



REFERENCE SAMPLE PROGRAM

AASHTO T 209: Standard Method of Test for Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures

2023 PROFICIENCY TEST RESULTS

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REFERENCE SAMPLE PROGRAM (RSP)

Proficiency Test on AASHTO T 209: Standard Method of Test for Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures

1.0 OVERVIEW

In December 2022, the Caltrans Reference Sample Program (RSP) sent a proficiency testing announcement letter to laboratories accredited to perform AASHTO T 209: “Standard Method of Test for Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures.” The purpose of performing this test was to determine laboratory technician operational proficiency in conducting this test, test equipment accuracy, and the ability to achieve satisfactory results.

AASHTO T 209 is a test method used for the determination of the theoretical maximum specific gravity (G_{mm}) and density of uncompacted hot mix asphalt (HMA). The G_{mm} and the density of HMA are fundamental properties whose values are influenced by the composition of the HMA mixtures in terms of types and amounts of aggregates and asphalt materials. G_{mm} is used to calculate the percent air voids in compacted HMA and to provide target values for the compaction of HMA. G_{mm} also is essential when calculating the amount of asphalt binder absorbed by the internal porosity of the individual aggregate particles in HMA.

To conduct this proficiency testing, Caltrans RSP sent out announcement letters to laboratories identified in the Statewide Independent Assurance Database (SIAD) as ‘currently accredited’ to perform AASHTO T 209. A total of 182 laboratories were evaluated.

Caltrans Independent Assurance (I.A.) staff sampled, packaged, and delivered the material to be used for testing from the Caltrans RSP Laboratory in Sacramento, CA. Three boxes of loose $\frac{3}{4}$ ” Rubberized Hot Mix Asphalt – Gap Graded (RHMA-G) were delivered to participating laboratories; each box with enough material to run a single AASHTO T 209 test. Laboratories were asked to perform one AASHTO T 209 test from each box and report the average. Instruction and reporting sheets were distributed with the samples too.

2.0 ANALYSIS OF TEST RESULTS

2.1 EVALUATION CRITERIA

The average of three Theoretical Maximum Specific Gravity (G_{mm}) results was used for the 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 Caltrans IA Manual criteria; shown in Table 1. A test result with a score of 3 or greater is considered an acceptable result. A test result with a score of 2 or less is deemed to be unacceptable, and a retest was required.

Table 1: Evaluation Criteria

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

2.2 INITIAL TEST

A total of 182 laboratories participated in this round of proficiency testing. Data outliers were analyzed according to ASTM E 178 based on the initial data collected from the 182 labs. These outliers are summarized in Table 2.

Table 2: Laboratories and Test Results Considered as Outliers

| Test Method | Count | Laboratory ID |
|--------------|-------|------------------|
| AASHTO T 209 | 4 | 9, 193, 248, 533 |

After excluding the outliers, the average and standard deviation values were re-calculated for the remaining 178 laboratories. The analysis results are presented in Tables 3A & 3B. The reported test results and the corresponding score ratings are provided in Appendix A.

Table 3A: Summary of Initial Test Results (Outliers Removed)

| Test Method | Number of Laboratories | Theoretical Maximum Specific Gravity (G_{mm}) | Standard Deviation |
|--------------|------------------------|---|--------------------|
| AASHTO T 209 | 178 | 2.43 | 0.009398415 |

Table 3B: Summary of Initial Test Laboratory Rating Scores

| Laboratory Rating | # Of Laboratories |
|-------------------|-------------------|
| 5 | 129 |
| 4 | 29 |
| 3 | 6 |
| 2 | 9 |
| 1 | 9 |

2.3 RETEST

Retest samples were sent to laboratories whose test results were considered outliers or rated 2 and below. In the initial analysis, 18 laboratories did not achieve acceptable ratings. The laboratories were provided a retested sample for re-evaluation. The retest summary is presented in Table 4. The retest results and scores are provided in Appendix B.

Five laboratories did not achieve acceptable ratings for the retest. A third sample was sent to these laboratories for a 2nd retest which also requires a Caltrans I.A. Staff to witness the testing.

Table 4: Summary of Retest Results Percentages

| Laboratory Rating | # Of Laboratories |
|-------------------|-------------------|
| 5 | 10 |
| 4 | 1 |
| 3 | 2 |
| 2 | 2 |
| 1 | 3 |

2.4 I.A. WITNESS TEST

A Caltrans I.A. staff contacted the five laboratories that did not achieve satisfactory ratings in the retest to schedule witness testing. Only one laboratory was unable to schedule a witness test due to equipment malfunction and calibration issues. Caltrans I.A. has suspended the AASHTO T 209 accreditation of this lab.

The other four laboratories were able to set up a witness test with an I.A. staff who positively verified that proper testing procedures were followed by a certified technician and calibration paperwork for the apparatus used for testing. A summary of the IA witness test is presented in Appendix C.

3.0 SUMMARY

182 laboratories participated in the 2023 Caltrans AASHTO T 209 proficiency testing. Out of these 182 laboratories, 18 laboratories failed the initial round of testing. Failure constitutes laboratories whose results were considered outliers or those with results below a score rating of 3 per statistical evaluation method described in the IA Manual for Reference Sample Program participants. Out of those 18 laboratories, 13 laboratories turned in satisfactory on the second attempt, whereas five laboratories failed the retest. IA witness testing was required for the five laboratories that failed the retest, out of which, four were able to schedule an IA personnel visit and perform a second retest. These four laboratories turned in satisfactory results in the witness testing.

Caltrans IA suspended the AASHTO T 209 accreditation of just one laboratory at the end of the proficiency testing. This laboratory was not able to schedule an I.A. visit for witness testing due to equipment malfunction and calibration issues.

4.0 REFERENCES

1. AASHTO T 209-22, " Standard Method of Test for Theoretical Maximum Specific Gravity (G_{mm}) and Density of Asphalt Mixtures"
2. ASTM E 178, "Standard Practice for Dealing with Outlying Observations."

APPENDIX – A

Results from the Initial Round of Testing

| Laboratory ID | G _{mm} (Average) | Rating Score |
|---------------|---------------------------|--------------|
| 1 | 2.431 | 5 |
| 7 | 2.433 | 5 |
| 9* | 2.389 | 1 |
| 10 | 2.425 | 5 |
| 11 | 2.436 | 5 |
| 15 | 2.429 | 5 |
| 18 | 2.427 | 5 |
| 20 | 2.435 | 5 |
| 22 | 2.434 | 5 |
| 23 | 2.453 | 2 |
| 24 | 2.417 | 4 |
| 29 | 2.422 | 5 |
| 32 | 2.424 | 5 |
| 34 | 2.434 | 5 |
| 38 | 2.430 | 5 |
| 43 | 2.438 | 5 |
| 47 | 2.427 | 5 |
| 49 | 2.409 | 2 |
| 52 | 2.438 | 5 |
| 53 | 2.429 | 5 |
| 55 | 2.422 | 5 |
| 58 | 2.430 | 5 |
| 59 | 2.432 | 5 |
| 66 | 2.435 | 5 |
| 67 | 2.430 | 5 |
| 69 | 2.425 | 5 |
| 70 | 2.421 | 5 |
| 73 | 2.433 | 5 |
| 75 | 2.419 | 4 |
| 80 | 2.434 | 5 |
| 87 | 2.424 | 5 |
| 88 | 2.431 | 5 |
| 91 | 2.433 | 5 |
| 93 | 2.437 | 5 |
| 94 | 2.405 | 1 |
| 96 | 2.418 | 4 |

* Test results considered as outliers are automatically given a rating score of 1.

| Laboratory ID | G _{mm} (Average) | Rating Score |
|---------------|---------------------------|--------------|
| 99 | 2.431 | 5 |
| 100 | 2.429 | 5 |
| 103 | 2.438 | 5 |
| 110 | 2.440 | 4 |
| 112 | 2.434 | 5 |
| 114 | 2.439 | 5 |
| 119 | 2.455 | 1 |
| 130 | 2.441 | 4 |
| 135 | 2.417 | 4 |
| 139 | 2.416 | 4 |
| 140 | 2.419 | 4 |
| 143 | 2.439 | 5 |
| 145 | 2.400 | 1 |
| 146 | 2.433 | 5 |
| 147 | 2.412 | 3 |
| 154 | 2.421 | 4 |
| 156 | 2.423 | 5 |
| 158 | 2.431 | 5 |
| 160 | 2.419 | 4 |
| 161 | 2.428 | 5 |
| 164 | 2.427 | 5 |
| 170 | 2.450 | 2 |
| 171 | 2.431 | 5 |
| 173 | 2.417 | 4 |
| 177 | 2.428 | 5 |
| 182 | 2.429 | 5 |
| 183 | 2.438 | 5 |
| 184 | 2.426 | 5 |
| 185 | 2.423 | 5 |
| 192 | 2.438 | 5 |
| 193* | 2.370 | 1 |
| 196 | 2.436 | 5 |
| 197 | 2.428 | 5 |
| 200 | 2.425 | 5 |
| 207 | 2.425 | 5 |
| 209 | 2.438 | 5 |
| 214 | 2.431 | 5 |
| 219 | 2.431 | 5 |
| 221 | 2.455 | 1 |
| 223 | 2.443 | 4 |

* Test results considered as outliers are automatically given a rating score of 1.

| Laboratory ID | G _{mm} (Average) | Rating Score |
|---------------|---------------------------|--------------|
| 225 | 2.430 | 5 |
| 229 | 2.421 | 4 |
| 233 | 2.437 | 5 |
| 241 | 2.431 | 5 |
| 244 | 2.423 | 5 |
| 246 | 2.436 | 5 |
| 248* | 2.373 | 1 |
| 252 | 2.446 | 3 |
| 255 | 2.425 | 5 |
| 256 | 2.426 | 5 |
| 257 | 2.431 | 5 |
| 261 | 2.449 | 2 |
| 263 | 2.431 | 5 |
| 264 | 2.438 | 5 |
| 265 | 2.418 | 4 |
| 266 | 2.432 | 5 |
| 269 | 2.432 | 5 |
| 273 | 2.431 | 5 |
| 278 | 2.432 | 5 |
| 281 | 2.438 | 5 |
| 283 | 2.440 | 4 |
| 284 | 2.437 | 5 |
| 290 | 2.450 | 2 |
| 297 | 2.440 | 4 |
| 301 | 2.436 | 5 |
| 303 | 2.432 | 5 |
| 309 | 2.423 | 5 |
| 310 | 2.423 | 5 |
| 332 | 2.432 | 5 |
| 333 | 2.437 | 5 |
| 334 | 2.428 | 5 |
| 349 | 2.425 | 5 |
| 352 | 2.408 | 2 |
| 353 | 2.424 | 5 |
| 356 | 2.445 | 3 |
| 359 | 2.441 | 4 |
| 361 | 2.436 | 5 |
| 379 | 2.437 | 5 |
| 395 | 2.430 | 5 |
| 396 | 2.429 | 5 |

* Test results considered as outliers are automatically given a rating score of 1.

| Laboratory ID | G _{mm} (Average) | Rating Score |
|---------------|---------------------------|--------------|
| 399 | 2.429 | 5 |
| 401 | 2.433 | 5 |
| 407 | 2.435 | 5 |
| 413 | 2.427 | 5 |
| 417 | 2.417 | 4 |
| 418 | 2.436 | 5 |
| 419 | 2.417 | 4 |
| 422 | 2.427 | 5 |
| 423 | 2.421 | 4 |
| 437 | 2.435 | 5 |
| 438 | 2.412 | 3 |
| 441 | 2.430 | 5 |
| 444 | 2.423 | 5 |
| 464 | 2.429 | 5 |
| 476 | 2.423 | 5 |
| 482 | 2.429 | 5 |
| 485 | 2.440 | 4 |
| 495 | 2.423 | 5 |
| 501 | 2.432 | 5 |
| 508 | 2.409 | 2 |
| 521 | 2.422 | 5 |
| 533* | 2.352 | 1 |
| 534 | 2.433 | 5 |
| 535 | 2.433 | 5 |
| 538 | 2.434 | 5 |
| 543 | 2.440 | 4 |
| 551 | 2.417 | 4 |
| 552 | 2.445 | 3 |
| 569 | 2.433 | 5 |
| 574 | 2.433 | 5 |
| 576 | 2.438 | 5 |
| 580 | 2.422 | 5 |
| 595 | 2.438 | 5 |
| 608 | 2.429 | 5 |
| 612 | 2.423 | 5 |
| 634 | 2.421 | 4 |
| 636 | 2.428 | 5 |
| 642 | 2.443 | 4 |
| 644 | 2.423 | 5 |
| 647 | 2.426 | 5 |

* Test results considered as outliers are automatically given a rating score of 1.

| Laboratory ID | G _{mm} (Average) | Rating Score |
|---------------|---------------------------|--------------|
| 652 | 2.431 | 5 |
| 655 | 2.444 | 4 |
| 1720 | 2.439 | 5 |
| 1721 | 2.425 | 5 |
| 1722 | 2.431 | 5 |
| 1724 | 2.421 | 4 |
| 1725 | 2.434 | 5 |
| 1728 | 2.433 | 5 |
| 1729 | 2.445 | 3 |
| 1730 | 2.411 | 2 |
| 1731 | 2.449 | 2 |
| 1733 | 2.419 | 4 |
| 1737 | 2.429 | 5 |
| 1740 | 2.454 | 1 |
| 1742 | 2.428 | 5 |
| 1743 | 2.422 | 5 |
| 1744 | 2.431 | 5 |
| 1750 | 2.431 | 5 |
| 1751 | 2.423 | 5 |
| 1752 | 2.429 | 5 |
| 1754 | 2.418 | 4 |
| 1756 | 2.431 | 5 |
| 1760 | 2.435 | 5 |
| 1765 | 2.433 | 5 |
| 1766 | 2.437 | 5 |
| F1 | 2.425 | 5 |

APPENDIX – B

Retest Results

| Laboratory ID | G _{mm} | Rating Score |
|---------------|-----------------|--------------|
| 9 | 2.421 | 5 |
| 23 | 2.434 | 5 |
| 49 | 2.446 | 3 |
| 94 | 2.439 | 5 |
| 119 | 2.461 | 1 |
| 145 | 2.424 | 5 |
| 170 | 2.457 | 1 |
| 193 | 2.442 | 4 |
| 221 | 2.423 | 5 |
| 248 | 2.427 | 5 |
| 261 | 2.438 | 5 |
| 290 | 2.431 | 5 |
| 352 | 2.453 | 2 |
| 508 | 2.435 | 5 |
| 533 | 2.400 | 1 |
| 1730 | 2.451 | 2 |
| 1731 | 2.424 | 5 |
| 1740 | 2.447 | 3 |

APPENDIX – C

IA Witness Test Results

| Laboratory ID | G _{mm} | Rating Score |
|---------------|-----------------|--------------|
| 119 | 2.443 | 4 |
| 170 | 2.434 | 5 |
| 352 | 2.44 | 4 |
| 533 | N/A | N/A |
| 1730 | 2.444 | 4 |