Procedure for Resolving Differences in Asphalt Binder Testing

Using an Acceptable Range of Variability in the Superpave Binder Testing Specification

AI Research

Asphalt Institute

Procedure for Resolving Differences in Asphalt Binder Testing

Using an Acceptable Range of Variability in the Superpave Binder Testing Specification

Executive Summary

The procedure described in ASTM D3244 provides a logical approach to solving disputes between suppliers and receivers based on the reproducibility of the test procedure. It is important for all parties involved in specification testing to agree how to settle disputes before they occur.

Background

Disputes between suppliers and receivers (users) of asphalt binder most commonly arise when test results measured at the receiver's laboratory do not meet specification criteria. Variability in test results has many causes and is impossible to eliminate. Causes include sample handling, sample storage, operator error, and testing equipment variability. These factors add to an overall testing error, making it impossible to determine the "true" value of any test result. It then becomes more important to monitor the precision of test results, than to say this result is "correct," while that result is "incorrect." Statements of repeatability and reproducibility are included in the precision and bias statement for most ASTM and AASHTO standards that produce a numerical test result. These statements are based on data collected by AMRL as part of its proficiency sample program.

It is important to understand the difference between repeatability and reproducibility. Repeatability is listed in the precision and bias statement as single operator precision. This is the allowable difference in two test results measured under the 'repeatability conditions' (same sample, measured by the same operator, on the same piece of equipment, in the same lab). Standard deviation, s, is a measure of the spread of the data. The d2s% is the allowable range between two test results, expressed as a percent of their mean.

Example 1:

For BBR Stiffness

A single operator has run two beams from the same sample in the same BBR at -12°C.

Beam #1: S_1 = 356 MPa

Beam #2: S_2 = 318 MPa

S_{ave} = 337 MPa

From AASHTO T 313-02, two results obtained under 'repeatability conditions' are considered acceptable if their difference, expressed as a percent of their mean does not exceed d2s% = 9.1%

Are the above single operator BBR results acceptable?

*((356 – 318) / 337) * 100 = 11.3%*

These stiffness values vary by more than 9.1%; therefore the results are not acceptable. Another set of beams should be run.

Reproducibility is the allowable difference between two sets of test results obtained under the 'reproducibility conditions' (same split sample, run by different operators in different labs). It is listed in the precision and bias statement as multilaboratory precision.

Example 2:

A supplier and a receiver have each tested a split sample of asphalt binder for original binder G/sind at 64°C. A discrepancy was found between the two test results and the receiver's test result has failed the specification at this temperature.*

$G^*/sind_{supplier}$ = 1.115 kPa

$G^*/sind_{receiver}$ = 0.998 kPa

$G^*/sind_{average}$ = 1.057 kPa

For original binder, d2s% from AASHTO T 315-02 = 29.1%, which means that two test results obtained under 'reproducibility conditions' are considered acceptable if their difference, expressed as a percent of their mean, does not exceed 29.1%.

Are the above two test results within the allowable range for multilaboratory precision?

*((1.115 – 0.998) / 1.057) * 100 = 11.1 %*

These two results are within the acceptable range for test results run in two different laboratories and therefore, both results are admissible.

Example 2 is a typical example of a dispute between a supplier and a receiver. The supplier's lab tested the sample and found it to pass the specification criterion at 64°C. The receiver also tested the sample in their lab and found it to fail the specification criterion. Because the test results are within the acceptable range of testing variability for two laboratories, how then do the involved parties go about deciding which value is correct, keeping in mind that due to inherent variability in the test procedure, it is impossible to ever determine the "true" value for the measured property?

Procedure

ASTM D3244, Standard Practice for Utilization of Test Data to Determine Conformance with Specification, provides a procedure for resolving testing disputes between laboratories.

The following steps illustrate how to handle disputes according to ASTM D3244:

Step 1:

Determine the reproducibility (R) for the test method at the specification level using available d2s% values from the Precision and Bias statement for multi-laboratory precision:

R = d2s% * S

where S = Specification criterion

Example 3:

For BBR m-value

d2s% = 13.0%

S = 0.300

*R = 0.13 * 0.300 = 0.039*

Example 4:

*For DSR G*sind*

d2s% = 56.1%

S = 5000 kPa

*R = 0.561 * 5000 = 2805 kPa*

Step 2:

Determine if the two disputed test results are within the reproducibility (R) of the test method.

Example 5:

For BBR m-value

$m_{supplier} = 0.315$

$m_{receiver} = 0.295$

R = 0.039 from Example 1

Dm = 0.315 – 0.295 = 0.020 < 0.039
Therefore, these values are within R of the test method for m-value.

Example 6:

*For DSR G*sind*

$G^*sind_{supplier} = 4725$ kPa

$G^*sind_{receiver} = 5890$ kPa

*DG*sind = 1165 < 2805*

*Therefore, these values are within R of the test method for DSR G*sind.*

If the difference between the test results exceeds the reproducibility of the test, then a new split sample should be obtained and both laboratories should rerun the test. If the test results still exceed the reproducibility of the test, then a referee lab should be used. If two labs find that they must frequently use a referee lab, then every effort should be made to determine the cause of the bias and correct it.

If the test results are within the accepted range, then the parties can average the two independently obtained test results to obtain an Assigned Test Value (ATV) as described in ASTM D3244.

Step 5:

Calculate the Assigned Test Value (ATV)

$ATV = (X_{receiver} + X_{supplier}) / 2$

Example 7:

For BBR m-value

$m_{receiver} = 0.295$

$m_{supplier} = 0.315$

$ATV = (0.295 + 0.315) / 2 = 0.305$

Example 8:

*For DSR G*sind*

$G^*sind_{supplier} = 4725\ kPa$

$G^*sind_{receiver} = 5890\ kPa$

$ATV = (4725 + 5890) / 2 = 5308\ kPa$

In the case of Example 7, the ATV meets the specification criterion for the BBR m-value, therefore this sample should be considered as passing the specification. In Example 8, the ATV does not meet the specification criterion for PAV DSR. Even though the test results were within the allowed variability of the test, the ATV exceeds the 5000 kPa specification value and is therefore considered a failing result.

If the difference between the two test results is greater than the reproducibility of the test, then a new split sample should be obtained and the tests rerun by both parties. If the second set of test results is still outside of the allowed variability, then a third test should be run by a referee lab. The reproducibility should be multiplied by 1.2 (to convert from a range for two labs to a range for three labs), and the difference between the highest and lowest of the three values evaluated to see if it falls within the new reproducibility limits. If the difference is acceptable, then the ATV for this set of test results will be the average of the three results. If the difference exceeds the allowed reproducibility, the ATV should be assigned as the average of the two closest results.

Example 9:

For BBR m-value

One set of test results was rejected because the difference between the two labs was greater than 0.039 (from Example 3). Two additional sets of samples have been run.

$m_{supplier} = 0.335$

$m_{receiver} = 0.289$

$Dm = 0.335 - 0.289 = 0.046 > 0.039$ *these values also differ by more than R*

A referee lab is hired and produces a test result $m_{referee} = 0.305$

$R = 1.2 * 0.039 = 0.047$ *for three labs*

$Dm = 0.335 - 0.289 = 0.046 < 0.047$ *therefore*

$ATV = (0.335 + 0.289 + 0.305) / 3 = 0.310$

In this example, the ATV meets the specification criterion for the BBR m-value by using a referee lab. If the situation described in Example 9 is a frequent occurrence, or if there is a consistent bias in the test results (i.e. one lab always higher than the other lab), then the two labs should work together to determine the cause of the bias and make necessary changes.

Summary

The procedure described in ASTM D3244 provides a logical approach to solving disputes between suppliers and receivers based on the reproducibility of the test procedure. It is important for all parties involved in specification testing to agree how to settle disputes before they occur.

For more information, contact:

Asphalt Institute
Research Park Drive
P.O. Box 14052
Lexington, KY 40512
Phone: (859) 288-4960
Fax: (859) 288-4999

Visit us on the web at **www.asphaltinstitute.org**

AIResearch

Research Park Drive
P.O. Box 14052
Lexington, KY 40512
Phone 859/288-4960
Fax 859/288-4999
www.asphaltinstitute.org