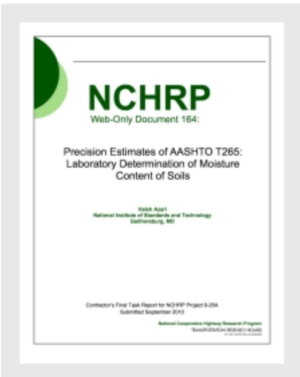

Precision Estimates of AASHTO T265: Laboratory Determination of Moisture Content of Soils

DETAILS

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Other Participating Laboratories:
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ABSTRACT

This report presents the results of an interlaboratory study (ILS) to prepare precision estimates for AASHTO T265 test method used for Laboratory Determination of Moisture Content of Soils. The materials for the ILS included two coarse- and two fine- grained soil-aggregate blends that were prepared according to Grading A and Grading E of AASHTO M147, "Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses." Each of the four blends had less than 10% soil passing #200 sieve to represent suitable materials for base and subbase. The comparison of the statistics of moisture content data for the four soil-aggregate blends indicated that the variability of moisture content measurement is the same for the blends with clay and silt; however, the variability is different for the blends with fine and coarse gradations. A precision statement for AASHTO T265 that includes the precision estimates developed in this study has been prepared and provided in the report.

CHAPTER 1- INTRODUCTION AND RESEARCH APPROACH

1.1 Background

Under the National Cooperative Highway Research Program (NCHRP) Project 09-26A, the AASHTO Materials Reference Laboratory (AMRL) is conducting a multi-phase research project to determine or update estimates of precision for selected AASHTO test methods. The AASHTO T265 standard test method, "Laboratory Determination of Moisture Content of Soils" [1] is among the test methods that lack precision estimates. The T265 test method is used to determine moisture or water content of a soil, expressed as a percentage of the mass of water in a given mass of soil to the mass of the solid particles. An interlaboratory study (ILS) was designed to determine the precision estimates for AASHTO T265, which were incorporated in a precision statement provided in this report.

1.2 Problem Statement

The accurate determination of in-situ moisture content of soil and aggregate is an important step in characterization of base and subbase materials for pavement construction. The level of precision in which percent moisture content of soil-aggregate mixture is measured has a significant effect on the method used for treating the base and subbase materials. Currently, there are no precision estimates that would define the accuracy requirements for water content measurements following AASHTO T265. Therefore, this study aims to determine repeatability and reproducibility precisions of soil-aggregate moisture content measured according to AASHTO T265 test method.

1.3 Research Objectives

The overall objective of this study is to determine precision estimates for the AASHTO T265, "Laboratory Determination of Moisture Content of Soils" test method. The change in precision estimates for water content determination with the change in soil-aggregate gradation and soil type is also being investigated here.

1.4 Scope of Study

The scope of the project involved the following major activities:

I. Design and conduct an interlaboratory study (ILS):

   a. Select four soil-aggregate blends using two different grading (coarse and fine) and two types of fillers (silt and clay) that satisfy the grading requirements of pavement base and subbase.

   b. Conduct preliminary testing on the selected materials.

   c. Select the laboratories participating in the ILS.

   d. Produce test specimens to send to the participating laboratories in the ILS.

e. Analyze results and develop precision estimates for moisture content determination.

II. Recommend a precision statement for AASHTO T265 including the precision estimates developed from ILS data.

III. Make conclusions and recommendations based on the findings of the study.

CHAPTER 2- DESIGN AND CONDUCT OF THE ILS

The development of precision estimates for AASHTO T265 required conduct of an interlaboratory study (ILS) involving measurement of moisture content of selected soil-aggregate blends prepared with known levels of moisture. The following sections will report the details of the design of the ILS. The approach used for the design of the ILS was based on ASTM E691-07, Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method [2]. The development of the precision statement for T265 required participation of a minimum of 6 laboratories with a preferred number of 30 as specified in E691.

2.1 Materials Selection

The materials used in the study were blended according to the Grading A and Grading E requirements of AASHTO M147, "Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses" [3]. Grading A was used to create a coarse gradation with a 19.0-mm nominal maximum aggregate size and Grading E was used to create a finer gradation with a 4.75-mm nominal maximum aggregate size. Four soil-aggregate blends were prepared, two fine graded and two coarse graded. The two fine and the two coarse graded blends were similar in gradation but differed by the type of mineral filler (passing # 200). Two of the blends, one coarse and one fine, included silt as mineral filler, and the other two blends included clay as mineral filler. The amount of filler was limited to 7% in all four mixtures to meet the requirement for good quality subbase and base materials. The gradations of the four mixtures as well as Gradings A and E from AASHTO M147 are provided in Table 2-1. The sources of aggregate materials utilized in the study and their classifications according to AASHTO M 145 [4] are provided in Table 2-2.

Table 2-1: Gradations of ILS fine and coarse blends and Grading E and A of AASHTO M147

Sieve Size	Fine w/Clay	Fine w/Silt	Grading E	Coarse w/Clay	Coarse w/Silt	Grading A
1"	100.0	100.0	100	100.0	100.0	100
1/2"	100.0	100.0	100	90.0	90.8	-
3/8"	100.0	100.0	100	64.0	64.0	30-65
# 4	99.8	99.8	55-100	45.9	46.9	25-55
#8	45.2	46.2	-	29.8	30.8	-
# 10	41.6	42.5	40-100	23.6	24.6	15-40
# 40	22.5	23.0	20-50	11.3	11.8	8-20
# 200	7.1	6.9	6-20	7.0	7.0	2-8

Table 2-2: Sources and classifications of ILS soil-aggregate blends according to AASHTO M145

Soil-Aggregate-Type	Soil-Aggregate Classification (AASHTO M 145)	Materials	Source
Fine-Graded (Grading E of AASHTO M147)	A3	Crushed Limestone (particle size passing #4 and retained on #8)	Lafarge Frederick, MD
		Washed Concrete Sand (Natural Sand Passing #8)	Aggtrans in Hanover, MD
		Lean Clay (CL)	Aggregate Transport Corporation in Harwood, MD
		Silt (ML)	U.S. Army Corps of Engineers, Waterways Experimental Station in Vicksburg, MS
Coarse-Graded (Grading A of AASHTO M147)	A1	Crushed Limestone	Lafarge Frederick, MD
		Manufactured Fine Aggregate (Limestone Buell Dust)	Lafarge Frederick, MD
		Lean Clay (CL)	Aggregate Transport Corporation in Harwood, MD
		Silt (ML)	U.S. Army Corps of Engineers, Waterways Experimental Station in Vicksburg, MS

2.2 Participating Laboratories

Hundreds of laboratories that are certified by the AASHTO Accreditation Program (AAP) [5] for soil and aggregate testing were contacted and invited to participate in the T265 ILS. The laboratories were ranked by their scores earned through the accreditation process. Thirty-five laboratories including commercial, governmental, and research laboratories with the maximum score of 5 were selected to participate in the study.

2.3 Interlaboratory Sample Preparation and Shipping

The ILS samples were prepared by the AMRL staff in the Proficiency Sample Facility located at the National Institute of Standards and Technology (NIST) using procedures developed for the AMRL Proficiency Sample Program [6]. A total of 1260 samples were prepared to be sent to the 35 selected laboratories. Each laboratory received 36 samples that consisted of three replicates of each of the four soil-aggregate blends prepared at three different percentages of moisture. The coarse blend samples weighed about 350 g and the fine blends samples weighed about 150 g. The fine blend samples were prepared with 4%, 6%, and 8% moisture and the coarse blend samples were prepared with 3 %, 5 %, and 7% moisture. Tables 2-3 through 2-6 provide the weight of the components of each blend.

Table 2-3: Weights (g) of various components of the coarse-graded samples with clay (CC)

ID	#1/2	#3/8	#4	#8	Buell Dust	Clay	Water
CC (3 %)	35.0	91.0	59.5	35.0	105.0	24.5	10.5
CC (5 %)	35.0	91.0	59.5	35.0	105.0	24.5	17.5
CC (7 %)	35.0	91.0	59.5	35.0	105.0	24.5	24.5

Table 2-4: weights (g) of different components of the coarse-graded samples with silt (CS)

ID	#1/2	#3/8	#4	#8	Buell Dust	Silt	Water
CS (3 %)	31.5	94.5	56.0	35.0	105.0	28.0	10.5
CS (5 %)	31.5	94.5	56.0	35.0	105.0	28.0	17.5
CS (7 %)	31.5	94.5	56.0	35.0	105.0	28.0	24.5

Table 2-5: weights (g) of different components of the fine- graded samples with clay (FC)

ID	#8	Sand	Clay	Water
FC (4 %)	76.5	60.0	13.5	6.0
FC (6 %)	76.5	60.0	13.5	9.0
FC (8 %)	76.5	60.0	13.5	12.0

Table 2-6: weights (g) of different components of the fine graded samples with silt (FS)

ID	#8	Sand	Silt	Water
FS (4 %)	75.0	60.0	15.0	6.0
FS (6 %)	75.0	60.0	15.0	9.0
FS (8 %)	75.0	60.0	15.0	12.0

2.4 Interlaboratory Study Instructions

Laboratory participants were provided with the testing instructions and data sheets to record the data. The laboratories were requested to follow AASHTO T265 to determine the moisture content of the four soil-aggregate blends, each prepared with three different moisture percentages. The instructions and the data entry sheet are provided in Appendix A.

CHAPTER 3- INTERLABORATORY TEST RESULTS AND ANALYSIS

3.1 Test Data

The moisture data were received for four aggregate-soil blends: coarse with clay (CC), coarse with silt (CS), fine with clay (FC), and fine with silt (FS). The moisture content data are provided in the tables in Appendices B thorough E. The empty cells in the tables indicate that the laboratory did not submit data and the shaded cells indicate that the data were considered as outliers and were eliminated from the analysis. The collected data are shown in Figures B-1, C-1, D-1, and E-1 of the appendices. In each graph, the middle point represents the median and the lower and upper bars represent the minimum and maximum data values, respectively. Appendices B through D also provide the graphical representation of the computed and critical h- and k- statistics (Graph B-2, C-2, D-2, and E-2), which are defined in ASTM E 691 for determining the outlier data.

3.2 Method of Analysis

Test results of the ILS were analyzed for precision in accordance to ASTM E 691[2]. Prior to the analysis, any partial sets of data were eliminated by following the procedures described in E691 in determining repeatability (S_r) and reproducibility (S_R) estimates of precision. Data exceeding critical *h* and *k* values were eliminated as described in Sections 3.3. Once identified for elimination, the same data were eliminated from any smaller subsets analyzed.

3.3 Analysis of Results

3.3.1 Coarse Blend with Clay

The moisture content measurements of coarse aggregate with clay were received from 29 laboratories. The average and the repeatability and reproducibility standard deviations of the data were determined after eliminating the outlier data. The eliminated data are shown shaded in **Table B-1** and are shown in Figure B-2 of Appendix B. Based on exceedance of h and k statistics, the results of two laboratories for the blend with 3 % moisture, the results of one laboratory for the blend with 5 % moisture, and the results of 4 laboratories for the blend with7 % moisture were eliminated from the analysis. All remaining data were re-analyzed according to E691 method to determine the S_r and S_R precision estimates shown in Table 3-1. As indicated from the table, the average target values of 3 %, 5%, and 7 % were met very well by the average measured values of 3.02%, 4.98 %, and 6.89 %. It is also observed from the table that the variability of the water content measurement increased with increase in percentage of water.

Table 3-1: Summary of Statistics of % moisture content of coarse aggregate with clay (CC)

Sample Type	# of Labs	Target %	Average %	S_x	CV %	Repeatability (S_r)		Reproducibility (S_R)	
						1s, %	d2, %	1s, %	d2s, %
Coarse Aggregate w/Clay (3%)	27	3.0	3.02	0.06	1.9	0.042	0.1	0.07	0.2
Coarse Aggregate w/Clay (5%)	28	5.0	4.98	0.11	2.3	0.044	0.1	0.12	0.3
Coarse Aggregate w/Clay (7%)	25	7.0	6.89	0.26	3.8	0.060	0.2	0.27	0.8

3.3.2 Coarse Blend with Silt

The moisture content measurements of coarse aggregate with silt (CS) were received from 30 laboratories. The average and the repeatability and reproducibility standard deviations of the data were determined after eliminating the outlier data. The eliminated data are shown shaded in Table C-1 and are shown in Figure C-2 of Appendix C. Based on exceedance of h and k statistics, the results from the following number of laboratories were eliminated from the analysis: two laboratories for blends with 3% moisture, one laboratory for the blends with 5% moisture, and one laboratory for the blend with7% moisture. All remaining data were re-analyzed according to E691 method to determine the S_r and S_R precision estimates shown in Table 3-2. As indicated from the table, the average target values of 3 %, 5%, and 7 % were met relatively well by the average measured values of 3.03 %, 5.02 %, 6.60 %. Similar to the blend with clay, the variability of the moisture content measurements of the CS blends has increased with the increase in the level of moisture content.

Table 3-2: Summary of Statistics of % moisture content of coarse blend with silt (CS)

Sample Type	# of Labs	Target %	Average %	S_x	CV %	Repeatability (S_r)		Reproducibility (S_R)	
						1s, %	d2, %	1s, %	d2s, %
Coarse aggregate w/ Silt (3%)	27	3.0	3.03	0.05	1.6	0.05	0.1	0.06	0.2
Coarse aggregate w/ Silt (5%)	29	5.0	5.02	0.10	2.1	0.06	0.2	0.12	0.3
Coarse aggregate w/ Silt (7%)	29	6.6	6.60	0.33	5.0	0.44	1.2	0.49	1.4

3.3.3 Fine Blend with Clay

The moisture content measurements of fine aggregate with clay (FC) were received from 31 laboratories. The average and the repeatability and reproducibility statistics of the data were determined after eliminating the outlier data. The eliminated data are shown shaded in Table D-1 and are shown in Figure D-2 of Appendix D. Based on exceedance of h and k statistics, the results from the following numbers of laboratories were eliminated from the analysis: one laboratory for the blend with 4% moisture, two laboratories for the blend with 6% moisture, and one laboratory for the blend with 8% moisture. All remaining data were re-analyzed according to E691 method to determine the statistics shown in Table 3-3. As indicated from the table, the average measured values of 4.04%, 5.92% are in very good agreement with the target values of 4% and 6%. However, for the blend with 8% moisture, the average measured value of 7.39 % was considerably below the expected value. In addition, the variability of the measurements for the blend with 8 % moisture as indicated from the standard deviations and coefficient of variation (CV %) was considerably larger than those of the blends with 4 % and 6 % moisture (CV of 8.5 % vs. 3.4%). It is speculated that this large variability is caused by higher probability of moisture loss during shipment and storage for the blends with above optimum moisture content than those with below optimum moisture content. When mixture is above the optimum, free moisture particles are available to evaporate and escape from microscopic pores of the bottles. While in mixtures below the optimum and at the optimum, moisture particles are adhered to the soil-aggregate particles.

Table 3-3: Summary of Statistics of % moisture content of fine blend with clay (FC)

Sample Type	# of Labs	Target %	Averag e %	Sx	CV %	Repeatability (Sr)		Reproducibility (SR)	
						1s, %	d2s, %	1s, %	d2s, %
Fine Aggregate w/ Clay (4%)	30	4.0	4.04	0.14	3.4	0.18	0.5	0.20	0.6
Fine Aggregate w/ Clay (6%)	29	6.0	5.92	0.20	3.4	0.17	0.5	0.25	0.7
Fine Aggregate w/ Clay (8%)	30	8.0	7.39	0.63	8.5	0.73	2.0	0.87	2.4

3.3.4 Fine Blend with Silt

The moisture content measurements of fine aggregate with silt (FS) were received from 31 laboratories. The average and the repeatability and reproducibility statistics of the data were determined after eliminating the outlier data. The eliminated data are shaded in Table E-1 and are shown in Figure E-2 of Appendix E. Based on exceedance of h and k statistics, the results from two laboratories for the blend with 4% moisture, one laboratory for the blend with 6% moisture, and one laboratory for the blend with 8% moisture were eliminated from the analysis. All remaining data were re-analyzed according to E691 method to determine the statistics shown in Table 3-4. Similar to the observation for the FC blends, the target values of 4 % and 6% for the FS blends were met very well by the average measured values of 3.97 % and 5.97 %. However, for the blend with above optimum moisture content, the average measured value of 7.69 % was considerably below the expected value of 8%. The variability of the data as indicated from standard deviations and coefficient of variation (CV %) was also considerably larger for the blend with 8 % moisture than the blends with 4 % and 6 % moisture (CV of

6.0 % vs. 2.9% and 2.7%). It is speculated that this larger variability is caused by the higher probability of moisture loss during shipment and storage of the blends with above optimum moisture content than those with below and at optimum moisture content.

Table 3-4: Summary of Statistics of % moisture content of fine blend with silt (FS)

Sample Type	# of Labs	Target %	Average %	Sx	CV %	Repeatability (Sr)		Reproducibility (SR)	
						1s, %	d2s, %	1s, %	d2s, %
Fine Aggregate w/ silt (4%)	29	4.0	3.97	0.11	2.9	0.17	0.5	0.18	0.5
Fine Aggregate w/ silt (6%)	30	6.0	5.97	0.16	2.7	0.12	0.3	0.19	0.5
Fine Aggregate w/ silt (8%)	30	8.0	7.69	0.46	6.0	0.60	1.7	0.68	1.9

3.4 Tests for Statistical Significance

The tests of statistical significance were conducted to examine the significance of the differences in the average and standard deviations of the measurements. For each blend, a one sample t-test was performed to examine the significance of the difference between the average measured and expected percentage of moisture. In addition, an F-test on variance was performed to examine if the standard deviations of the measurements are different for different gradations, filler types (clay or silt), and moisture contents. The following section discusses the result of the statistical analysis.

3.4.1 Comparison of the Average Measured and Target Moisture Contents

3.4.1.1 Coarse Aggregate with Clay (CC)

The results of the t-test for comparison of average and target moisture content of the coarse aggregate with clay for 1 % level of significance are provided in Table 3-5. A rejection probability (p) of smaller than 0.01 would indicate that the average measured value is significantly different from the target moisture level of the blend. As shown in Table 3-5, the p values are all above 0.01 indicating that the measured moisture contents of the coarse blend with clay were the same as the target moisture contents for that blend.

Table 3-5: Results of t-test for comparison of measured and target moisture content of CC blend

Sample Type	Comparison	Computed t	Degrees of Freedom	Critical t	Rejection Prob. (P)	Decision
Coarse Aggregate w/Clay (3%)	3.00% vs. 3.02%	2.140	26	2.779	0.042	Accept
Coarse Aggregate w/Clay (5%)	5.00% vs. 4.98%	0.967	27	2.771	0.342	Accept
Coarse Aggregate w/Clay (7%)	7.00% vs. 6.89%	2.022	24	2.797	0.055	Accept

3.4.1.2 Coarse Aggregate with Silt (CS)

The results of a t-test for comparison of the measured and target moisture content of the coarse aggregate with silt for 1 % level of significance are provided in Table 3-6. A rejection probability (p) of smaller than 0.01 would indicate that the average measured value is significantly different than the target moisture level of the blend. As shown in Table 3-6, the p value for the comparison of the measured and target values of the CS blend with 3% moisture is slightly smaller than 0.01 indicating that the measured and target values are different. However, this decision is mainly due to the small standard deviation of the measurements and not the large difference between the average and target values. The p values corresponding to the blends with 5% and 7 % moisture indicate statistical agreement between the measured and target values.

Table 3-6: Results of t-test for comparison of measured and target moisture content of CS blend

Sample Type	Comparison	Computed t	Degrees of Freedom	Critical t	Rejection Prob. (P)	Decision
Coarse aggregate w/ Silt (3%)	3.00 % vs. 3.03 %	2.880	26	2.779	0.0079	Reject
Coarse aggregate w/ Silt (5%)	5.00 % vs. 5.02 %	0.783	28	2.763	0.4405	Accept
Coarse aggregate w/ Silt (7%)	7.00 % vs. 6.60 %	0.047	28	2.763	0.9626	Accept

3.4.1.3 Fine Aggregate with Clay (FC)

The results of a t-test on average moisture content of the fine aggregate with clay for 1 % level of significance are provided in Table 3-7. A rejection probability (p) of smaller than 0.01 would indicate that the average measured value is significantly different than the target moisture level of the blend. As shown in Table 3-7, the p value for the comparison of the measured and target values of the FC blends with 3 % and 5% are larger than 0.01 indicating that the measured values are the same as the target values. However, the p value for the blend with 8% moisture is significantly smaller than 0.01

indicating that the measured and target values are not the same. As discussed previously, this significant difference between measured and target moisture content values might be due to loss of moisture during shipment of the mixtures with above optimum moisture content.

Table 3-7: Results of t-test on comparison of measured and target moisture content of fine aggregate with clay

Sample Type	Comparison	Computed t	Df	Critical t	P	Decision
Fine Aggregate w/ Clay (4%)	4.00 % vs. 4.04 %	1.719	29	2.756	0.0963	Accept
Fine Aggregate w/ Clay (6%)	6.00 % vs. 5.92 %	2.002	28	2.763	0.0551	Accept
Fine Aggregate w/ Clay (8%)	8.00 % vs. 7.39 %	5.327	29	2.756	<0.0001	Reject

3.4.1.4 Fine Aggregate with Silt (FS)

The results of a t-test on average moisture content of the fine aggregate with silt for 1 % level of significance are provided in Table 3-8. A rejection probability (p) of smaller than 0.01 would indicate that the average measured value is significantly different from the target moisture level of the blend. As shown in Table 3-8, the p value for the comparison of the measured and target values of the FS blends with 3 % and 5 % moisture are larger than 0.01 indicating that the measured values are the same as the target values. However, the p value for the blend with 8% moisture is significantly smaller than 0.01, indicating that the measured and target values are different. Similar to the previous reasoning, the significant difference between measured and target moisture contents might be due to the loss of moisture during shipment of the mixtures with above optimum moisture content.

Table 3-8: Results of t-test on comparison of measured and target moisture content of FS blend

Sample Type	Comparison	Computed t	Df	Critical t	P	Decision
Fine Aggregate w/ silt (4%)	4.00 % vs. 3.97 %	1.481	28	2.763	0.1498	Accept
Fine Aggregate w/ silt (6%)	6.00 % vs. 5.97 %	1.138	29	2.756	0.2645	Accept
Fine Aggregate w/ silt (8%)	8.00 % vs. 7.69 %	3.627	29	2.756	0.0011	Reject

3.4.2 Comparison of the Variability of Moisture Content Measurement

The preparation of the precision estimates for moisture content determination requires combining the standard deviations that are statistically similar. Statistical F-test on variances was performed to examine the significance of the difference between the variances. This was done in three steps. In the first step, the standard deviations of the clay and silt blends, for each gradation, will be compared at each moisture level. If the standard deviations of the clay and silt blends, at a specific moisture level, are not significantly different, they would be combined. In the second comparison, the combined standard deviations at different moisture levels will be compared for each gradation. The standard deviations from various moisture levels that are not significantly different would be combined. In the third comparison, the combined standard deviations of different gradations will be statistically compared. If the standard deviations of the coarse and fine blends are not different they would be combined, otherwise they would be reported separately. The following sections provide the results of the statistical comparisons on variances.

3.4.2.1 Statistical Test on Standard Deviations of Various Blends

A statistical F- test for comparison of the variances of measurements on coarse blend with clay and coarse blend with silt would indicate if the standard deviations from the two blends can be combined. The results of an F-test on comparison of the repeatability (Sr) and reproducibility (SR) standard deviations of the coarse blends, at each moisture level, are shown in Table 3-9. The comparison of the computed and critical F values on S_r or S_R estimates at 1% level of significance indicates that the standard deviations are the same for clay and silt blends at 3 % and at 5% moisture level. However, the standard deviations of the clay and silt blends are significantly different at 7% moisture level. The small rejection probability values (<0.0001 and 0.002) corresponding to the comparisons of the variability of the blends with 7% moisture specifies the problem with the test samples having above optimum moisture content.

Table 3-9: Results of F-test on comparison of variability of moisture content measurements of coarse aggregate with clay (CC) and coarse aggregate with silt (CS), critical F value correspond to 1% level of significance

Comparison	Df	Cr. F	Repeatability				Reproducibility			
			Standard Deviations	Comp. F	p	Decision	Standard Deviations	Comp. F	p	Decision
CC vs. Cs 3%	26 vs. 26	2.55	0.05 vs. 0.04	1.29	0.260	Accept	0.07 vs. 0.06	1.19	0.330	Accept
CC vs. Cs 5%	28 vs. 27	2.50	0.06 vs. 0.04	2.03	0.035	Accept	0.12 vs. 0.12	1.09	0.412	Accept
CC vs. Cs 7%	28 vs. 24	2.60	0.44 vs. 0.06	50.36	<0.0001	Reject	0.49 vs. 0.27	3.31	0.002	Reject

Table 3-10 provides the pooled repeatability and reproducibility standard deviations of the coarse blends with clay and silt. Since the standard deviations for the clay and silt at 3% moisture level were not significantly different they were combined. Similarly, the standard deviations for the coarse clay and coarse silt at 5 % moisture level were not significantly different and they were combined. However, the standard deviations for the coarse clay and coarse silt with 7 % moisture were significantly different and are presented separately.

Table 3-10: Pooled repeatability and reproducibility standard deviations of the clay and silt blends

Blend Type	Moisture Content of the Blend	Pooled Repeatability	Pooled Reproducibility
Coarse blend (Clay & Silt)	3%	0.04	0.06
Coarse blend (Clay & Silt)	5%	0.05	0.12
Coarse blend (Clay)	7%	0.06	0.27
Coarse blend (Silt)	7%	0.44	0.49

Table 3-11 provides the results of statistical F test on comparison of the variances of measurements on fine blend with clay and fine blend with silt at various moisture levels. The comparison of the computed and critical F values for 1% level of significance indicates that there is no significant difference between either S_r or S_R estimates for moisture content of the clay and silt blends at any moisture content. Therefore, the standard deviations of the fine silt and fine clay blends could be pooled at each moisture level.

Table 3-11: Results of F-test on comparison of variability of moisture content measurements of FC and FS blends

Comparison	Df	Cr. F	Repeatability				Reproducibility			
			Standard Deviation	Comp. F	p	Decision	Standard Deviation	Comp. F	p	Decision
FC vs. FS (4%)	29 vs. 28	2.45	0.18 vs. 0.17	1.08	0.42	Accept	0.20 vs. 0.18	1.22	0.30	Accept
FC vs. FS (6%)	28 vs.29	2.44	0.17 vs. 0.12	1.97	0.04	Accept	0.25 vs. 0.19	1.65	0.09	Accept
FC vs. FS (8%)	29 vs. 29	2.42	0.73 vs. 0.60	1.46	0.16	Accept	0.87 vs. 0.68	1.64	0.09	Accept

Table 3-12 provides the pooled standard deviations of FC and FS blends at different moisture contents. As shown in the table, the pooled standard deviation of fine blend at 8% moisture level is considerably larger than the standard deviations of the blend at other moisture levels indicating the problem with the blends at above optimum moisture content. The statistical significance of the difference in standards deviations of various moisture levels will be examined in next Section.

Table 3-12: Pooled repeatability and reproducibility standard deviations of the clay and silt blends

Blend Type	Moisture Content of the Blend	Pooled Repeatability	Pooled Reproducibility
Fine blend (Clay & silt)	4%	0.17	0.19
Fine blend (Clay & silt)	6%	0.15	0.22
Fine blend (Clay & silt)	8%	0.67	0.78

3.4.2.2 Statistical Test on Standard Deviations of Various Moisture Levels

The results of F-test at 1% level of significance for comparison of repeatability and reproducibility statistics of the coarse blends are presented in Table 3-13. As indicated from Column 5, Table 3-13, the rejection probabilities (p) corresponding to the repeatability of the blends with 3 % and 5% moisture were not significantly different from each other and from the repeatability of CC blend at 7% moisture. Therefore, they can be combined. However, the standard deviation of the CS blend at 7% moisture content was significantly larger than those of other coarse blends and could not be combined. The rejection probabilities, in Column 7 of Table 3-13, from comparison of the reproducibility standard deviations indicates that the standard deviations corresponding to different moisture levels were all significantly different from each other (p<0.0001) and could not be combined.

Table 3-13: Results of F-test on comparison of variability of moisture content measurements of coarse blends at various moisture contents

Compare	Df	Critical F	Computed F (Repeatability)	p (Repeatability)	Computed F (Reproducibility)	p (Reproducibility)
5% (CC & CS) vs. 3% (CC & CS)	56 & 53	1.90	1.44	0.09	3.37	<0.0001
7% (CC) vs. 3% (CC & CS)	24 & 53	2.16	1.91	0.03	17.55	<0.0001
7% (CC) vs. 5% (CC & CS)	24 &56	2.14	1.33	0.19	5.21	<0.0001
7% (CS) vs. 3% (CC & CS)	28 & 53	2.29	96.01	<0.0001	58.36	<0.0001
7% (CS) vs. 5% (CC & CS)	28 & 56	2.15	66.78	<0.0001	17.33	<0.0001

The results of F-test at 1% level of significance for comparison of repeatability and reproducibility statistics of the fine blends are presented in Table 3-14. As indicated from the p values (Column 5), the standard deviations corresponding to 4% and 6% moisture were not significantly different from each other and could be combined. However, the standard deviations corresponding to 8% moisture were significantly different from the blends with 4% and 5% moisture and could not be combined.

Table 3-14: Results of F-test on comparison of variability of moisture content measurements at various moisture contents, fine aggregate with clay (FC), and fine aggregate with silt (FS)

Compare	Df	Critical F	Computed F (Repeatability)	p (Repeatability)	Computed F (Reproducibility)	p (Reproducibility)
4% (FC & FS) vs. 6%(FC & FS)	58 & 58	1.86	1.38	0.11	1.35	0.13
8% (FC & FS) vs. 4%(FC & FS)	59 & 58	1.87	15.01	<0.0001	16.86	<0.0001
8% (FC & FS) vs. 6% (FC & FS)	59 & 58	1.87	20.69	<0.0001	12.50	<0.0001

3.4.3 Combined Standard Deviations of Various Moisture Levels

To prepare the precision estimates, the standard deviations were combined based on the rationality of the values and based on the significance of their differences. For the coarse blends, the large standard deviation of the coarse blends at 7% moisture appeared to be suspect. Therefore, it was judged that both repeatability and reproducibility standard deviations of CS blend at 7% to be eliminated from the precision estimate calculation. Similarly, for the fine blends, both repeatability and reproducibility standard deviations of the blend with 8% moisture seemed unreasonably high and were eliminated from the analysis. The remaining standards deviations were pooled to compute separate standard deviations for the coarse and fine blends as provided in Table 3-15.

Table 3-15: Computed standard deviations for water content measurement of coarse and fine blends

Blend Type	Repeatability Standard deviation, %	Reproducibility Standard deviation, %
Coarse blend	0.05	0.12
Fine blend	0.16	0.21

To examine if the standard deviations can be further combined, an F-test was conducted to examine the significance of the difference between variability of the coarse and fine blends. The results of statistical F test at 1 % level of significance are provided in Table 3-16. As seen from the table, the comparison indicates significant difference between the standard deviations of the coarse and fine blends. Therefore, the variability of the blends cannot be further combined and would be presented separately.

Table 3-16: Results of F test for comparison of standard deviations of water content measurements of coarse and fine blends

Compare	Degrees of Freedom	Critical F	Computed F(Sr)	Rejection Probability (SR)	Computed F(SR)	Rejection Probability (SR)
Coarse & Fine	117 & 110	1.58	8.85	<0.0001	2.92	<0.0001

3.4.4 Precision Estimates of AASHTO T265

Table 3-17 provides the precision estimates for water content determination based on the results of the ILS conducted in this study. The standard deviations corresponding to coarse and fine blends in Table 3-15 were used to compute the allowable differences between two water content measurements. A proposed precision statement for NCHRP T265, based on the precision estimates in Table 3-17 is provided in Appendix F.

Table 3-17: Pooled standard deviations of the blends with various moisture contents

Material and Type Index	Standard deviations (1s)	Acceptable Range of Two Results (d2s)
Single-Operator Precision:		
Coarse blend	0.05	0.14
Fine blend	0.16	0.46
Multilaboratory Precision:		
Coarse blend	0.12	0.33
Fine blend	0.21	0.58

CHAPTER 4- CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

This study was conducted to prepare precision estimates for AASHTO T265, “Laboratory Determination of Moisture Content of Soils.” An interlaboratory study was conducted to collect data from testing four aggregate-soil blends that were found suitable for base and subbase construction. Four blends, two coarse graded and two fine graded, with limited amount of materials passing #200 sieve were selected. The difference between the blends with similar gradation was in the type of filler added. One blend of each gradation was prepared with clay and the other blend was prepared with silt. The following summarizes the findings of this study:

- The standard deviations of the blends with clay were not significantly different from those of the blends with silt and therefore standard deviations were combined.
- The standard deviations of the coarse blends with 3% moisture (below optimum) were not significantly different from those of the blends with 5% moisture (at optimum) and therefore were combined.
- The standard deviations of the coarse blends with 7% moisture (above optimum) were significantly different from those of the blends with 3% and 5% moisture content. Due to uncertainty in the results of 7% moisture content, they were not included in the precision estimate analysis.
- The standard deviations of the fine blends with 4% moisture content (below optimum) and those of the blends with 6% moisture content (at optimum) were not significantly different and therefore standard deviations were combined.
- The bias and low precision of the moisture content data was speculated to be due to availability of excess moisture for evaporation. When mixture is above the optimum, free moisture particles are available to evaporate and escape from the pores of the bottles. While in mixtures below the optimum and at the optimum, moisture particles are adhered to the soil-aggregate particles.
- The standard deviations of the fine blends with 8 % moisture content (above optimum) were significantly different from those of the blends with 4% and 6% moisture content. Due to uncertainty in the results of 8% moisture content, they were not included in the precision estimate analysis.
- The standard deviations of the coarse blends were significantly different from those of fine blends. Therefore the computed precision estimates from the two blends were presented separately in a proposed precision statement.

4.2 Recommendations

The accurate determination of water content of a soil-aggregate blend is important for the proper preparation of base and subbase of a pavement. The level of accuracy in which water content of base and subbase is measured has a significant effect on the performance of the pavement as a whole. Currently, there are no precision estimates that would define the accuracy requirements for water content measurements following AASHTO T265. Therefore, it is recommended that the precision statement in Appendix F, which is prepared based on analysis of the data collected through an interlaboratory study to be published in AASHTO T265.

REFERENCES

1. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing (Part 2 – Tests), Twenty-Eight Edition, American Association of State Highway and Transportation Officials, Washington, DC. 2008.

2. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing (Part 1A – specifications), Twenty-Eight Edition, American Association of State Highway and Transportation Officials, Washington, DC. 2008.

3. AMRL Web Site: **http://www.nist.gov/amrl**

4. ASTM Standards on Precision and Bias for Various Applications, Fifth Edition, West Conshohocken, PA, 1997.

APPENDIX A- INSTRUCTIONS AND DATA SHEET FOR INTERLABORATORY STUDY

Instructions to Laboratories for Testing AASHTO T265 Specimens

Dear laboratories,

Thank you for participating in the AASHTO T265 interlaboratory study. Please follow the instructions below to ensure that all the required data for precision-estimates determination will be collected.

1. Please check the boxes to make sure that you have received all the specimens:

    - Box 1 of 3 is marked as Fine Soil-Aggregate Blend, which contains 9 bottles of Fine blend with clay (FC) and 9 bottles of fine blend with silt (FS).
    - Box 2 of 3 is marked as Coarse Soil-Aggregate Blend with Clay (CC), which contains 9 bottles.
    - Box 3 of 3 is marked as Coarse Soil-Aggregate Blend with Silt (CS), which contains 9 bottles.

2. Follow Section 5 of AASHTO T265 to determine the moisture contents of specimens. Use the entire content of each bottle for one moisture content determination. Please note that it is important to scrape out everything out of a bottle for each moisture content determination.

3. Record the required weights to the nearest 0.01 g in the attached worksheet. An electronic file of the data sheet has been sent via email. Please let me know if you have not received it. The file has two different sheets, one sheet for recording the data for the coarse blend and another sheet for recording the data for the fine blend.

4. Calculate moisture content of each specimen as a percentage of the mass of the water removed to the mass of the solid particles accordance to Section 6 of AASHTO T265. Report percent moisture content to the nearest 0.01 percent.

5. Please return the data by May 22, 2009.

Please call at (301) 975-2112 or send email to hazari@amrl.net if you have any questions.

Sample Data Sheet for Entering T265 ILS Data

		Fine Blend with Clay			
ID	**Mass of Bottle + Cap+ Moist Soil, g**	**Mass of Oven Proof Dish + Oven-Dried Soil, g**	**Mass of Oven Proof Dish, g**	**Mass of Empty Bottle + Original Cap (washed & dried), g**	**Moisture Content, %**
FC(a)-1					
FC(a)-2					
FC(a)-3					
FC(b)-1					
FC(b)-2					
FC(b)-3					
FC(c)-1					
FC(c)-2					
FC(c)-3					

APPENDIX B- MOISTURE CONTENT OF COARSE WITH CLAY AGGREGATE-SOIL BLEND AND COMPUTED ASTM E691 STATISTICS

Table B-1: Moisture content (%) of three replicates of coarse with clay aggregate-soil blends in the ILS study and the computed statistics according to ASTM E 691

Coarse w/ Clay				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
1																					
2	2.9 3.0 3.0	4.7 4.6 4.7	6.0 6.0 6.0	2.9	4.7	6.0	0.05	0.04	0.04	-0.95	-1.97	-2.57	1.21	0.78	0.30	2.9	4.7	6.0	0.05	0.04	0.04
3	3.1 3.0 3.1	5.0 5.0 5.0	7.0 7.0 7.0	3.1	5.0	7.0	0.04	0.03	0.02	0.78	0.10	0.15	0.89	0.60	0.17	3.1	5.0	7.0	0.04	0.03	0.02
4	 3.1 3.1	5.1 5.0 5.1	7.0 7.1 7.0	3.1	5.1	7.1	0.04	0.04	0.05	1.24	0.49	0.29	0.96	0.81	0.33	3.1	5.1	7.1	0.04	0.04	0.05
5	3.0 3.0 3.0	5.0 4.9 5.0	6.9 6.9 6.9	3.0	5.0	6.9	0.01	0.06	0.04	0.09	-0.17	-0.09	0.23	1.08	0.32	3.0	5.0	6.9	0.01	0.06	0.04
6	3.0 3.0 3.0	5.0 5.0 5.0	6.9 7.1 7.6	3.0	5.0	7.2	0.01	0.00	0.33	-0.41	-0.06	0.59	0.29	0.08	2.43	3.0	5.0	FALSE	0.01	0.00	FALSE
7	3.0 3.0 3.1	5.0 5.0 5.0	7.0 6.6 7.2	3.0	5.0	6.9	0.04	0.02	0.32	0.50	0.16	-0.06	0.83	0.33	2.31	3.0	5.0	FALSE	0.04	0.02	FALSE
8	3.0 3.0 3.0	5.0 5.0 5.1	7.0 6.9 7.0	3.0	5.0	6.9	0.01	0.03	0.06	-0.19	0.14	-0.01	0.18	0.50	0.46	3.0	5.0	6.9	0.01	0.03	0.06
9																					
10	3.0 3.0 3.0	5.0 5.0 5.0	6.9 6.9 7.0	3.0	5.0	7.0	0.02	0.03	0.09	-0.67	-0.17	0.00	0.41	0.62	0.62	3.0	5.0	7.0	0.02	0.03	0.09
11	3.0 3.0 3.0	4.8 4.9 4.9	6.6 6.6 6.5	3.0	4.9	6.6	0.02	0.05	0.02	-0.47	-0.92	-1.03	0.49	0.82	0.15	3.0	4.9	6.6	0.02	0.05	0.02
12	3.0 2.9 3.0	5.0 4.9 5.0	6.9 6.9 7.0	3.0	5.0	6.9	0.07	0.07	0.05	-0.34	-0.21	-0.06	1.45	1.22	0.40	3.0	5.0	6.9	0.07	0.07	0.05
13	3.0 3.0 3.0	5.0 4.9 5.0	7.0 7.0 7.0	3.0	4.9	7.0	0.03	0.04	0.04	-0.57	-0.36	0.11	0.58	0.76	0.33	3.0	4.9	7.0	0.03	0.04	0.04
14	3.1 3.0 3.1	5.0 5.2 5.1	7.1 6.9 6.9	3.1	5.1	7.0	0.05	0.09	0.15	0.68	0.49	0.07	1.15	1.70	1.06	3.1	5.1	7.0	0.05	0.09	0.15
15	2.9 2.9 3.0	5.0 4.9 4.9	7.0 6.8 6.9	3.0	4.9	6.9	0.03	0.05	0.06	-0.91	-0.32	-0.10	0.56	0.91	0.42	3.0	4.9	6.9	0.03	0.05	0.06
16	3.1 3.1 3.1	5.6 5.4 5.8	8.7 8.4 8.1	3.1	5.6	8.4	0.02	0.19	0.34	0.98	3.69	3.87	0.35	3.38	2.44	3.1	FALSE	FALSE	0.02	FALSE	FALSE
17	2.9 2.9 2.9	4.8 4.9 4.9	6.9 6.9 6.8	2.9	4.9	6.9	0.01	0.04	0.03	-1.10	-0.81	-0.21	0.17	0.70	0.20	2.9	4.9	6.9	0.01	0.04	0.03
18	3.1 3.0 2.9	5.0 5.0 5.1	7.0 6.9 6.9	3.0	5.0	6.9	0.08	0.04	0.05	-0.25	0.23	-0.06	1.67	0.71	0.37	3.0	5.0	6.9	0.08	0.04	0.05
19	3.1 3.0 3.1	5.1 5.1 5.0	7.0 7.0 7.0	3.1	5.1	7.0	0.05	0.03	0.03	0.80	0.50	0.16	1.10	0.61	0.22	3.1	5.1	7.0	0.05	0.03	0.03
20	3.0 3.0 3.0	4.9 4.9 4.9	7.0 7.0 6.9	3.0	4.9	7.0	0.02	0.01	0.03	-0.03	-0.37	0.05	0.42	0.17	0.24	3.0	4.9	7.0	0.02	0.01	0.03
21	3.1 3.1 3.1	5.1 5.1 5.1	7.0 7.1 7.1	3.1	5.1	7.1	0.03	0.01	0.04	1.27	0.51	0.33	0.57	0.11	0.31	3.1	5.1	7.1	0.03	0.01	0.04

Table B-1(Continued): Moisture content (%) of three replicates of coarse with clay aggregate-soil blends in the ILS study and the computed statistics according to ASTM E 691

Coarse w/ Clay				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
22	3.1	5.1	7.2	3.1	5.2	7.2	0.08	0.09	0.10	1.51	1.16	0.56	1.70	1.56	0.74	3.1	5.2	7.2	0.08	0.09	0.10
	3.0	5.2	7.2																		
	3.2	5.3	7.0																		
23	2.9	5.0	7.0	3.0	5.0	6.8	0.02	0.03	0.36	-0.77	0.22	-0.53	0.52	0.57	2.60	3.0	5.0	FALSE	0.02	0.03	FALSE
	2.9	5.0	6.3																		
	3.0	5.1	6.9																		
24	2.8	4.8	6.8	2.8	4.8	6.8	0.03	0.03	0.04	-2.90	-1.23	-0.46	0.57	0.56	0.30	FALSE	4.8	6.8	FALSE	0.03	0.04
	2.8	4.8	6.8																		
	2.8	4.8	6.8																		
25	2.9	5.0	7.0	3.0	4.9	7.0	0.08	0.04	0.03	-0.90	-0.51	0.02	1.71	0.78	0.21	3.0	4.9	7.0	0.08	0.04	0.03
	3.0	4.9	7.0																		
	2.9	4.9	6.9																		
26	3.1	5.0	7.2	3.1	5.1	7.1	0.01	0.05	0.06	0.57	0.43	0.38	0.20	0.90	0.45	3.1	5.1	7.1	0.01	0.05	0.06
	3.0	5.1	7.0																		
	3.1	5.1	7.1																		
27	3.1	5.1	7.0	3.1	5.1	7.0	0.02	0.03	0.05	1.62	0.66	0.23	0.47	0.55	0.36	3.1	5.1	7.0	0.02	0.03	0.05
	3.1	5.1	7.1																		
	3.1	5.1	7.1																		
28	3.1	5.0	7.0	3.0	5.0	7.1	0.04	0.05	0.07	0.47	0.05	0.29	0.82	0.82	0.48	3.0	5.0	7.1	0.04	0.05	0.07
	3.0	5.0	7.1																		
	3.1	5.1	7.1																		
29	3.2	5.0	7.0	3.1	5.0	7.0	0.07	0.03	0.03	1.19	-0.02	0.05	1.53	0.53	0.19	3.1	5.0	7.0	0.07	0.03	0.03
	3.1	5.0	6.9																		
	3.1	5.0	7.0																		
30	3.0	4.7	6.1	3.0	4.7	6.2	0.10	0.00	0.09	-0.91	-1.90	-1.89	2.29	0.05	0.67	FALSE	4.7	6.2	FALSE	0.00	0.09
	2.8	4.7	6.3																		
	3.0	4.7	6.3																		
31	3.0	5.0	7.0	3.0	5.0	6.9	0.04	0.04	0.09	-0.31	0.17	-0.08	0.96	0.67	0.64	3.0	5.0	6.9	0.04	0.04	0.09
	2.9	5.1	7.0																		
	3.0	5.0	6.8																		
				29	29	29	29	29	29	29	29	29	29	29	29	27	28	25	27	28	25

X_dbl_bar / Sx			Sr / SR			h Critical			k Critical			Corrected X_dbl_bar / Sx			Corrected Sr / SR		
3.0	5.0	7.0	0.05	0.06	0.14	2.64	2.64	2.64	2.24	2.24	2.24	3.0	5.0	6.9	0.04	0.04	0.06
0.07	0.16	0.38	0.08	0.17	0.40							0.06	0.11	0.26	0.07	0.12	0.27

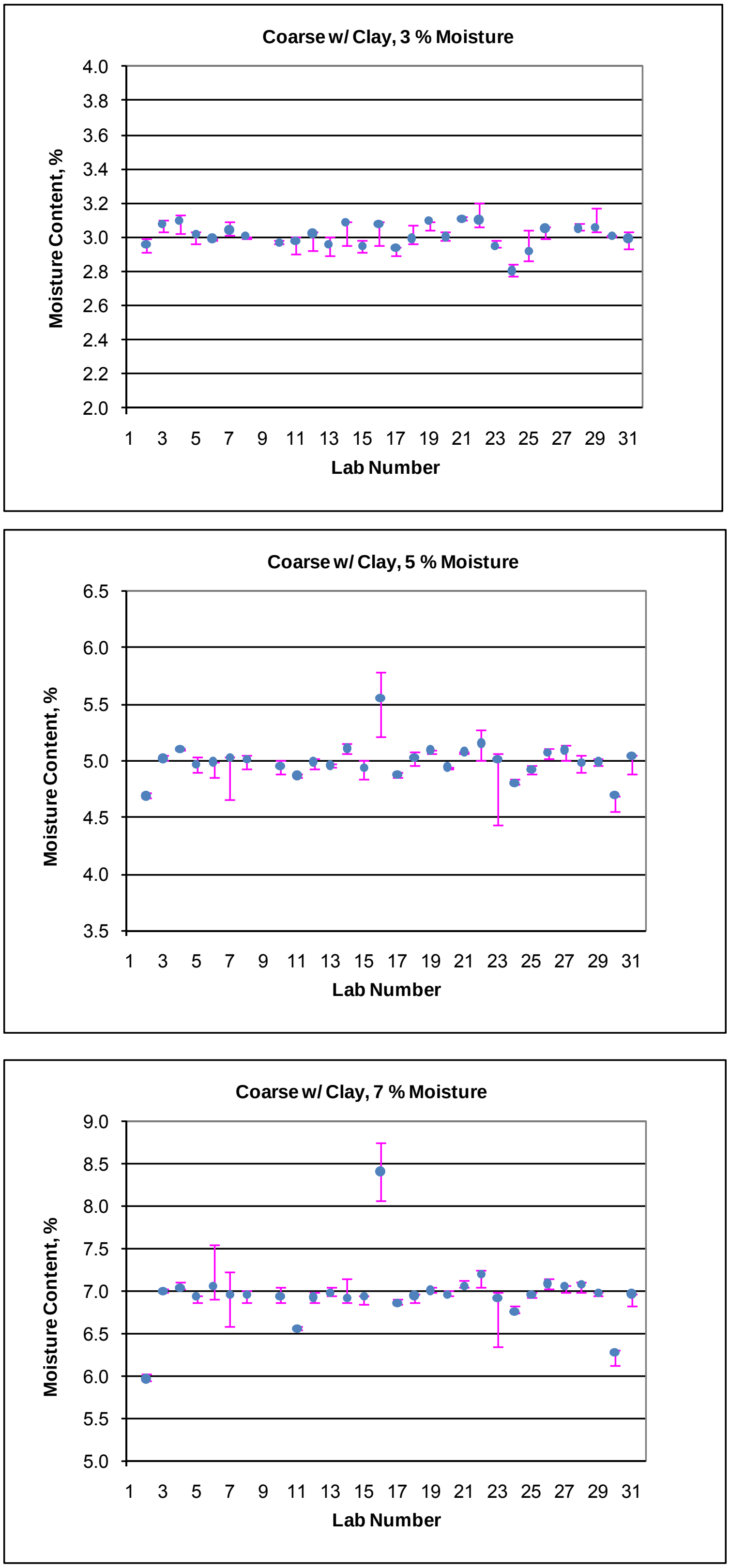


Figure B-1: Median water content values of coarse with clay aggregate-soil blends and the corresponding error bands

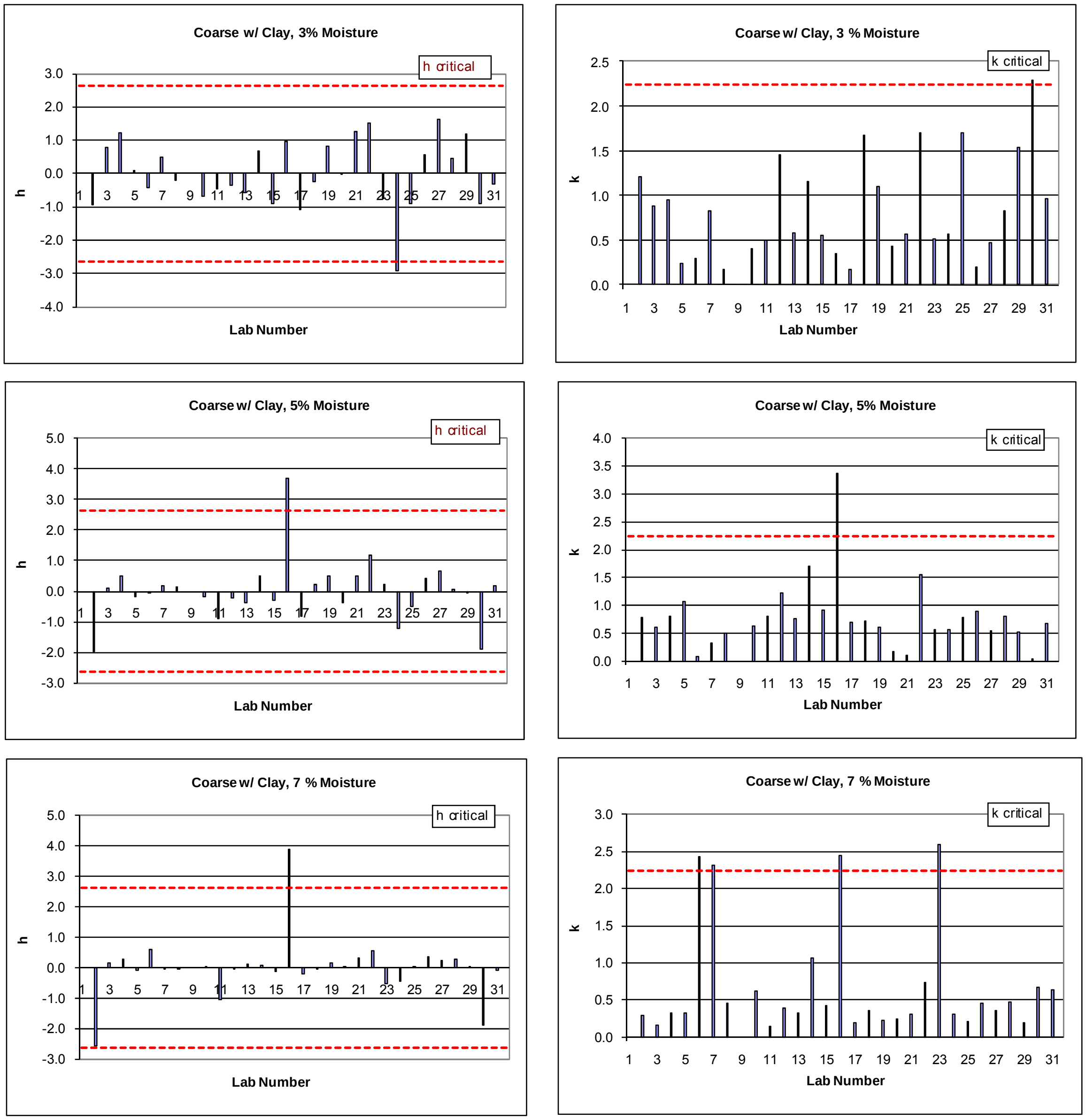


Figure B-2: h and k consistency statistics of water content measurements of coarse with clay aggregate-soil blends

APPENDIX C- MOISTURE CONTENT OF COARSE WITH SILT AGGREGATE-SOIL BLEND AND COMPUTED ASTM E691 STATISTICS

Table C-1: Moisture content (%) of three replicates of coarse with silt aggregate –soil blends in the ILS study and the computed statistics according to ASTM E 691

Coarse w/ silt				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
1	3.05 3.03 3.03	5.08 5.05 5.02	6.74 6.74 6.72	3.0	5.1	6.7	0.01	0.03	0.01	-0.04	0.06	0.39	0.03	0.36	0.03	3.0	5.1	6.7	0.01	0.03	0.01
2	2.58 3.06 2.99	4.63 4.77 4.71	5.32 6.02 6.12	2.9	4.7	5.8	0.26	0.07	0.44	-0.93	-1.90	-1.33	0.83	0.90	0.96	2.9	4.7	5.8	0.26	0.07	0.44
3	3.04 3.04 3.06	5.14 5.07 5.00	6.50 7.02 7.04	3.0	5.1	6.9	0.01	0.07	0.31	0.01	0.14	0.61	0.03	0.91	0.68	3.0	5.1	6.9	0.01	0.07	0.31
4	3.01 3.08 3.07	5.20 5.12 5.08	7.07 7.07 6.46	3.1	5.1	6.9	0.04	0.06	0.35	0.04	0.52	0.65	0.13	0.78	0.78	3.1	5.1	6.9	0.04	0.06	0.35
5	3.02 3.03 3.03	5.09 5.01 5.02	6.92 6.96 6.71	3.0	5.0	6.9	0.00	0.04	0.13	-0.12	-0.01	0.64	0.01	0.58	0.29	3.0	5.0	6.9	0.00	0.04	0.13
6	3.02 3.04 3.05	5.07 5.01 5.06	6.50 6.88 6.86	3.0	5.0	6.7	0.02	0.03	0.21	-0.06	0.03	0.42	0.06	0.43	0.47	3.0	5.0	6.7	0.02	0.03	0.21
7	3.13 2.92 3.05	5.13 5.03 5.01	3.88 3.90 5.16	3.0	5.1	4.3	0.11	0.07	0.74	-0.07	0.09	-4.18	0.34	0.85	1.62	3.0	5.1	FALSE	0.11	0.07	FALSE
8	2.97 3.02 2.90	5.09 5.01 4.99	6.48 5.95	3.0	5.0	6.2	0.06	0.05	0.37	-0.47	-0.07	-0.58	0.19	0.69	0.82	3.0	5.0	6.2	0.06	0.05	0.37
9																					
10	2.93 3.01 5.82	5.05 4.97 5.04	6.63 6.89 6.96	3.9	5.0	6.8	1.65	0.05	0.18	4.85	-0.14	0.56	5.26	0.59	0.39	FALSE	5.0	6.8	FALSE	0.05	0.18
11	2.99 2.99 3.00	4.95 4.92 4.74	5.70 6.67 6.50	3.0	4.9	6.3	0.01	0.12	0.52	-0.30	-0.96	-0.44	0.02	1.52	1.14	3.0	4.9	6.3	0.01	0.12	0.52
12	3.00 2.94 3.00	4.97 5.03 4.91	5.85 6.68 6.62	3.0	5.0	6.4	0.03	0.06	0.46	-0.37	-0.39	-0.27	0.10	0.75	1.01	3.0	5.0	6.4	0.03	0.06	0.46
13	2.96 2.98 3.02	5.04 4.98 5.05	6.59 6.85 6.81	3.0	5.0	6.8	0.03	0.04	0.14	-0.34	-0.09	0.42	0.09	0.52	0.30	3.0	5.0	6.8	0.03	0.04	0.14
14	3.05 3.08 3.08	5.11 5.11 5.11	5.26 5.90 6.86	3.1	5.1	6.0	0.02	0.00	0.81	0.15	0.39	-0.98	0.05	0.05	1.78	3.1	5.1	6.0	0.02	0.00	0.81
15	2.98 3.00 2.95	5.03 5.01 5.00	6.87 6.73 6.82	3.0	5.0	6.8	0.02	0.02	0.07	-0.38	-0.16	0.53	0.07	0.21	0.15	3.0	5.0	6.8	0.02	0.02	0.07
16	2.98 3.13 3.24	6.11 5.62 5.71	5.63 7.56 6.78	3.1	5.8	6.7	0.13	0.26	0.97	0.40	4.34	0.24	0.41	3.35	2.14	3.1	FALSE	6.7	0.13	FALSE	0.97
17	3.08 3.02 3.08	4.96 5.00 4.99	6.97 7.01 6.96	3.1	5.0	7.0	0.03	0.02	0.02	0.09	-0.33	0.85	0.11	0.24	0.05	3.1	5.0	7.0	0.03	0.02	0.02
18	3.05 3.01 2.99	5.11 5.01 5.08	6.87 6.98 6.94	3.0	5.1	6.9	0.03	0.05	0.05	-0.16	0.13	0.76	0.10	0.68	0.12	3.0	5.1	6.9	0.03	0.05	0.05
19	3.0 3.0 3.0	5.1 5.1 5.1	6.9 6.9 7.1	3.0	5.1	7.0	0.01	0.05	0.08	-0.12	0.27	0.83	0.05	0.65	0.19	3.0	5.1	7.0	0.01	0.05	0.08
20	3.09 3.03 3.03	5.14 4.99 4.97	6.55 7.00 6.91	3.0	5.0	6.8	0.04	0.09	0.24	0.01	-0.05	0.55	0.11	1.19	0.53	3.0	5.0	6.8	0.04	0.09	0.24
21	3.08 3.09 3.13	5.12 5.13 5.10	5.88 6.67 6.31	3.1	5.1	6.3	0.03	0.01	0.40	0.29	0.44	-0.45	0.09	0.19	0.87	3.1	5.1	6.3	0.03	0.01	0.40

Table C-1(Continued): Moisture content (%) of three replicates of coarse with silt aggregate –soil blends in the ILS study and the computed statistics according to ASTM E 691

Coarse w/ silt				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
22	3.13	5.21	7.12	3.1	5.1	7.1	0.04	0.17	0.02	0.30	0.21	1.10	0.13	2.14	0.05	3.1	5.1	7.1	0.04	0.17	0.02
	3.12	5.13	7.11																		
	3.05	4.89	7.08																		
23	3.00	5.17	6.52	3.1	5.1	6.7	0.07	0.10	0.19	0.08	0.05	0.26	0.21	1.31	0.43	3.1	5.1	6.7	0.07	0.10	0.19
	3.13	4.97	6.59																		
	3.06	5.01	6.88																		
24	2.85	4.83	5.81	2.8	4.8	6.2	0.06	0.02	0.39	-1.27	-1.29	-0.58	0.18	0.23	0.86	2.8	4.8	6.2	0.06	0.02	0.39
	2.85	4.80	6.25																		
	2.75	4.80	6.59																		
25	2.92	5.08	6.76	3.0	5.0	6.8	0.05	0.04	0.11	-0.40	-0.01	0.49	0.15	0.54	0.24	3.0	5.0	6.8	0.05	0.04	0.11
	3.02	5.00	6.70																		
	2.98	5.04	6.91																		
26	3.04	5.18	5.46	3.1	5.1	6.5	0.02	0.05	0.92	0.11	0.43	-0.01	0.06	0.68	2.03	3.1	5.1	6.5	0.02	0.05	0.92
	3.07	5.10	7.01																		
	3.08	5.08	7.09																		
27		5.07	6.01		5.0	6.6		0.03	0.54		0.02	0.19		0.42	1.19		5.0	6.6		0.03	0.54
		5.01	6.89																		
		5.05	6.98																		
28	3.04	5.10	5.51	3.1	5.1	6.5	0.01	0.03	0.84	0.07	0.19	-0.11	0.04	0.34	1.85	3.1	5.1	6.5	0.01	0.03	0.84
	3.06	5.07	6.86																		
	3.07	5.05	7.04																		
29	2.82	5.06	6.90	2.9	5.0	6.9	0.10	0.06	0.03	-0.66	-0.05	0.70	0.31	0.71	0.07	2.9	5.0	6.9	0.10	0.06	0.03
	3.00	4.97	6.87																		
	2.97	5.07	6.93																		
30	2.97	4.79	6.05	3.0	4.8	6.3	0.02	0.06	0.24	-0.30	-1.60	-0.38	0.06	0.75	0.53	3.0	4.8	6.3	0.02	0.06	0.24
	3.00	4.69	6.40																		
	3.01	4.80	6.52																		
31	2.98	5.04	5.21	3.0	5.0	6.1	0.01	0.04	0.76	-0.38	-0.29	-0.89	0.02	0.56	1.67	3.0	5.0	6.1	0.01	0.04	0.76
	2.97	4.96	6.27																		
	2.98	4.97	6.68																		
				29	30	30	29	30	30	29	30	30	29	30	30	28	29	29	28	29	29

X_dbl_bar / Sx			Sr / SR			h Critical			k Critical			Corrected X_dbl_bar / Sx			Corrected Sr / SR		
3.0	5.0	6.5	0.31	0.08	0.45	2.64	2.64	2.64	2.24	2.24	2.24	3.0	5.0	6.6	0.07	0.06	0.44
0.18	0.18	0.53	0.36	0.19	0.69							0.07	0.10	0.33	0.09	0.12	0.55

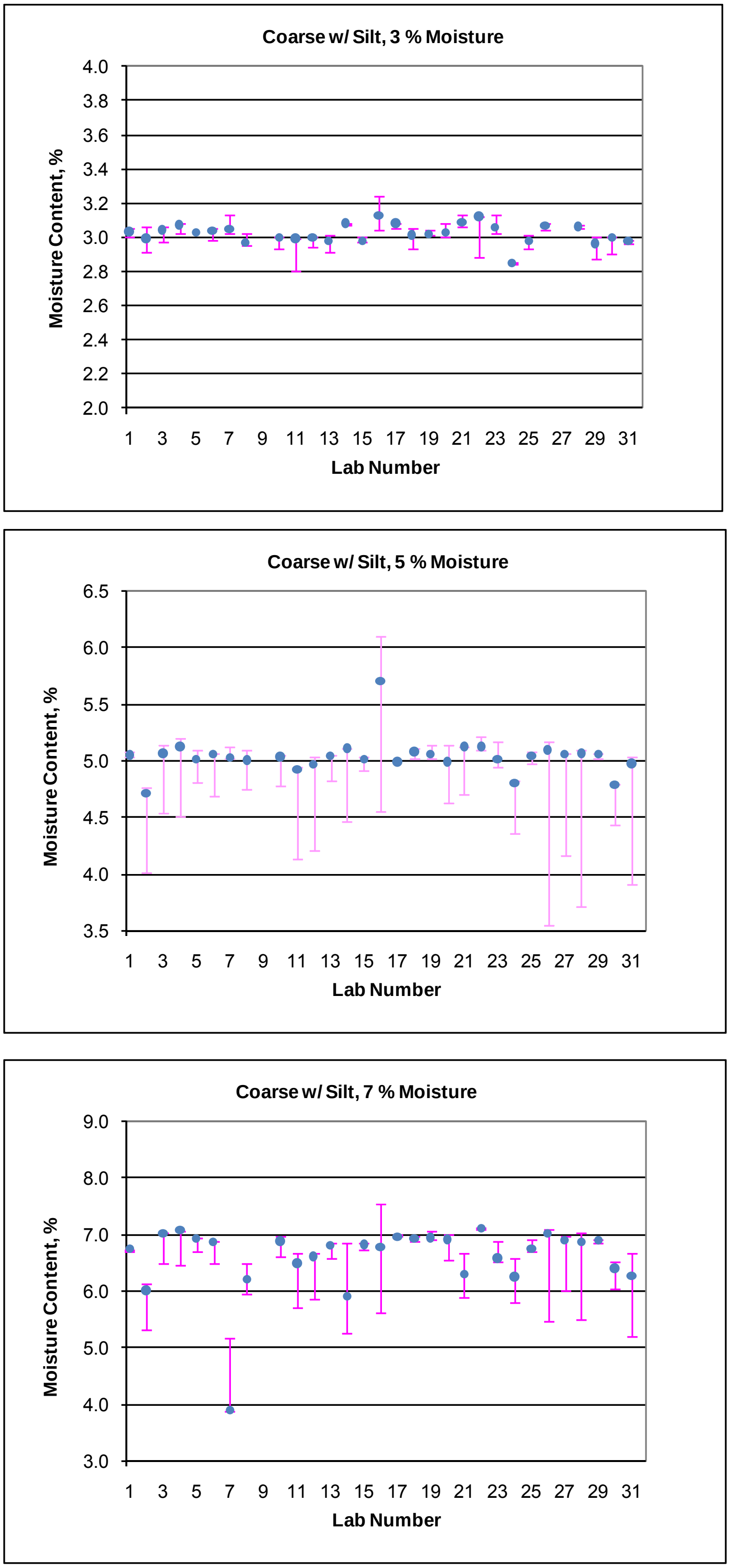


Figure C-1: Median water content values of coarse with silt aggregate-soil blends and the corresponding error bands

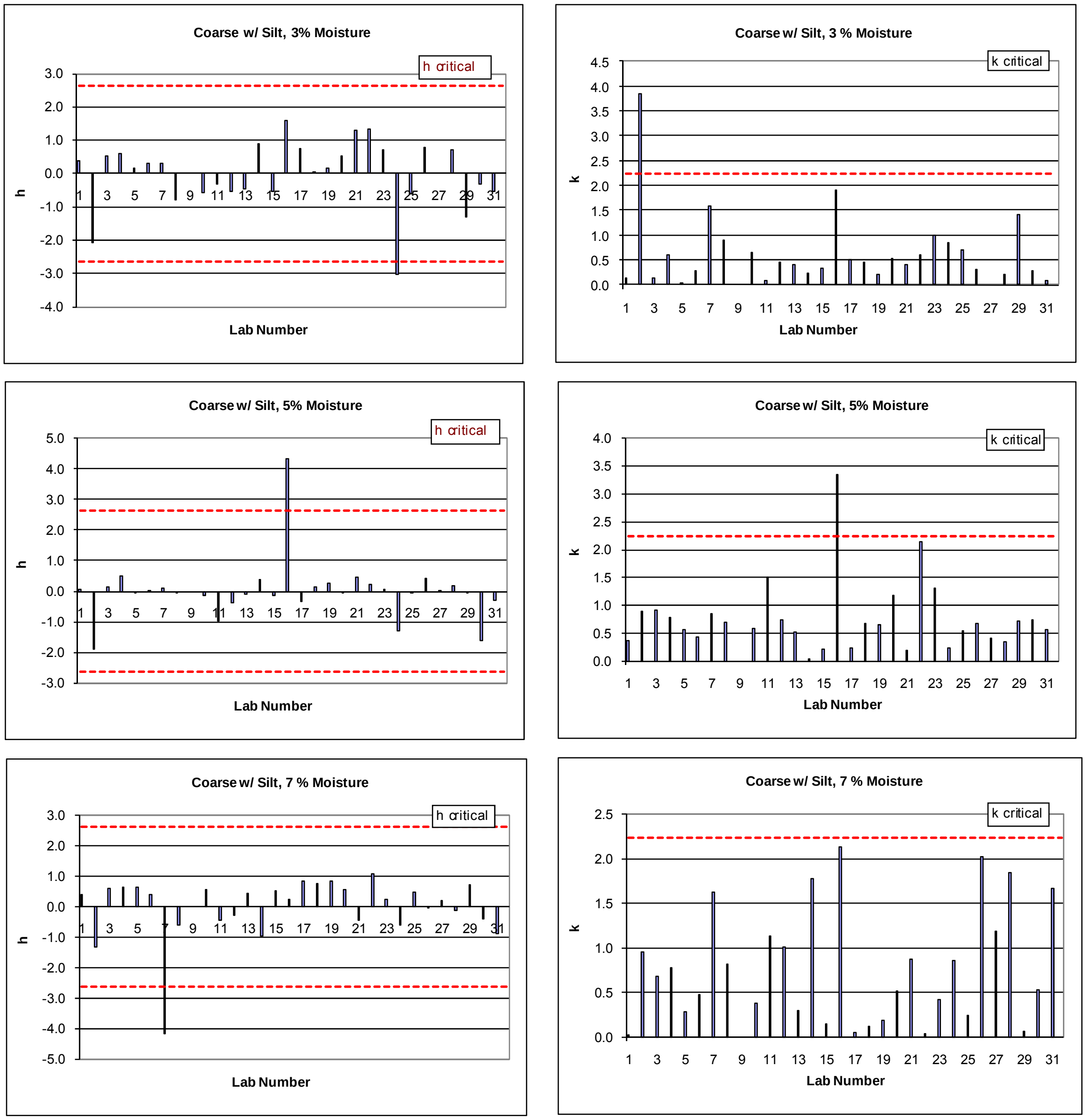


Figure C-2: h and k consistency statistics of water content measurements of coarse with silt aggregate-soil blends

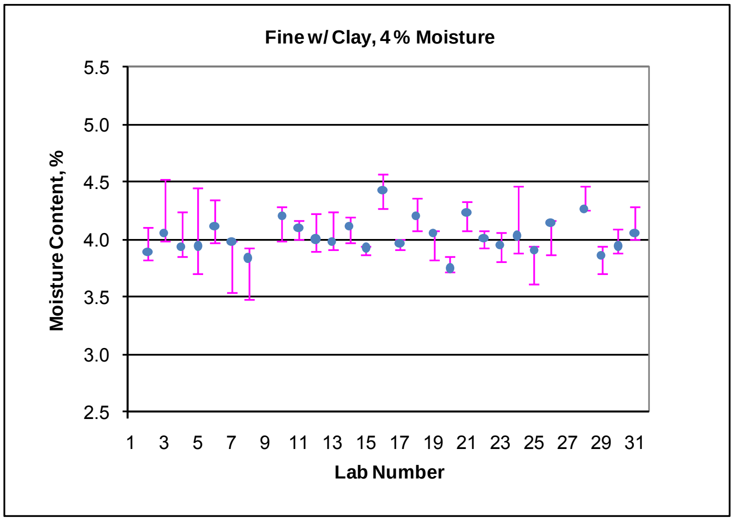
APPENDIX D- MOISTURE CONTENT OF FINE WITH CLAY AGGREGATE-SOIL BLEND AND COMPUTED ASTM E691 STATISTICS

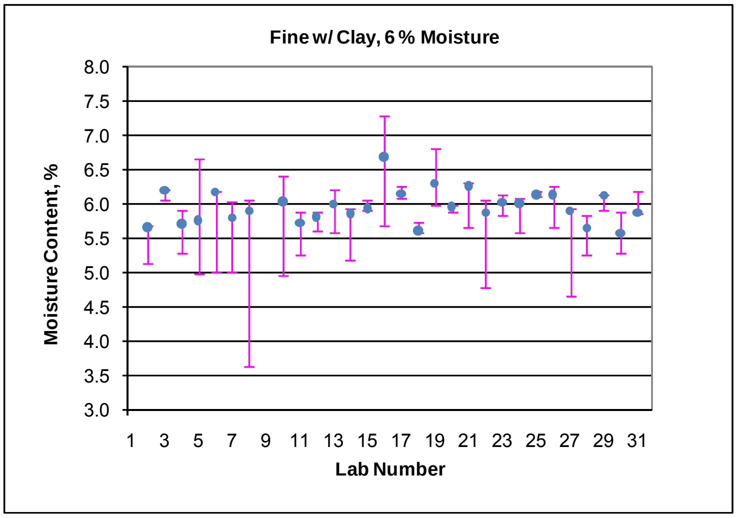
Table D-1: Moisture content (%) of three replicates of fine with clay aggregate–soil blends in the ILS study and the computed statistics according to ASTM E 691

Fine w/ Clay				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
1	4.0 4.2 3.9	5.6 5.8 5.7	6.9 7.0 7.0	4.0	5.7	7.0	0.17	0.11	0.07	-0.05	-1.01	-0.69	0.78	0.26	0.09	4.0	5.7	7.0	0.17	0.11	0.07
2	4.1 3.9 3.9	5.7 5.7 5.6	6.9 7.6 7.4	4.0	5.6	7.3	0.13	0.04	0.37	-0.51	-1.11	-0.20	0.59	0.09	0.47	4.0	5.6	7.3	0.13	0.04	0.37
3	4.0 4.5 4.1	6.1 6.2 6.2	8.9 7.2 7.1	4.2	6.2	7.7	0.29	0.04	0.98	1.09	0.66	0.52	1.34	0.10	1.23	4.2	6.2	7.7	0.29	0.04	0.98
4	4.2 3.9 3.9	5.6 5.7 5.9	6.4 7.4 6.8	4.0	5.8	6.9	0.19	0.14	0.48	-0.11	-0.77	-0.84	0.89	0.34	0.60	4.0	5.8	6.9	0.19	0.14	0.48
5	3.9 4.5 3.9	5.8 9.4 5.5	8.2 6.9 7.6	4.1	6.9	7.6	0.30	2.16	0.67	0.56	2.95	0.25	1.39	5.05	0.85	4.1	FALSE	7.6	0.30	FALSE	0.67
6	3.5 4.4 4.1	6.2 6.0 6.2	7.5 9.0 8.7	4.0	6.1	8.4	0.44	0.08	0.79	-0.30	0.47	1.57	2.06	0.19	0.99	4.0	6.1	8.4	0.44	0.08	0.79
7	3.9 4.0 4.0	5.4 6.0 5.8	6.1 6.1 5.3	4.0	5.7	5.8	0.05	0.34	0.48	-0.56	-0.84	-2.51	0.25	0.79	0.60	4.0	5.7	5.8	0.05	0.34	0.48
8	3.9 3.8 3.8	5.5 6.1 5.9	7.4 7.0 4.8	3.9	5.8	6.4	0.05	0.27	1.42	-1.16	-0.49	-1.59	0.25	0.63	1.79	3.9	5.8	6.4	0.05	0.27	1.42
9	4.0 4.0 4.0	5.7 5.4 5.8	6.2 6.5 7.1	4.0	5.7	6.6	0.02	0.21	0.46	-0.07	-1.04	-1.31	0.09	0.48	0.58	4.0	5.7	6.6	0.02	0.21	0.46
10	4.3 4.2 4.0	6.0 6.4 5.8	7.0 8.5 8.1	4.2	6.1	7.8	0.12	0.30	0.77	1.03	0.32	0.69	0.57	0.70	0.96	4.2	6.1	7.8	0.12	0.30	0.77
11	3.8 4.1 4.2	5.9 5.6 5.7	7.8 8.3 8.5	4.0	5.8	8.2	0.20	0.13	0.34	-0.10	-0.77	1.24	0.92	0.30	0.43	4.0	5.8	8.2	0.20	0.13	0.34
12	4.0 4.2 4.0	5.7 5.8 5.9	8.4 7.4 7.6	4.1	5.8	7.8	0.14	0.09	0.53	0.25	-0.60	0.57	0.65	0.21	0.67	4.1	5.8	7.8	0.14	0.09	0.53
13	4.0 4.2 3.8	6.2 6.0 5.9	7.4 6.9 7.4	4.0	6.0	7.2	0.20	0.16	0.24	-0.07	0.20	-0.29	0.93	0.37	0.30	4.0	6.0	7.2	0.20	0.16	0.24
14	4.2 4.1 3.9	5.7 5.9 5.9	7.6 7.8 6.9	4.1	5.8	7.4	0.13	0.11	0.48	0.38	-0.47	0.05	0.62	0.25	0.60	4.1	5.8	7.4	0.13	0.11	0.48
15	3.9 3.9 3.9	6.1 5.9 5.9	7.3 8.5 7.3	3.9	6.0	7.7	0.04	0.09	0.73	-0.83	-0.10	0.45	0.21	0.21	0.92	3.9	6.0	7.7	0.04	0.09	0.73
16	4.6 4.4 4.2	7.3 6.7 6.5	7.5 6.5 10.2	4.4	6.8	8.1	0.19	0.41	1.89	2.52	2.80	1.06	0.88	0.95	2.37	4.4	FALSE	FALSE	0.19	FALSE	FALSE
17	4.0 3.8 4.0	6.1 6.1 6.3	8.0 5.4 5.5	3.9	6.2	6.3	0.12	0.09	1.48	-0.78	0.59	-1.78	0.58	0.21	1.86	3.9	6.2	6.3	0.12	0.09	1.48
18	4.0 4.4 4.2	5.5 5.6 5.7	7.4 7.4 7.6	4.2	5.6	7.5	0.18	0.13	0.09	1.13	-1.22	0.10	0.82	0.31	0.11	4.2	5.6	7.5	0.18	0.13	0.09
19	4.0 4.1 4.1	6.1 6.8 6.3	8.0 7.7 7.4	4.1	6.4	7.7	0.03	0.38	0.27	0.15	1.33	0.48	0.15	0.90	0.33	4.1	6.4	7.7	0.03	0.38	0.27
20	3.7 3.9 3.8	6.0 5.9 6.0	7.3 8.9 7.2	3.8	6.0	7.8	0.09	0.03	0.92	-1.94	-0.07	0.64	0.44	0.07	1.16	3.8	6.0	7.8	0.09	0.03	0.92
21	4.2 4.1 4.3	6.3 6.3 6.1	9.1 7.5 6.9	4.2	6.2	7.9	0.14	0.11	1.15	1.23	0.79	0.72	0.67	0.25	1.45	4.2	6.2	7.9	0.14	0.11	1.15

Table D-1 (Continued): Moisture content (%) of three replicates of fine with clay aggregate–soil blends in the ILS study and the computed statistics according to ASTM E 691

Fine w/ Clay				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
22	4.0	5.8	8.4	4.0	5.9	8.0	0.05	0.13	0.65	-0.02	-0.24	0.98	0.22	0.31	0.82	4.0	5.9	8.0	0.05	0.13	0.65
	4.0	5.9	7.3																		
	4.1	6.1	8.4																		
23	3.9	5.9	8.1	4.0	6.0	6.8	0.09	0.13	1.11	-0.44	0.11	-0.92	0.42	0.31	1.40	4.0	6.0	6.8	0.09	0.13	1.11
	3.9	6.1	6.3																		
	4.1	6.0	6.1																		
24	3.9	5.9	9.3	4.2	6.0	7.9	0.28	0.12	1.22	0.82	0.01	0.78	1.31	0.29	1.54	4.2	6.0	7.9	0.28	0.12	1.22
	4.5	6.0	7.4																		
	4.0	6.1	7.0																		
25	3.8	6.2	7.0	3.9	6.1	6.8	0.06	0.19	0.18	-0.95	0.23	-1.05	0.28	0.44	0.23	3.9	6.1	6.8	0.06	0.19	0.18
	3.9	6.1	6.7																		
	3.9	5.8	6.6																		
26	4.1	6.3	8.0	3.8	6.1	7.6	0.70	0.20	0.46	-1.95	0.32	0.28	3.26	0.47	0.58	FALSE	6.1	7.6	FALSE	0.20	0.46
	4.2	6.1	7.6																		
	2.9	5.9	7.1																		
27	4.2	5.9	7.0	4.2	5.9	8.1	0.05	0.03	1.00	0.81	-0.27	1.03	0.23	0.08	1.26	4.2	5.9	8.1	0.05	0.03	1.00
	4.1	5.9	9.0																		
	4.1	5.9	8.2																		
28	4.0	5.6	7.0	4.2	5.7	7.5	0.25	0.11	0.68	1.39	-0.91	0.21	1.16	0.26	0.85	4.2	5.7	7.5	0.25	0.11	0.68
	4.3	5.8	7.4																		
	4.5	5.6	8.3																		
29	3.9	6.1	7.8	3.9	6.1	8.0	0.07	0.09	0.16	-1.18	0.30	0.94	0.34	0.20	0.20	3.9	6.1	8.0	0.07	0.09	0.16
	3.9	6.1	8.1																		
	3.8	6.0	8.0																		
30	3.6	5.5	6.6	3.9	5.7	6.6	0.24	0.20	0.21	-0.99	-1.07	-1.31	1.11	0.46	0.27	3.9	5.7	6.6	0.24	0.20	0.21
	3.9	5.9	6.8																		
	4.1	5.6	6.3																		
31	4.0	6.2	7.3	4.1	6.0	7.4	0.14	0.20	0.08	0.65	-0.11	-0.05	0.65	0.46	0.10	4.1	6.0	7.4	0.14	0.20	0.08
	4.1	5.9	7.5																		
	4.3	5.8	7.3																		
				31	31	31	31	31	31	31	31	31	31	31	31	30	29	30	30	29	30
				X_dbl_bar / Sx			Sr / SR			h Critical			k Critical			Corrected X_dbl_bar / Sx			Corrected Sr / SR		
				4.0	6.0	7.4	0.21	0.43	0.79	2.64	2.64	2.64	2.24	2.24	2.24	4.0	5.9	7.4	0.18	0.17	0.73
				0.14	0.31	0.63	0.26	0.52	1.00							0.14	0.20	0.63	0.22	0.26	0.95





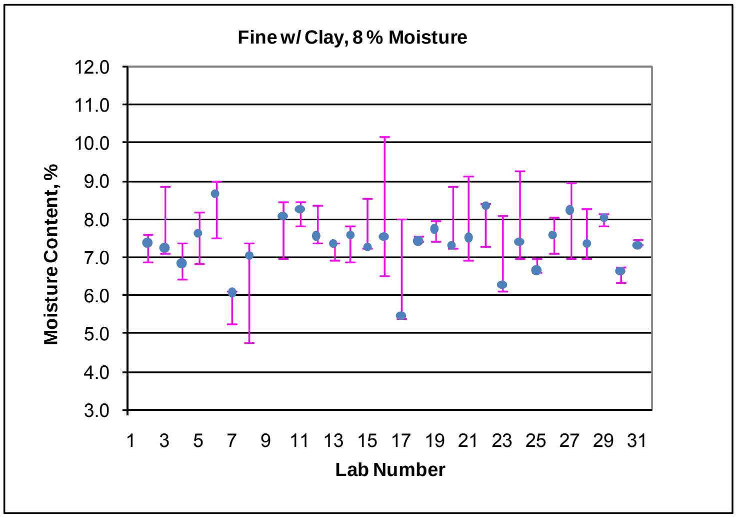


Figure D-1: Median water content values of fine with clay aggregate-soil blends and the corresponding error bands

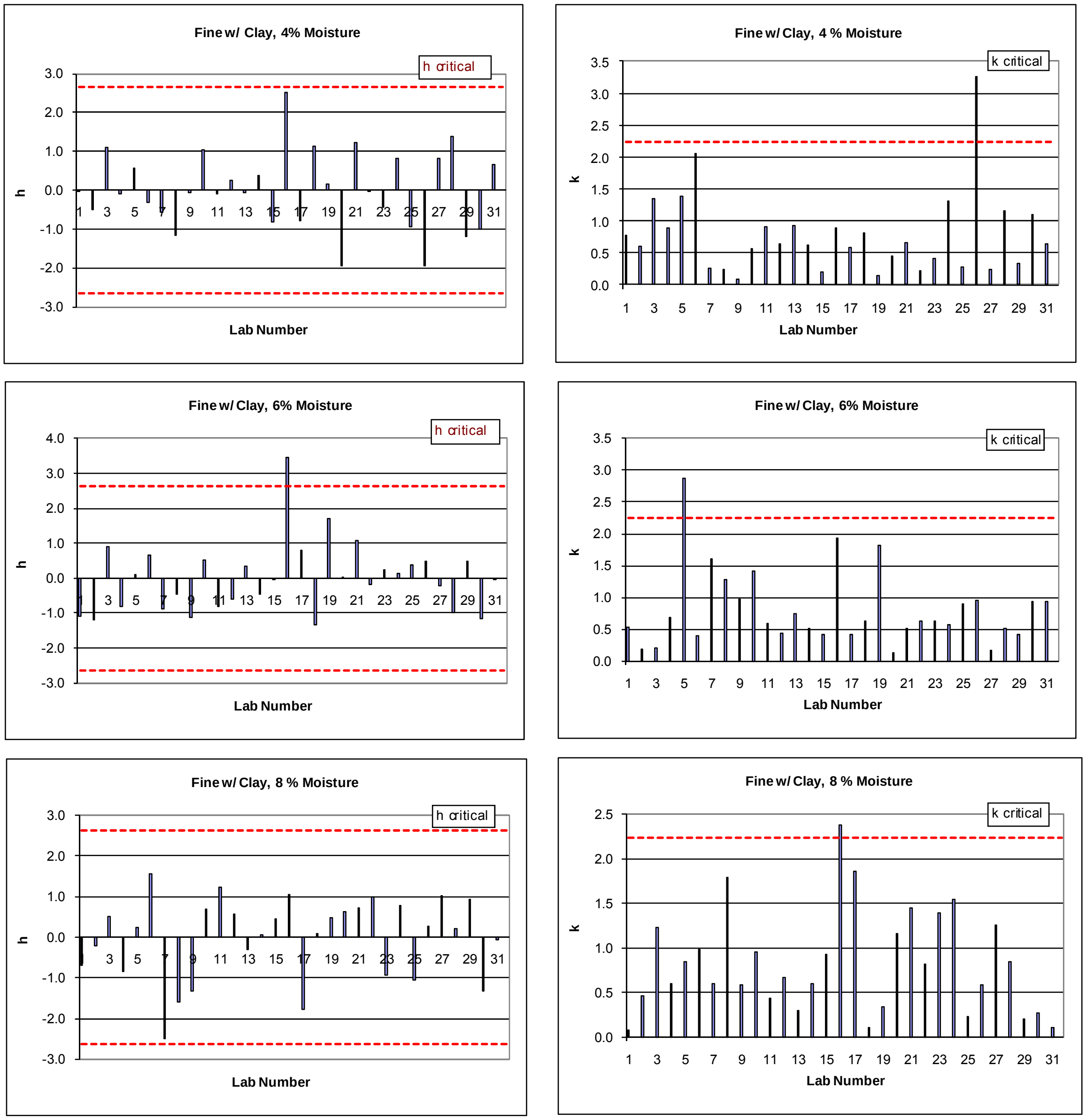


Figure D-2: h and k consistency statistics of water content measurements of fine with clay aggregate-soil blends

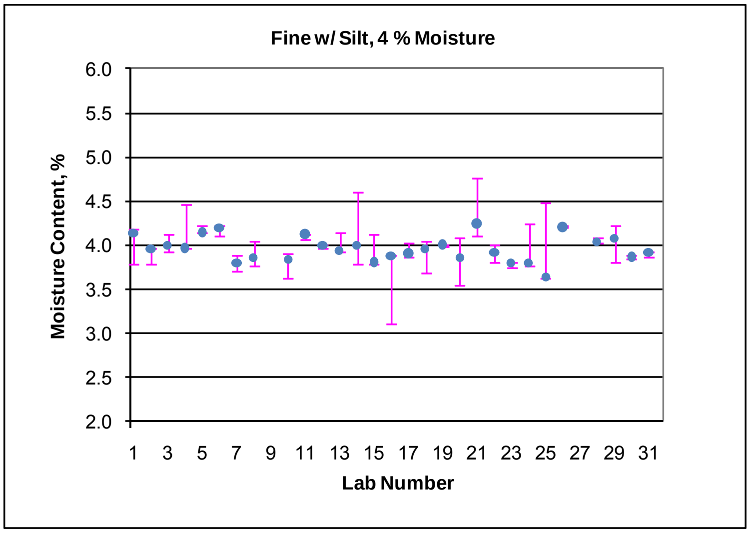
APPENDIX E- MOISTURE CONTENT OF FINE WITH SILT AGGREGATE-SOIL BLEND AND COMPUTED ASTM E691 STATISTICS

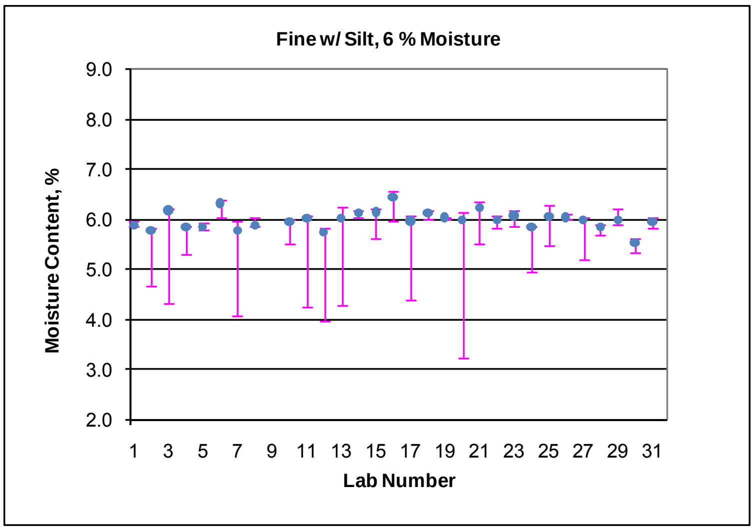
Table E-1: Moisture content (%) of three replicates of fine with silt aggregate-soil blends in the ILS study and the computed statistics according to ASTM E 691

Fine w/ Silt				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
1	4.1	5.5	7.6	4.1	5.8	7.6	0.06	0.23	0.02	1.09	-1.05	-0.15	0.29	1.53	0.03	4.1	5.8	7.6	0.06	0.23	0.02
	4.1	5.9	7.6																		
	4.2	6.0	7.6																		
2	3.9	5.6	7.5	3.9	5.7	7.1	0.03	0.12	0.67	-0.27	-1.39	-1.38	0.16	0.84	1.01	3.9	5.7	7.1	0.03	0.12	0.67
	4.0	5.8	7.4																		
	4.0	5.8	6.3																		
3	3.9	6.1	8.7	4.0	6.2	8.0	0.13	0.06	1.09	0.10	1.13	0.80	0.66	0.41	1.65	4.0	6.2	8.0	0.13	0.06	1.09
	4.0	6.2	8.6																		
	4.1	6.2	6.8																		
4	4.5	5.8	7.1	4.1	5.8	7.6	0.31	0.01	0.48	1.00	-0.79	-0.14	1.57	0.08	0.73	4.1	5.8	7.6	0.31	0.01	0.48
	4.0	5.9	7.7																		
	3.9	5.8	8.1																		
5	4.0	5.9	7.5	4.1	5.9	7.6	0.10	0.05	0.05	1.16	-0.56	-0.21	0.51	0.31	0.07	4.1	5.9	7.6	0.10	0.05	0.05
	4.1	5.9	7.6																		
	4.2	5.9	7.6																		
6	4.2	6.2	8.0	4.2	6.3	8.3	0.05	0.07	0.34	1.47	2.02	1.33	0.28	0.49	0.51	4.2	6.3	8.3	0.05	0.07	0.34
	4.2	6.3	8.6																		
	4.1	6.4	8.3																		
7	3.9	6.0	7.9	3.8	5.8	7.6	0.08	0.14	1.28	-1.29	-0.93	-0.14	0.39	0.97	1.94	3.8	5.8	7.6	0.08	0.14	1.28
	3.8	5.7	8.7																		
	3.7	5.8	6.2																		
8	3.8	5.8	7.8	3.9	5.9	8.0	0.13	0.12	0.25	-0.62	-0.43	0.60	0.68	0.84	0.38	3.9	5.9	8.0	0.13	0.12	0.25
	3.9	6.0	8.2																		
	4.0	5.9	7.8																		
9	4.0	5.7	7.5	4.0	5.8	7.7	0.10	0.21	0.22	-0.05	-1.33	0.09	0.49	1.41	0.33	4.0	5.8	7.7	0.10	0.21	0.22
	3.9	5.6	7.8																		
	4.1	6.0	7.9																		
10	3.8	6.0	7.5	3.9	5.9	7.5	0.05	0.15	0.43	-0.92	-0.50	-0.34	0.25	1.05	0.65	3.9	5.9	7.5	0.05	0.15	0.43
	3.8	5.9	7.1																		
	3.9	5.7	8.0																		
11	3.9	5.9	7.4	4.0	6.0	7.0	0.15	0.06	1.21	0.48	0.20	-1.44	0.74	0.39	1.83	4.0	6.0	7.0	0.15	0.06	1.21
	4.1	6.1	8.0																		
	4.1	6.0	5.7																		
12	4.0	5.8	7.1	4.0	5.8	6.7	0.05	0.06	1.29	-0.11	-1.16	-2.06	0.25	0.39	1.95	4.0	5.8	6.7	0.05	0.06	1.29
	4.0	5.8	5.3																		
	3.9	5.7	7.8																		
13	3.9	6.2	6.2	4.0	6.1	7.4	0.13	0.13	1.02	0.20	0.69	-0.70	0.64	0.90	1.54	4.0	6.1	7.4	0.13	0.13	1.02
	4.2	6.0	7.9																		
	3.9	6.0	8.0																		
14	4.6	5.9	8.0	4.1	6.1	8.2	0.42	0.13	0.28	1.06	0.66	1.03	2.16	0.90	0.42	4.1	6.1	8.2	0.42	0.13	0.28
	4.0	6.2	8.5																		
	3.8	6.1	8.0																		
15	3.8	6.2	7.4	3.8	6.2	7.9	0.27	0.04	0.50	-1.06	1.16	0.57	1.38	0.26	0.75	3.8	6.2	7.9	0.27	0.04	0.50
	4.1	6.1	8.0																		
	3.6	6.2	8.4																		
16	3.8	6.6	8.4	3.9	6.2	8.8	0.04	0.48	0.35	-0.90	1.55	2.40	0.18	3.28	0.54	3.9	FALSE	8.8	0.04	FALSE	0.35
	3.9	5.7	8.9																		
	3.9	6.5	9.1																		
17	3.7	6.1	7.6	3.9	6.0	7.2	0.15	0.09	1.05	-0.72	0.09	-1.06	0.77	0.58	1.59	3.9	6.0	7.2	0.15	0.09	1.05
	3.9	6.0	8.0																		
	4.0	5.9	6.0																		
18	3.8	5.9	8.0	3.9	6.1	8.0	0.15	0.17	0.07	-0.46	0.50	0.68	0.77	1.18	0.11	3.9	6.1	8.0	0.15	0.17	0.07
	4.0	6.2	8.0																		
	4.0	6.1	7.9																		
19	4.0	6.0	8.0	3.9	6.0	8.2	0.11	0.00	0.24	-0.23	0.40	1.12	0.54	0.03	0.37	3.9	6.0	8.2	0.11	0.00	0.24
	4.0	6.0	8.5																		
	3.8	6.0	8.1																		
20	4.1	6.1	5.5	3.9	5.9	7.4	0.14	0.22	1.62	-0.45	-0.21	-0.64	0.73	1.52	2.44	3.9	5.9	FALSE	0.14	0.22	FALSE
	3.8	6.0	8.3																		
	3.9	5.7	8.4																		
21	4.8	6.2	7.9	4.4	6.2	7.8	0.31	0.12	0.49	3.10	1.51	0.22	1.59	0.82	0.74	FALSE	6.2	7.8	FALSE	0.12	0.49
	4.2	6.3	8.2																		
	4.2	6.1	7.2																		

Table E-1 (Continued): Moisture content (%) of three replicates of fine with silt aggregate-soil blends in the ILS study and the computed statistics according to ASTM E 691

Fine w/ Silt				X_bar			S			h			k			X_bar_corr			S_corr		
Lab No	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%	3%	5%	7%
22	3.9	5.9	7.7	3.9	6.0	7.8	0.06	0.10	0.09	-0.25	0.01	0.25	0.29	0.70	0.13	3.9	6.0	7.8	0.06	0.10	0.09
	4.0	6.0	7.9																		
	3.9	6.1	7.8																		
23	3.8	6.2	8.0	3.8	6.1	8.2	0.01	0.08	0.14	-1.33	0.76	1.14	0.06	0.58	0.21	3.8	6.1	8.2	0.01	0.08	0.14
	3.8	6.1	8.3																		
	3.8	6.0	8.3																		
24	4.3	5.8	6.7	3.8	5.8	7.3	0.41	0.03	0.59	-1.10	-0.79	-0.80	2.08	0.19	0.89	3.8	5.8	7.3	0.41	0.03	0.59
	3.8	5.8	7.5																		
	3.4	5.9	7.8																		
25	4.5	6.1	7.0	3.9	6.1	6.8	0.51	0.13	0.35	-0.61	0.94	-1.91	2.62	0.88	0.53	FALSE	6.1	6.8	FALSE	0.13	0.35
	3.6	6.3	7.0																		
	3.6	6.0	6.4																		
26	4.2	6.1	8.0	4.1	6.1	8.0	0.14	0.05	0.09	1.14	0.54	0.72	0.69	0.32	0.13	4.1	6.1	8.0	0.14	0.05	0.09
	4.0	6.0	8.1																		
	4.2	6.0	7.9																		
27	4.3	5.9	7.7	4.1	6.0	7.5	0.24	0.06	0.57	0.64	0.12	-0.38	1.20	0.42	0.87	4.1	6.0	7.5	0.24	0.06	0.57
	4.0	6.0	6.9																		
	3.9	6.1	8.0																		
28	3.9	5.9	7.8	4.0	5.9	7.7	0.10	0.04	0.11	0.22	-0.68	0.05	0.50	0.26	0.17	4.0	5.9	7.7	0.10	0.04	0.11
	4.0	5.8	7.6																		
	4.1	5.8	7.7																		
29	3.9	6.0	7.7	4.1	6.0	7.9	0.16	0.25	0.20	0.65	-0.01	0.49	0.81	1.70	0.30	4.1	6.0	7.9	0.16	0.25	0.20
	4.1	6.2	7.8																		
	4.2	5.7	8.1																		
30	3.9	5.5	7.1	3.8	5.6	7.3	0.05	0.05	0.16	-0.99	-2.45	-0.88	0.26	0.36	0.24	3.8	5.6	7.3	0.05	0.05	0.16
	3.8	5.6	7.4																		
	3.9	5.5	7.3																		
31	3.9	5.9	7.9	3.9	6.0	8.0	0.12	0.07	0.28	-0.96	-0.02	0.75	0.63	0.48	0.43	3.9	6.0	8.0	0.12	0.07	0.28
	3.9	6.0	8.3																		
	3.7	6.0	7.8																		
				31	31	31	31	31	31	31	31	31	31	31	31	29	30	30	29	30	30
				X_dbl_bar / Sx			Sr / SR			h Critical			k Critical			Corrected X_dbl_bar / Sx			Corrected Sr / SR		
				4.0	6.0	7.7	0.20	0.15	0.66	2.64	2.64	2.64	2.24	2.24	2.24	4.0	6.0	7.7	0.17	0.12	0.60
				0.14	0.17	0.46	0.24	0.22	0.80							0.11	0.16	0.46	0.20	0.20	0.75





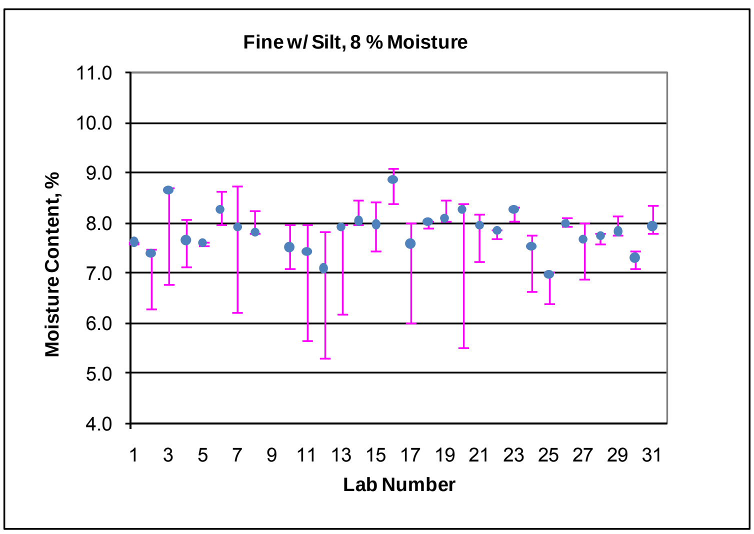


Figure E-1: Median water content values of Coarse with Clay aggregate-soil blends and the corresponding error bands

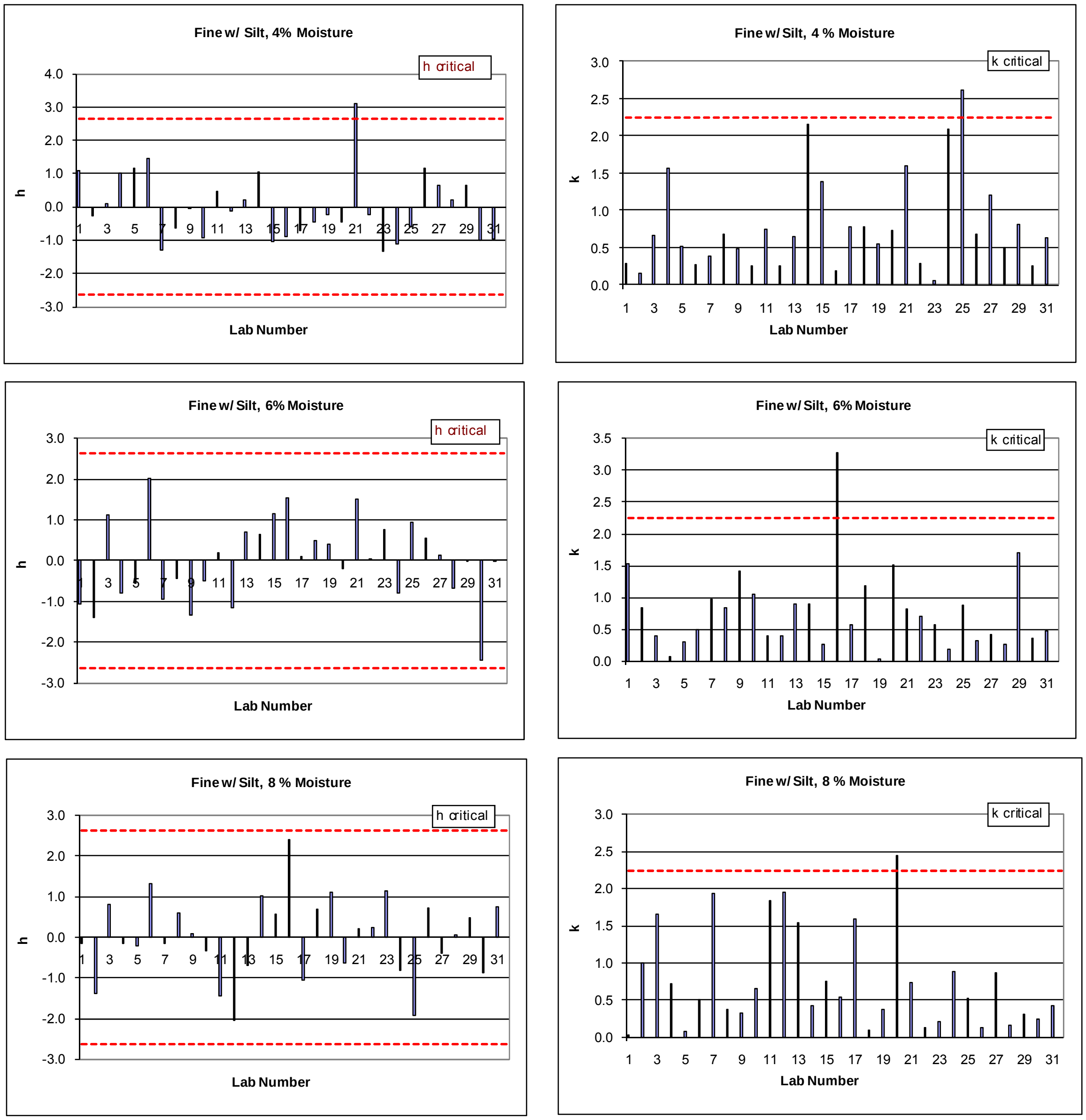


Figure E-2: h and k consistency statistics of water content measurements of fine with silt aggregate-soil blends

APPENDIX F- PRECISION STATEMENT FOR AASHTO T265

PRECISION STATEMENT FOR AASHTO T265, STANDARD METHOD OF TEST FOR LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS

1 Precision and Bias

1.1 Precision– Criteria for judging the acceptability of determining percentage of moisture content of soil using T265 are given in Table 1:

1.1.1 Single-Operator Precision (Repeatability) – The figures in Column 2 of Table 1 are the standard deviations that have been found to be appropriate for percent moisture content of the materials in Column 1. Two results obtained in the same laboratory, by the same operator using the same equipment, in the shortest practical period of time, should not be considered suspect unless the difference in the two results exceeds the single-operator limits given in Table 1, Column 3.

1.1.2 Multilaboratory Precision (Reproducibility) – The figures in Column 2 of Table 1 are the standard deviations that have been found to be appropriate for the percent moisture content of the materials in Column 1. Two results submitted by two different operators testing the same material in different laboratories shall not be considered suspect unless the difference in the two results exceeds the multilaboratory limits given in Table 1, Column 3.

Table 1 – Precision Estimates for AASHTO T265

Material and Type Index	Standard Deviation [a] (Percent)	Acceptable Range of Two Results [a] (Percent)
Single-Operator precision:		
Coarse aggregate-soil blend	0.05	0.1
Fine aggregate-soil blend	0.16	0.5
Multilaboratory Precision:		
Coarse aggregate-soil blend	0.12	0.3
Fine aggregate-soil blend	0.21	0.6

[a] These values represent the 1s and d2s limits described in ASTM Practice C670.

Note – The precision estimates given in Table 1 are based on the analysis of test results from AMRL interlaboratory study (ILS). The ILS data consisted of results from 26 to 29 laboratories tested three replicates of four different aggregate-soil blends each having about 7% passing #200 sieve. The average moisture contents of the test specimens ranged from 3 % to 6 %. The details of this analysis are in *NCHRP Web-Only Document 164*.

Bias– No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.