October 20, 2009 Matls. IM 216
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GUIDELINES FOR DETERMINING THE ACCEPTABILITY OF TEST RESULTS

GENERAL

Criteria for determining the acceptability of test results is an integral part of the Quality Assurance Program. The comparison between two different operator's results is used in the independent assurance program and sometimes in the validation process. The tolerances in this IM are for comparing individual test results except in the case of the profile index where averages are used. When criteria for comparing tests results is not established in this IM or any other IM, use of the AASHTO or ASTM test procedure precision criteria is appropriate for determining acceptability of test results.

When the tolerances are exceeded, an immediate investigation must be made to determine possible cause so that any necessary corrections can be made. Below are some steps that may be used to identify the possible cause:

1. Check all numbers and calculations.
2. Review past proficiency and validation data.
3. Review sampling and testing procedures.
4. Check equipment operation, calibrations and tolerances.
5. Perform tests on split samples or reference samples.
6. Involve the Central Materials Laboratory.

TOLERANCES

TEST NAME	TEST METHOD	TOLERANCE
Slump of PC Concrete		
1" or less on IA or Verification	IM 317	1/4 in. (6 mm)
More than 1" on IA or Verification		3/4 in. (18 mm)
Air Content of PC Concrete	IM 318	0.4%
Length of Concrete Cores	IM 347	0.10 in. (2 mm)
Free Moisture in Aggregate, by Pycnometer	IM 308	0.2%
Specific Gravity of Aggregate, by Pycnometer	IM 307	0.02
Moisture in Aggregate, by Hot Plate		0.3%
Wet Density by Nuclear Gauge, Soils & Bases	IM 334	2.0 lb./ft.^{3} (32 kg/m^3)
G_{mm} Maximum Specific Gravity	IM 350	0.010
G_{mb} Density of HMA Concrete, by Displacement	IM 321	0.020

G*/Sin Delta	T315	10% of mean
% Binder, Ignition Oven	IM 338	0.3%
G_{sa} Apparent Specific Gravity	IM 380	0.010
G_{sb} Bulk Specific Gravity	IM 380	0.028
Percent Absorption	IM 380	0.37%
Fine Aggregate Angularity	T304	2.0%
Sand Equivalency	T176	10 % of mean

Pavement Profile Index (0.2” blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		1.0 in./mi. (16 mm/km)
6.1 to 20.0 (96 to 315)		2.0 in./mi. (32 mm/km)
20.1 to 40.0 (316 to 630)		3.0 in./mi. (47 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Pavement Profile Index (0.0” blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
25.0 (395) or less		3.0 in./mi. (47 mm/km)
25.1 to 40.0 (396 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Bridge Profile Index (0.2” blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		2.0 in./mi. (32 mm/km)
6.1 to 20.0 (96 to 315)		3.0 in./mi. (47 mm/km)
20.1 to 40.0 (316 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		6.0 in./mi. (95 mm/km)

TOLERANCES FOR AGGREGATE GRADATIONS

Determining the precision of an aggregate sieve analysis presents a special problem because the result obtained with a sieve is affected by the quantity of material retained on the sieve and by results obtained on sieves coarser than the sieve in question. Tolerances are, therefore, given for different ranges of percentage of aggregate passing one sieve and retained on the next finer sieve used.

Comparisons of test results are made on each fraction of the sample, expressed in percent that occurs between consecutive sieves.

NOTE: Unless otherwise noted, tolerances for aggregate gradations are only valid if the two tests were made on a split sample. Experience has shown that improper sample reduction, as well as differences in test procedures can contribute to results being out of tolerance. When a comparison exceeds the tolerance limits, a review of the test procedures and equipment will be performed. Where practical, additional comparisons will be done with similar equipment and methods.

Table 1 Tolerances for All Aggregates Except HMA-Combined Aggregate

	Size Fraction Between Consecutive Sieves, %*	Tolerance, %
Coarse Portion:	0.0 to 3.0	2
#4 Sieve and larger	3.1 to 10.0	3
	10.1 to 20.0	5
	20.1 to 30.0	6
	30.1 to 40.0	7
	40.1 to 50.0	9
Fine portion:	0.0 to 3.0	1
#8 Sieve and smaller	3.1 to 10.0	2
	10.1 to 20.0	3
	20.1 to 30.0	4
	30.1 to 40.0	4

Table 2 Tolerances for All HMA-Combined Aggregate

Size Fraction Between Consecutive Sieves, %*	Tolerances(1)
0.0 to 3.0	2
3.1 to 10.0	3
10.1 to 20.0	5
20.1 to 30.0	6
30.1 to 40.0	7
40.1 to 50.0	9

(1) Minimum tolerance of 5% is applied to all size fractions coarser than the #4 sieve when comparing cold feed to ignition oven as shown on page 3 of Appendix A.
*The verification test analysis fraction is used to find the proper tolerance.

COMPARISON OF AGGREGATE GRADATIONS

Use of these tolerances is explained in the following examples. Computer spreadsheets to perform the analysis are available on the Iowa DOT Materials Office website. Use of the spreadsheets is preferred when possible. Appendix A contains a copy of the printouts from the spreadsheets.

Example 1 - PC Concrete Coarse Aggregate

Sieve Size	DOT Coarse Aggr Percent Passing	Prod./CPI Coarse Aggr Percent Passing	DOT Coarse Aggr Percent Retained	Prod./CPI Coarse Aggr Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5"/37.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
1"/25.0mm	97.1	99.1	2.9	0.9	2.0	2	Yes
3/4"/19.0mm	72.2	65.1	24.9	34.0	9.1	6	No
1/2"/12.5mm	38.1	34.9	34.1	30.2	3.9	7	Yes
3/8"/9.5mm	12.0	8.8	26.1	26.1	0.0	6	Yes
#4/4.75mm	0.6	0.2	11.4	8.6	2.8	5	Yes
#8/2.36mm	0.5	0.2	0.1	0.0	0.1	1	Yes
Minus #200	0.3	0.2	0.3	0.2	0.1	1	Yes

The size fraction between consecutive sieves is found by calculating the difference between the percent passing reported for the two sieves. For example, the fraction between the 1.5 in. (37.5 mm) and 1 in. (25 mm) sieves for the above verification test is 100.0 - 97.1 = 2.9%. Between the 1/2 in. (12.5 mm) and 3/8 in. (9.5mm) sieves it is 38.1 – 12.0 = 26.1%. Since nothing passes the pan, the size fraction between the #200 sieve and the pan is equal to the percent passing the #200.

The example shows the fraction between each pair of consecutive sieve sizes for both tests and the difference between these fractions for both tests. The difference is compared with the applicable tolerance to determine a disposition. In this example, a suspect result is found in the fraction between the 1 in. (25 mm) and 3/4 in. (19 mm) sieves. Since the suspect difference is due primarily to the percent passing results on the 3/4 in. (19 mm) sieves, it is these results that should at least be investigated first. Only further investigation can determine which 3/4 in. (19 mm) sieve, if any is faulty.

NOTE: The applicable tolerance changes between #4 and #8 size fractions.

Example 2 - PC Concrete Fine Aggregate

Sieve Size	DOT Fine Aggregate Percent Passing	Prod./CPI Fine Aggregate Percent Passing	DOT Fine Aggregate Percent Retained	Prod./CPI Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8"/9.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
#4/4.75mm	95.0	95.0	5.0	5.0	0.0	3	Yes
#8/2.36mm	87.8	86.3	7.2	8.7	1.5	2	Yes
#16/1.18mm	72.0	71.5	15.8	14.8	1.0	3	Yes
#30/600um	44.0	43.8	28.0	27.7	0.3	4	Yes
#50/300um	12.2	13.0	31.8	30.8	1.0	4	Yes
#100/150um	1.5	1.3	10.7	11.7	1.0	3	Yes
Minus #200	0.4	0.4	0.4	0.4	0.0	1	Yes

Example 3 - HMA Combined Aggregate

		Sieve Sizes										
		1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
	Specs.											
	D.O.T.		100	99.1	87.3	68.8	54.2	41.4	28.2	15.5	9.1	6.9
	Prod./C.P.I.		100	98.8	86.1	74.9	56.1	41.9	28.7	15.1	10.9	8.6

D.O.T. FBR: _____

D.O.T. % Retained	Prod./C.P.I. % Retained	Diff.	Tol. %	Comply (Y/N)
NA	NA	0.0	2	Y
0.9	1.2	0.3	2	Y
11.8	12.7	0.9	5	Y
18.5	11.2	7.3	5	N
14.6	18.8	4.2	5	Y
12.8	14.2	1.4	5	Y
13.2	13.2	0.0	5	Y
12.7	13.6	0.9	5	Y
6.4	4.2	2.2	3	Y
2.2	2.3	0.1	2	Y
6.9	8.6	1.7	3	Y

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9

NOTE: The applicable tolerance for this combined aggregate sample is from Table 2. In this example, the suspect fractions would indicate a possible problem for two pairs of consecutive sieve sizes involving the #4 (4.75 mm) sieves. This evidence and the difference in the test values found for the #4 (4.75 mm) sieves, strongly point to an error in one of the #4 (4.75 mm) sieve results.

When RAP mixes are used, the comparison data is of the composite gradation results and not of the cold feed.

Example 4 HMA Cold-Feed to Ignition Oven Comparison

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.	**100**	100	100	90-100	76-90	50-64	30-40		20-28			3.0-7.0
Sample ID		Ign. Oven	100.0	100.0	100.0	92.0	82.0	62.0	40.0	30.0	20.0	15.0	9.0	5.0
Sample ID		Cold-Feed	100.0	100.0	100.0	90.0	80.0	60.0	35.0	27.0	22.0	13.0	7.0	3.0
	Correction Factor		0.0	0.0	0.0	0.0	-0.3	-0.5	-0.5	-0.3	-0.3	-0.2	-0.3	-0.3

Sieves	Ign. Oven % Retained	Cold-Feed % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	0.0	0.0	0.0	2	Y
1 - 3/4	0.0	0.0	0.0	2	Y
3/4 - 1/2	8.0	10.0	2.0	3	Y
1/2 - 3/8	10.3	10.0	0.3	5	Y
3/8 - 4	20.2	20.0	0.2	6	Y
4 - 8	22.0	25.0	3.0	6	Y
8 - 16	9.8	8.0	1.8	3	Y
16 - 30	10.0	5.0	5.0	3	N
30 - 50	4.9	9.0	4.1	3	N
50 - 100	6.1	6.0	0.1	3	Y
100 - 200	4.0	4.0	0.0	3	Y
200	4.7	3.0	1.7	3	Y

Corrected Ign. Oven SA:	5.6	Film Thickness:	7.3
Cold-Feed Surface Area:	4.7	Film Thickness:	8.7
Correction Factor:	-0.1		

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9
+#4 sieves minimum tolerance =			5

When comparing an ignition oven extracted gradation to a cold-feed gradation a correction factor must be applied to the ignition oven extracted gradation before comparing it to the cold-feed gradation. The correction factor is determined by calculating the difference between a cold-feed gradation and an ignition oven gradation on the first day of HMA production according to IM 501. The correction factor is then applied to all subsequent comparisons. In the example above, the correction factor was determined on a previous sample. The District Materials Engineer may establish new or average correction factors when needed.