

CALTRANS REFERENCE SAMPLE PROGRAM



AASHTO T 166: Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

2024 PROFICIENCY TEST RESULTS

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Caltrans Reference Sample Program (RSP)

Laboratory Proficiency Testing on AASHTO T 166: Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

1.0 Overview

In September 2024, Caltrans RSP sent a proficiency testing announcement letter to laboratories that are Caltrans Independent Assurance (IA) accredited to perform AASHTO T 166: "Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens". This test aims to ensure that laboratories performing AASHTO T 166 tests are proficient in conducting this test, including using the correct testing procedure and test equipment, as well as accurate test results to Caltrans RSP.

The AASHTO T 166 test measures the bulk specific gravity (Gmb) of compacted asphalt to determine the weight per unit volume of the mixture. The bulk-specific gravity of aggregate is essential for designing HMA as it is used to calculate voids in mineral aggregate and voids filled with asphalt.

To conduct this proficiency testing, Caltrans RSP sent announcement letters to laboratories identified in the Statewide Independent Assurance Database (SIAD) as Caltrans IA accredited to perform AASHTO T 166. A total of 80 laboratories were evaluated.

Caltrans IA staff sampled, packaged, and shipped the materials from the Caltrans RSP Laboratory in Sacramento, CA. Four boxes of ¾" RHMA-G labeled A, B, C, and D were sent to participating laboratories. Each box contained approximately 7 kg of materials, totaling 28 kg to 30 kg. Laboratories were provided instructions to 1) heat and blend the materials from each box, thus creating a combined sample, and 2) reduce the sample in accordance with AASHTO R 47: "Method of Test for Reducing Samples of Asphalt Mixtures of Testing Size". Laboratories used either the mechanical splitter Type B or the quartering method, according to AASHTO R 47, to reduce the sample to testing size. Once the combined sample reached the compaction temperature of 305°F (152°C), three specimens were cast using the gyratory compactor according to AASHTO T 312. The suggested starting mass to prepare specimens was 4400 gm. Other compaction parameters such as specimen diameter, height, number of gyrations, ram pressure and hold time were provided to the testing laboratories.

The three specimens were tested for the Bulk Specific Gravity (Gmb) using AASHTO

T 166 (non-destructive). Then the same replicates were oven-dried to constant mass and cooled to room temperature for Gmb testing using AASHTO T 275, Method A (destructive). This report pertains to the AASHTO T 166 proficiency test results.

2.0 Analysis of Test Results

2.1 Evaluation Criteria

Results were evaluated using a statistical evaluation system in which the mean (\bar{X}) and standard deviation (s) were calculated. A rating score was then applied to the test results based on the criteria shown in Table 1. A test result with a score of 3 or greater was considered an acceptable result. A test result with a score of 2 or less was deemed to be unacceptable, and a retest was required.

Table 1: Evaluation Criteria

Test Result	Rating	Interpretation of Results	Acceptance
$\bar{X} \pm 1.0s$	5	Very Good	Acceptable
$\bar{X} \pm 1.5s$	4	Good	Acceptable
$\bar{X} \pm 2.0s$	3	Fair	Acceptable
$\bar{X} \pm 2.5s$	2	Poor	Unacceptable
$\bar{X} \pm 3.0s$	1	Very Poor	Unacceptable

Data outliers were analyzed according to ASTM E 178 based on the initial data collected. A common method to identify potential outliers is using the "z-score," which measures how many standard deviations a data point is away from the mean. Values with a z-score exceeding 3 are often considered outliers.

2.2 Initial Round of Testing

A total of 76 laboratories participated in the initial round of tests. An analysis for outliers in accordance with ASTM E 178 was conducted for each set of samples. There were no outliers identified.

The average and standard deviation values were calculated to determine the score for each of the 76 laboratories. The analysis results are presented in Tables 2A & 2B. Detailed test results are provided in Appendix A.

Table 2A: Summary of Initial Test Results

Test Method	Number of Laboratories	Average Bulk Specific Gravity (Gmb)	Standard Deviation
AASHTO T 166	76	2.214	0.02247

Table 2B: Summary of Initial Test Results Percentages

Rating	5	4	3	2	1
Number of Laboratories	52	16	4	2	2
Percentage of Total Laboratories (Approximate)	68%	21%	5%	3%	3%

Figure 1 below shows the normal distribution curve for the average data collected from each participating laboratory from the initial round of testing.

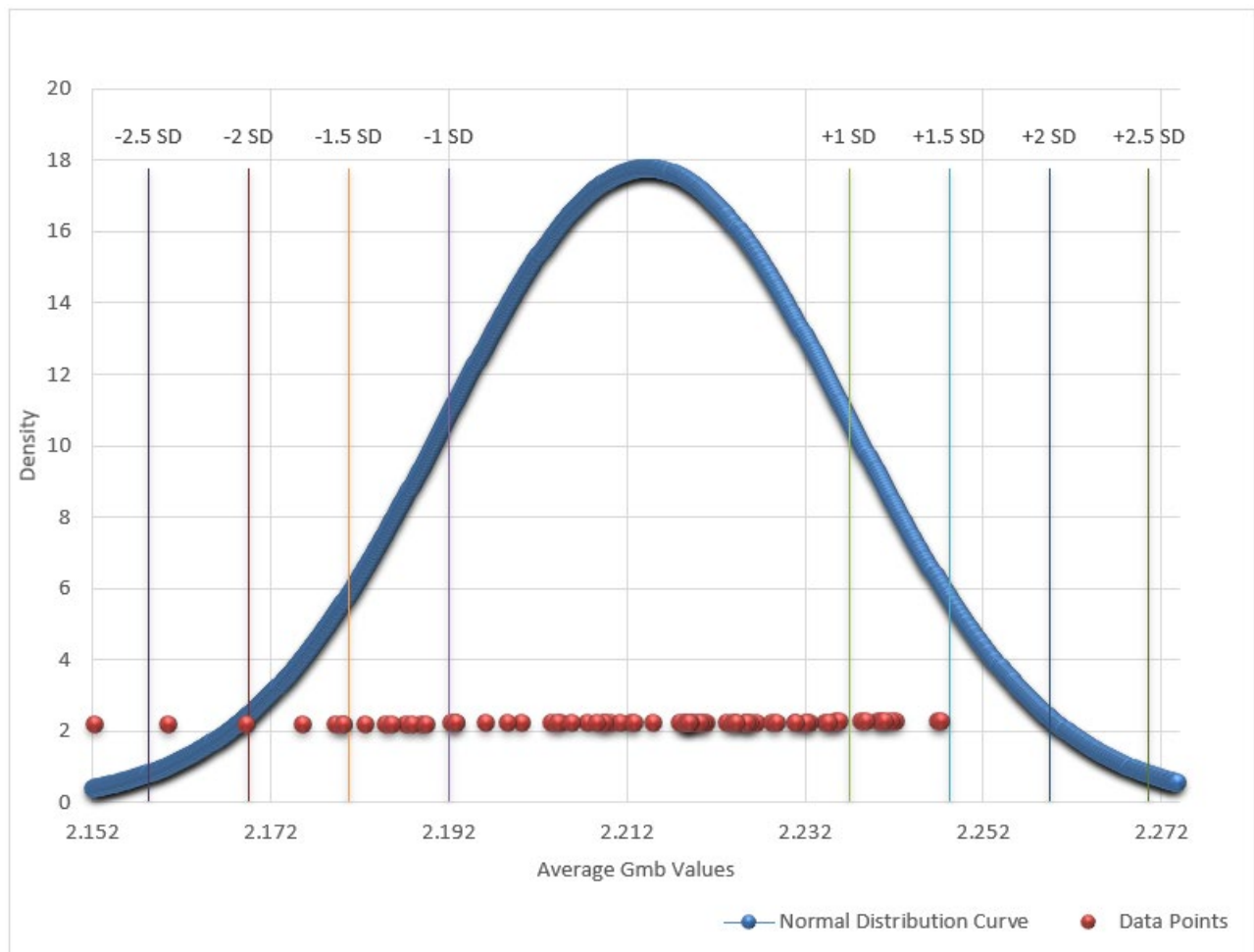


Figure 1: Normal Distribution Curve with Data Points and Standard Deviation Lines

2.3 Late Participation

Four laboratories turned in their initial test results past the deadline stated in the test data reporting instructions. These laboratories' results were evaluated based on the initial data average and standard deviation calculated from the data submitted by the 76 laboratories that turned in their initial results on time. Table 3 below is a summary of the laboratories' results. The late test results and scores are provided in Appendix B.

Table 3: Summary of Late Test Results

Rating	5	4	3	2	1
Number of Laboratories	3	0	1	0	0

2.4 Retests

Retest samples were sent to laboratories whose test results were identified as outliers or received a rating of 2 or below. Four laboratories did not achieve acceptable ratings and were provided retest samples for re-evaluation. The retest results were assessed using the initial statistical analysis parameters.

Out of the four laboratories that underwent retesting, three reported acceptable results. However, one laboratory was unable to complete the proficiency testing due to a gyratory compactor malfunction. As a result, the Caltrans IA laboratory accreditation for this lab has been suspended due to non-compliance.

The retest summary is presented in Table 4. The full retest results and scores are provided in Appendix C.

Table 4: Summary of Retest Results

Rating	5	4	3	2	1
Number of Laboratories	3	0	0	0	0

2.5 I.A. Witness Tests

IA witness testing was not required for this round of laboratory proficiency testing on AASHTO T 166, as all participating laboratories successfully reported acceptable results by the conclusion of the retesting phase.

3.0 Summary

A total of 80 laboratories participated in the 2024 Caltrans RSP AASHTO T 166 laboratory proficiency testing. In the initial testing round, 76 laboratories submitted their results on time for evaluation, while four laboratories submitted their results after the deadline. Of the 80 participants, four laboratories failed the initial round of testing. Failure was defined as either submitting results deemed outliers or obtaining a score below 3, as determined by the statistical evaluation method outlined in the Caltrans IA Manual for Reference Sample Program participants.

Among the four laboratories that scored unsatisfactory ratings in the initial round of testing, three provided acceptable retest results. However, one laboratory was unable to complete the retesting due to equipment malfunction. As a result, this laboratory's Caltrans IA AASHTO T 166 accreditation has been suspended pending corrective action and re-evaluation by Caltrans IA staff.

4.0 References

1. AASHTO R 47, "Standard Practice for Reducing Samples of Asphalt Mixtures to Testing Size".
2. AASHTO T 166, "Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens".
3. AASHTO T 312, "Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor".

APPENDIX – A

Test Results from Initial Round of Testing

Laboratory ID	Gmb (average)	Rating
1	2.221	5
2	2.176	3
3	2.193	5
5	2.200	5
8	2.192	5
10	2.234	5
11	2.231	5
20	2.219	5
22	2.221	5
23	2.227	5
29	2.189	4
32	2.224	5
46	2.215	5
47	2.196	5
52	2.232	5
53	2.242	4
58	2.223	5
59	2.224	5
73	2.247	4
75	2.233	5
99	2.226	5
103	2.210	5
147	2.219	5
154	2.235	5
156	2.226	5
160	2.204	5
161	2.213	5
163	2.152	1
164	2.219	5
173	2.225	5
177	2.180	3
183	2.242	4
193	2.236	5
196	2.218	5
197	2.169	2
200	2.210	5
209	2.220	5

Laboratory ID	Gmb (average)	Rating
233	2.236	5
241	2.240	4
255	2.228	5
256	2.219	5
261	2.219	5
264	2.193	5
265	2.220	5
273	2.211	5
281	2.238	4
283	2.205	5
284	2.219	5
289	2.213	5
297	2.226	5
309	2.183	4
326	2.241	4
352	2.185	4
353	2.187	4
356	2.219	5
359	2.232	5
377	2.179	3
395	2.208	5
396	2.229	5
413	2.204	5
441	2.247	4
464	2.274	1
482	2.210	5
521	2.231	5
552	2.241	4
569	2.209	5
576	2.224	5
584	2.235	5
634	2.161	2
1742	2.239	4
1743	2.188	4
1744	2.206	5
1751	2.190	4
1756	2.180	3
1760	2.199	5
1762	2.186	4

APPENDIX - B

Late Test Results

Laboratory ID	Gmb (average)	Rating
63	2.193	5
143	2.228	5
301	2.200	5
551	2.173	3

APPENDIX - C

Retest Test Results

Laboratory ID	Gmb (average)	Rating
163	Incomplete	N/A
197	2.197	5
464	2.231	5
634	2.197	5