South Carolina Department of Transportation

CLEMSON GLENN DEPARTMENT OF CIVIL ENGINEERING

U.S. Department of Transportation
Federal Highway Administration

Validation of Contractor HMA Testing Data in the Materials Acceptance Process — Phase II

Summary: This study was conducted in response to an FHWA Quality Assurance (QA) Stewardship Review that concluded that changes were needed to the then current QC/Acceptance and Independent Assurance (IA) processes used by SCDOT.

Extensive statistical analyses were conducted to determine appropriate standard deviation values to represent the variability for asphalt content (AC), air voids (AV), voids in mineral aggregate (VMA), and Density. SCDOT provided test result data from their projects. A total of 2,789 AC tests, 2,234 AV tests, and 2,230 VMA tests were provided from 20 different projects, with some projects having multiple Mix Types and JMFs involved. A total of 2,010 Density test results also were provided from 15 of the 20 projects.

However, issues with the data required that some of these tests be eliminated from the analysis. Due to an insufficient amount of data, Base and Intermediate Courses were eliminated from the analyses. Similarly, Surface C, Surface E, and OGFC were eliminated due to insufficient data. As a result, analyses for the project were performed on a data set consisting only of Surface A and Surface B Mix Types. This data set had 1,831 AC and AV tests, 1,827 VMA tests, and 1,590 Density tests.

Analyses were conducted on the project test results for AC, AV, VMA, and Density with the primary goal of determining values to use to represent the typical variability for each characteristic. This is a subjective decision that ultimately must be made by SCDOT. These variabilities are necessary to evaluate the appropriateness of the existing specification limits.

Also, since SCDOT's allowable tolerances for differences between split sample test results were a major concern from the Stewardship Review, test result data from the SCDOT verification testing program also were provided from 16 of the 20 projects. These data consisted of 487 AC and 452 AV and VMA test results. In addition, the data set included 411 AC, and 387 AV and VMA Contractor verification test results.

Concerns with the Data: One concern with the data is the widely uneven distribution of test data among the Projects and Contractors. Well over half of the test data came from only 6 of the 20 projects, and the 2 largest projects accounted for 40% of the AC data, and 32% of the AV and VMA data. Any analysis results are likely to be biased towards the larger projects.

Similarly, only 7 different Contractors were represented on the 20 Projects. Two of the 7 Contractors performed 11 (55%) of the projects from which data were obtained. The distribution by Contractor is even more pronounced when the number of tests is considered. Two Contractors accounted for 69% of the AC data, and 62% of the AV and VMA data. As a result, it is questionable whether the results of the analyses are applicable for the "typical" Contractor that does work for SCDOT.

(*Continued on back*)

SUMMARY REPORT

Report No.
FHWA–SC–16–03
August 2016

South Carolina
Department of Transportation
955 Park Street
P. O. Box 191
Columbia, SC 29202

Analyses of Test Results: The values for typical standard deviations that SCDOT might consider to represent the typical within-lot variability and overall process variability used to evaluate existing specification limits for Surface A and Surface B mixes include:

		Within-Lot	Overall Process
Asphalt Content:		0.175%	0.20%
Air Voids:		0.45%	0.60%
VMA:		0.44%	0.57%
Density:	Surface A only	0.99%	1.03%
	Surface B only	1.27%	1.39%
	Surface A & B combined	1.09%	1.18%

Results of Verification Testing: The split sample analysis data set had 232 sets of split samples for Surface A mixes and 127 sets for Surface B mixes. To establish allowable tolerances for the difference between the Contractor and SCDOT split sample result, it is necessary to decide on a population for the differences for AC, AV, and VMA. Since a subjective decision by SCDOT is required to establish the standard deviation to use to represent the population of split sample differences for the typical Contractor, the research cannot recommend a specific answer for the allowable tolerances. However, in sample calculations using the 75^{th} percentile of the standard deviation of split samples, the following allowable tolerances resulted: AC = 0.43%, AV = 1.35%, and VMA = 1.42%.

It also was determined that, when the SCDOT verification tests are used for acceptance in lieu of the Contractor tests, the specification limits to be used may vary with the number of Lots in the verification data set. For example, the 7-Lot standard deviation was larger than the 1-Lot standard deviation by over 10% for AC and VMA, and by over 20% for AV.

Recommendations: An abbreviated listing of some of the recommendations from this project is shown below. Any recommendations must be tempered with the concerns stated on page 1, and are limited to Surface A and Surface B mixes. More thorough discussions of the recommendations are presented in the final report for the project.

- The results support switching to combining the AC, AV, and VMA test results of multiple JMFs on a Project provided they are for the same Mix Type (i.e., Surface A or Surface B). The available data probably are too limited to support combining multiple JMFs from different Mix Types.
- There is nothing in the limited data that were analyzed that indicates that switching to a specified quantity would improve the acceptance process over the current day's production definition.
- Concerning a last partial verification data set, rather than using the same test results in 2 different verification decisions, it is recommended that SCDOT consider 1 of 2 options:
  - Increase the size of the last verification data set to include the last partial set with the previous complete verification data set.
  - Add the last partial data set to the previous complete verification data set and then divide the resulting data set into 2 equally sized verification data sets.
- SCDOT should implement a research study to examine whether re-heating, lack of re-heating, delays before testing, and lack of delay have an effect on the resulting test results. Such a study should be a laboratory study so that each test specimen can be prepared to be as similar as possible, by the same technician, using the same equipment. In this way, if any differences were detected in the results they likely would come from re-heating and delays between testing.
- Considering the verification procedures in SC-T-97, SCDOT should consider using a level of significance of $\alpha = 0.05$ to increase the power of the F-tests and t-tests that they conduct, and should consider simplifying their verification procedure by always using the t-test for unequal variances regardless of the outcome of the F-test.

James Burati, Alex Carr, & Matt Shuler conducted this research at Clemson University.
For further information, contact Terry Swygert at SCDOT: 803-737-6691; SwygertTL@scdot.org