ALDOT-381-93
METHOD FOR CORRELATION OF MARSHALL HAMMERS

1. Scope

1.1. This procedure explains the Alabama Department of Transportation method for correlating all Marshall Hammers used on Department Quality Control (QC) work. All contractor quality control hammers, all Division quality assurance (QA) hammers and all design hammers shall be calibrated to the Bureau of Materials and Tests' Marshall Hammer.

2. Referenced Documents

2.1. AASHTO T-166 Bulk Specific Gravity of Compacted Hot Mix Asphalt.

2.2. ALDOT-307 Design Method for Selecting Optimum Asphalt Cement Content of Hot Mix Asphalt by Means of the Marshall Apparatus.

2.3. ALDOT-375 Contractor Quality Control System for Hot Mix Asphalt.

3. Correlation Procedure

3.1. The Bureau of Materials and Tests' Marshall hammer is the standard to which all Marshall hammers performing Alabama Department of Transportation work shall be calibrated. The contractor assumes responsibility for beginning work if no correlation factor has been established and/or if there is no correlation history for either the contractor's QC hammer or the Divisions QA hammer. A job mix formula and the recommended compaction temperature must be included in every hammer correlation.

3.2. Mixture Design Hammer

3.2.1. The hammer calibration factor (HCF) will be developed from the data generated by the Department's one-point checks of the submitted mixture designs. The average bulk specific gravity (AASHTO T-166) of the Marshall specimens made by Materials and Tests will be divided by the uncorrected bulk specific gravity for the Contractor's mixture design Marshall specimens obtained from the plot of unit weight versus asphalt content at the design asphalt content.

$$HCF = \frac{\text{Materials and Tests Compacted Marshall SG}}{\text{Contractor Marshall SG from Data Curve}}$$

3.2.2. A HCF will be developed for all designs from a given hammer. A running average of the last 10 HCF will be maintained by the contractor. If less than 10 values are available, the average shall include all data that is available. The current running average for HCF will be used to correct the actual test data for mixture design submitted and for calibrating the quality control hammer. If a new hammer is being used for mixture design, the procedures in Section 3.5 should be conducted in cooperation with the Bureau of Materials and Tests.

3.2.3. Every mix design submitted to the Bureau of Materials and Tests must include the uncorrected bulk gravity at the design asphalt content, the current running average of the hammer calibration factor, and the resulting corrected bulk specific gravity.

3.3. Quality Control Hammer

3.3.1. The Contractor is responsible for the development of a QC-HCF for each quality control hammer. A new factor shall be developed at least every three months. This procedure can be conducted using the Materials and Tests' standard hammer or the Contractor's calibrated design hammer. Samples will be obtained and tested according to the procedures out-lined in section 3.5 of this procedure. The correction factor will be calculated as follows:

$$\text{QC-HCF} = \frac{\text{Calibrated Hammer Marshall SG}}{\text{Quality Control Hammer Marshall SG}}$$

3.3.2. A running average of the last 10 QC-HCF factors will be maintained by the Contractor. If less than 10 values are available, the average shall include all data that is available. The current running average of the QC-HCF shall be used to correct all field quality control data.

3.4. Quality Assurance Hammer

3.4.1. The Division is responsible for the development of a QA-HCF for each quality assurance hammer. A new factor shall be developed at least every three months. Samples will be obtained and tested according to the procedures outlined in Section 3.5 of this procedure. This procedure can be conducted in cooperation with the Materials and Tests standard hammer or the Contractor's calibrated design hammer. The quality assurance hammer can be calibrated at the same time the quality control hammer is calibrated. The correction factor will be calculated as follows:

$$\text{QA-HCF} = \frac{\text{Calibrated Hammer Marshall SG}}{\text{Quality Assurance Hammer Marshall SG}}$$

3.4.2. A running average of the last 10 QA-HCF will be maintained by the Division. If less than 10 values are available, the average shall include all data that is available. The current running average of the QA-HCF shall be used to correct all field quality assurance data.

3.5. Samples for Hammer Calibration

3.5.1. Samples of any Alabama Department of Transportation mixture may be used for hammer calibration, regardless of type mix or number of blows. The sample should be obtained in such a manner such that it is uniform throughout. If either the contractor's QC hammer and/or the Division's QA hammer do not have a correction factor then the contractor has the responsibility to initiate this procedure.

3.5.2. The contractor must prepare sufficient mixture to supply each hammer to be correlated, possibly including the Materials and Tests' hammer, with four Marshall samples. Sufficient mixture is considered to be 10 per-cent in excess (110% or 1.10) of the amount required to produce a compacted specimen thickness of 3 in. +/- ½ in. (75 + 1 mm). Each sample shall be loaded into separate sample cans having a volume of approximately 1 qt. (1 L).

3.5.3. All of these samples for all hammers to be correlated shall be placed into one large group and then the four samples for each individual hammer shall be randomly selected from the large group. Place the four 1 qt. (L) cans containing the mix into an oven that has been preheated to 320°F (160ºC). Compact four pills when the mixture reaches 293 +/-10°F (145 +/- 5ºC)as close to 293°F (145°C) as practical (it normally takes 1 hour and 15 minutes for the mixture to reach 293°F (145ºC). If the recommended design compaction temperature is not 293°F (145ºC), use the design temperature recommended.

3.6. Each laboratory will report the four individual bulk specific gravities, the job mix formula, and the compaction temperature to the Materials and Tests' laboratory. The Materials and Tests' laboratory will average these bulk specific gravities, determining which, if any, bulk specific gravities are not to be included in the average due to a deviation from the other values. The laboratories' hammers will be calibrated by using the Materials and Tests' average bulk gravity as the standard.

3.7. A calibration factor will be determined for each specific hammer by dividing the Materials and Tests' results by the results of each laboratory's hammer. (This correction factor will be multiplied by the average compacted bulk specific gravity produced by the calibrated hammer. This gives a corrected bulk specific gravity which is used to determine air voids.) This procedure may be repeated as often as the engineer deems necessary.

3.8. When the Division is obtaining a QA-HCF (Quality Assurance Hammer Calibration Factor) based upon the contractor's calibrated design hammer (as allowed in Section 3.4.1) or the contractor is obtaining a QC-HCF (Quality Control Hammer Calibration Factor) based upon the contractor's calibrated design hammer (as allowed in Section 3.3.1).The average of Marshall bulk specific gravities for the four (4) specimens will be used to compute the correction factor. If one or more of the individual specimens deviates by more than ± 0.015 from the average, discard the individual bulk specific gravity that deviates the most from the average of four, and then recompute the average based on the remaining three specimens. If one of the remaining three values deviates by more than ± 0.015 from the new average, the entire set of results are considered suspect and a new set of specimens must be fabricated.

3.9. The running average of the calibration factors shall be documented and available at the site of the hammer and include the last ten individual calibration factors.

3.10. When either the Department or Contractor deems it necessary, Marshall Hammers may be recalibrated, and, with the approval of Materials and Tests, a previous calibration factor or factors discarded (this may be necessary when a hammer is repaired).

Example:

A contractor has these last ten calibration factors: 0.997, 0.995, 0.994, 0.988, 0.999, 0.995, 0.991, 1.002, 0.996 and 0.993. This gives an average calibration factor of 0.995. During the mix design process all bulk specific gravities (to determine optimum asphalt content) will be multiplied by this calibration factor. At four percent air voids the corrected bulk specific gravity is 2.388.

Uncorrected Bulk Gravity		Correction Factor		Corrected Bulk Gravity
2.400	X	0.995	=	2.388

On all job mix formulas the contractor will report these three numbers.

A one point check is performed by Materials and Tests and results in a bulk gravity of 2.382.

$$HCF = \frac{2.382}{2.400} = 0.992$$

The contractor, for future use of this hammer, uses 0.992 in the last ten HCF running average for a new HCF average of 0.994.