SIEVE ANALYSIS OF AGGREGATES

SCOPE

This method of test covers the procedure for determination of the particle size distribution of aggregates.

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1 percent of the weight (mass) of the sample to be tested. **NOTE:** The balance shall be reset to zero before each weighing.

2. Sieves with square openings mounted on substantial frames, constructed in such a manner to prevent loss of material during sieving. Use suitable sieve sizes to furnish the information required by the specifications covering the material to be tested. The woven wire cloth shall conform to AASHTO M-92. This will normally consist of a set of **Box Sieves** for testing coarse aggregates consisting of the following sizes:

   1 ½ in., 1 in., ¾ in., ½ in., ⅜ in., No. 4, and No. 8.

   A set of **8 in. Diameter Sieves** for testing fine aggregates consisting of the following sizes:

   No. 4, No. 8, No. 16, No. 30, No. 50, No.100, No. 200, and Pan.

   A set of **12 in. Diameter Sieves** may be used for testing fine aggregate or aggregate containing both coarse and fine material.

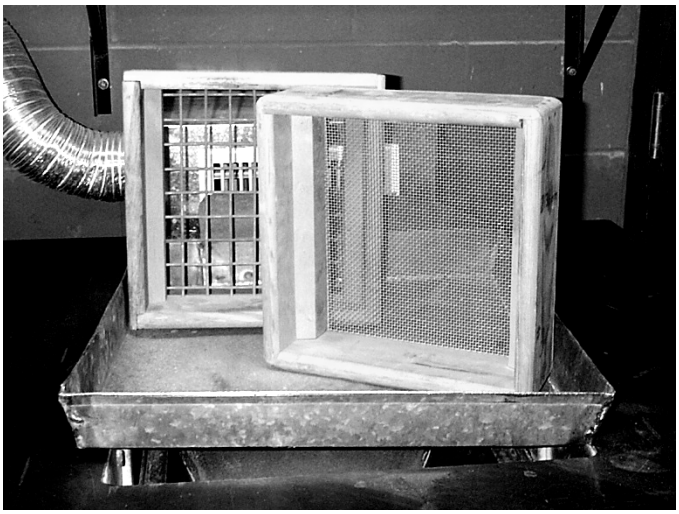

Figure 1. Box Sieves for testing coarse aggregates.

Figure 2. 12 and 8 in. sieves.

3. Mechanical and hand-powered sieve shakers

4. Drying oven or stove

5. Fiber bristle sieve cleaning brush (similar to stencil brush or cropped paintbrush)

B. Test Sample

1. Test samples for sieve analysis shall conform to the sample size for the applicable material as indicated by Materials IM 301.

2. Obtain the sample for sieve analysis (test sample) from the material to be tested (field sample) by the appropriate method as outlined in Materials IM 336. The test sample shall be approximately of the weight (mass) desired when dry and must be the end result of the reduction. Reduction to an exact predetermined weight (mass) shall not be permitted.

C. Preparation of Sample

1. When a determination of the amount of material passing the No. 200 sieve is required, test the sample according to Materials IM 306, *"Determining the Amount of Material Finer Than the No. 200 Sieve",* before completing the sieve analysis. For coarse aggregates with a nominal maximum size greater than ½ in., a single test sample may be used to determine both sieve analysis and the amount passing the No. 200, or separate test samples may be used for Materials IMs 306 and 302.

2. When the absorbed moisture stays essentially the same for different particle sizes the sample may be sieved at a surface-dry condition (no free water present).

3. Samples with a significant amount of material finer than the No. 4 sieve, or highly absorptive coarse aggregates (i.e. lightweight aggregates) which have changes in moisture for different particle sizes, must be dried to a constant weight (mass) before performing sieve analysis.

4. Coated particles may also be a problem. When this condition exists, the dried material must be washed over the smallest sieve for which there is a specification requirement (usually the No. 8 sieve), and dried again.

5. Recycled Materials: Material from crushed composite (HMA/PC) pavements must be sieved at a surface-dry condition using no artificial heat. No gradation determination will be made for material finer than the No. 8 sieve. In some instances, larger particles may be coated to the extent that dry sieving will not accurately reflect the true gradation of the material. In these instances, the air-dried sample must be washed over the No. 8 sieve and allowed to come to a surface-dry condition by air-drying.

   Note: For material made from crushed PC pavement, determination of the percent passing the No. 200 sieve may be required.

D. Test Procedure

1. Weigh and record the weight (mass) of the test sample as the Original Dry Mass. (This is the 'Dry Mass Washed Weight" if tested by Materials IM 306.)

2. Sieve the sample over the required sieves. The sieving operation must be accomplished by using a lateral and vertical motion of the sieve(s), accompanied by a jarring action, which keeps the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the aggregate particle through the sieve openings by hand.

When using a mechanical sieve shaker, excessive sieving times may result in degradation of the sample.

Method A

When testing a sample with a mixture of coarse and fine aggregate (combined aggregate), and sieve overload of the fine aggregate sieves is anticipated, the material finer than the No. 4 may distributed among two or more sets of sieves and each increment recombined for weighing:

Method B

Alternately, weigh and record the total minus No. 4 material (W1). Reduce the minus No. 4 material through the 1 in. or smaller mechanical splitter to a minimum 500 g. sample size. Weigh and record the selected reduced portion (W2) and place this material into the nest of fine aggregate sieves and continue step 2 (above).

The conversion factor is calculated by dividing W_1 by W_2, and recorded to the nearest 0.0001.

NOTE: Method B is recommended when using 8 in. sieves to test the fine aggregate portion of a sample, when overload is anticipated. If using 12 in. sieves and the original test sample is reasonably close to the required weight (mass), overload should not occur. When sieve overload is anticipated on the No. 8 sieve only, sieve the original sample through the No. 8 box sieve before placing the fine portion in the nest of 8 in. round sieves.

3. The sieving operation may be considered complete when not more than 0.5 percent by weight (mass) of the original sample passes any sieve during an additional one minute of hand-sieving.

   On the No. 4 and larger sieves, limit the amount of material carried on the sieve to a single layer when determining sieving to completion.

   When using 8 in. and 12 in. diameter sieves, the weights retained should not exceed the following:

8 in. diameter sieves	12 in. diameter sieves
No more than 200 grams	No. 4 no more than 850 grams No. 8 and smaller no more than 450 grams

   If sieving to completion (as described above) is not readily accomplished, reduce the amount of material carried on the sieve.

6. Clean the retained material from each sieve for weighing. Remove as much material as practical without damaging the wire cloth. Particles may be removed most readily from a sieve by inverting the sieve over a pan and tapping the sieve by hand and/or pushing

(without force) the particles out of the mesh into the pan. Care must be taken while cleaning the sieves, so no damage occurs to the wire mesh by bending or breaking the wires. A fiber-bristle brush should be used for cleaning the No. 16, No. 30 and No. 50 sieves. When cleaning the No. 100 or No. 200 sieves, a *soft* fiber bristle brush and gentle tapping may be employed. Avoid excessive force on the wire cloth. If clogging of the mesh occurs on these finer sieves, they should be sent to the District Materials Laboratory for cleaning.

5. Weight the fraction of material retained on each sieve and in the pan, to at least the nearest 0.5 gram and record.

6. Total the weight (mass) of the material retained on the sieves and in the pan. An accuracy check must be made comparing the weight (mass) of the material before sieving to the total of the weights (mass) after sieving. The total of the weights retained on the sieves and in the pan must be within 0.5 percent of the weight of the sample before sieving.

When the percent finer than the No. 200 sieve is <u>not</u> determined:

$$\frac{\text{Total}}{\text{Original Dry Mass}} \times 100 = \text{Tolerance (99.5 to 100.5)}$$

When the percent finer than the No. 200 sieve is determined by washing (IM 306):

$$\frac{\text{Total - Washing Loss}}{\text{Dry Mass Washed}} \times 100 = \text{Tolerance (99.5 to 100.5)}$$

If the difference exceeds the 0.5 percent tolerance, check all the calculations, the sieves for retained material and the balance for proper care. If needed, weigh each increment of material retained again. If the error cannot be found, the test is void and a new sample shall be tested.

E. Calculations

1. When alternate step (D,2 b) has been used and a conversion factor determined, multiply each of the retained weights (B) from the sieved, reduced sample by the conversion factor and record to the nearest 0.1 as the *calculated weight* (A). Add this column and determine accuracy (Step D, 6).

2. Calculate the percent retained on each sieve by dividing the total *or calculated* weight (mass) of the material retained on each sieve, and in the pan, by the Original Dry Weight (mass) of the sample. Record to the nearest 0.1 percent when determining percent retained and the consequent percent passing. When computing the percent retained of a

washed sample, divide the **sum** of the washing loss and pan weight (mass) by the Original Dry Weight (mass).

3. Total the percent retained column. The percent-retained column should equal 100 percent. Because the weight (mass) of material retained on the sieves may not equal the Original Dry Weight (mass), the total of the percentages retained may not equal 100 percent. If this occurs, the percentages retained should be altered by prorating on the larger quantities, so they do equal 100 percent.

4. The percent passing is then determined by subsequent subtraction starting with the sieve with no material retained (100 percent passing).

5. Sieve analysis results are to be reported as percent passing and recorded to two significant figures, i.e., to the nearest whole percent for percentages above 10.0 and to the nearest tenth of a percent for lower results.

Examples:	Test Result	Report
	10.5	11
	11.5	12
	11.4	11
	9.8	9.8
	0.5	0.5

6. The Fineness Modulus, when required, may now be calculated by cumulative addition of the percent retained on each of the following sieves coarser than the No. 200 sieve and dividing that sum by 100: No.100; No. 50; No. 30; No. 16; No. 8; No. 4. The Fineness Modulus is typically calculated on the fine aggregate but the 3/8 in.; 3/4 in.; 1 ½ in., and larger, may be used in the calculation (i.e. doubling the previous sieve size).

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EXAMPLE #1, COARSE AGGREGATE

Lab. No.:		
Material:		Grad. No.:
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Weight:	5793.0	Total Minus No. 4 (W1):	
Dry Weight Washed:		Reduced Minus No. 4 (W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus No. 4	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
1½"		0.0	0.0	100.0	
1"		657.0	11.3	88.7	
¾"		1068.0	18.4	70.3	
½"		1448.0	25.0 (25.1)	45.2	
⅜"		1383.0	23.9 (24.0)	21.2	
No.4		1082.0	18.7 (18.8)	2.4	
No. 8	(B)	141.0 (A)	2.4	0	
No.16	(B)	(A)			
No. 30	(B)	(A)			
No. 50	(B)	(A)			
No. 100	(B)	(A)			
No. 200	(B)	(A)			
Washing Loss					
Pan	(B)	1.5 (A)	0		
Total		5780.5	99.7 (100.0)		
Accuracy Check		99.8			

Wash Sample

Original Dry Weight:	2571.0
Dry Weight Washed:	2555.0
Washing Loss:	16.0

Sieve Size	Weight Retd.	% Retd.	% Passing	Specs.
No. 200			0.8	
Washing Loss	16.0			
Pan	4.0	0.8		

Date Reported:	Cert No.:
Tested By:	

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: _____

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EXAMPLE # 2, FINE AGGREGATE

Lab. No.:		
Material:		Grad. No.:
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Weight:	594.0	Total Minus No. 4 (W1):	
Dry Weight Washed:	591.5	Reduced Minus No. 4 (W2)	
Washing Loss:	2.5	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus No. 4	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
1½"					
1"					
¾"					
½"					
⅜"		0.0	0.0	100.0	
No.4		29.0	4.9	95.1	
No. 8	(B)	64.5 (A)	10.9	84.2	
No.16	(B)	102.0 (A)	17.2	67.0	
No. 30	(B)	181.5 (A)	30.6**(30.7)**	36.3	
No. 50	(B)	154.5 (A)	26.0**(26.1)**	10.2	
No. 100	(B)	51.0 (A)	8.6	1.6	
No. 200	(B)	6.0 (A)	1.0	0.6	
Washing Loss		2.5			
Pan	(B)	1.0 (A)	0.6		
Total		592.0	99.8**(100.0)**		
Accuracy Check		99.7			

Wash Sample

Original Dry Weight:	
Dry Weight Washed:	
Washing Loss:	

Sieve Size	Weight Retd.	% Retd.	% Passing	Specs.
No. 200				
Washing Loss				
Pan				

Date Reported:	Cert No.:
Tested By:	

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: _____

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EXAMPLE #3, COMBINED AGGREGATE,
8" AND BOX SIEVES

Lab. No.:		
Material:		Grad. No.:
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Weight:	2457.2	Total Minus No. 4 (W1):	2115.7
Dry Weight Washed:	2410.5	Reduced Minus No. 4 (W2)	537.2
Washing Loss:	46.7	Conversion Factor: W1/W2	3.9384
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus No. 4	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
1½"					
1"		0.0	0.0	100.0	
¾"		14.6	0.6	99.4	
½"		45.9	1.9	97.5	
⅜"		81.0	3.3	94.2	
No.4		154.0	6.3	87.9	
No. 8	57.6 (B)	226.9 (A)	9.2	78.7	
No.16	93.0 (B)	366.3 (A)	14.9	63.8	
No. 30	178.3 (B)	702.2 (A)	28.6 **(28.5)**	35.3	
No. 50	172.5 (B)	679.4 (A)	27.6 **(27.5)**	7.8	
No. 100	32.7 (B)	128.8 (A)	5.2	2.6	
No. 200	3.9 (B)	15.4 (A)	0.6	2.0	
Washing Loss		46.7			
Pan	0.8 (B)	3.2 (A)	2.0		
Total	538.8	2464.4	**100.2 (100.0)**		
Accuracy Check	100.3	100.2			

Wash Sample

Original Dry Weight:	
Dry Weight Washed:	
Washing Loss:	

Sieve Size	Weight Retd.	% Retd.	% Passing	Specs.
No. 200				
Washing Loss				
Pan				

Date Reported:	Cert No.:
Tested By:	

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: _____

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EXAMPLE #4, COMBINED AGGREGATE, 12" SIEVES

Lab. No.:		
Material:		Grad. No.:
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Weight:	2051.2	Total Minus No. 4 (W1):	
Dry Weight Washed:	2011.4	Reduced Minus No. 4 (W2)	
Washing Loss:	39.8	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus No. 4	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
1½"					
1"		0.0	0.0	100.0	
¾"		26.8	1.3	98.7	
½"		80.7	3.9	94.8	
⅜"		55.1	2.7	92.1	
No.4		182.7	8.9	83.2	
No. 8	(B)	229.7 (A)	11.2	72.0	
No.16	(B)	362.8 (A)	17.7	54.3	
No. 30	(B)	**610.5*** (A)	29.8	24.5	
No. 50	(B)	377.1 (A)	18.4	6.1	
No. 100	(B)	72.2 (A)	3.5	2.6	
No. 200	(B)	10.2 (A)	0.5	2.1	
Washing Loss		39.8			
Pan	(B)	3.4 (A)	2.1		
Total		2051.0	100.0		
Accuracy Check		100.0			

Wash Sample

Original Dry Weight:	
Dry Weight Washed:	
Washing Loss:	

Sieve Size	Weight Retd.	% Retd.	% Passing	Specs.
No. 200				
Washing Loss				
Pan				

Date Reported:	Cert No.:
Tested By:	

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ***The No. 30 sieve was overloaded. Sieving to completion was verified by hand sieving.**

Fineness Modulus Calculation
For Concrete Sand (Grad. #1 – Spec. 4110)
AASHTO T27

The Fineness Modulus is simply a calculation based on the 'cumulative' percent retained from the sieve analysis sample.

Starting with the largest sieve retaining any material, add the cumulative percents retained on each sieve through the No. 100 sieve and divide this total by 100. The result is reported to the nearest 0.01%.

Note: The percent retained on the No. 200 sieve is not calculated in determining the Fineness Modulus.

Example:

Sieve	Percent Retained	Cumulative Percent Retained
3/8"	0	0
No. 4	3.6	3.6
No. 8	16.9	20.5
No. 16	19.6	40.1
No. 30	23.4	63.5
No. 50	26.1	89.6
No. 100	9.5	99.1

Total Cumulative Percent Retained = 316.4

316.4 ÷ 100 = 3.16 Fineness Modulus