Sieve	Bin 2			Sieve	Bin 1			Sieve	Filler		
Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass
Sample				Sample				Sample	5711.1			Sample	1535.1			Sample	780.7			Sample	142.4		
1 1/2"				1 1/2"				1 1/2"			100.0%	1 1/2"			100.0%	1 1/2"			100.0%	1 1/2"			100.0%
1 1/4"				1 1/4"				1 1/4"			100.0%	1 1/4"			100.0%	1 1/4"			100.0%	1 1/4"			100.0%
1"				1"				1"			100.0%	1"			100.0%	1"			100.0%	1"			100.0%
3/4"				3/4"				3/4"			100.0%	3/4"			100.0%	3/4"			100.0%	3/4"			100.0%
1/2"				1/2"				1/2"			100.0%	1/2"			100.0%	1/2"			100.0%	1/2"			100.0%
3/8"				3/8"				3/8"	833.8	14.6%	85.4%	3/8"	4.6	0.3%	99.7%	3/8"			100.0%	3/8"			100.0%
# 4				# 4				# 4	5574.0	97.6%	2.4%	# 4	620.1	40.4%	59.6%	# 4			100.0%	# 4			100.0%
# 8				# 8				# 8	5665.4	99.2%	0.8%	# 8	1493.6	97.3%	2.7%	# 8	92.1	11.8%	88.2%	# 8			100.0%
# 16				# 16				# 16				# 16	1515.1	98.7%	1.3%	# 16	263.9	33.8%	66.2%	# 16			100.0%
# 30				# 30				# 30				# 30	1521.3	99.1%	0.9%	# 30	400.5	51.3%	48.7%	# 30	1.7	1.2%	98.8%
# 50				# 50				# 50				# 50	1530.6	99.7%	0.3%	# 50	543.4	69.6%	30.4%	# 50	1.9	1.3%	98.7%
# 100				# 100				# 100				# 100	1532.3	99.8%	0.2%	# 100	673.0	86.2%	13.8%	# 100	2.7	1.9%	98.1%
# 200				# 200				# 200				# 200	1533.3	99.9%	0.1%	# 200	754.9	96.7%	3.3%	# 200	5.3	3.7%	96.3%
Pan				Pan				Pan				Pan				Pan				Pan			
Wash				Wash				Wash				Wash				Wash				Wash			

Sieve	Bin 5	Bin 4	Bin 3	Bin 2	Bin 1	Filler	Total	Job Tolerence		General Spec.		Sieve
Size			32.0	24.0	41.5	2.5	100.0	Lower	Upper	Lower	Upper	Size
1 1/2"			32.0	24.0	41.5	2.5	100.0	100	100	100	100	1 1/2"
1 1/4"			32.0	24.0	41.5	2.5	100.0	100	100	100	100	1 1/4"
1"			32.0	24.0	41.5	2.5	100.0	100	100	100	100	1"
3/4"			32.0	24.0	41.5	2.5	100.0	100	100	100	100	3/4"
1/2"			32.0	24.0	41.5	2.5	100.0	100	100	100	100	1/2"
3/8"			27.3	23.9	41.5	2.5	95.3			80	100	3/8"
# 4			0.8	14.3	41.5	2.5	59.1			55	85	# 4
# 8			0.3	0.6	36.6	2.5	40.0		40	32	42	# 8
# 16				0.3	27.5	2.5	30.3			20	30	# 16
# 30				0.2	20.2	2.5	22.9			12	22	# 30
# 50				0.1	12.6	2.5	15.2			7	16	# 50
# 100				0.0	5.7	2.5	8.2			3	12	# 100
# 200				0.0	1.4	2.4	3.8			2	6	# 200

CONTRACT #	Rosphalt 50
PLANT :	Tilcon NY Inc., Mt. Hope, NJ - 'C' Plant
MIX :	I-5A Rosphalt 50
TECHNICIAN :	J. Varrone, A. Frisvold
DATE:	########
REMARKS:	Trial # 4 (Target 1.0% air voids @ 75 blows)



THE PORT AUTHORITY OF NY & NJ
MATERIALS ENGINEERING DIVISION
LABORATORY BATCH PROPORTIONS

CONTRACT # :	Rosphalt 50
PLANT :	Tilcon NY Inc., Mt. Hope, NJ - 'C' Plant
MIX :	I-5A Rosphalt 50
TECHNICIAN :	J. Varrone, A. Frisvold
DATE :	1/24/2006
REMARKS :	Trial # 4 (Target 1.0% air voids @ 75 blows)

MATERIAL	LOT NUMBER	MATERIAL SOURCE	TYPE / SIZE	PROPORTIONS
BIN # 5 - 1 " STONE			1" STONE	**0.0** %
BIN # 4 - 3/4 " STONE			3/4" STONE	**0.0** %
BIN # 3 - 3/8 " STONE	A04-11	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	3/8" STONE	**29.5** %
BIN # 2 - 1/4 " STONE	A04-12	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	1/4" STONE	**22.2** %
BIN # 1 - STONE SAND		Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	STONE SAND	**38.3** %
SCREENINGS	A04-13			
FILLER	A04-14	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin		**2.3** %
ASPHALT CEMENT			PG64-22	**5.45** %
ADDITIVE		Royston Laboratories, Pittsburgh, PA	Rosphalt 50	**2.25** %

INDIVIDUAL COMPONENTS	PERCENTAGES BY WEIGHT	BATCH WEIGHTS IN GRAMS				
		1x4" MARSHALL	PCYNOMETER	3x4" MARSHALLS	1x6 " MARSHALL	GYRATORY
AGGREGATE TOTAL	**100.0%**	**1250.0**	**2000.0**	**4000.0**	**4200.0**	**4500.0**
BIN # 5 - 1 " STONE	**0.0%**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
BIN # 4 - 3/4 " STONE	**0.0%**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
BIN # 3 - 3/8 " STONE	**32.0%**	**400.0**	**640.0**	**1280.0**	**1344.0**	**1440.0**
BIN # 2 - 1/4 " STONE	**24.0%**	**300.0**	**480.0**	**960.0**	**1008.0**	**1080.0**
BIN # 1 - SCREENINGS	**41.5%**	**518.8**	**830.0**	**1660.0**	**1743.0**	**1867.5**
STONE SAND						
FILLER	**2.5%**	**31.3**	**50.0**	**100.0**	**105.0**	**112.5**
ASPHALT CEMENT	**5.45%**	**73.8**	**118.1**	**236.2**	**248.0**	**265.7**
ADDITIVE	**2.25%**	**30.5**	**48.8**	**97.5**	**102.4**	**109.7**

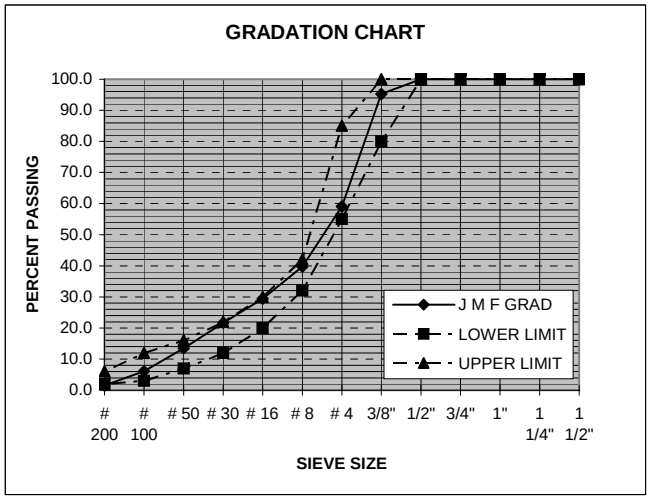
APPENDIX A – Mix Design for Rosphalt-50 3% Air Void Design

THE PORT AUTHORITY OF NY & NJ
MATERIALS ENGINEERING DIVISION
COMBINED BIN GRADATION ANALYSIS

Sieve	Bin 5			Sieve	Bin 4			Sieve	Bin3			Sieve	Bin 2			Sieve	Bin 1			Sieve	Filler		
Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass	Size	Wgt.	% Ret.	% Pass
Sample				Sample				Sample	5711.1			Sample	1535.1			Sample	780.7			Sample	142.4		
1 1/2"				1 1/2"				1 1/2"			100.0%	1 1/2"			100.0%	1 1/2"			100.0%	1 1/2"			100.0%
1 1/4"				1 1/4"				1 1/4"			100.0%	1 1/4"			100.0%	1 1/4"			100.0%	1 1/4"			100.0%
1"				1"				1"			100.0%	1"			100.0%	1"			100.0%	1"			100.0%
3/4"				3/4"				3/4"			100.0%	3/4"			100.0%	3/4"			100.0%	3/4"			100.0%
1/2"				1/2"				1/2"			100.0%	1/2"			100.0%	1/2"			100.0%	1/2"			100.0%
3/8"				3/8"				3/8"	833.8	14.6%	85.4%	3/8"	4.6	0.3%	99.7%	3/8"			100.0%	3/8"			100.0%
# 4				# 4				# 4	5574.0	97.6%	2.4%	# 4	620.1	40.4%	59.6%	# 4			100.0%	# 4			100.0%
# 8				# 8				# 8	5665.4	99.2%	0.8%	# 8	1493.6	97.3%	2.7%	# 8	92.1	11.8%	88.2%	# 8			100.0%
# 16				# 16				# 16				# 16	1515.1	98.7%	1.3%	# 16	263.9	33.8%	66.2%	# 16			100.0%
# 30				# 30				# 30				# 30	1521.3	99.1%	0.9%	# 30	400.5	51.3%	48.7%	# 30	1.7	1.2%	98.8%
# 50				# 50				# 50				# 50	1530.6	99.7%	0.3%	# 50	543.4	69.6%	30.4%	# 50	1.9	1.3%	98.7%
# 100				# 100				# 100				# 100	1532.3	99.8%	0.2%	# 100	673.0	86.2%	13.8%	# 100	2.7	1.9%	98.1%
# 200				# 200				# 200				# 200	1533.3	99.9%	0.1%	# 200	754.9	96.7%	3.3%	# 200	5.3	3.7%	96.3%
Pan				Pan				Pan				Pan				Pan				Pan			
Wash				Wash				Wash				Wash				Wash				Wash			

Sieve	Bin 5	Bin 4	Bin 3	Bin 2	Bin 1	Filler	Total	Job Tolerence		General Spec.		Sieve
Size			32.0	24.0	44.0		100.0	Lower	Upper	Lower	Upper	Size
1 1/2"			32.0	24.0	44.0		100.0	100	100	100	100	1 1/2"
1 1/4"			32.0	24.0	44.0		100.0	100	100	100	100	1 1/4"
1"			32.0	24.0	44.0		100.0	100	100	100	100	1"
3/4"			32.0	24.0	44.0		100.0	100	100	100	100	3/4"
1/2"			32.0	24.0	44.0		100.0	100	100	100	100	1/2"
3/8"			27.3	23.9	44.0		95.3			80	100	3/8"
# 4			0.8	14.3	44.0		59.1			55	85	# 4
# 8			0.3	0.6	38.8		39.7		40	32	42	# 8
# 16				0.3	29.1		29.4			20	30	# 16
# 30				0.2	21.4		21.6			12	22	# 30
# 50				0.1	13.4		13.4			7	16	# 50
# 100				0.0	6.1		6.1			3	12	# 100
# 200				0.0	1.5		1.5			2	6	# 200

CONTRACT #	Rosphalt 50
PLANT :	Tilcon NY Inc., Mt. Hope, NJ - 'C' Plant
MIX :	I-5A Rosphalt 50
TECHNICIAN :	J. Varrone, A. Frisvold, D. Rana
DATE:	2/1/2006
REMARKS:	Trial # 9 (Target 3.0% air voids @ 75 blows)



THE PORT AUTHORITY OF NY & NJ
MATERIALS ENGINEERING DIVISION
LABORATORY BATCH PROPORTIONS

CONTRACT # :	Rosphalt 50
PLANT :	Tilcon NY Inc., Mt. Hope, NJ - 'C' Plant
MIX :	I-5A Rosphalt 50
TECHNICIAN :	J. Varrone, A. Frisvold, D. Rana
DATE :	2/1/2006
REMARKS :	Trial # 9 (Target 3.0% air voids @ 75 blows)

MATERIAL	LOT NUMBER	MATERIAL SOURCE	TYPE / SIZE	PROPORTIONS
BIN # 5 - 1 " STONE			1" STONE	**0.0** %
BIN # 4 - 3/4 " STONE			3/4" STONE	**0.0** %
BIN # 3 - 3/8 " STONE	A04-11	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	3/8" STONE	**30.1** %
BIN # 2 - 1/4 " STONE	A04-12	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	1/4" STONE	**22.6** %
BIN # 1 - STONE SAND		Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin	STONE SAND	**41.4** %
SCREENINGS	A04-13			
FILLER	A04-14	Tilcon NY, Inc. - Mt. Hope NJ "C" Plant Hot Bin		**0.0** %
ASPHALT CEMENT			PG64-22	**3.75** %
ADDITIVE		Royston Laboratories, Pittsburgh, PA	Rosphalt 50	**2.25** %

INDIVIDUAL COMPONENTS	PERCENTAGES BY WEIGHT	BATCH WEIGHTS IN GRAMS				
		1x4" MARSHALL	PCYNOMETER	3x4" MARSHALLS	1x6 " MARSHALL	GYRATORY
AGGREGATE TOTAL	**100.0%**	**1250.0**	**2000.0**	**4000.0**	**4200.0**	**4500.0**
BIN # 5 - 1 " STONE	**0.0%**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
BIN # 4 - 3/4 " STONE	**0.0%**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
BIN # 3 - 3/8 " STONE	**32.0%**	**400.0**	**640.0**	**1280.0**	**1344.0**	**1440.0**
BIN # 2 - 1/4 " STONE	**24.0%**	**300.0**	**480.0**	**960.0**	**1008.0**	**1080.0**
BIN # 1 - SCREENINGS	**44.0%**	**550.0**	**880.0**	**1760.0**	**1848.0**	**1980.0**
STONE SAND						
FILLER	**0.0%**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
ASPHALT CEMENT	**3.75%**	**49.9**	**79.8**	**159.6**	**167.6**	**179.5**
ADDITIVE	**2.25%**	**29.9**	**47.9**	**95.7**	**100.5**	**107.7**