Airport Asphalt Pavement Technology Program

Balanced Mix Design: Rutting Performance Tests

Mix Design Verification Data

Appendix D

August 2025

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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List of Acronyms and Abbreviations

1s	One-sigma limit
AC	Asphalt content
AL	FAA Action Limits
APA	Asphalt Pavement Analyzer
ASTM	ASTM International
AV	Air voids
BMD	Balanced Mix Design
d1s	Single-operator one-sigma limit
d2s	Difference two-sigma limit
EWR	Newark Liberty International Airport
FAA	Federal Aviation Administration
G_{mb}	Mix bulk specific gravity
G_{mm}	Maximum theoretical specific gravity
G_{sb}	Aggregate bulk specific gravity
JMF	Job mix formula
JMF2	Job mix formula no. 2
LMLC	Laboratory-mixed laboratory-compacted
PANYNJ	Port Authority of New York and New Jersey
PHL	Philadelphia International Airport
RPMLC	Reheated plant-mixed laboratory-compacted
RTS	Reno Stead Airport
SFO	San Francisco International Airport
SL	FAA Suspension Limit
SMF	Sacramento International Airport
SSD	Saturated surface dry
TEB	Teterboro Airport
TPA	Tampa International Airport
TWM	Total weight of mix
VFA	Voids filled with asphalt
VMA	Voids in mineral aggregates

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 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 ideal rutting test. Improved 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 incorporating 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. The 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 pavement sections with known performance histories. Revisions to FAA's P-401/P-403 asphalt mixtures specifications 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 the correlations between laboratory criteria and in-service performance of airfield asphalt pavements.

Mix Design Verification

A mix design verification plan was developed and implemented to ensure high consistency and minimal variability in testing results across different entities within the research team. The first step involved verifying that both the field- and plant-produced asphalt mixtures and the raw materials conformed to the job mix formula (JMF) within acceptable production tolerances prescribed by the Federal Aviation Administration (FAA) specifications (FAA, 2018).

The mix design verification plans for laboratory-mixed laboratory-compacted (LMLC) samples and reheated plant-mixed laboratory-compacted (RPMLC) samples are illustrated in Figure 1 and Figure 2, respectively. Verification of the plant- and field-produced mixtures was conducted using the centrifuge extraction method to determine the asphalt binder content and the gradation of extracted aggregates. Once the gradation of extracted aggregates was confirmed to meet the JMF production tolerances, a similar gradation verification was performed using sieve analysis on two samples split from the raw aggregate stockpiles.

Aggregate stockpiles were then blended to produce a total of 50 kg, following the mix design bin percentages, and sieved into passing-retained control buckets. The aggregate gradation from the passing-control buckets was verified against the JMF control chart limits for each 50-kg blend prior to batching the samples. The batched samples were subsequently mixed, compacted, conditioned, and subjected to rutting mechanical tests.

To maintain consistency in testing across the three laboratories within the research team, the gradation of both extracted and raw aggregates was regularly checked against the JMF control charts. FAA advisory circular 150/5370-10H (FAA, 2018), specifies two types of control charts:

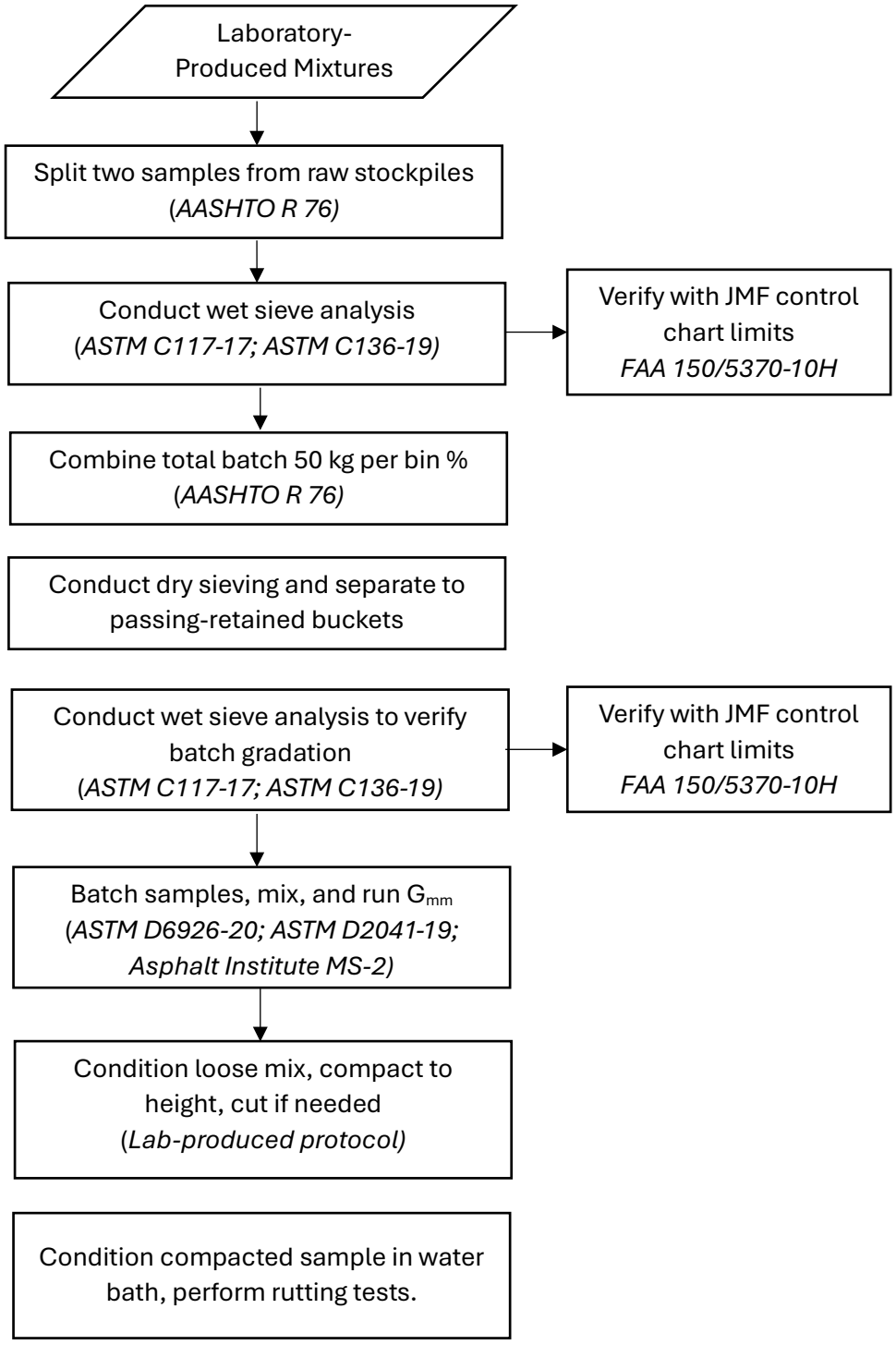
- **Control chart limits for individual measurements:** Use the JMF target values as indicators of central tendency for each measurement.
- **Control chart limits based on range:** Use the range of two measurements to control process variability.

To monitor compliance during production, these control charts are compared against action and suspension limits. According to FAA advisory circular 150/5370-10H, a process is deemed out of control, requiring production to stop and corrective action to be taken, if any of the following occur (FAA, 2018):

- A single point falls outside the Suspension Limit line for individual measurements or range; or
- Two consecutive points fall outside the Action Limit line for individual measurements.

Additionally, the terms d1s and d2s, used in the tables in subsequent sections of this report, are defined by ASTM International (ASTM) in ASTM C670 (ASTM, 2015a) as follows:

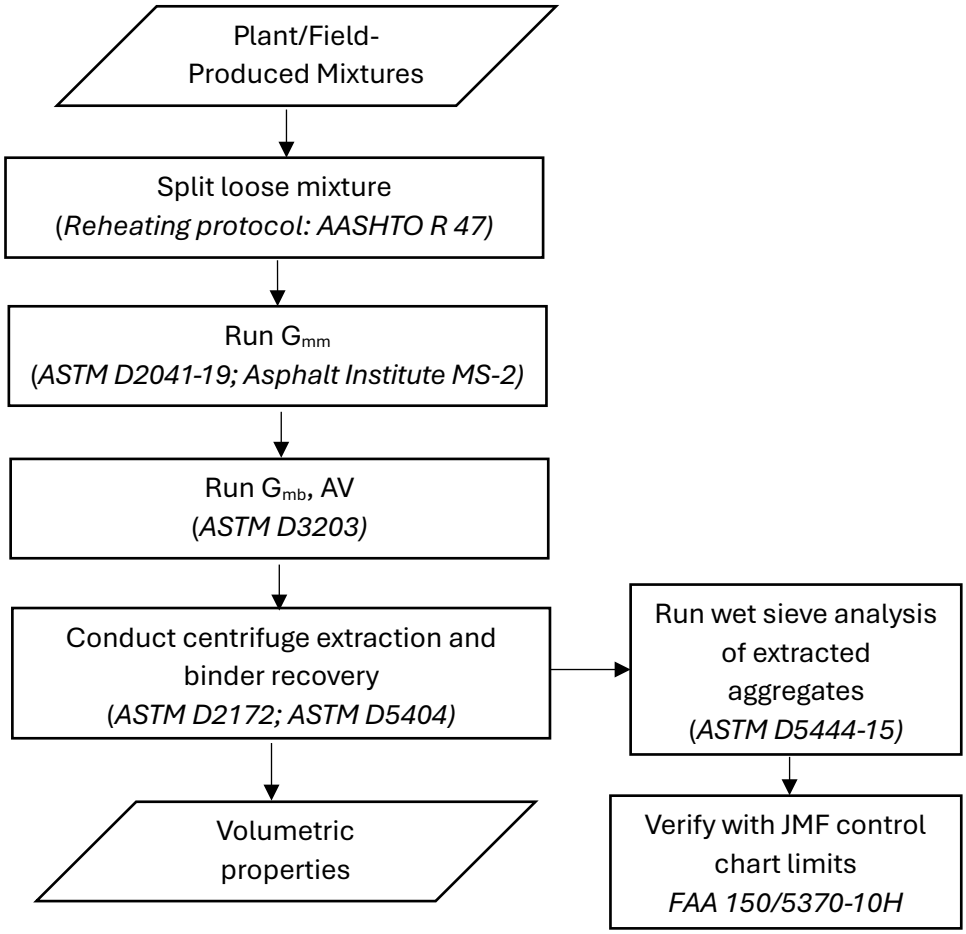
- **d1s:** The one-sigma limit or single-operator standard deviation, referred to as the repeatability standard deviation in ASTM E177 (ASTM, 2021).
- **d2s:** The difference limit—d2s indicates the maximum acceptable difference between two results obtained on identical test specimens.



G_{mm} = maximum theoretical specific gravity.

Source: University of Nevada, Reno

Figure 1. Verification Plan for LMLC Samples (FAA, 2018) (ASTM, 2020b) (ASTM, 2020a) (ASTM, 2017) (ASTM, 2019a)



G_{mb} = mix bulk specific gravity; AV = air voids.

Source: University of Nevada, Reno

Figure 2. Verification Plan for RPMLC Samples (FAA, 2018) (ASTM, 2020b) (ASTM, 2017) (ASTM, 2019a) (ASTM, 2019b) (ASTM, 2018) (Asphalt Institute, 2014) (AASHTO, 2022) (ASTM, 2010) (ASTM, 2015b).

Newark Liberty International Airport (EWR)

Raw Aggregate Gradation and Maximum Theoretical Specific Gravity

Table 1. Gradation Control Charts for Individual Measurement: EWR Sample A (Raw Aggregates)

Sieve Size	Percent Passing	JMF2 (with Plant Adjustments), %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1"	99	99	0	–	–
3/4"	96	96	1	6	9
1/2"	82	78	4	6	9
3/8"	69	64	5	6	9
#4	47	44	2	6	9
#8	36	35	1	5	7.5
#16	26	26	1	5	7.5
#30	23	18	>AL	3	4.5
#50	13	11	2	3	4.5
#100	8	5	>AL	2	3
#200	5.1	3.1	>AL	2.0	3.0

JMF2 = job mix formula no. 2; PANYNJ = Port Authority of New York and New Jersey.
>AL = Exceeding FAA Action Limits.
– = Not applicable.

Table 2. Gradation Control Charts for Individual Measurement: EWR Sample B (Raw Aggregates)

Sieve Size	Percent Passing	JMF2 (with Plant Adjustments), %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1"	99	99	0	–	–
3/4"	96	96	0	6	9
1/2"	82	78	4	6	9
3/8"	70	64	5	6	9
#4	47	44	3	6	9
#8	36	35	1	5	7.5
#16	26	26	1	5	7.5
#30	23	18	>SL	3	4.5
#50	13	11	2	3	4.5
#100	8	5	>AL	2	3
#200	5.1	3.1	>AL	2.0	3.0

>SL = Exceeding FAA Suspension Limits.

Table 3. Gradation Control Charts Based on Range: EWR (Raw Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2)	PANYNJ Suspension Limits
1''	99	99	1	–
3/4"	96	96	1	–
1/2"	82	82	0	11
3/8"	69	70	1	11
#4	47	47	0	11
#8	36	36	0	–
#16	26	26	0	9
#30	23	23	0	–
#50	13	13	0	6
#100	8	8	0	–
#200	5	5	0.0	3.5

Table 4. Maximum Theoretical Specific Gravity: EWR (LMLC)

Measurement	Sample A	Sample B	Acceptance
Bowl Empty Underwater, g	1441.7	1441.7	–
Dry Sample Mass, g	2668.8	2645.9	–
Sample + Bowl Underwater, g	3075.5	3065.8	–
Sample Underwater, g	1633.8	1624.1	–
G_{mm}	2.579	2.589	–

Summary Statistics	Samples A & B	Acceptance
Average G_{mm}	2.584	2.582
d1s	0.008	
d2s	0.011	

G_{mm} = Maximum theoretical specific gravity.

RPMLC Volumetric Properties

Table 5. Maximum Theoretical Specific Gravity: EWR (RPMLC)

Measurement	Sample A	Sample B	Acceptance
Bowl Empty Underwater, g	1442.5	1442.5	–
Dry Sample Mass, g	2595.1	2505.7	–
Sample + Bowl Underwater, g	3041.3	2983.7	–
Sample Underwater, g	1598.8	1541.2	–
G_{mm}	2.605	2.598	–
Summary Statistics	**Samples A & B**		**Acceptance**
Average G_{mm}	2.601		2.584
d1s	0.005		
d2s	0.007		

Table 6. Volumetric Properties: EWR (RPMLC)

Measurement	Sample A	Sample B	Sample C	Acceptance
Air Sample, g	1246	1244.8	1236.6	–
Underwater Mass, g	750.6	748.5	747.1	–
SSD Mass, g	1249.6	1247.6	1238.7	–
G_{mb}	2.497	2.494	2.515	–
VMA, %	14.9	15.0	14.2	15.3
VFA, %	73.0	72.5	76.8	73.9
Height, mm	63.3	62.9	62.3	–
G_{mm}	2.601	2.601	2.601	2.584
AV, %	4.0	4.1	3.3	–
Summary Statistics	**Samples A, B & C**			**Acceptance**
G_{sb}	2.797			–
Average G_{mb}	2.502			2.481
d1s	0.012			–
d2s	0.021			–
Average AV, %	3.8			4.0

SSD = saturated surface dry; VMA = voids in mineral aggregates; VFA = voids filled with asphalt.
G_{mb} = Mix bulk specific gravity.
G_{sb} = Aggregate bulk specific gravity.

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 7. Binder Extraction Data: EWR

Measurement	Sample A	Sample B	JMF	Acceptance
Empty Bowl, g	1903.6	1903.6	–	–
Filter Only, g	20.71	20.45	–	–
Rotary Tube Empty, g	226.74	226.65	–	–
Empty Centrifuge Screen, g	504.72	504.69	–	–
Sample Weight, g	2689.6	2659	–	–
Filter+ Fine, g	22.96	22.76	–	–
Rotary Tube + Fine, g	240.80	238.68	–	–
Dry Aggregate + Bowl, g	4450	4426.7	–	–
Centrifuge Screen + Fine	505.03	504.90	–	–
AC, % by TWM	4.71	4.56	–	–

Summary Statistics	Samples A & B	JMF	Acceptance
Average AC, % by TWM	4.6	4.7	4.5
1s	0.101		
d2s	0.143		

AC = asphalt content; TWM = total weight of mix.
1s = One-sigma limit.

Table 8. Gradation Control Charts for Individual Measurement: EWR Sample A (Extracted Aggregates)

Sieve Size	Percent Passing	JMF2 (with Plant Adjustments), %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	99	1	–	–
3/4"	97	96	2	6	9
1/2"	77	78	1	6	9
3/8"	65	64	1	6	9
#4	45	44	1	6	9
#8	34	34	0	5	7.5
#16	25	26	0	5	7.5
#30	19	18	1	3	4.5
#50	12	11	2	3	4.5
#100	7	5	2	2	3
#200	3.8	3.2	0.5	2.0	3.0

Table 9. Gradation Control Charts for Individual Measurement: EWR Sample B (Extracted Aggregates)

Sieve Size	Percent Passing	JMF2 (with Plant Adjustments), %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	99	1	–	–
3/4"	98	96	2	6	9
1/2"	79	78	0	6	9
3/8"	67	64	3	6	9
#4	46	44	1	6	9
#8	34	34	0	5	7.5
#16	25	26	0	5	7.5
#30	19	18	0	3	4.5
#50	12	11	2	3	4.5
#100	7	5	1	2	3
#200	3.5	3.2	0.3	2.0	3.0

Table 10. Gradation Control Charts Based on Range: EWR (Extracted Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	PANYNJ Suspension Limits, %
1''	100	100	0	–
3/4"	97	98	1	–
1/2"	77	79	1	11
3/8"	65	67	2	11
#4	45	46	1	11
#8	34	34	0	–
#16	25	25	0	9
#30	19	19	0	–
#50	12	12	0	6
#100	7	7	0	–
#200	3.8	3.5	0.2	3.5

Philadelphia International Airport (PHL)

RPMLC Volumetric Properties

Table 11. Maximum Theoretical Specific Gravity: PHL (RPMLC)

Measurement	Sample A	Sample B	JMF	Acceptance
Bowl Empty Underwater, g	1442.3	1442.1	–	–
Dry Sample Mass, g	3103.5	2661.6	–	–
Sample + Bowl Underwater, g	3397.8	3119.9	–	–
Sample Underwater, g	1955.5	1677.8	–	–
G_{mm}	2.703	2.705	–	–
Summary Statistics	**Samples A & B**		**JMF**	**Acceptance**
Average G_{mm}	2.704		2.658	2.691
d1s	0.001		–	–
d2s	0.002		–	–

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 12. Binder Extraction Data: PHL

Measurement	Sample A	Sample B	JMF	Quality Control
Empty Bowl, g	1903.4	1903.4	–	–
Filter Only, g	20.98	21.30	–	–
Rotary Tube Empty, g	225.14	225.82	–	–
Empty Centrifuge Screen, g	504.69	504.70	–	–
Sample Weight, g	2333.3	2129.7	–	–
Filter + Fine, g	24.04	23.38	–	–
Rotary Tube + Fine, g	238.00	239.02	–	–
Dry Aggregate + Bowl, g	4096.4	3906.4	–	–
Centrifuge Screen + Fine	505.01	504.92	–	–
AC, % by TWM	5.32	5.22	–	–
Summary Statistics	**Samples A & B**		**JMF**	**Quality Control**
Average AC, % by TWM	5.3		5.5	5.6
1s	0.068			
d2s	0.096			

Table 13. Gradation Control Charts for Individual Measurement: PHL Sample A (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	86	89	4	6	9
3/8"	77	83	5	6	9
#4	55	62	>AL	6	9
#8	40	44	4	–	–
#16	29	29	0	5	7.5
#30	19	20	1	–	–
#50	13	13	0	3	4.5
#100	7	8	1	–	–
#200	3.4	5	1.6	2.0	3.0

Table 14. Gradation Control Charts for Individual Measurement: PHL Sample B (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	90	89	1	6	9
3/8"	81	83	2	6	9
#4	61	62	1	6	9
#8	43	44	0	–	–
#16	31	29	2	5	7.5
#30	21	20	1	–	–
#50	14	13	0	3	4.5
#100	7	8	0	–	–
#200	3.8	5.0	1.2	2.0	3.0

Table 15. Gradation Control Charts Based on Range: PHL (Extracted Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	FAA Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	86	90	4	11
3/8"	77	81	4	11
#4	55	61	6	11
#8	40	43	4	–
#16	29	31	2	9
#30	19	21	2	–
#50	13	14	1	6
#100	7	7	0	–
#200	3.4	3.8	0.3	3.5

Reno Stead Airport (RTS)

Raw Aggregate Gradation and Maximum Theoretical Specific Gravity

Table 16. Gradation Control Charts for Individual Measurement: RTS Sample A (Raw Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	95	96	1	6	9
3/8"	88	88	0	6	9
#4	63	61	2	6	9
#8	51	49	2	–	–
#16	36	33	3	5	7.5
#30	25	23	2	–	–
#50	15	15	0	3	4.5
#100	9	9	0	–	–
#200	5.4	6.0	1	2.0	3.0

Table 17. Gradation Control Charts for Individual Measurement: RTS Sample B (Raw Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	95	96	1	6	9
3/8"	88	88	0	6	9
#4	64	61	3	6	9
#8	52	49	3	–	–
#16	37	33	4	5	7.5
#30	25	23	2	–	–
#50	15	15	0	3	4.5
#100	9	9	0	–	–
#200	5.7	6.0	0	2.0	3.0

Table 18. Gradation Control Charts Based on Range: RTS (Raw Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	FAA P-401 Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	95	95	0	11
3/8"	88	88	0	11
#4	63	64	1	11
#8	51	52	1	–
#16	36	37	0	9
#30	25	25	0	–
#50	15	15	0	6
#100	9	9	0	–
#200	5.4	5.7	0.4	3.5

Table 19. Maximum Theoretical Specific Gravity: RTS (LMLC)

Measurement	Sample A	Sample B	JMF
Bowl Empty Underwater, g	1442.7	1442.7	–
Dry Sample Mass, g	1552.6	1575	–
Sample + Bowl Underwater, g	2382.8	2395	–
Sample Underwater, g	940.1	952.3	–
G_{mm}	2.535	2.529	–

Summary Statistics	Samples A & B	JMF
Average G_{mm}	2.532	2.553
d1s	0.004	
d2s	0.006	

RPMLC Volumetric Properties

Table 20. Maximum Theoretical Specific Gravity: RTS (RPMLC)

Measurement	Sample A	Sample B	Sample C	JMF
Bowl Empty Underwater, g	1441.6	1441.6	1442.1	–
Dry Sample Mass, g	1553.7	1553.6	1398.5	–
Sample + Bowl Underwater, g	2374.6	2377.3	2282.8	–
Sample Underwater, g	933	935.7	840.7	–
G_{mm}	2.503	2.514	2.507	–
Summary Statistics	**Samples A, B, & C**			**JMF**
Average G_{mm}	2.508			2.553
d1s	0.006			
d2s	0.011			

Table 21. Volumetric Properties: RTS (RPMLC)

Measurement	Sample A	Sample B	Sample C	JMF
Air Sample, g	1229.4	1219.7	1219.6	–
Underwater Mass, g	728.1	723.9	723.5	–
SSD Mass, g	1229.6	1220.1	1219.7	–
G_{mb}	2.451	2.458	2.458	–
Height, mm	62.6	62.5	62.2	–
G_{mm}	2.508	2.508	2.508	2.553
VMA, %	15.3	15.0	15.0	15.0
VFA, %	85.2	86.7	86.7	76.9
AV, %	2.3	2.0	2.0	–
Summary Statistics	**Samples A, B & C**			**JMF**
G_{sb}	2.735			–
Average G_{mb}	2.456			2.464
d1s	0.004			–
d2s	0.007			–
Average AV, %	2.1			3.5

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 22. Binder Extraction Data: RTS

Measurement	Sample A	Sample B	JMF
Empty Bowl, g	1902.6	1902.5	–
Filter Only, g	20.35	20.95	–
Rotary Tube Empty, g	226.72	226.74	–
Empty Centrifuge Screen, g	504.60	504.65	–
Sample Weight, g	2622.5	2838.4	–
Filter + Fine, g	24.79	25.53	–
Rotary Tube + Fine, g	252.45	255.43	–
Dry Aggregate + Bowl, g	4351.8	4552.1	–
Centrifuge Screen + Fine	505.13	504.97	–
AC, % by TWM	5.44	5.47	–

Summary Statistics	Samples A & B	JMF
Average AC, % by TWM	5.5	5.7
1s	0.022	
d2s	0.031	

Table 23. Gradation Control Charts for Individual Measurement: RTS Sample A (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	94	96	2	6	9
3/8"	82	88	6	6	9
#4	58	61	3	6	9
#8	46	49	3	–	–
#16	32	33	1	5	7.5
#30	22	23	1	–	–
#50	14	15	1	3	4.5
#100	8	9	1	–	–
#200	5.6	6.0	0	2.0	3.0

Table 24. Gradation Control Charts for Individual Measurement: RTS Sample B (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	94	96	2	6	9
3/8"	84	88	4	6	9
#4	60	61	1	6	9
#8	48	49	1	–	–
#16	33	33	0	5	7.5
#30	23	23	0	–	–
#50	14	15	1	3	4.5
#100	8	9	1	–	–
#200	5.7	6.0	0	2.0	3.0

Table 25. Gradation Control Charts Based on Range: RTS (Extracted Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	FAA P-401 Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	94	94	1	11
3/8"	82	84	1	11
#4	58	60	2	11
#8	46	48	1	–
#16	32	33	1	9
#30	22	23	0	–
#50	14	14	0	6
#100	8	8	0	–
#200	5.6	5.7	0.1	3.5

San Francisco International Airport (SFO)

Raw Aggregate Gradation and Maximum Theoretical Specific Gravity

Table 26. Gradation Control Charts for Individual Measurement: SFO Sample A (Raw Aggregates)

Sieve Size	Percent Passing	JMF (Proposed Target Gradation), %	Control Chart for Individual Measurements, %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	99	97	2	6	9
1/2"	91	88	3	6	9
3/8"	84	82	2	6	9
#4	64	69	5	6	9
#8	46	50	4	–	–
#16	32	36	4	5	7.5
#30	20	22	2	–	–
#50	11	15	>AL	3	4.5
#100	5	8	3	–	–
#200	3.2	5.0	1.8	2.0	3.0

Table 27. Gradation Control Charts for Individual Measurement: SFO Sample B (Raw Aggregates)

Sieve Size	Percent Passing, %	JMF (Proposed Target Gradation), %	Control Chart for Individual Measurements, %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	99	97	2	6	9
1/2"	91	88	3	6	9
3/8"	84	82	2	6	9
#4	66	69	3	6	9
#8	47	50	3	–	–
#16	31	36	5	5	7.5
#30	20	22	2	–	–
#50	11	15	>AL	3	4.5
#100	5	8	3	–	–
#200	3.2	5.0	1.8	2.0	3.0

Table 28. Gradation Control Charts Based on Range: SFO (Raw Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	FAA Suspension Limits, %
1''	100	100	0	–
3/4"	99	99	0	–
1/2"	91	91	0	11
3/8"	84	84	1	11
#4	64	66	2	11
#8	46	47	0	–
#16	32	31	0	9
#30	20	20	0	–
#50	11	11	0	6
#100	5	5	0	–
#200	3.2	3.2	0.1	3.5

Table 29. Maximum Theoretical Specific Gravity: SFO (LMLC)

Measurement	Sample A	Sample B	JMF
Bowl Empty Underwater, g	1441.7	1441.7	–
Dry Sample Mass, g	2586.7	2599.4	–
Sample + Bowl Underwater, g	3014.9	3024.6	–
Sample Underwater, g	1573.2	1582.9	–
G_{mm}	2.552	2.557	–

Summary Statistics	Samples A & B	JMF
Average G_{mm}	2.555	2.532
Single Operator d1s	0.004	
Single Operator d2s	0.005	

RPMLC Volumetric Properties

Table 30. Maximum Theoretical Specific Gravity: SFO (RPMLC)

Measurement	Sample A	Sample B	JMF
Bowl Empty Underwater, g	1442.4	1442.4	–
Dry Sample Mass, g	2592.5	2543.2	–
Sample + Bowl Underwater, g	3014.7	2989.1	–
Sample Underwater, g	1572.3	1546.7	–
G_{mm}	2.541	2.552	–
Summary Statistics	**Samples A & B**		**JMF**
Average G_{mm}	2.547		2.532
Single Operator d1s	0.008		
Single Operator d2s	0.011		

Table 31. Volumetric Properties: SFO (RPMLC)

Measurement	Sample A	Sample B	Sample C	JMF
Air Sample, g	1219.8	1226.3	1224.9	–
Underwater Mass, g	726	730.3	731.3	–
SSD Mass, g	1220.4	1227.1	1225.5	–
G_{mb}	2.467	2.468	2.479	–
Height, mm	61.8	62.3	62.0	–
G_{mm}	2.547	2.547	2.547	2.532
VMA, %	13.4	13.3	13.0	14.5
VFA, %	76.6	76.9	79.4	75.2
AV, %	3.1	3.1	2.7	–
Summary Statistics	**Samples A, B & C**			**JMF**
G_{sb}	2.699			–
Average G_{mb}	2.471			2.441
Single Operator d1s	0.006			–
Single Operator d2s	0.011			–
Average AV, %	3.0			3.6

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 32. Binder Extraction Data: SFO

Measurement	Sample A	Sample B	Sample C	Sample D	JMF
Empty Bowl, g	1903.4	1903.4	1903.4	1903.4	–
Filter Only, g	21.05	20.91	21.2	20.78	–
Rotary Tube Empty, g	226.85	226.77	227.21	226.37	–
Empty Centrifuge Screen, g	504.65	504.73	504.72	504.61	–
Sample Weight, g	2520.5	2596.8	2544.5	2332.3	–
Filter + Fine, g	27.21	27.09	23.08	23.27	–
Rotary Tube + Fine, g	240.4	241.5	255.1	241.7	–
Dry Aggregate + Bowl, g	4269.3	4346.5	4283.4	4095.4	–
Centrifuge Screen + Fine	504.94	504.96	506.81	506.11	–
AC, % by TWM	5.3	5.1	5.2	5.2	–

Summary Statistics	Samples A, B, C & D	JMF
Average AC, % by TWM	5.2	5.5

Summary Statistics	Samples A & B
1s	0.017
d2s	0.024

Table 33. Gradation Control Charts for Individual Measurement: SFO Sample C (Extracted Aggregates)

Sieve Size	Percent Passing (Sample C)	JMF (Proposed Target Gradation), %	Control Chart for Individual Measurements (Sample C), %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	98	97	1	6	9
1/2"	86	88	2	6	9
3/8"	79	82	3	6	9
#4	62	69	>AL	6	9
#8	48	50	2	–	–
#16	35	36	1	5	7.5
#30	22	22	0	–	–
#50	13	15	2	3	4.5
#100	7	8	1	–	–
#200	4.4	5.0	0.6	2.0	3.0

Table 34. Gradation Control Charts for Individual Measurement: SFO Sample D (Extracted Aggregates)

Sieve Size	Percent Passing (Sample D)	JMF (Proposed Target Gradation), %	Control Chart for Individual Measurements (Sample D), %	FAA Action Limits, %	FAA Suspension Limits, %
1''	100	100	0	–	–
3/4"	97	97	0	6	9
1/2"	85	88	3	6	9
3/8"	79	82	3	6	9
#4	62	69	>AL	6	9
#8	48	50	2	–	–
#16	34	36	2	5	7.5
#30	23	22	1	–	–
#50	13	15	2	3	4.5
#100	7	8	1	–	–
#200	4.8	5.0	0.2	2.0	3.0

Table 35. Gradation Control Charts Based on Range: SFO (Extracted Aggregates)

Sieve Size	Sample C, %	Sample D, %	Control Chart Based on Range (n = 2), %	FAA Suspension Limits, %
1''	100	100	0	–
3/4"	98	97	1	–
1/2"	86	85	1	11
3/8"	79	79	0	11
#4	62	62	1	11
#8	48	48	0	–
#16	35	34	1	9
#30	22	23	0	–
#50	13	13	0	6
#100	7	7	0	–
#200	4.4	4.8	0.4	3.5

Sacramento International Airport (SMF)

RPMLC Volumetric Properties

Table 36. Maximum Theoretical Specific Gravity: SMF (RPMLC)

Measurement	Sample A	Sample B	Sample C	JMF	Quality Control *(Avg. Sub 2 and 3)*
Bowl Empty Underwater, g	1441.6	1441.6	1441.5	–	–
Dry Sample Mass, g	1863.1	1802.1	1566.9	–	–
Sample + Bowl Underwater, g	2574.6	2535.8	2389	–	–
Sample Underwater, g	1133	1094.2	947.5	–	–
G_{mm}	2.552	2.546	2.530	–	–

Summary Statistics	Samples A, B & C	JMF	Quality Control *(Avg. Sub 2 and 3)*
Average G_{mm}	2.549	2.556	2.515

Summary Statistics	Samples A & B
d1s	0.004
d2s	0.006

Table 37. Volumetric Properties: SMF (RPMLC)

Measurement	Sample A	Sample B	JMF	Quality Control *(Sublot 3)*
Air Sample, g	4899.9	4890.3	–	–
Underwater Mass, g	2877.3	2875.3	–	–
SSD Mass, g	4902.7	4894.7	–	–
G_{mb}	2.419	2.422	–	–
G_{mm}	2.549	2.549	2.556	2.515
VMA, %	16.5	16.4	15.0	16.2
VFA, %	69.2	69.6	75.9	79.0
AV, %	5.1	5.0	–	–

Summary Statistics	Samples A & B	JMF	Quality Control *(Sublot 3)*
G_{sb}	2.734	–	–
Average G_{mb}	2.420	2.464	2.429
d1s	0.002	–	–
d2s	0.002	–	–
Average AV, %	5.0	3.6	3.4

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 38. Binder Extraction Data: SMF

Measurement	Sample A	Sample B	JMF
Empty Bowl, g	1903.7	1903.4	–
Filter Only, g	21.05	20.41	–
Rotary Tube Empty, g	226.77	226.77	–
Empty Centrifuge Screen, g	504.66	504.58	–
Sample Weight, g	2741.9	2740.8	–
Filter + Fine, g	25.56	24.85	–
Rotary Tube + Fine, g	256.6	257.3	–
Dry Aggregate + Bowl, g	4454	4454.8	–
Centrifuge Screen + Fine	505.72	505.25	–
AC, % by TWM	5.7	5.6	–

Summary Statistics	Samples A & B	JMF
Average AC, % by TWM	5.7	5.7
1s	0.062	
d2s	0.087	

Table 39. Gradation Control Charts for Individual Measurement: SMF Sample A (Extracted Aggregates)

Sieve Size	Percent Passing , %	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	98	98	0	6	9
3/8"	87	84	3	6	9
#4	60	58	2	6	9
#8	41	38	3	–	–
#16	26	26	0	5	7.5
#30	18	18	0	–	–
#50	12	11	1	3	4.5
#100	9	7	2	–	–
#200	6.6	5.5	1.1	2.0	3.0

Table 40. Gradation Control Charts for Individual Measurement: SMF Sample B (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	FAA P-401 Action Limits, %	FAA P-401 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	97	98	1	6	9
3/8"	83	84	1	6	9
#4	57	58	1	6	9
#8	39	38	1	–	–
#16	26	26	0	5	7.5
#30	17	18	1	–	–
#50	12	11	1	3	4.5
#100	9	7	2	–	–
#200	6.5	5.5	1.0	2.0	3.0

Table 41. Gradation Control Charts Based on Range: SMF (Extracted Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	FAA P-401 Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	98	97	1	11
3/8"	87	83	4	11
#4	60	57	3	11
#8	41	39	1	–
#16	26	26	1	9
#30	18	17	0	–
#50	12	12	0	6
#100	9	9	0	–
#200	6.6	6.5	0.1	3.5

Teterboro Airport (TEB)

Raw Aggregate Gradation and Maximum Theoretical Specific Gravity

Table 42. Gradation Control Charts for Individual Measurement: TEB Sample A (Raw Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	89	89	0	6	9
3/8"	78	75	3	6	9
#4	49	47	2	6	9
#8	34	33	1	5	7.5
#16	23	22	1	5	7.5
#30	15	16	1	3	4.5
#50	10	10	1	3	4.5
#100	5	6	1	2	3
#200	2.8	3.1	0.3	2.0	3.0

Table 43. Gradation Control Charts for Individual Measurement: TEB Sample B (Raw Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	89	89	0	6	9
3/8"	78	75	4	6	9
#4	48	47	2	6	9
#8	33	33	0	5	7.5
#16	23	22	1	5	7.5
#30	15	16	1	3	4.5
#50	9	10	1	3	4.5
#100	5	6	1	2	3
#200	2.8	3.1	0.3	2.0	3.0

Table 44. Gradation Control Charts Based on Range: TEB (Raw Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	PANYNJ Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	89	89	0	11
3/8"	78	78	0	11
#4	49	48	0	11
#8	34	33	0	–
#16	23	23	0	9
#30	15	15	0	–
#50	10	9	0	6
#100	5	5	0	–
#200	2.8	2.8	0.0	3.5

Table 45. Maximum Theoretical Specific Gravity: TEB (LMLC)

Measurement	Sample A	Sample B	Acceptance
Bowl Empty Underwater, g	1442.9	1442.9	–
Dry Sample Mass, g	2592.3	2594.6	–
Sample + Bowl Underwater, g	2997.9	3000.4	–
Sample Underwater, g	1555	1557.5	–
G_{mm}	2.499	2.502	–

Summary Statistics	Samples A & B	Acceptance
Average G_{mm}	2.500	2.476
d1s	0.002	
d2s	0.003	

RPMLC Volumetric Properties

Table 46. Maximum Theoretical Specific Gravity: TEB (RPMLC)

Measurement	Sample A	Sample B	Sample C	Acceptance
Bowl Empty Underwater, g	1443	1443	–	–
Dry Sample Mass, g	2500	2501.8	–	–
Sample + Bowl Underwater, g	2936	2941.1	–	–
Sample Underwater, g	1493	1498.1	–	–
G_{mm}	2.483	2.493	–	–
Summary Statistics	**Samples A, B & C**			**Acceptance**
Average G_{mm}	2.488			2.476
d1s	0.007			
d2s	0.010			

Table 47. Volumetric Properties: TEB (RPMLC)

Measurement	Sample A	Sample B	Sample C	Acceptance
Air Sample, g	1204.1	1231.8	1232.9	–
Underwater Mass, g	710.9	727.1	728.2	–
SSD Mass, g	1204.4	1232.7	1233.7	–
G_{mb}	2.440	2.436	2.439	–
Height, mm	62.2	64.2	63.7	–
G_{mm}	2.488	2.488	2.488	2.476
VMA, %	14.0	14.1	14.0	15.1
VFA, %	86.3	85.4	86.1	82.1
AV, %	1.9	2.1	2.0	–
Summary Statistics	**Samples A, B & C**			**Acceptance**
G_{sb}	2.689			–
Average G_{mb}	2.438			2.410
d1s	0.002			–
d2s	0.004			–
Average AV, %	2.0			2.7

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 48. Binder Extraction Data: TEB

Measurement	Sample A	Sample B	JMF	Acceptance
Empty Bowl, g	1903.6	1903.5	–	–
Filter Only, g	21.16	20.81	–	–
Rotary Tube Empty, g	226.68	226.66	–	–
Empty Centrifuge Screen, g	504.67	504.64	–	–
Sample Weight, g	2646.9	2688.1	–	–
Filter + Fine, g	29.43	27.84	–	–
Rotary Tube + Fine, g	239.41	239.63	–	–
Dry Aggregate + Bowl, g	4387.3	4434.6	–	–
Centrifuge Screen + Fine	505.00	505.08	–	–
AC, % by TWM	5.36	5.08	–	–
Summary Statistics	**Samples A & B**		**JMF**	**Acceptance**
Average AC, % by TWM	5.2		5.3	5.3
1s	0.198			
d2s	0.280			

Table 49. Gradation Control Charts for Individual Measurement: TEB Sample A (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	83	89	>AL	6	9
3/8"	69	75	5	6	9
#4	45	47	2	6	9
#8	31	33	2	5	7.5
#16	22	22	0	5	7.5
#30	16	16	1	3	4.5
#50	11	10	0	3	4.5
#100	7	6	0	2	3
#200	4.0	3.1	0.9	2.0	3.0

Table 50. Gradation Control Charts for Individual Measurement: TEB Sample B (Extracted Aggregates)

Sieve Size	Percent Passing	JMF, %	Control Chart for Individual Measurements, %	PANYNJ Action Limits, %	PANYNJ Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	6	9
1/2"	89	89	0	6	9
3/8"	76	75	2	6	9
#4	50	47	3	6	9
#8	33	33	0	5	7.5
#16	23	22	1	5	7.5
#30	16	16	0	3	4.5
#50	11	10	1	3	4.5
#100	7	6	1	2	3
#200	4.1	3.1	1.0	2.0	3.0

Table 51. Gradation Control Charts Based on Range: TEB (Extracted Aggregates)

Sieve Size	Percent Passing (Sample A)	Percent Passing (Sample B)	Control Chart Based on Range (n = 2), %	PANYNJ Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	83	89	7	11
3/8"	69	76	7	11
#4	45	50	5	11
#8	31	33	2	–
#16	22	23	1	9
#30	16	16	1	–
#50	11	11	0	6
#100	7	7	0	–
#200	4.0	4.1	0.2	3.5

Tampa International Airport (TPA)

Raw Aggregate Gradation and Maximum Theoretical Specific Gravity

Table 52. Gradation Control Charts for Individual Measurement: TPA Sample A (Raw Aggregates)

Sieve Size	Percent Passing (Sample B)	JMF, %	Control Chart for Individual Measurements (Sample A), %	FAA P-404 Action Limits, %	FAA P-404 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	–	–
1/2"	100	100	0	–	–
3/8"	97	97	0	6	9
#4	69	71	2	6	9
#8	46	49	3	–	–
#16	33	37	4	5	7.5
#30	27	29	2	–	–
#50	21	21	0	3	4.5
#100	9	7	2	–	–
#200	3.0	4.0	1	2.0	3.0

Table 53. Gradation Control Charts for Individual Measurement: TPA Sample B (Raw Aggregates)

Sieve Size	Percent Passing (Sample C)	JMF, %	Control Chart for Individual Measurements (Sample B), %	FAA P-404 Action Limits, %	FAA P-404 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	–	–
1/2"	100	100	0	–	–
3/8"	97	97	0	6	9
#4	71	71	0	6	9
#8	46	49	3	–	–
#16	34	37	3	5	7.5
#30	26	29	3	–	–
#50	21	21	0	3	4.5
#100	9	7	2	–	–
#200	3.0	4.0	1	2.0	3.0

Table 54. Gradation Control Charts Based on Range: TPA (Raw Aggregates)

Sieve Size	Percent Passing (Sample B)	Percent Passing (Sample C)	Control Chart Based on Range (n = 2), %	FAA P-404 Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	100	100	0	–
3/8"	97	97	1	11
#4	69	71	2	11
#8	46	46	0	–
#16	33	34	0	9
#30	27	26	0	–
#50	21	21	0	6
#100	9	9	0	–
#200	3.0	3.0	0.0	3.5

Table 55. Maximum Theoretical Specific Gravity: TPA (LMLC)

Measurement	Sample A	Sample B	JMF
Bowl Empty Underwater, g	1441.4	1441.4	–
Dry Sample Mass, g	1564.7	1568.9	–
Sample + Bowl Underwater, g	2354.5	2358.0	–
Sample Underwater, g	913.1	916.6	–
G_{mm}	2.401	2.405	–
Summary Statistics	**Samples A & B**		**JMF**
Average G_{mm}	2.403		2.423
d1s	0.003		
d2s	0.004		

RPMLC Volumetric Properties

Table 56. Maximum Theoretical Specific Gravity: TPA (RPMLC)

Measurement	Sample A	Sample B	JMF	Quality Control (Test Strip)
Bowl Empty Underwater, g	1441.1	1440.5	–	–
Dry Sample Mass, g	1628	1538.4	–	–
Sample + Bowl Underwater, g	2390	2340	–	–
Sample Underwater, g	948.9	899.5	–	–
G_{mm}	2.397	2.408	–	–
Summary Statistics	**Samples A & B**		**JMF**	**Quality Control (Test Strip)**
Average G_{mm}	2.403		2.423	2.389
Single Operator d1s	0.007			
Single Operator d2s	0.011			

Table 57. Volumetric Properties: TPA (RPMLC)

Measurement	Sample A	Sample B	Sample C	JMF	Quality Control (Test Strip)
Air Sample, g	1217.5	1210.1	1212.4		
Underwater Mass, g	702.7	697.9	698.4		
SSD Mass, g	1217.5	1210.4	1213		
G_{mb}	2.365	2.361	2.356		
Height, mm	64.9	64.6	65.1	–	–
G_{mm}	2.403	2.403	2.403	2.423	2.389
VMA, %	17.1	17.3	17.4	17.3	19.0
VFA, %	90.9	90.0	88.9	85.7	84.1
AV, %	1.6	1.7	1.9	–	–
Summary Statistics	**Samples A, B & C**			**JMF**	**Quality Control (Test Strip)**
G_{sb}	2.663			–	2.662
Average G_{mb}	2.361			2.363	2.317
Single Operator d1s	0.005			–	–
Single Operator d2s	0.009			–	–
Average AV, %	1.7			2.5	3.0

Plant Mixture Binder Content and Extracted Aggregate Gradation

Table 58. Binder Extraction Data: TPA

Measurement	Sample C	Sample B	JMF	Quality Control (Test Strip)	Ignition Oven
Empty Bowl, g	1903.7	1903.7	–	–	3303.5
Filter Only, g	20.87	21.15	–	–	–
Rotary Tube Empty, g	226.52	226.84	–	–	–
Empty Centrifuge Screen, g	504.54	504.67	–	–	–
Sample Weight, g	1355.5	1112	–	–	1981.8
Filter + Fine, g	21.73	22.69	–	–	–
Rotary Tube + Fine, g	231.56	232.40	–	–	–
Dry Aggregate + Bowl, g	3163.4	2933.5	–	–	5140.9
Centrifuge Screen + Fine	504.64	504.80	–	–	–
AC, % by TWM	6.62	6.74	–	–	7.3

Summary Statistics	Samples A & B	JMF	Quality Control (Test Strip)	Ignition Oven
Average AC, % by TWM	6.7	6.8	6.9	7.3
1s	0.083			
d2s	0.117			

Table 59. Gradation Control Charts for Individual Measurement: TPA Sample B (Extracted Aggregates)

Sieve Size	Percent Passing (Sample B)	JMF, %	Control Chart for Individual Measurements (Sample B), %	FAA P-404 Action Limits, %	FAA P-404 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	–	–
1/2"	100	100	0	–	–
3/8"	97	97	0	6	9
#4	71	71	0	6	9
#8	49	49	0	–	–
#16	37	37	0	5	7.5
#30	30	29	1	–	–
#50	24	21	>AL	3	4.5
#100	10	7	3	–	–
#200	2.4	4.0	1.6	2.0	3.0

Table 60. Gradation Control Charts for Individual Measurement: TPA Sample C (Extracted Aggregates)

Sieve Size	Percent Passing (Sample C)	JMF, %	Control Chart for Individual Measurements (Sample C), %	FAA P-404 Action Limits, %	FAA P-404 Suspension Limits, %
1''	100	100	0	–	–
3/4"	100	100	0	–	–
1/2"	100	100	0	–	–
3/8"	97	97	0	6	9
#4	69	71	2	6	9
#8	46	49	3	–	–
#16	36	37	1	5	7.5
#30	29	29	0	–	–
#50	24	21	3	3	4.5
#100	9	7	2	–	–
#200	2.2	4.0	1.8	2.0	3.0

Table 61. Gradation Control Charts Based on Range: TPA (Extracted Aggregates)

Sieve Size	Percent Passing (Sample B)	Percent Passing (Sample C)	Control Chart Based on Range (n = 2), %	FAA P-404 Suspension Limits, %
1''	100	100	0	–
3/4"	100	100	0	–
1/2"	100	100	0	–
3/8"	97	97	0	11
#4	71	69	2	11
#8	49	46	3	–
#16	37	36	1	9
#30	30	29	1	–
#50	24	24	1	6
#100	10	9	0	–
#200	2.4	2.2	0.2	3.5

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