Airport Asphalt Pavement Technology Program

Balanced Mix Design: Rutting Performance Tests

Rutting Test Results

Appendix E

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Credit: NAPA

Airport Asphalt Pavement Technology Program

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The Airport Asphalt Pavement Technology Program (AAPTP) is a cooperative agreement effort between the **National Asphalt Pavement Association** (NAPA) and the **Federal Aviation Administration** (FAA) to advance asphalt pavements and pavement materials. The AAPTP advances solutions for asphalt pavement design, construction, and materials deemed important to airfield reliability, efficiency, and safety. The program leverages NAPA's unique technology implementation capabilities with assistance from the FAA and industry to advance deployment and adoption of innovative asphalt material technologies.

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Credit: NAPA

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List of Acronyms and Abbreviations

APA	Asphalt Pavement Analyzer
AV	Air voids
BMD	Balanced Mix Design
CI	Confidence interval
COV	Coefficient of variation
EWR	Newark Liberty International Airport
FAA	Federal Aviation Administration
HT-IDT	High temperature indirect tensile
HWTT	Hamburg wheel-tracking test
IRT	Ideal rutting test
LMLC	Laboratory-mixed laboratory-compacted
LTPP	Long-Term Pavement Performance
PHL	Philadelphia International Airport
RPMLC	Reheated plant-mixed laboratory-compacted
RT_{Index}	Rutting tolerance index
RTS	Reno Stead Airport
SFO	San Francisco International Airport
SMF	Sacramento International Airport
TPA	Tampa International Airport
TEB	Teterboro Airport

Executive Summary

This study aimed to establish representative rutting test protocols and criteria tailored to airfield asphalt mixtures, supporting the Federal Aviation Administration's (FAA's) balanced mix design (BMD) efforts at both the mix design and production stages. Four rutting test methods were evaluated, with an emphasis on laboratory protocols that best simulate field conditions by accounting for specimen preparation, air void (AV) levels, aging, conditioning, and test temperatures.

Experimental results revealed strong correlations between the rut depth from the Asphalt Pavement Analyzer (APA) at both 100 psi/100 lb and 250 psi/250 lb settings, the high temperature indirect tensile strength test, and the rutting tolerance index (RT_{index}) from the ideal rutting test. Enhanced correlations were observed when using Hamburg wheel-tracking test rut depths at 5,000 passes rather than 20,000 passes. An AV level of 7±0.5 percent was recommended for all rutting tests to ensure consistent specimen preparation.

A mechanistic-empirical approach was applied to refine the FAA's APA 250 psi/250 lb rutting test criterion by accounting for aircraft speed and load. The framework used the 3D-Move Analysis software tool to model pavement responses under varying temperatures, speeds, and loads, generating stress states for realistic field simulations.

Resulting rutting performance models quantified mixture sensitivity to operational conditions, leading to revised test criteria for slow/stationary aircraft and general airfield pavements. Laboratory verification of the recommended criteria was conducted using field cores from airfield sections with known performance. Revised specifications for P-401/P-403 asphalt mixtures are proposed. To expand BMD implementation into production, pilot projects are recommended to validate the proposed protocols and identify practical challenges. Long-term monitoring of sampled pavement sections will further refine correlations between laboratory criteria and in-service performance of airfield asphalt pavements.

Chapter 1. Laboratory-Mixed Laboratory-Compacted Samples

This chapter presents the full laboratory-mixed, laboratory-compacted sample (LMLC) data for the project experimental plan at the two selected air void (AV) levels, i.e., 5±0.5 percent and 7±0.5 percent, and at the relative environmental test temperature for each asphalt mixture. It is worth noting that the test temperature for each mixture was selected as the environmental Long-Term Pavement Performance Bind (LTPPBind) Online final performance grade, at surface with 50 percent reliability, and 12.5 mm target rut depth without any bumping.

The following five rutting tests were evaluated:

- Asphalt Pavement Analyzer (APA) test at 100 psi/100 lb: 150 m diameter by 75 mm height directly molded.
- APA test at 250 psi/250 lb: 150 mm diameter by 75 mm height directly molded.
- Hamburg wheel-tracking test (HWTT): 150 mm diameter by 62 mm height directly molded.
- High temperature indirect tensile (HT-IDT) test: 150 mm diameter by 62 mm height cut to 5 percent AV or directly molded to 7 percent AV.
- Ideal rutting test (IRT): 150 mm diameter by 62 mm height cut to 5 percent AV or directly molded to 7 percent AV.

Newark Liberty International Airport (EWR)

5±0.5 Percent AV Level

Table 1. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for EWR LMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 58 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.04	1.30	4.8
Replicate 2	0.85	1.09	4.7
Average	0.94	1.20	4.8
Standard Deviation	0.13	0.15	–
COV, %	14.09	12.43	–
95% CI – Lower Limit	0.76	0.99	–
95% CI – Upper Limit	1.13	1.40	–

CI = confidence interval; COV = coefficient of variation.

Table 2. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for EWR LMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 58 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	2.66	5.3
Replicate 2	2.73	5.5
Replicate 3	2.53	5.2
Average	2.64	5.3
Standard Deviation	0.10	–
COV, %	3.84	–
95% CI – Lower Limit	2.53	–
95% CI – Upper Limit	2.75	–

Table 3. HWTT Test Results at 5±0.5 Percent AV for EWR LMLC Samples

Rutting Test	HWTT; 5% AV; 58 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	3.2	3.4	3.6	4.5	–	4.8
Replicate 2	3.3	3.7	3.9	4.7	–	4.9
Average	3.3	3.6	3.8	4.6	–	4.9
Standard Deviation	0.07	0.21	0.21	0.14	–	–
COV, %	2.18	5.98	5.66	3.07	–	–
95% CI – Lower Limit	3.15	3.26	3.46	4.40	–	–
95% CI – Upper Limit	3.35	3.84	4.04	4.80	–	–

Table 4. HT-IDT Test Results at 5±0.5 Percent AV for EWR LMLC Samples

Rutting Test	HT-IDT; 5% AV; 58 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	30.20	4.8
Replicate 2	28.50	5.0
Replicate 3	36.30	4.5
Replicate 4	34.60	4.6
Average	32.40	4.7
Standard Deviation	3.66	–
COV, %	11.28	–
95% CI – Lower Limit	28.82	–
95% CI – Upper Limit	35.98	–

Table 5. IRT Results at 5±0.5 Percent AV for EWR LMLC Samples

Rutting Test	IRT; 5% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	122.40	4.7
Replicate 2	104.10	4.5
Replicate 3	115.90	5.1
Replicate 4	126.90	4.9
Average	117.33	4.8
Standard Deviation	9.91	–
COV, %	8.44	–
95% CI – Lower Limit	107.62	–
95% CI – Upper Limit	127.03	–

RT_{Index} = rutting tolerance index.

7±0.5 Percent AV Level

Table 6. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for EWR LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 58 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.28	1.50	7.0
Replicate 2	1.47	1.76	6.9
Average	1.38	1.63	6.9
Standard Deviation	0.13	0.18	–
COV, %	9.77	11.28	–
95% CI – Lower Limit	1.19	1.38	–
95% CI – Upper Limit	1.56	1.88	–

Table 7. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for EWR LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 58 °C	
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**AV, %**
Replicate 1	3.09	7.3
Replicate 2	3.24	7.2
Replicate 3	3.17	7.3
Average	0.11	7.3
Standard Deviation	3.35	–
COV, %	3.04	–
95% CI – Lower Limit	3.29	–
95% CI – Upper Limit	0.12	–

Table 8. HWTT Test Results at 7±0.5 Percent AV for EWR LMLC Samples

Rutting Test	HWTT; 7% AV; 58 °C					
Test Parameter	**Rut Depth at 3,500 Passes, mm**	**Rut Depth at 5,000 Passes, mm**	**Rut Depth at 7,000 Passes, mm**	**Rut Depth at 20,000 Passes, mm**	**Stripping Failure, Cycles**	**AV, %**
Replicate 1	2.9	3.1	3.4	4.00	–	6.8
Replicate 2	2.4	2.8	2.9	3.40	–	7.3
Average	2.6	2.9	3.2	3.70	–	7.1
Standard Deviation	0.33	0.25	0.35	0.42	–	–
COV, %	12.37	8.64	11.22	11.47	–	–
95% CI – Lower Limit	2.18	2.60	2.66	3.11	–	–
95% CI – Upper Limit	3.08	3.30	3.64	4.29	–	–

Table 9. HT-IDT Test Results at 7±0.5 Percent AV for EWR LMLC Samples

Rutting Test	HT-IDT; 7% AV; 58 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	25.50	7.3
Replicate 2	27.40	6.6
Replicate 3	27.70	6.4
Replicate 4	23.20	7.4
Average	25.95	6.9
Standard Deviation	2.08	–
COV, %	8.00	–
95% CI – Lower Limit	23.92	–
95% CI – Upper Limit	27.98	–

Table 10. IRT Results at 7±0.5 Percent AV for EWR LMLC Samples

Rutting Test	IRT; 7% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	98.50	7.4
Replicate 2	87.30	7.5
Replicate 3	99.10	7.3
Average	94.97	7.4
Standard Deviation	6.65	–
COV, %	7.00	–
95% CI – Lower Limit	87.45	–
95% CI – Upper Limit	102.49	–

Reno Stead Airport (RTS)

5±0.5 Percent AV Level

Table 11. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for RTS LMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 52 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.01	1.25	5.2
Replicate 2	1.28	1.54	4.9
Replicate 3	1.27	1.53	4.9
Average	1.19	1.44	5.0
Standard Deviation	0.15	0.16	–
COV, %	12.90	11.43	–
95% CI – Lower Limit	1.01	1.25	–
95% CI – Upper Limit	1.36	1.63	–

Table 12. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for RTS LMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	2.00	5.1
Replicate 2	2.14	5.0
Replicate 3	2.25	5.2
Average	2.13	5.1
Standard Deviation	0.13	–
COV, %	5.88	–
95% CI – Lower Limit	1.99	–
95% CI – Upper Limit	2.27	–

Table 13. HWTT Test Results at 5±0.5 Percent AV for RTS LMLC Samples

Rutting Test	HWTT; 5% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	4.2	4.7	5.3	12.50	4,997	5.1
Replicate 2	3.9	4.3	4.8	11.50	5,584	5.0
Average	4.1	4.5	5.0	12.00	5,291	5.1
Standard Deviation	0.21	0.26	0.37	0.71	415.07	–
COV, %	5.24	5.90	7.44	5.89	7.85	–
95% CI – Lower Limit	3.76	4.12	4.52	11.02	4715.25	–
95% CI – Upper Limit	4.34	4.85	5.55	12.98	5865.75	–

Table 14. HT-IDT Test Results at 5±0.5 Percent AV for RTS LMLC Samples

Rutting Test	HT-IDT; 5% AV; 52 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	29.6	5.2
Replicate 2	28.4	5.5
Replicate 3	28.4	5.3
Replicate 4	30.4	5.0
Average	29.20	5.3
Standard Deviation	0.98	–
COV, %	3.36	–
95% CI – Lower Limit	28.24	–
95% CI – Upper Limit	30.16	–

Table 15. IRT Results at 5±0.5 Percent AV for RTS LMLC Samples

Rutting Test	IRT; 5% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	104.97	4.7
Replicate 2	109.25	4.8
Replicate 3	107.14	4.9
Average	107.12	4.8
Standard Deviation	2.14	–
COV, %	2.00	–
95% CI – Lower Limit	104.70	–
95% CI – Upper Limit	109.54	–

7±0.5 Percent AV Level

Table 16. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for RTS LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 52 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.48	1.80	7.1
Replicate 2	1.55	1.81	7.3
Replicate 3	1.49	1.83	7.4
Average	1.51	1.82	7.2
Standard Deviation	0.04	0.02	–
COV, %	2.51	0.85	–
95% CI – Lower Limit	1.46	1.80	–
95% CI – Upper Limit	1.55	1.83	–

Table 17. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for RTS LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	2.98	7.1
Replicate 2	3.07	7.2
Replicate 3	3.02	7.1
Average	3.02	7.1
Standard Deviation	0.05	–
COV, %	1.49	–
95% CI – Lower Limit	2.97	–
95% CI – Upper Limit	3.07	–

Table 18. HWTT Test Results at 7±0.5 Percent AV for RTS LMLC Samples

Rutting Test	HWTT; 7% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	2.9	3.1	3.4	4.51	–	6.8
Replicate 2	2.4	2.6	2.9	4.46	–	7.0
Average	2.7	2.9	3.2	4.49	–	6.9
Standard Deviation	0.35	0.35	0.35	0.04	–	–
COV, %	13.34	12.41	11.22	0.79	–	–
95% CI – Lower Limit	2.16	2.36	2.66	4.44	–	–
95% CI – Upper Limit	3.14	3.34	3.64	4.53	–	–

Table 19. HT-IDT Test Results at 7±0.5 Percent AV for RTS LMLC Samples

Rutting Test	HT-IDT; 7% AV; 52 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	22.10	7.4
Replicate 2	20.80	7.2
Replicate 3	21.90	7.0
Average	21.60	7.2
Standard Deviation	0.70	–
COV, %	3.24	–
95% CI – Lower Limit	20.81	–
95% CI – Upper Limit	22.39	–

Table 20. IRT Results at 7±0.5 Percent AV for RTS LMLC Samples

Rutting Test	IRT; 7% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	95.36	7.0
Replicate 2	79.28	7.4
Replicate 3	93.07	6.9
Average	89.24	7.1
Standard Deviation	8.70	–
COV, %	9.75	–
95% CI – Lower Limit	79.40	–
95% CI – Upper Limit	99.08	–

San Francisco International Airport (SFO)

5±0.5 Percent AV Level

Table 21. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for SFO LMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 40 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	0.69	0.93	5.0
Replicate 2	0.81	1.01	5.2
Replicate 3	0.98	1.12	5.2
Average	0.83	1.02	5.1
Standard Deviation	0.15	0.10	–
COV, %	17.63	9.35	–
95% CI – Lower Limit	0.66	0.91	–
95% CI – Upper Limit	0.99	1.13	–

Table 22. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for SFO LMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 40 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.63	5.1
Replicate 2	1.37	5.1
Replicate 3	1.36	5.1
Average	1.45	5.1
Standard Deviation	0.15	–
COV, %	10.53	–
95% CI – Lower Limit	1.28	–
95% CI – Upper Limit	1.63	–

Table 23. HWTT Test Results at 5±0.5 Percent AV for SFO LMLC Samples

Rutting Test	HWTT; 5% AV; 40 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	1.8	1.9	2.0	2.50	–	4.9
Replicate 2	1.9	2.0	2.2	3.00	–	5.0
Average	1.8	2.0	2.1	2.75	–	5.0
Standard Deviation	0.05	0.07	0.14	0.35	–	–
COV, %	2.70	3.63	6.73	12.86	–	–
95% CI – Lower Limit	1.77	1.85	1.90	2.26	–	–
95% CI – Upper Limit	1.90	2.05	2.30	3.24	–	–

Table 24. HT-IDT Test Results at 5±0.5 Percent AV for SFO LMLC Samples

Rutting Test	HT-IDT; 5% AV; 40 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	61.00	5.0
Replicate 2	61.90	4.9
Replicate 3	66.20	5.3
Replicate 4	61.10	5.7
Average	62.55	5.2
Standard Deviation	2.47	–
COV, %	3.94	–
95% CI – Lower Limit	60.13	–
95% CI – Upper Limit	64.97	–

Table 25. IRT Results at 5±0.5 Percent AV for SFO LMLC Samples

Rutting Test	IRT; 5% AV; 40 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	187.50	5.5
Replicate 2	203.40	5.2
Replicate 3	194.80	5.4
Replicate 4	194.40	5.5
Average	195.03	5.4
Standard Deviation	6.51	–
COV, %	3.34	–
95% CI – Lower Limit	188.6	–
95% CI – Upper Limit	201.4	–

7±0.5 Percent AV Level

Table 26. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for SFO LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 40 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	0.86	1.14	7.3
Replicate 2	1.15	1.37	7.0
Replicate 3	1.04	1.23	7.3
Average	1.02	1.25	7.2
Standard Deviation	0.15	0.12	–
COV, %	14.40	9.30	–
95% CI – Lower Limit	0.85	1.12	–
95% CI – Upper Limit	1.18	1.38	–

Table 27. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for SFO LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 40 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	2.12	7.4
Replicate 2	2.44	7.4
Replicate 3	2.05	7.2
Average	2.20	7.4
Standard Deviation	0.21	–
COV, %	9.44	–
95% CI – Lower Limit	1.97	–
95% CI – Upper Limit	2.44	–

Table 28. HWTT Test Results at 7±0.5 Percent AV for SFO LMLC Samples

Rutting Test	HWTT; 7% AV; 40 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	1.6	1.7	1.9	2.7	–	6.7
Replicate 2	1.8	2.1	2.5	4.0	–	6.6
Average	1.7	1.9	2.2	3.4	–	6.7
Standard Deviation	0.14	0.28	0.42	0.92	–	–
COV, %	8.32	14.89	19.28	27.44	–	–
95% CI – Lower Limit	1.50	1.51	1.61	2.08	–	–
95% CI – Upper Limit	1.90	2.29	2.79	4.62	–	–

Table 29. HT-IDT Test Results at 7±0.5 Percent AV for SFO LMLC Samples

Rutting Test	HT-IDT; 7% AV; 40 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	53.20	6.9
Replicate 2	65.10	6.7
Replicate 3	55.20	7.0
Average	57.83	6.9
Standard Deviation	6.37	–
COV, %	11.02	–
95% CI – Lower Limit	50.62	–
95% CI – Upper Limit	65.04	–

Table 30. IRT Results at 7±0.5 Percent AV for SFO LMLC Samples

Rutting Test	IRT; 7% AV; 40 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	160.10	7.2
Replicate 2	185.30	7.0
Replicate 3	172.70	7.5
Average	172.70	7.2
Standard Deviation	12.60	–
COV, %	7.30	–
95% CI – Lower Limit	158.4	–
95% CI – Upper Limit	187.0	–

Teterboro Airport (TEB)

5±0.5 Percent AV Level

Table 31. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for TEB LMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 52 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.92	2.33	5.0
Replicate 2	2.17	2.56	5.0
Replicate 3	2.14	2.60	5.2
Average	2.08	2.50	5.0
Standard Deviation	0.14	0.15	–
COV, %	6.57	5.84	–
95% CI – Lower Limit	1.92	2.33	–
95% CI – Upper Limit	2.23	2.66	–

Table 32. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for TEB LMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	4.14	5.0
Replicate 2	4.27	4.4
Replicate 3	3.54	5.0
Average	3.98	4.8
Standard Deviation	0.39	–
COV, %	9.78	–
95% CI – Lower Limit	3.54	–
95% CI – Upper Limit	4.42	–

Table 33. HWTT Test Results at 5±0.5 Percent AV for TEB LMLC Samples

Rutting Test	HWTT; 5% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	7.1	7.9	8.6	12.47	–	5.4
Replicate 2	6.2	6.9	7.7	12.45	17,904	5.4
Average	6.7	7.4	8.1	12.46	–	5.4
Standard Deviation	0.64	0.71	0.65	0.02	–	–
COV, %	9.57	9.56	7.99	0.13	–	–
95% CI – Lower Limit	5.77	6.42	7.24	12.44	–	–
95% CI – Upper Limit	7.53	8.38	9.04	12.48	–	–

Table 34. HT-IDT Test Results at 5±0.5 Percent AV for TEB LMLC Samples

Rutting Test	HT-IDT; 5% AV; 52 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	19.00	5.3
Replicate 2	20.10	4.9
Replicate 3	17.90	5.4
Replicate 4	16.20	5.1
Average	18.30	5.2
Standard Deviation	1.66	–
COV, %	9.09	–
95% CI – Lower Limit	16.67	–
95% CI – Upper Limit	19.93	–

Table 35. IRT Results at 5±0.5 Percent AV for TEB LMLC Samples

Rutting Test	IRT; 5% AV; 52 °C	
Test Parameter	RT_{Index}	AV, %
Replicate 1	94.80	–
Replicate 2	95.80	–
Replicate 3	93.00	–
Replicate 4	87.4	–
Average	92.75	–
Standard Deviation	3.75	–
COV, %	4.04	–
95% CI – Lower Limit	89.07	–
95% CI – Upper Limit	96.43	–

7±0.5 Percent AV Level

Table 36. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for TEB LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 52 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	2.20	2.59	6.5
Replicate 2	2.53	3.03	6.5
Replicate 3	2.54	2.93	7.3
Average	2.42	2.85	6.8
Standard Deviation	0.19	0.23	–
COV, %	7.98	8.09	–
95% CI – Lower Limit	2.20	2.59	–
95% CI – Upper Limit	2.64	3.11	–

Table 37. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for TEB LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	4.99	6.8
Replicate 2	5.21	7.0
Replicate 3	5.59	6.6
Average	5.26	6.8
Standard Deviation	0.30	–
COV, %	5.77	–
95% CI – Lower Limit	4.92	–
95% CI – Upper Limit	5.61	–

Table 38. HWTT Test Results at 7±0.5 Percent AV for TEB LMLC Samples

Rutting Test	HWTT; 7% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	6.3	7.0	7.7	12.50	–	7.3
Replicate 2	5.1	5.7	6.3	9.70	–	6.9
Average	5.7	6.3	7.0	11.10	–	7.1
Standard Deviation	0.85	0.95	0.99	1.98	–	–
COV, %	14.89	14.97	14.14	17.84	–	–
95% CI – Lower Limit	4.52	5.02	5.63	8.36	–	–
95% CI – Upper Limit	6.88	7.64	8.37	13.84	–	–

Table 39. HT-IDT Test Results at 7±0.5 Percent AV for TEB LMLC Samples

Rutting Test	HT-IDT; 7% AV; 52 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	15.12	7.3
Replicate 2	18.44	6.6
Replicate 3	15.54	6.4
Replicate 4	16.79	7.4
Average	16.47	6.9
Standard Deviation	1.49	–
COV, %	9.05	–
95% CI – Lower Limit	15.01	–
95% CI – Upper Limit	17.93	–

Table 40. IRT Results at 7±0.5 Percent AV for TEB LMLC Samples

Rutting Test	IRT; 7% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	80.40	–
Replicate 2	81.30	–
Replicate 3	84.90	–
Average	82.20	–
Standard Deviation	2.38	–
COV, %	2.90	–
95% CI – Lower Limit	79.51	–
95% CI – Upper Limit	84.89	–

Tampa International Airport (TPA)

5±0.5 Percent AV Level

Table 41. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for TPA LMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 64 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.22	1.41	3.1
Replicate 2	1.42	1.69	3.0
Replicate 3	1.29	1.73	2.9
Average	1.31	1.61	3.0
Standard Deviation	0.10	0.17	–
COV, %	7.75	10.83	–
95% CI – Lower Limit	1.20	1.41	–
95% CI – Upper Limit	1.42	1.81	–

Table 42. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for TPA LMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	3.36	3.5
Replicate 2	3.20	3.5
Replicate 3	3.76	3.5
Average	3.44	3.5
Standard Deviation	0.29	–
COV, %	8.39	–
95% CI – Lower Limit	3.11	–
95% CI – Upper Limit	3.77	–

Table 43. HWTT Test Results at 5±0.5 Percent AV for TPA LMLC Samples

Rutting Test	HWTT; 5% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	3.2	3.7	4.5	12.5	2790	2.9
Replicate 2	3.1	3.5	4.1	11.3	4745	3.1
Average	3.1	3.6	4.3	11.9	3768	3.0
Standard Deviation	0.10	0.14	0.28	0.85	1382.39	–
COV, %	3.16	3.93	6.58	7.13	36.69	–
95% CI – Lower Limit	2.99	3.40	3.91	10.72	1851.64	–
95% CI – Upper Limit	3.27	3.80	4.69	13.08	5683.36	–

Table 44. HT-IDT Test Results at 5±0.5 Percent AV for TPA LMLC Samples

Rutting Test	HT-IDT; 5% AV; 64 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	22.00	3.5
Replicate 2	26.20	3.1
Replicate 3	25.90	3.2
Average	24.70	3.3
Standard Deviation	2.34	–
COV, %	9.49	–
95% CI – Lower Limit	22.05	–
95% CI – Upper Limit	27.35	–

Table 45. IRT Results at 5±0.5 Percent AV for TPA LMLC Samples

Rutting Test	IRT; 5% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	84.90	2.9
Replicate 2	84.60	2.9
Replicate 3	91.80	2.6
Average	87.10	2.8
Standard Deviation	4.07	–
COV, %	4.68	–
95% CI – Lower Limit	82.5	–
95% CI – Upper Limit	91.7	–

7±0.5 Percent AV Level

Table 46. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for TPA LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 64 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.44	1.70	5.3
Replicate 2	1.46	1.95	5.0
Replicate 3	1.64	2.15	5.0
Average	1.51	1.94	5.1
Standard Deviation	0.11	0.22	–
COV, %	7.28	11.55	–
95% CI – Lower Limit	1.39	1.68	–
95% CI – Upper Limit	1.64	2.19	–

Table 47. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for TPA LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	3.90	5.0
Replicate 2	4.54	5.1
Replicate 3	3.93	5.1
Average	4.12	5.1
Standard Deviation	0.36	–
COV, %	8.76	–
95% CI – Lower Limit	3.71	–
95% CI – Upper Limit	4.53	–

Table 48. HWTT Test Results at 7±0.5 Percent AV for TPA LMLC Samples

Rutting Test	HWTT; 7% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	5.4	6.3	8.0	12.50	2,529	5.2
Replicate 2	5.2	5.9	6.9	12.45	3,383	5.3
Average	5.3	6.1	7.5	12.48	2,956	5.3
Standard Deviation	0.14	0.28	0.78	0.04	603.87	–
COV, %	2.67	4.64	10.44	0.28	20.43	–
95% CI – Lower Limit	5.10	5.71	6.37	12.43	2119.10	–
95% CI – Upper Limit	5.50	6.49	8.53	12.52	3792.90	–

Table 49. HT-IDT Test Results at 7±0.5 Percent AV for TPA LMLC Samples

Rutting Test	HT-IDT; 7% AV; 64 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	24.10	4.8
Replicate 2	22.00	5.0
Replicate 3	22.60	4.9
Average	22.90	4.9
Standard Deviation	1.08	–
COV, %	4.72	–
95% CI – Lower Limit	21.68	–
95% CI – Upper Limit	24.12	–

Table 50. IRT Results at 7±0.5 Percent AV for TPA LMLC Samples

Rutting Test	IRT; 7% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	64.10	5.1
Replicate 2	62.30	5.4
Replicate 3	67.70	5.4
Average	64.70	5.3
Standard Deviation	2.75	–
COV, %	4.25	–
95% CI – Lower Limit	61.6	–
95% CI – Upper Limit	67.8	–

Chapter 2. Reheated Plant-Mixed Laboratory-Compacted Samples

This chapter presents the full reheated plant-mixed laboratory-compacted (RPMLC) data for the project experimental plan at the two selected AV levels, i.e., 5±0.5 percent and 7±0.5 percent, and at the relative environmental test temperature for each asphalt mixture. It is worth noting that the test temperature for each mixture was selected as the environmental LTPPBind final performance grade, at surface with 50 percent reliability, and 12.5 mm target rut depth without any bumping.

The five evaluated rutting tests are as follows:

- APA test at 100 psi/100 lb: 150 m diameter by 75 mm height directly molded.
- APA test at 250 psi/250 lb: 150 mm diameter by 75 mm height directly molded.
- HWTT: 150 mm diameter by 62 mm height directly molded.
- HT-IDT: 150 mm diameter by 62 mm height cut to 5 percent AV or directly molded to 7 percent AV.
- IRT: 150 mm diameter by 62 mm height cut to 5 percent AV or directly molded to 7 percent AV.

Newark Liberty International Airport (EWR)

5±0.5 Percent AV Level

Table 51. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 58 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	0.91	1.10	4.9
Replicate 2	1.16	1.30	4.6
Average	1.04	1.20	4.8
Standard Deviation	0.18	0.14	–
COV, %	17.08	11.79	–
95% CI – Lower Limit	0.79	1.00	–
95% CI – Upper Limit	1.28	1.40	–

Table 52. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 58 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.38	5.3
Replicate 2	1.64	5.4
Average	1.51	5.3
Standard Deviation	0.18	–
COV, %	12.18	–
95% CI – Lower Limit	1.26	–
95% CI – Upper Limit	1.76	–

Table 53. HWTT Test Results at 5±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	HWTT; 5% AV; 58 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	2.2	2.3	2.5	3.00	–	4.9
Replicate 2	2.2	2.5	2.9	3.40	–	5.0
Average	2.2	2.4	2.7	3.20	–	5.0
Standard Deviation	0.02	0.14	0.28	0.28	–	–
COV, %	0.96	5.89	10.48	8.84	–	–
95% CI – Lower Limit	2.19	2.20	2.31	2.81	–	–
95% CI – Upper Limit	2.24	2.60	3.09	3.59	–	–

Table 54. HT-IDT Test Results at 5±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 58 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	37.40	5.0
Replicate 2	37.60	5.5
Replicate 3	43.20	4.5
Replicate 4	41.70	5.5
Average	39.98	5.1
Standard Deviation	2.92	–
COV, %	7.31	–
95% CI – Lower Limit	37.11	–
95% CI – Upper Limit	42.84	–

Table 55. IRT Results at 5±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	IRT; 5% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	140.00	5.5
Replicate 2	142.60	5.3
Replicate 3	158.20	4.9
Replicate 4	162.20	5.0
Average	150.75	5.2
Standard Deviation	11.08	–
COV, %	7.35%	–
95% CI – Lower Limit	139.89	–
95% CI – Upper Limit	161.61	–

7±0.5 Percent AV Level

Table 56. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 58 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.24	1.60	7.2
Replicate 2	1.31	1.70	7.3
Average	1.28	1.65	7.3
Standard Deviation	0.05	0.07	–
COV, %	3.88	4.29	–
95% CI – Lower Limit	1.21	1.55	–
95% CI – Upper Limit	1.34	1.75	–

Table 57. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 58 °C	
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**AV, %**
Replicate 1	2.60	7.4
Replicate 2	2.42	6.6
Average	2.51	7.0
Standard Deviation	0.13	–
COV, %	5.07	–
95% CI – Lower Limit	2.3	–
95% CI – Upper Limit	2.7	–

Table 58. HWTT Test Results at 7±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	HWTT; 7% AV; 58 °C					
Test Parameter	**Rut Depth at 3,500 Passes, mm**	**Rut Depth at 5,000 Passes, mm**	**Rut Depth at 7,000 Passes, mm**	**Rut Depth at 20,000 Passes, mm**	**Stripping Failure, Cycles**	**AV, %**
Replicate 1	2.6	2.8	3.0	4.00	–	7.1
Replicate 2	2.4	2.8	3.0	3.80	–	6.7
Average	2.5	2.8	3.0	3.90	–	6.9
Standard Deviation	0.14	0.00	0.02	0.14	–	–
COV, %	5.66	0.03	0.70	3.63	–	–
95% CI – Lower Limit	2.30	2.80	2.99	3.70	–	–
95% CI – Upper Limit	2.70	2.80	3.04	4.10	–	–

Table 59. HT-IDT Test Results at 7±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 58 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	36.60	6.9
Replicate 2	29.60	7.5
Replicate 3	33.50	7.1
Average	33.23	7.2
Standard Deviation	3.51	–
COV, %	10.55	–
95% CI – Lower Limit	29.26	–
95% CI – Upper Limit	37.20	–

Table 60. IRT Results at 7±0.5 Percent AV for EWR RPMLC Samples

Rutting Test	IRT; 7% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	131.40	6.8
Replicate 2	118.70	7.4
Replicate 3	136.80	7.0
Average	128.97	7.0
Standard Deviation	9.29	–
COV, %	7.21	–
95% CI – Lower Limit	118.45	–
95% CI – Upper Limit	139.48	–

Philadelphia International Airport (PHL)

5±0.5 Percent AV Level

Table 61. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 58 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	0.88	1.18	4.7
Replicate 2	1.08	1.21	5.0
Average	0.98	1.20	4.9
Standard Deviation	0.14	0.02	–
COV, %	14.43	1.78	–
95% CI – Lower Limit	0.78	1.17	–
95% CI – Upper Limit	1.18	1.22	–

Table 62. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 58 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.33	5.4
Replicate 2	1.24	5.1
Replicate 3	1.55	5.2
Average	1.37	5.2
Standard Deviation	0.16	–
COV, %	11.61	–
95% CI – Lower Limit	1.19	–
95% CI – Upper Limit	1.55	–

Table 63. HWTT Test Results at 5±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	HWTT; 5% AV; 58 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	1.7	1.9	2.0	2.53	–	5.2
Replicate 2	1.4	1.7	1.7	2.17	–	5.1
Average	1.5	1.8	1.8	2.35	–	5.2
Standard Deviation	0.20	0.15	0.22	0.25	–	–
COV, %	12.86	8.41	11.88	10.83	–	–
95% CI – Lower Limit	1.27	1.56	1.54	2.00	–	–
95% CI – Upper Limit	1.81	1.97	2.15	2.70	–	–

Table 64. HT-IDT Test Results at 5±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 58 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	60.30	5.2
Replicate 2	51.80	5.4
Replicate 3	53.50	4.5
Replicate 4	55.50	4.5
Average	55.28	4.9
Standard Deviation	3.68	–
COV, %	6.65	–
95% CI – Lower Limit	51.67	–
95% CI – Upper Limit	58.88	–

Table 65. IRT Results at 5±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	IRT; 5% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	149.00	4.6
Replicate 2	146.70	4.7
Replicate 3	152.50	4.6
Replicate 4	152.40	4.5
Average	150.15	4.6
Standard Deviation	2.82	–
COV, %	1.88	–
95% CI – Lower Limit	147.39	–
95% CI – Upper Limit	152.91	–

7±0.5 Percent AV Level

Table 66. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 58 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.18	1.30	6.5
Replicate 2	1.20	1.46	6.5
Average	1.19	1.38	6.5
Standard Deviation	0.01	0.11	–
COV, %	1.19	8.20	–
95% CI – Lower Limit	1.17	1.22	–
95% CI – Upper Limit	1.21	1.54	–

Table 67. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 58 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.79	7.0
Replicate 2	2.65	7.2
Replicate 3	2.18	7.1
Average	2.21	7.1
Standard Deviation	0.43	–
COV, %	19.51	–
95% CI – Lower Limit	1.72	–
95% CI – Upper Limit	2.69	–

Table 68. HWTT Test Results at 7±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	HWTT; 7% AV; 58 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	2.3	2.5	2.7	3.50	–	7.2
Replicate 2	1.9	2.0	2.5	3.40	–	7.2
Average	2.1	2.3	2.6	3.45	–	7.2
Standard Deviation	0.28	0.35	0.14	0.07	–	–
COV, %	13.47	15.71	5.44	2.05	–	–
95% CI – Lower Limit	1.71	1.76	2.40	3.35	–	–
95% CI – Upper Limit	2.49	2.74	2.80	3.55	–	–

Table 69. HT-IDT Test Results at 7±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 58 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	41.10	7.2
Replicate 2	38.60	7.4
Replicate 3	39.00	7.4
Average	39.57	7.3
Standard Deviation	1.34	–
COV, %	3.39	–
95% CI – Lower Limit	38.05	–
95% CI – Upper Limit	41.09	–

Table 70. IRT Results at 7±0.5 Percent AV for PHL RPMLC Samples

Rutting Test	IRT; 7% AV; 58 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	114.50	6.6
Replicate 2	112.40	6.6
Replicate 3	112.40	6.7
Average	113.10	6.6
Standard Deviation	1.21	–
COV, %	1.07	–
95% CI – Lower Limit	111.73	–
95% CI – Upper Limit	114.47	–

Reno Stead Airport (RTS)

5±0.5 Percent AV Level

Table 71. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 52 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.21	1.47	5.1
Replicate 2	1.14	1.35	5.2
Average	1.18	1.41	5.2
Standard Deviation	0.05	0.06	–
COV, %	4.21	4.26	–
95% CI – Lower Limit	1.11	1.34	–
95% CI – Upper Limit	1.24	1.48	–

Table 72. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	3.22	5.0
Replicate 2	3.71	5.3
Replicate 3	3.37	5.3
Average	3.43	5.2
Standard Deviation	0.25	–
COV, %	7.31	–
95% CI – Lower Limit	3.15	–
95% CI – Upper Limit	3.72	–

Table 73. HWTT Test Results at 5±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	HWTT; 5% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	2.4	2.6	2.9	4.10	–	4.6
Replicate 2	2.8	3.1	3.6	6.90	9,286	4.8
Average	2.6	2.9	3.3	5.50	–	4.7
Standard Deviation	0.28	0.35	0.49	1.98	–	–
COV, %	10.88	12.41	15.23	36.00	–	–
95% CI – Lower Limit	2.21	2.36	2.56	2.76	–	–
95% CI – Upper Limit	2.99	3.34	3.94	8.24	–	–

Table 74. HT-IDT Test Results at 5±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 52 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	31.1	4.6
Replicate 2	31.5	5.2
Replicate 3	31.5	5.2
Replicate 4	30.7	5.5
Average	31.20	5.1
Standard Deviation	0.38	–
COV, %	1.23	–
95% CI – Lower Limit	30.82	–
95% CI – Upper Limit	31.58	–

Table 75. IRT Results at 5±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	IRT; 5% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	100.50	4.6
Replicate 2	96.80	4.5
Replicate 3	88.20	5.5
Replicate 4	86.40	5.4
Average	92.98	5.0
Standard Deviation	6.76	–
COV, %	7.28	–
95% CI – Lower Limit	86.35	–
95% CI – Upper Limit	99.60	–

7±0.5 Percent AV Level

Table 76. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 52 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.33	1.60	7.0
Replicate 2	1.46	1.76	6.9
Average	1.40	1.68	7.0
Standard Deviation	0.09	0.11	–
COV, %	6.59	6.73	–
95% CI – Lower Limit	1.27	1.52	–
95% CI – Upper Limit	1.52	1.84	–

Table 77. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	4.32	7.5
Replicate 2	3.67	6.6
Replicate 3	4.80	7.0
Average	4.26	7.0
Standard Deviation	0.57	–
COV, %	13.30	–
95% CI – Lower Limit	3.62	–
95% CI – Upper Limit	4.91	–

Table 78. HWTT Test Results at 7±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	HWTT; 7% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	4.2	4.7	5.4	12.50	5.0	6.8
Replicate 2	3.4	3.9	4.5	12.50	3.6	6.8
Average	3.8	4.3	5.0	12.5	4.3	6.8
Standard Deviation	0.57	0.57	0.64	–	0.99	–
COV, %	14.89	13.16	12.86	–	23.02	–
95% CI – Lower Limit	3.02	3.52	4.07	–	2.93	–
95% CI – Upper Limit	4.58	5.08	5.83	–	5.67	–

Table 79. HT-IDT Test Results at 7±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 52 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	27.10	7.0
Replicate 2	30.00	6.7
Replicate 3	28.50	6.9
Average	28.53	6.9
Standard Deviation	1.45	–
COV, %	5.08	–
95% CI – Lower Limit	26.89	–
95% CI – Upper Limit	30.17	–

Table 80. IRT Results at 7±0.5 Percent AV for RTS RPMLC Samples

Rutting Test	IRT; 7% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	73.20	7.0
Replicate 2	59.40	7.5
Replicate 3	62.00	7.1
Average	64.87	7.2
Standard Deviation	7.33	–
COV, %	11.30	–
95% CI – Lower Limit	56.57	–
95% CI – Upper Limit	73.16	–

San Francisco International Airport (SFO)

5±0.5 Percent AV Level

Table 81. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 40 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	0.65	0.69	5.1
Replicate 2	0.88	0.93	5.2
Average	0.77	0.81	5.2
Standard Deviation	0.16	0.17	–
COV, %	21.26	20.95	–
95% CI – Lower Limit	0.54	0.57	–
95% CI – Upper Limit	0.99	1.05	–

Table 82. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 40 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.2	5.4
Replicate 2	0.9	5.3
Replicate 3	1.2	5.2
Average	1.1	5.3
Standard Deviation	0.16	–
COV, %	14.16	–
95% CI – Lower Limit	0.93	–
95% CI – Upper Limit	1.29	–

Table 83. HWTT Test Results at 5±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	HWTT; 5% AV; 40 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	1.1	1.2	1.3	1.8	–	5.1
Replicate 2	1.2	1.3	1.3	1.7	–	5.1
Average	1.1	1.2	1.3	1.8	–	5.1
Standard Deviation	0.04	0.04	0.01	0.07	–	–
COV, %	3.75	3.33	0.55	4.04	–	–
95% CI – Lower Limit	1.07	1.17	1.29	1.65	–	–
95% CI – Upper Limit	1.19	1.29	1.30	1.85	–	–

Table 84. HT-IDT Test Results at 5±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 40 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	90.00	5.6
Replicate 2	93.30	5.0
Replicate 3	88.30	5.2
Replicate 4	85.30	5.3
Average	89.23	5.3
Standard Deviation	3.34	–
COV, %	3.74	–
95% CI – Lower Limit	85.95	–
95% CI – Upper Limit	92.50	–

Table 85. IRT Results at 5±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	IRT; 5% AV; 40 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	254.10	5.3
Replicate 2	277.70	4.8
Replicate 3	266.20	5.4
Average	266.00	5.2
Standard Deviation	11.80	–
COV, %	4.44	–
95% CI – Lower Limit	252.6	–
95% CI – Upper Limit	279.4	–

7±0.5 Percent AV Level

Table 86. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 40 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	0.77	0.88	7.0
Replicate 2	0.78	0.92	6.9
Average	0.78	0.90	7.0
Standard Deviation	0.01	0.03	–
COV, %	0.91	3.14	–
95% CI – Lower Limit	0.77	0.86	–
95% CI – Upper Limit	0.78	0.94	–

Table 87. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 40 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	1.4	6.6
Replicate 2	1.3	6.9
Replicate 3	1.6	7.2
Average	1.5	6.9
Standard Deviation	0.13	–
COV, %	9.16	–
95% CI – Lower Limit	1.30	–
95% CI – Upper Limit	1.60	–

Table 88. HWTT Test Results at 7±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	HWTT; 7% AV; 40 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	1.2	1.4	1.5	1.7	–	6.8
Replicate 2	1.3	1.6	1.6	1.9	–	6.6
Average	1.3	1.5	1.5	1.8	–	6.7
Standard Deviation	0.07	0.14	0.10	0.14	–	–
COV, %	5.66	9.43	6.47	7.86	–	–
95% CI – Lower Limit	1.15	1.30	1.39	1.60	–	–
95% CI – Upper Limit	1.35	1.70	1.67	2.00	–	–

Table 89. HT-IDT Test Results at 7±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 40 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	71.70	7.1
Replicate 2	85.50	7.0
Replicate 3	88.90	7.0
Average	82.03	7.0
Standard Deviation	9.11	–
COV, %	11.10	–
95% CI – Lower Limit	71.73	–
95% CI – Upper Limit	92.34	–

Table 90. IRT Results at 7±0.5 Percent AV for SFO RPMLC Samples

Rutting Test	IRT; 7% AV; 40 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	208.30	6.9
Replicate 2	220.90	6.9
Replicate 3	226.10	6.7
Average	218.43	6.8
Standard Deviation	9.15	–
COV, %	4.19	–
95% CI – Lower Limit	208.1	–
95% CI – Upper Limit	228.8	–

Sacramento International Airport (SMF)

5±0.5 Percent AV Level

Table 91. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 64 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.29	1.57	5.0
Replicate 2	1.57	1.97	4.8
Average	1.43	1.77	4.9
Standard Deviation	0.20	0.28	–
COV, %	13.85	15.98	–
95% CI – Lower Limit	1.16	1.38	–
95% CI – Upper Limit	1.70	2.16	–

Table 92. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	2.17	5.5
Replicate 2	2.86	5.5
Replicate 3	2.77	5.2
Average	2.60	5.4
Standard Deviation	0.38	–
COV, %	14.43	–
95% CI – Lower Limit	2.18	–
95% CI – Upper Limit	3.02	–

Table 93. HWTT Test Results at 5±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	HWTT; 5% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	3.2	3.8	4.9	12.50	2920	5.1
Replicate 2	2.6	2.9	3.2	8.30	5140	4.7
Average	2.9	3.4	4.1	10.40	4030	4.9
Standard Deviation	0.42	0.64	1.20	2.97	1569.78	–
COV, %	14.63	19.00	29.68	28.56	38.95	–
95% CI – Lower Limit	2.31	2.47	2.38	6.28	1854.44	–
95% CI – Upper Limit	3.49	4.23	5.72	14.52	6205.56	–

Table 94. HT-IDT Test Results at 5±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 64 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	24.29	4.8
Replicate 2	25.91	4.7
Replicate 3	27.10	5.1
Replicate 4	24.64	4.7
Average	25.49	4.8
Standard Deviation	1.28	–
COV, %	5.03	–
95% CI – Lower Limit	24.23	–
95% CI – Upper Limit	26.74	–

Table 95. IRT Results at 5±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	IRT; 5% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	88.90	4.5
Replicate 2	99.80	5.1
Replicate 3	92.10	4.5
Average	93.60	4.7
Standard Deviation	5.60	–
COV, %	5.99	–
95% CI – Lower Limit	87.26	–
95% CI – Upper Limit	99.94	–

7±0.5 Percent AV Level

Table 96. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 64 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.74	2.17	7.1
Replicate 2	1.70	2.10	6.9
Average	1.72	2.14	7.0
Standard Deviation	0.03	0.05	–
COV, %	1.64	2.32	–
95% CI – Lower Limit	1.68	2.07	–
95% CI – Upper Limit	1.76	2.20	–

Table 97. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	3.45	7.1
Replicate 2	4.70	7.0
Replicate 3	3.80	7.4
Average	3.98	7.2
Standard Deviation	0.64	–
COV, %	16.19	–
95% CI – Lower Limit	3.25	–
95% CI – Upper Limit	4.71	–

Table 98. HWTT Test Results at 7±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	HWTT; 7% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	2.8	3.2	3.6	6.60	10566	6.5
Replicate 2	3.0	3.5	4.1	12.50	4458	6.7
Average	2.9	3.3	3.8	9.55	7512	6.6
Standard Deviation	0.14	0.22	0.39	4.17	4319.01	–
COV, %	4.88	6.55	10.17	43.69	57.49	–
95% CI – Lower Limit	2.70	3.04	3.29	3.77	1526.27	–
95% CI – Upper Limit	3.10	3.65	4.36	15.33	13497.73	–

Table 99. HT-IDT Test Results at 7±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 64 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	24.32	6.9
Replicate 2	26.92	6.8
Replicate 3	23.33	6.7
Average	24.86	6.8
Standard Deviation	1.85	–
COV, %	7.46	–
95% CI – Lower Limit	22.76	–
95% CI – Upper Limit	26.96	–

Table 100. IRT Results at 7±0.5 Percent AV for SMF RPMLC Samples

Rutting Test	IRT; 7% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	74.00	6.6
Replicate 2	78.70	6.5
Replicate 3	85.40	6.6
Average	79.37	6.6
Standard Deviation	5.73	–
COV, %	7.22	–
95% CI – Lower Limit	72.88	–
95% CI – Upper Limit	85.85	–

Teterboro Airport (TEB)

5±0.5 Percent AV Level

Table 101. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 52 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	2.00	2.58	4.9
Replicate 2	2.21	2.80	5.1
Average	2.11	2.69	5.0
Standard Deviation	0.15	0.16	–
COV, %	7.05	5.78	–
95% CI – Lower Limit	1.90	2.47	–
95% CI – Upper Limit	2.31	2.91	–

Table 102. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	3.92	5.1
Replicate 2	4.10	5.4
Replicate 3	4.07	5.5
Average	4.03	5.3
Standard Deviation	0.10	–
COV, %	2.39	–
95% CI – Lower Limit	3.92	–
95% CI – Upper Limit	4.14	–

Table 103. HWTT Test Results at 5±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	HWTT; 5% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	4.1	4.5	4.9	7.1	–	5.1
Replicate 2	3.9	4.4	4.9	6.8	–	5.0
Average	4.0	4.5	4.9	6.9	–	5.1
Standard Deviation	0.14	0.07	0.03	0.19	–	–
COV, %	3.54	1.59	0.57	2.75	–	–
95% CI – Lower Limit	3.80	4.35	4.88	6.68	–	–
95% CI – Upper Limit	4.20	4.55	4.96	7.21	–	–

Table 104. HT-IDT Test Results at 5±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 52 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	24.80	4.9
Replicate 2	24.20	5.3
Replicate 3	25.60	5.0
Replicate 4	26.40	5.2
Average	25.25	5.1
Standard Deviation	0.96	–
COV, %	3.79	–
95% CI – Lower Limit	24.31	–
95% CI – Upper Limit	26.19	–

Table 105. IRT Results at 5±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	IRT; 5% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	82.40	4.9
Replicate 2	80.40	5.1
Replicate 3	75.30	5.3
Replicate 4	73	5.5
Average	77.78	5.2
Standard Deviation	4.37	–
COV, %	5.61	–
95% CI – Lower Limit	73.50	–
95% CI – Upper Limit	82.05	–

7±0.5 Percent AV Level

Table 106. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 52 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	2.33	2.83	6.9
Replicate 2	2.46	3.04	6.7
Average	2.40	2.94	6.8
Standard Deviation	0.09	0.15	–
COV, %	3.84	5.06	–
95% CI – Lower Limit	2.27	2.73	–
95% CI – Upper Limit	2.52	3.14	–

Table 107. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 52 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	4.92	7.5
Replicate 2	4.95	7.3
Replicate 3	4.54	7.5
Average	4.80	7.5
Standard Deviation	0.23	–
COV, %	4.76	–
95% CI – Lower Limit	4.54	–
95% CI – Upper Limit	5.06	–

Table 108. HWTT Test Results at 7±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	HWTT; 7% AV; 52 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	4.7	5.1	5.6	7.7	–	7.3
Replicate 2	4.8	5.4	5.9	8.0	–	7.0
Average	4.7	5.3	5.8	7.9	–	7.2
Standard Deviation	0.09	0.21	0.21	0.21	–	–
COV, %	1.94	4.04	3.69	2.70	–	–
95% CI – Lower Limit	4.61	4.96	5.46	7.56	–	–
95% CI – Upper Limit	4.86	5.54	6.04	8.14	–	–

Table 109. HT-IDT Test Results at 7±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	HT-IDT; 7% AV; 52 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	17.10	7.1
Replicate 2	18.90	7.3
Replicate 3	19.70	7.3
Replicate 4	19.40	6.7
Average	18.78	7.1
Standard Deviation	1.16	–
COV, %	6.20	–
95% CI – Lower Limit	17.63	–
95% CI – Upper Limit	19.92	–

Table 110. IRT Results at 7±0.5 Percent AV for TEB RPMLC Samples

Rutting Test	IRT; 7% AV; 52 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	64.10	7.2
Replicate 2	63.90	6.8
Replicate 3	65.00	6.8
Average	64.33	6.9
Standard Deviation	0.59	–
COV, %	0.91	–
95% CI – Lower Limit	63.67	–
95% CI – Upper Limit	65.00	–

Tampa International Airport (TPA)

5±0.5 Percent AV Level

Table 111. APA 100 psi/100 lb Test Results at 5±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 5% AV; 64 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	1.70	2.32	2.8
Replicate 2	1.88	2.61	2.9
Average	1.79	2.47	2.9
Standard Deviation	0.13	0.21	–
COV, %	7.11	8.32	–
95% CI – Lower Limit	1.61	2.18	–
95% CI – Upper Limit	1.97	2.75	–

Table 112. APA 250 psi/250 lb Test Results at 5±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 5% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	8.5	3.2
Replicate 2	7.2	3.1
Replicate 3	8.4	2.9
Average	8.0	3.0
Standard Deviation	0.70	–
COV, %	8.72	–
95% CI – Lower Limit	7.24	–
95% CI – Upper Limit	8.83	–

Table 113. HWTT Test Results at 5±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	HWTT; 5% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	7.1	8.5	10.6	12.5	7,626	3.5
Replicate 2	5.1	6.0	7.1	11.4	–	3.5
Average	6.1	7.2	8.8	12.0	–	3.5
Standard Deviation	1.41	1.77	2.45	0.78	–	–
COV, %	23.18	24.52	27.77	6.51	–	–
95% CI – Lower Limit	4.14	4.76	5.43	10.87	–	–
95% CI – Upper Limit	8.06	9.66	12.24	13.03	–	–

Table 114. HT-IDT Test Results at 5±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	HT-IDT; 5% AV; 64 °C	
Test Parameter	**HT-IDT Strength Value, psi**	**AV, %**
Replicate 1	20.70	3.3
Replicate 2	21.90	3.4
Replicate 3	22.70	3.2
Average	21.77	3.3
Standard Deviation	1.01	–
COV, %	4.62	–
95% CI – Lower Limit	20.63	–
95% CI – Upper Limit	22.91	–

Table 115. IRT Results at 5±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	IRT; 5% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	56.5	3.3
Replicate 2	62.8	3.1
Replicate 3	63.1	3.1
Average	60.8	3.2
Standard Deviation	3.73	–
COV, %	6.13	–
95% CI – Lower Limit	56.6	–
95% CI – Upper Limit	65.0	–

7±0.5 Percent AV Level

Table 116. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 64 °C		
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**Rut Depth at 8,000 Cycles, mm**	**AV, %**
Replicate 1	1.81	2.52	4.5
Replicate 2	2.72	3.82	4.9
Average	2.27	3.17	4.7
Standard Deviation	0.64	0.92	–
COV, %	28.41	29.00	–
95% CI – Lower Limit	1.37	1.90	–
95% CI – Upper Limit	3.16	4.44	–

Table 117. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 64 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	9.5	5.2
Replicate 2	10.1	5.1
Replicate 3	7.9	4.9
Average	9.2	5.1
Standard Deviation	1.12	–
COV, %	12.18	–
95% CI – Lower Limit	7.91	–
95% CI – Upper Limit	10.43	–

Table 118. HWTT Test Results at 7±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	HWTT; 7% AV; 64 °C					
Test Parameter	Rut Depth at 3,500 Passes, mm	Rut Depth at 5,000 Passes, mm	Rut Depth at 7,000 Passes, mm	Rut Depth at 20,000 Passes, mm	Stripping Failure, Cycles	AV, %
Replicate 1	6.6	7.5	8.6	12.5	9,099	4.9
Replicate 2	5.3	6.0	6.9	12.5	–	5.1
Average	5.9	6.8	7.8	12.5	–	5.0
Standard Deviation	0.89	1.06	1.20	0.00	–	–
COV, %	15.02	15.71	15.51	0.01	–	–
95% CI – Lower Limit	4.70	5.28	6.08	12.50	–	–
95% CI – Upper Limit	7.16	8.22	9.42	12.50	–	–

Table 119. HT-IDT Test Results at 7±0.5 Percent AV for TPA RPMLC Samples

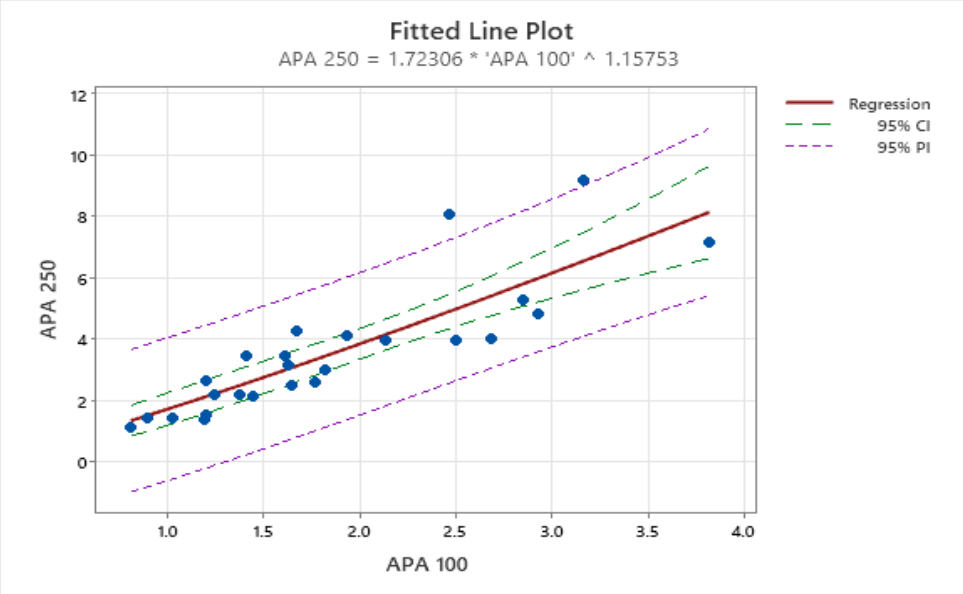
Rutting Test	HT-IDT; 7% AV; 64 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	20.20	4.9
Replicate 2	20.10	5.3
Replicate 3	18.90	5.2
Average	19.73	5.1
Standard Deviation	0.72	–
COV, %	3.67	–
95% CI – Lower Limit	18.91	–
95% CI – Upper Limit	20.55	–

Table 120. IRT Results at 7±0.5 Percent AV for TPA RPMLC Samples

Rutting Test	IRT; 7% AV; 64 °C	
Test Parameter	**RT_{Index}**	**AV, %**
Replicate 1	44.3	5.1
Replicate 2	50.5	4.7
Replicate 3	49.7	5.3
Average	48.2	5.0
Standard Deviation	3.37	–
COV, %	7.00	–
95% CI – Lower Limit	44.4	–
95% CI – Upper Limit	52.0	–

Chapter 3. Statistical Correlations Between Rutting Tests

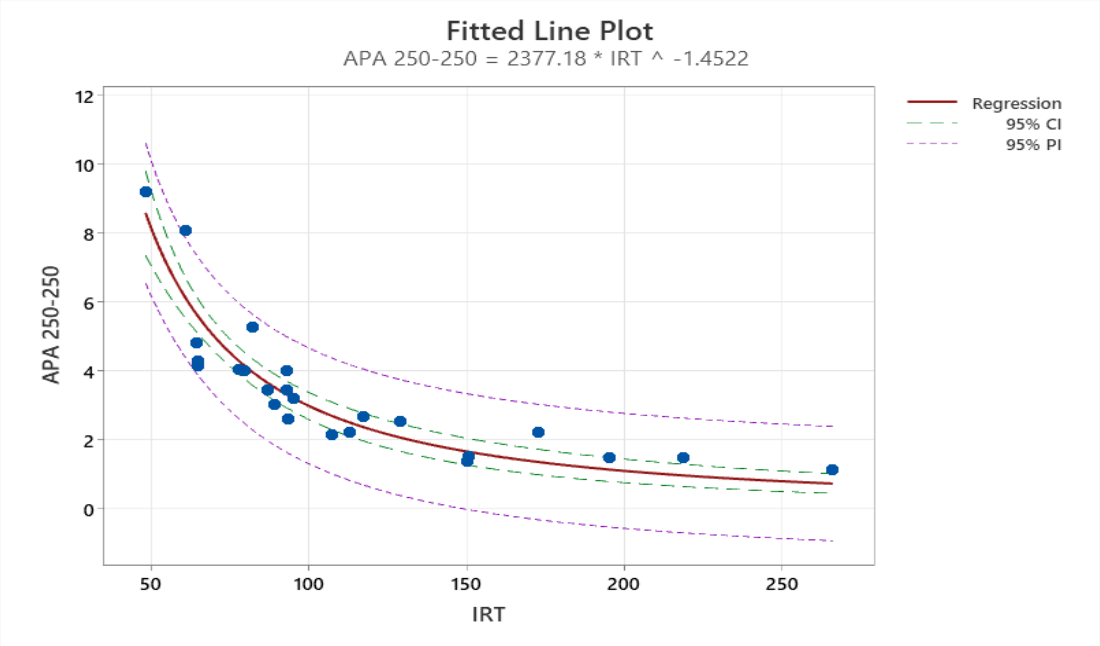
The following statistical correlations represent relationships between different rutting test parameters, incorporating data from both LMLC and RPMLC samples for all tested airfield asphalt mixtures. Each mixture was tested at its corresponding environmental test temperature. Data points from HWTT specimens that were cut to a 5 percent AV level were excluded due to the variability observed with cut specimens, as documented in Technical Memo 2 (Appendix C) of this project.[1] Hence, only data points from directly molded samples were included for the HWTT in the following correlations.



Source: University of Nevada, Reno

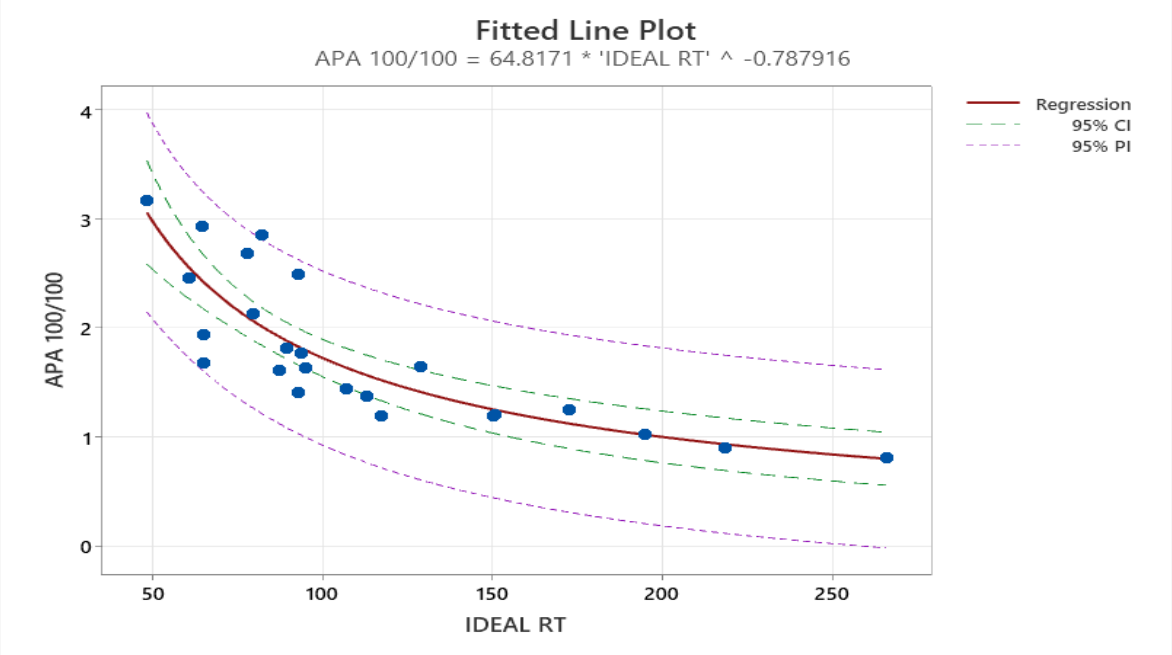
Figure 1. Correlation Between APA 100 psi/100 lb Rut Depth After 8,000 Cycles and APA 250 psi/250 lb Rut Depth After 4,000 Cycles

[1] E. Y. Hajj, N. G. Elias, B. Khanal, A. Alrajhi, A. Hand, T. Bennert, . . . J. Duval (2025). *Technical Memo 2: Recommendations of Air Void Level for Flexible Airfield Pavements Mechanical Tests*. Airport Asphalt Pavement Technology Program.



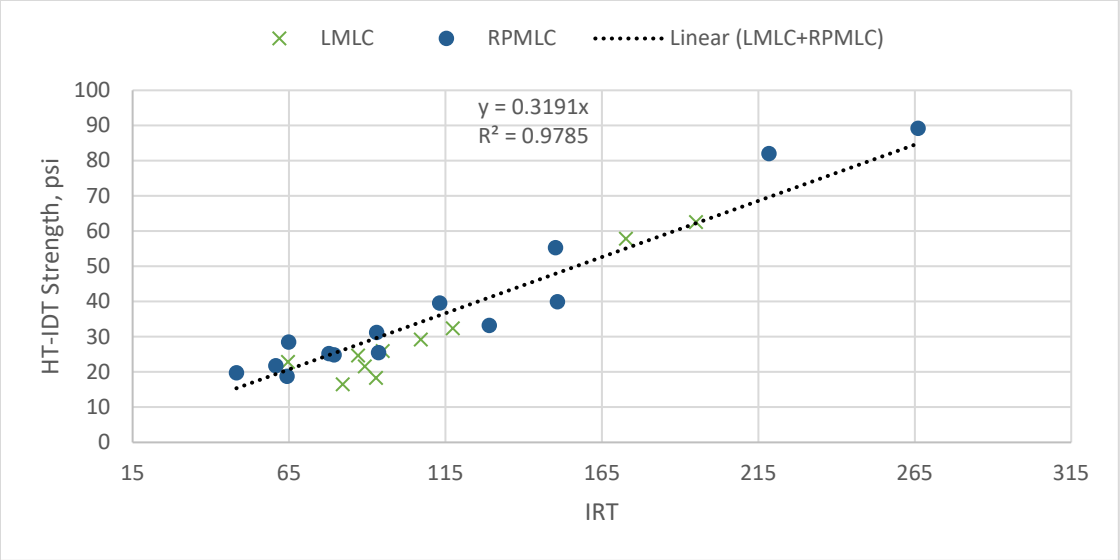
Source: University of Nevada, Reno

Figure 2. Correlation Between IRT and APA 250 psi/250 lb Rut Depth After 4,000 Cycles



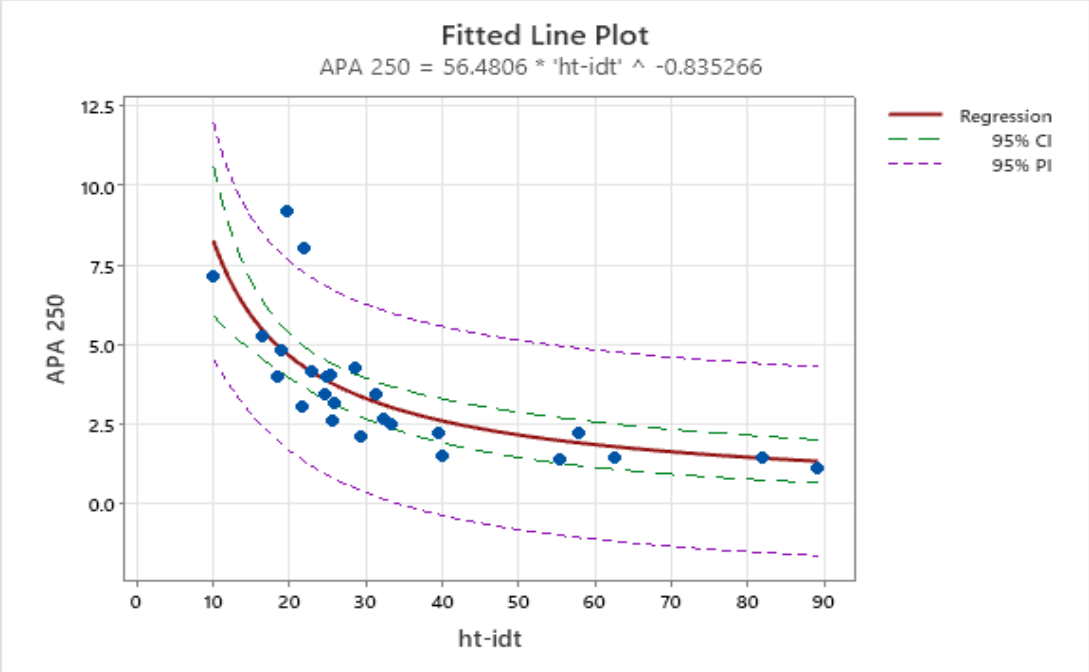
Source: University of Nevada, Reno

Figure 3. Correlation Between IRT and APA 100 psi/100 lb Rut Depth After 8,000 Cycles



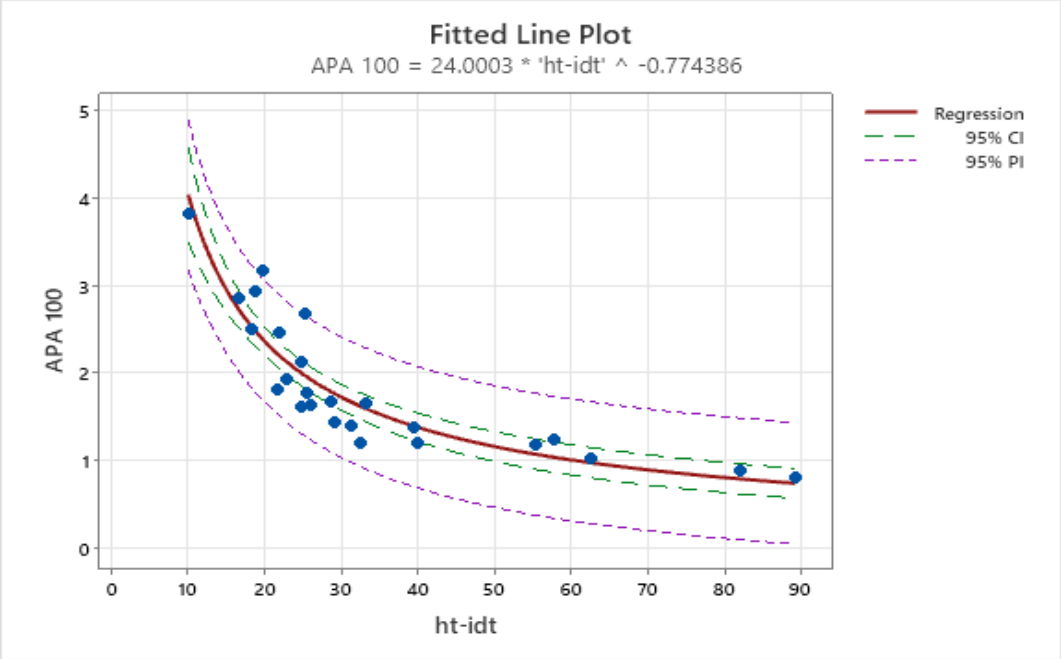
Source: University of Nevada, Reno

Figure 4. Correlation Between IRT and HT-IDT Test



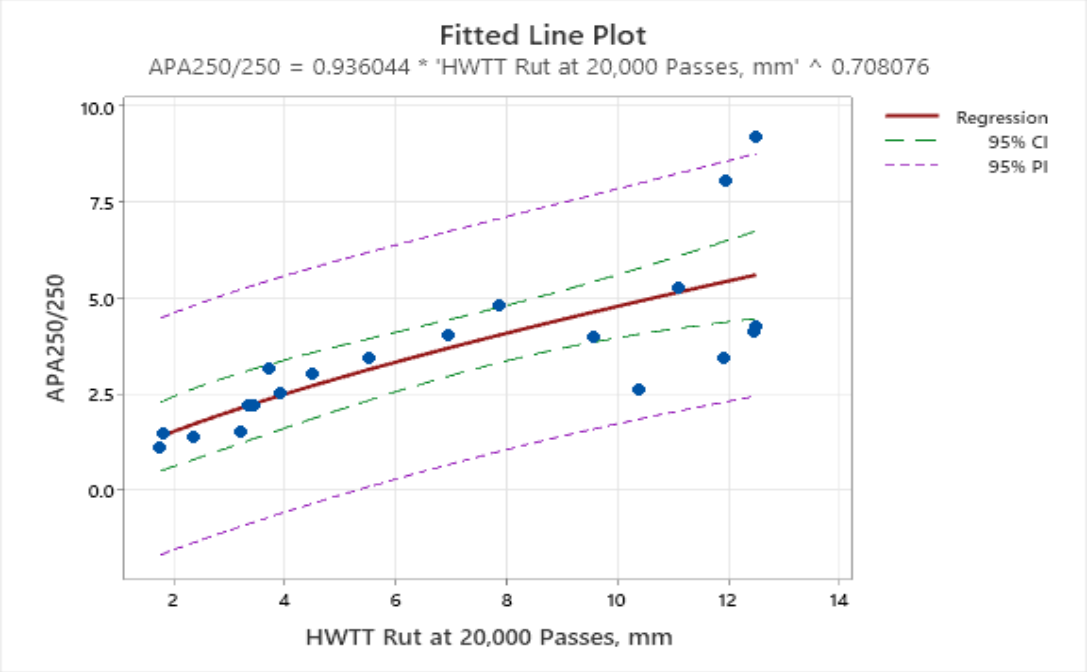
Source: University of Nevada, Reno

Figure 5. Correlation Between HT-IDT and APA 250 psi/250 lb Rut Depth After 4,000 Cycles



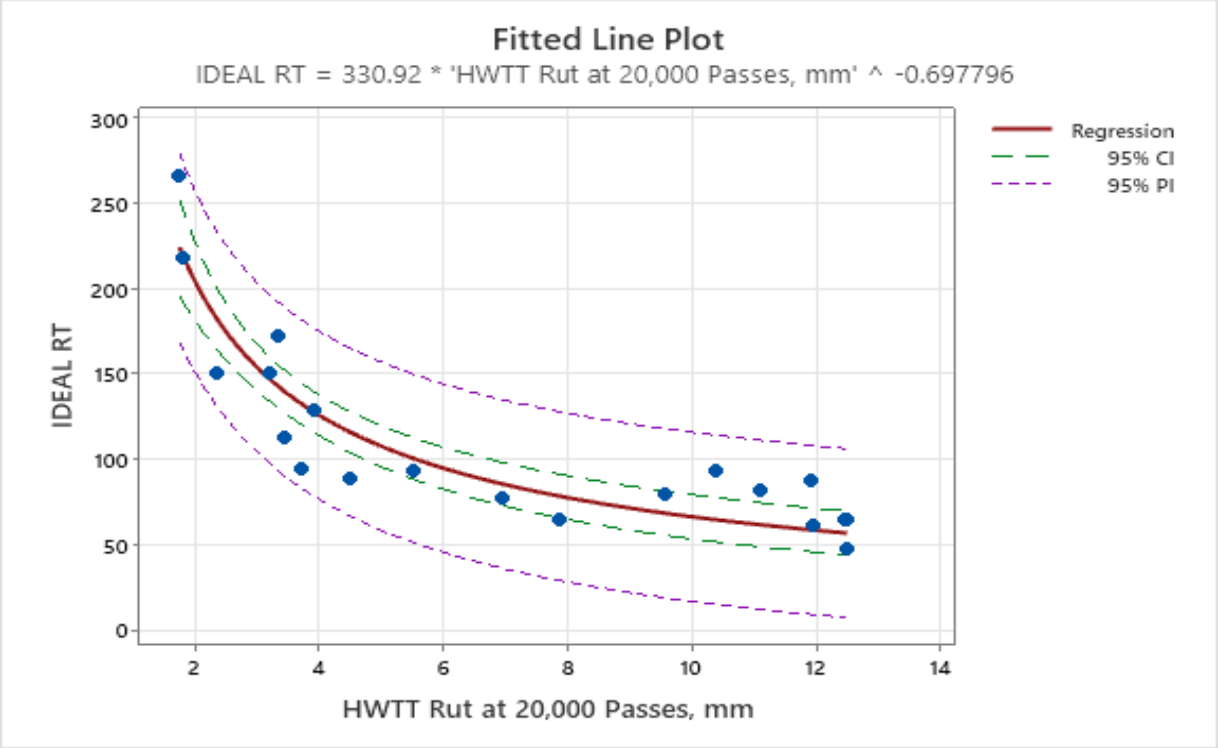
Source: University of Nevada, Reno

Figure 6. Correlation Between HT-IDT and APA 100 psi/100 lb Rut Depth After 8,000 Cycles



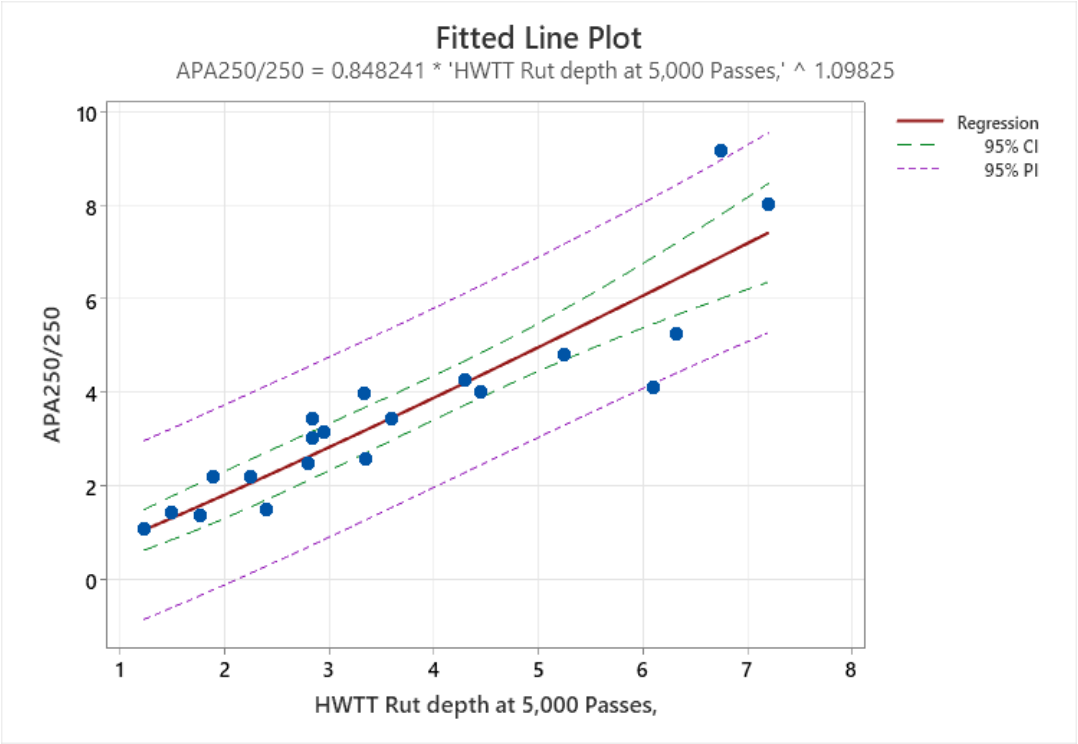
Source: University of Nevada, Reno

Figure 7. Correlation Between HWTT Rut Depth After 20,000 Passes and APA 250 psi/250 lb Rut Depth After 4,000 Cycles



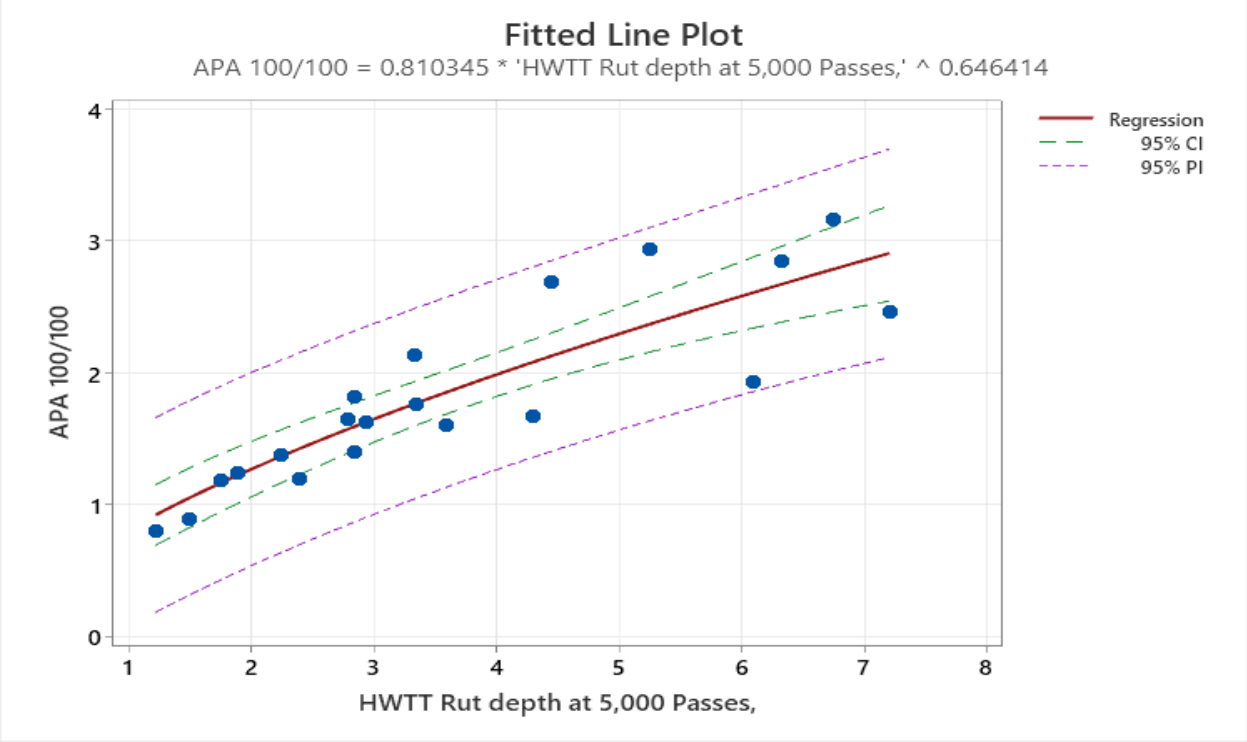
Source: University of Nevada, Reno

Figure 8. Correlation Between HWTT Rut Depth After 20,000 Passes and IRT



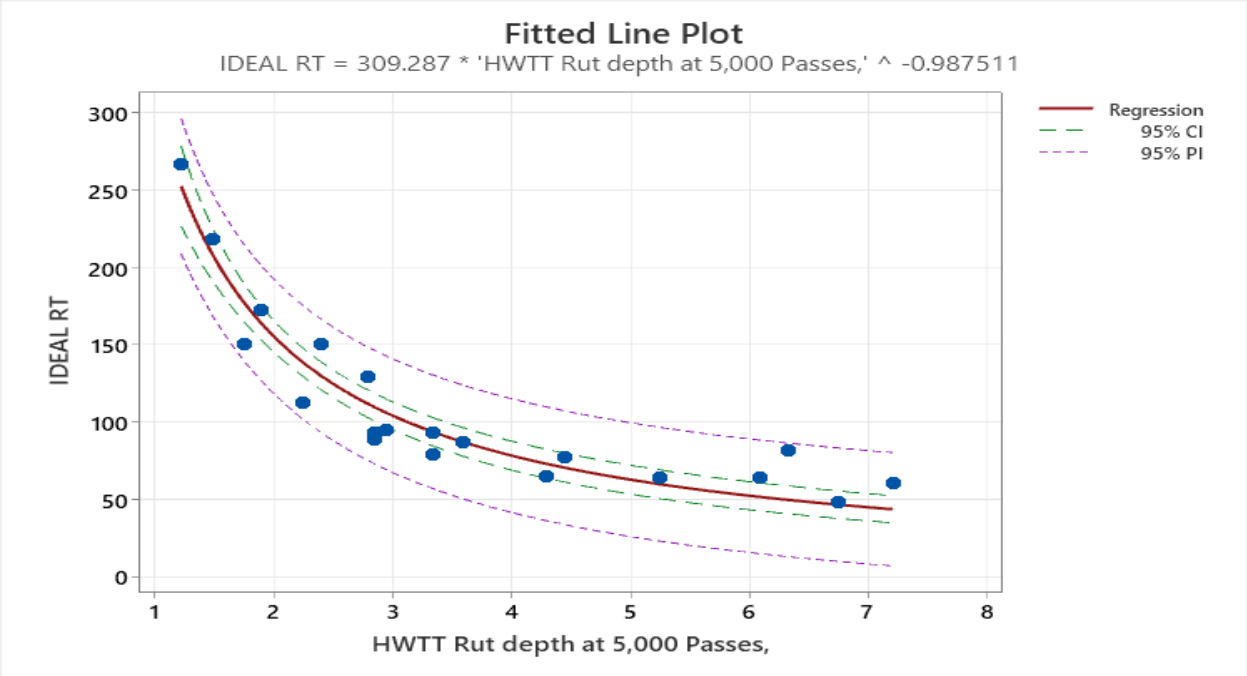
Source: University of Nevada, Reno

Figure 9. Correlation Between HWTT Rut Depth After 5,000 Passes and APA 250 psi/250 lb Rut Depth After 4,000 Cycles



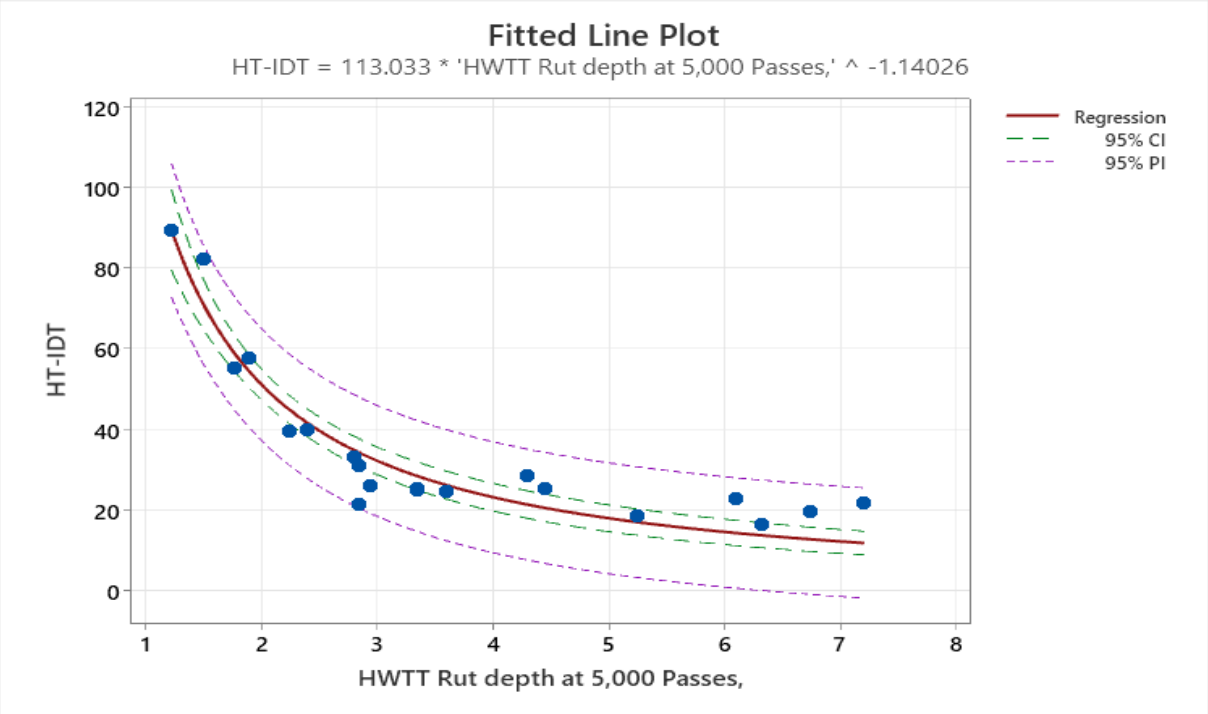
Source: University of Nevada, Reno

Figure 10. Correlation Between HWTT Rut Depth after 5,000 Passes and APA 100 psi/100 lb Rut Depth After 8,000 Cycles



Source: University of Nevada, Reno

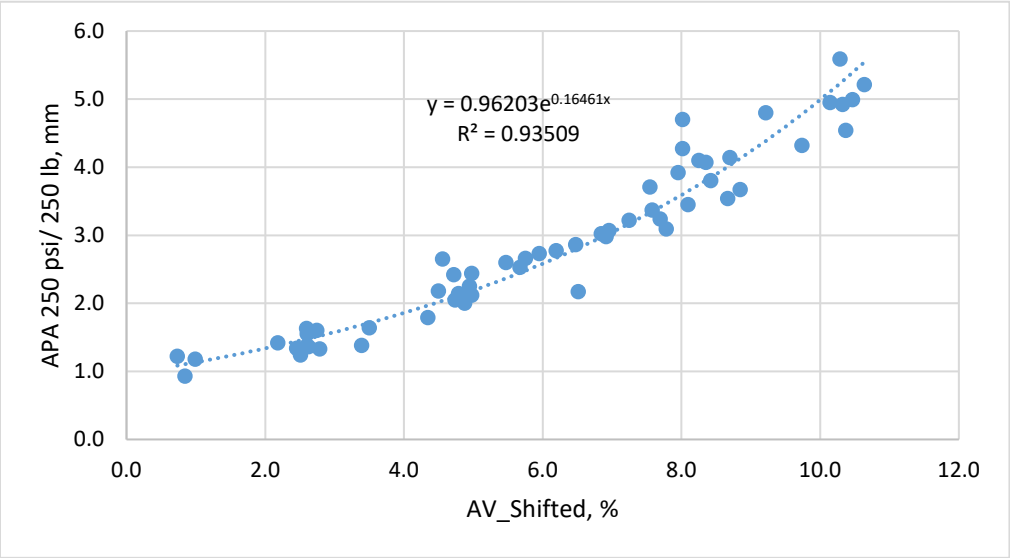
Figure 11. Correlation Between HWTT Rut Depth After 5,000 Passes and IRT



Source: University of Nevada, Reno

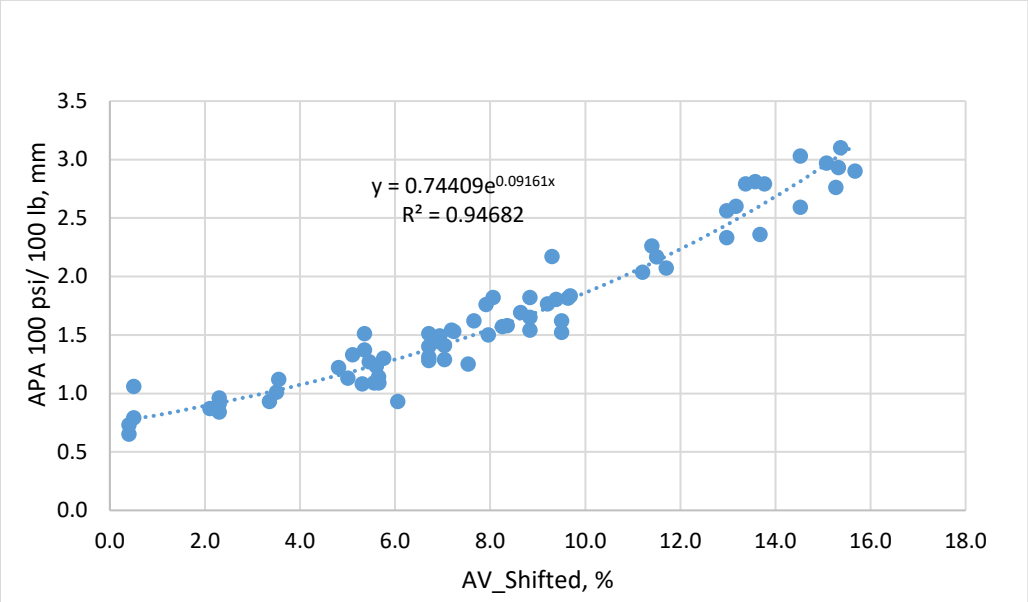
Figure 12. Correlation Between HWTT Rut Depth After 5,000 Passes and HT-IDT Test

Chapter 4. Statistical Correlations with Air Voids



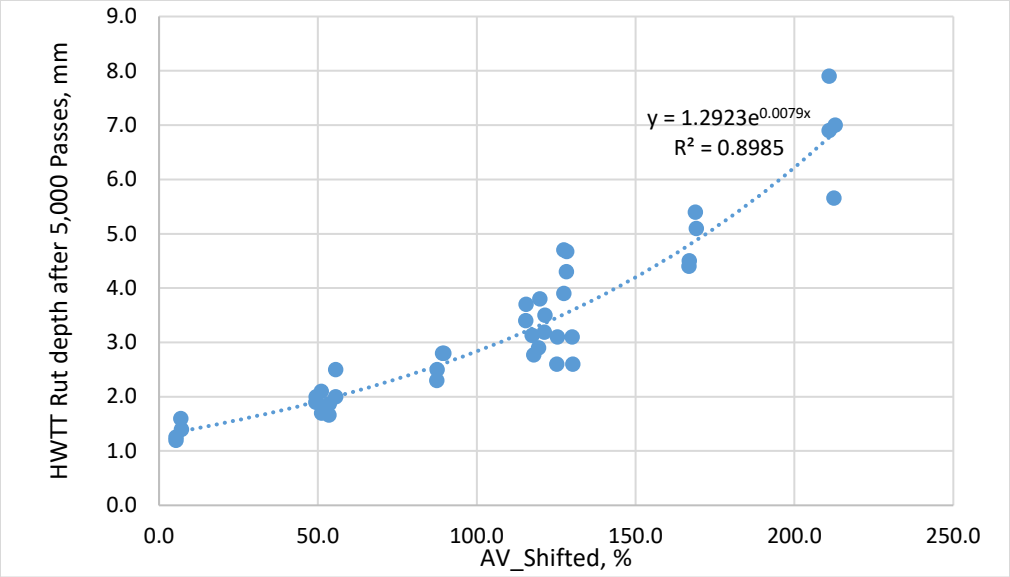
Source: University of Nevada, Reno

Figure 13. Correlation Between AV and APA 250 psi/250 lb Rut Depth After 4,000 Cycles



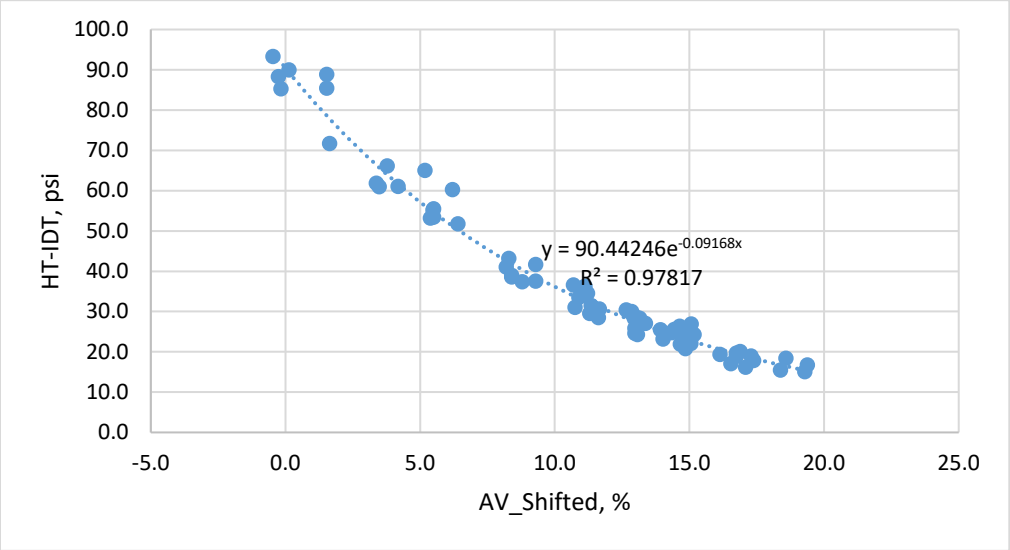
Source: University of Nevada, Reno

Figure 14. Correlation Between AV and APA 100 psi/100 lb Rut Depth After 8,000 Cycles



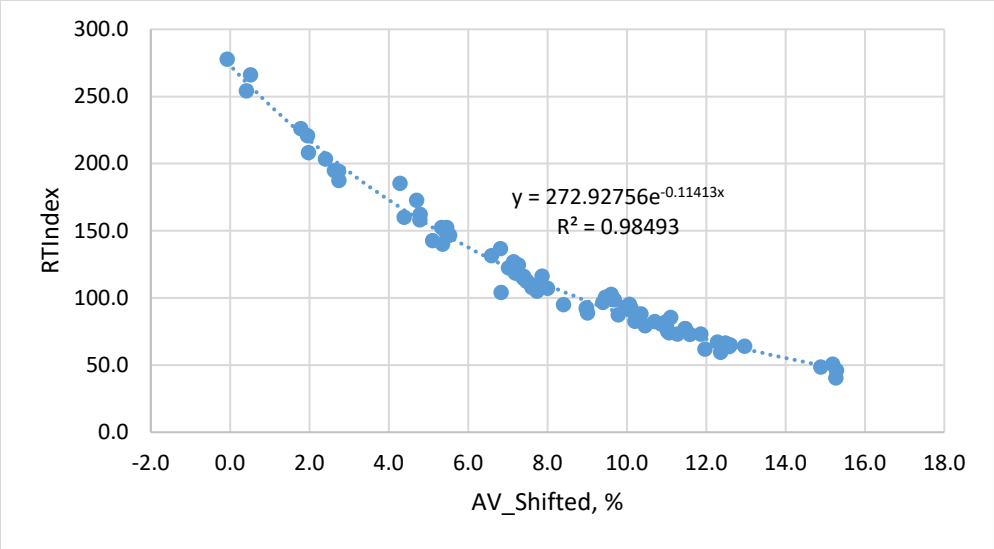
Source: University of Nevada, Reno

Figure 15. Correlation Between AV and HWTT Rut Depth After 5,000 Passes



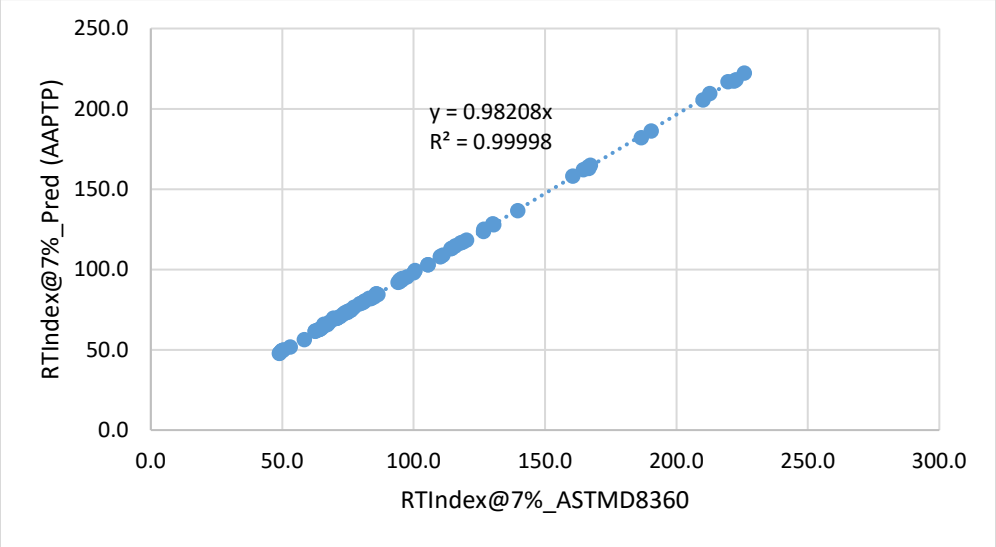
Source: University of Nevada, Reno

Figure 16. Correlation Between AV and HT-IDT Test



Source: University of Nevada, Reno

Figure 17. Correlation Between AV and RT_{Index}



Source: University of Nevada, Reno

Figure 18. Correlation Between RT_{Index} Corrected to 7 Percent AV from ASTM D8369 Equation and RT_{Index} Corrected to 7 Percent AV from the Airport Asphalt Pavement Technology Program BMD Rutting Tests Project Equation

Chapter 5. Additional Rutting Tests

After completing the project experimental test matrix at both AV levels and environmental test temperature for LMLC and RPMLC samples, additional rutting tests were performed at different test conditions for comparative evaluation and verification purposes.

Reno Stead Airport (RTS)

RPMLC Samples

Table 121. APA 250 psi/250 lb Test Results at Design AV and 64 °C for RTS RPMLC Samples

Rutting Test	APA 250 psi/250 lb; Design AV; 64 °C	
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**AV, %**
Replicate 1	2.85	3.5
Replicate 2	4.52	3.6
Replicate 3	3.71	3.4
Replicate 4	5.15	3.3
Average	4.06	3.5
Standard Deviation	1.00	–
COV, %	24.59	–
95% CI – Lower Limit	3.08	–
95% CI – Upper Limit	5.04	–

Teterboro Airport (TEB)

LMLC Samples

Table 122. APA 100 psi/100 lb Test Results at 7±0.5 Percent AV and 58 °C for TEB LMLC Samples

Rutting Test	APA 100 psi/100 lb; 7% AV; 58 °C		
Test Parameter	Rut Depth at 4,000 Cycles, mm	Rut Depth at 8,000 Cycles, mm	AV, %
Replicate 1	2.69	3.27	6.8
Replicate 2	3.46	4.38	6.9
Average	3.07	3.82	6.9
Standard Deviation	0.54	0.78	–
COV, %	17.68	20.55	–
95% CI – Lower Limit	2.32	2.73	–
95% CI – Upper Limit	3.82	4.91	–

Table 123. APA 250 psi/250 lb Test Results at 7±0.5 Percent AV and 58 °C for TEB LMLC Samples

Rutting Test	APA 250 psi/250 lb; 7% AV; 58 °C	
Test Parameter	Rut Depth at 4,000 Cycles, mm	AV, %
Replicate 1	6.68	7.5
Replicate 2	7.57	7.0
Average	7.13	7.2
Standard Deviation	0.63	–
COV, %	8.83	–
95% CI – Lower Limit	6.25	–
95% CI – Upper Limit	8.00	–

Table 124. HT-IDT Test Results at 7±0.5 Percent AV and 58 °C for TEB LMLC Samples

Rutting Test	HT-IDT; 7% AV; 58 °C	
Test Parameter	HT-IDT Strength Value, psi	AV, %
Replicate 1	9.40	6.9
Replicate 2	10.80	7.2
Replicate 3	10.40	6.9
Average	10.20	7.0
Standard Deviation	0.72	–
COV, %	7.07	–
95% CI – Lower Limit	9.38	–
95% CI – Upper Limit	11.02	–

RPMLC Samples

Table 125. APA 250 psi/250 lb Test Results at Design AV and 64 °C for TEB RPMLC Samples

Rutting Test	APA 250 psi/250 lb; Design AV; 64 °C	
Test Parameter	**Rut Depth at 4,000 Cycles, mm**	**AV, %**
Replicate 1	7.68	4.0
Replicate 2	8.59	4.5
Replicate 3	7.18	4.2
Replicate 4	9.32	4.3
Average	8.19	4.3
Standard Deviation	0.95	–
COV, %	11.62	–
95% CI – Lower Limit	7.26	–
95% CI – Upper Limit	9.13	–