REFERENCE SAMPLE PROGRAM

CT 207, "METHOD OF TEST FOR DETERMINING SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE"

CT 234, "METHOD OF TEST FOR UNCOMPACTED VOID CONTENT OF FINE AGGREGATES"

2012 PROFICIENCY TEST RESULTS

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REFERENCE SAMPLE PROGRAM

SPECIFIC GRAVITY, PERCENT ABSORPTION AND UNCOMPACTED VOID CONTENT OF FINE AGGREGATE

2012 PROFICIENCY TEST RESULTS

1.0 Overview

In mid-2012, proficiency tests using reference samples of fine aggregate were initiated. The purpose of the proficiency tests is to determine if a participating laboratory is able to correctly conduct the test and achieve a statistically satisfactory result. The test results also assist in the assessment of the testing equipment used by the laboratory for the proficiency test.

These proficiency tests were based on two Caltrans test methods: CT 207 "Method of Test for Determining Specific Gravity and Absorption of Fine Aggregates" and CT 234 "Method of Test for Uncompacted Void Content of Fine Aggregates". CT 207 determines the bulk specific gravity (saturated surface dry basis) and absorption (after a prescribed soaking) of fine aggregate. CT 234 determines the loose, uncompacted void content of a sample of fine aggregate. The bulk specific gravity of the fine aggregate (determined by CT 207) is used in calculating the void content in CT 234.

Seventy (70) laboratories participated in this round of reference sample testing. Participating laboratories are from Caltrans, local agencies and private industry. The test results requested were: specific gravity, percent absorption and uncompacted void content.

1.1 Proficiency Sample Preparation

The proficiency samples were prepared at the Caltrans Reference Sample Program (RSP) laboratory in Sacramento, CA. Each proficiency sample is batched to specific target values that are determined prior to sample fabrication and distribution. The bulk material for the samples is obtained from one source to minimize variability. Quality control is performed on 10% of the fabricated samples to ensure consistency in the reference samples.

The proficiency samples were prepared in accordance with CT 201 and CT 202. The target sample mass for the fine specific gravity and percent absorption was 1000 g ± 10 g of material passing No. 4 sieve. The target sample mass for the uncompacted void content test was 1000 g ± 10 g, also using material passing the No. 4 sieve.

2.0 Analysis of Test Results

Proficiency samples were sent to 70 participating laboratories. Five of the 70 laboratories failed to submit results (Lab ID# 91, 186, 192, 200 and 490). Sixty five (65) laboratories submitted results for specific gravity and percent absorption. Sixty two (62) laboratories submitted results for uncompacted void content. The three laboratories that did not submit results for uncompacted void content do not perform CT 234.

2.1 Proficiency Sample Test Results: Standard Evaluation Criteria

As outlined in the 2005 *Caltrans Independent Assurance Manual*, RSP test results are analyzed using a statistical evaluation system in which the mean (**X**) and standard deviation (**s**) is calculated for each test parameter. A rating score is then given to the test result based on the criteria shown in Table 1. A test result with a score of 3 or greater is considered acceptable. A test result with a score of 2 or less is considered unacceptable.

Table 1: Evaluation Criteria

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

2.2 Analysis of Outlying Observations per ASTM E178-08

An analysis for outliers was conducted using ASTM E178-08, Section 4.1 and the upper 5% significance level table shown in the ASTM test method. Table 2 summarizes the number of laboratory test results considered as outliers for each test parameter. Outlying data is not included in the statistical analysis to determine the mean and standard deviation.

Table 2: Summary of Outlier Results

	Laboratories Submitting Test Results	Number of Outliers	ID of Laboratories Reporting Outlier Results	Total Number of Laboratories used in Statistical Analysis
Specific Gravity	65	4	Lab ID: 119, 256, 281 and 352	61
Percent Absorption	65	0	n/a	65
Uncompacted Void Content	62	1	Lab ID: 24	61

2.3 Data Analysis and Results

After excluding the outliers from the data set, the mean and standard deviation for each test parameter was calculated to determine the rating for each of the test parameters. Test results and the rating for each laboratory are presented in Appendix I, Table 7 and 8. A summary of test results are shown below in Table 3 and 4.

Table 3: Summary of Test Results for Specific Gravity and Percent Absorption (CT 207)

CT 207	No. of Labs	Mean	Standard Deviation	Number of Labs Receiving a Score of				
				5	4	3	2	1
Specific Gravity	61	2.64	0.018	46	9	4	2	0
% of Total				**75**	**15**	**7**	**3**	**0**
Percent Absorption	65	1.02	0.18	41	17	4	1	2
% of Total				**63**	**26**	**6**	**2**	**3**

Table 4: Summary of Test Results for Uncompacted Void Content (CT 234)

CT 234	No. of Labs	Mean	Standard Deviation	Number of Labs Receiving a Score of				
				5	4	3	2	1
Uncompacted Void Content	61	41.90	0.59	42	8	7	3	1
% of Total				**69**	**13**	**11**	**5**	**2**

2.4 Additional Criteria for CT 234 Test Results

Per CT 234, the uncompacted void content test result is reported based on the average of two readings. This average result was used in the statistical analysis to determine the mean and standard deviation of the CT 234 proficiency sample test results.

2.5 Retest Overview and Results

A retest sample is sent to a laboratory that receives an unacceptable rating or provides a result that is considered an outlier. A total of 9 laboratories received retest samples in November 2012. In most cases, the laboratory chose to redo all the proficiency tests. The complete retest results and ratings are in Appendix II, Tables 9, 10 and 11.

The retest results are summarized below in Tables 5 and 6.

Table 5: Summary of Retest Results for Specific Gravity and Percent Absorption (CT 207)

CT 207	No. of Labs	Mean	Standard Deviation	Number of Labs Receiving a Score of				
				5	4	3	2	1
Specific Gravity	9	2.64	0.018	8	-	1	-	-
% of Total				**89**	**0**	**11**	**0**	**0**
Percent Absorption	9	1.02	0.18	6	3	0	0	0
% of Total				**67**	**33**	**0**	**0**	**0**

Table 6: Summary of Retest Results for Uncompacted Void Content (CT-234)

CT 234	No. of Labs	Average	Standard Deviation	Number of Labs Achieved Score of				
				5	4	3	2	1
Uncompacted Void Content	9	41.90	0.59	8	0	1	-	-
% of Total				**89**	**0**	**11**	**0**	**0**

3.0 Observations

Variances in test results are caused by several factors. The following factors were noted as effecting test results in the 2012 proficiency testing:

CT 207

- Sample size – A small variance in the "as received" sample size is not expected to affect the outcome of the test results. However, CTM 207 (March 2012) provides the following formula for bulk specific gravity:

  Bulk Specific Gravity = 500/ (V-W)

  The formula clearly uses a 500 g sample size of material and any deviance from this may affect the test results. If a different mass is used, then the formula should be modified to reflect the actual sample size.

- Equipment - CT 207 calls for a volumetric flask of 500 ml capacity that is calibrated to 0.15 ml at 73° F. Caution should be taken by the tester when calibrating equipment to make sure that the true volume of the flask is known. An improperly calibrated flask will produced erroneous test results.

- Water temperature - if the water temperature is below or above the specified limits indicated in the test method inaccurate results may occur.

- Not following proper test procedures can affect final results i.e., errors in equipment calibration, poor weighing procedures or poor sample preparation are factors that may compromise the test results.

- Arithmetic and round-off errors - it was observed that some laboratories rounded up their values and while other laboratories performed incorrect calculations. One of the most common errors was to use the formula SG = 500/ (V-W) when the actual mass was other than 500 g. Another common error was to use the weight of the flask plus water as the calibrated value for the flask. In some cases, 650 ml was provided as the calibrated value of the flask instead of 500 ml.

CT 234

- Incorrect specific gravity test results from CT 207 impact the test results for CT 234. The uncompacted void content is calculated using the specific gravity determined in CT 207, thus an incorrect specific gravity may result in an incorrect uncompacted void content.

4.0 References

ASTM Designation E 178-80, "Standard Practice for Dealing with Outlying Observations"

Caltrans, "Independent Assurance Manual," Sacramento, July 2005.

CT 201, "Method of Test for Soil and Aggregate Sample Preparation"

CT 202, "Method of Test for Sieve Analysis of Fine and Course Aggregates"

CT 207, "Method of Test for Determining Specific Gravity and Absorption of Fine Aggregates"

CT 234, "Method of Test for Uncompacted Void Content of Fine Aggregates"

APPENDIX I

Table 7: Initial Test Results for CT 207

CT ID#	Specific Gravity	Score	Absorption, %	Score
2	2.61	4	0.80	4
5	2.65	5	1.20	4
8	2.64	5	1.10	5
9	2.63	5	1.05	5
11	2.63	5	1.10	5
12	2.67	2	0.80	5
18	2.64	5	1.20	4
24	2.63	5	1.00	5
43	2.68	2	1.20	4
47	2.64	5	0.80	4
52	2.66	4	0.90	5
53	2.65	4	1.20	4
58	2.63	5	0.90	5
59	2.63	5	1.05	5
63	2.63	5	1.10	5
64	2.63	5	0.90	5
65	2.63	5	1.00	5
68	2.62	5	0.70	3
69	2.63	5	1.00	5
71	2.63	5	1.20	4
73	2.65	5	1.10	5
75	2.65	5	1.10	5
94	2.67	3	1.00	5
102	2.62	5	1.20	4
119	1.40	O	1.10	5
131	2.64	5	1.00	5
133	2.64	5	0.80	4
135	2.62	5	0.80	4
140	2.63	5	0.80	4
143	2.66	4	1.00	5
145	2.61	4	0.80	4
147	2.62	5	0.90	5
154	2.64	5	1.20	4
156	2.63	5	1.10	5
158	2.63	5	1.40	2

CT ID#	Specific Gravity	Score	Absorption, %	Score
160	2.62	5	0.90	5
161	2.65	5	1.10	5
164	2.66	4	1.09	5
173	2.62	4	1.10	5
176	2.65	5	1.24	4
196	2.63	5	0.98	5
237	2.63	5	1.10	5
255	2.61	4	1.00	5
256	1.42	O	1.10	5
257	2.61	4	1.20	4
263	2.63	5	1.20	4
265	2.62	5	1.10	5
266	2.62	5	1.10	5
281	1.39	O	1.10	5
293	2.63	5	1.10	5
294	2.65	5	0.95	5
316	2.65	5	1.20	4
352	1.43	O	1.10	5
353	2.63	5	1.00	5
359	2.65	5	0.90	5
373	2.60	3	1.50	1
377	2.65	5	1.09	5
393	2.65	5	1.10	5
396	2.62	5	0.72	3
464	2.65	5	1.03	5
482	2.60	3	1.30	3
493	2.65	5	1.03	5
560	2.67	3	0.71	3
564	2.64	5	1.10	5
582	2.63	5	0.50	1

Table 8: Initial Test Results for CT 234

CT ID#	Average Uncompacted Void Content %	Score
2	41.80	5
5	42.80	3
8	41.70	5
9	42.00	5
11	40.90	3
12	41.60	5
18	41.70	5
24	51.00	O
43	43.20	2
47	42.00	5
52	41.90	5
53	42.00	5
58	42.20	5
59	41.60	5
63	41.30	4
64	42.38	5
65	42.00	5
68	41.80	5
69	40.90	3
71	42.20	5
73	42.00	5
75	41.50	5
94	42.90	3
102	42.00	5
119	42.00	5
131	41.70	5
133	42.10	5
135	41.40	5
140	41.40	5
143	42.30	5
145	42.00	5
147	41.60	5
154	N/A	
156	N/A	
158	43.10	2

CT ID#	Average Uncompacted Void Content %	Score
160	40.80	3
161	40.70	2
164	42.70	4
173	41.70	5
176	42.60	4
196	42.10	5
237	41.40	5
255	41.30	4
256	42.00	5
257	41.70	5
263	41.80	5
265	42.00	5
266	41.80	5
281	40.40	1
293	42.40	5
294	42.30	5
316	42.30	5
352	42.30	5
353	40.80	3
359	42.30	5
373	N/A	
377	42.50	4
393	42.70	4
396	42.00	5
464	42.00	5
482	41.30	4
493	41.70	5
560	42.40	5
564	42.80	3
582	41.20	4

1,2 **Unacceptable Score**

O **Outlier**

Note: N/A – Laboratory does not perform test method

APPENDIX II

Table 9: Retest Results for CT 207 (Specific Gravity)

CT ID#	Specific Gravity	Score
12	2.64	5
24	2.64	5
43	2.60	3
119	2.63	5
158	2.64	5
161	2.65	5
256	2.62	5
281	2.65	5
352	2.63	5

Table 10: Retest Results for CT 207 (Absorption)

CT ID#	Absorption, %	Score
12	0.8	4
24	1.0	5
43	1.2	4
119	1.1	5
158	0.8	4
161	1.1	5
256	1.1	5
281	1.1	5
352	1.1	5

Table 11: Retest Results for CT 234

CT ID#	Average Uncompacted Void Content %	Score
12	41.6	5
24	42.3	5
43	41.8	5
119	42.0	5
158	42.2	5
161	41.4	5
256	42.0	5
281	42.9	3
352	42.3	5