METHOD OF TEST FOR

SIEVE ANALYSIS OF AGGREGATES

1. SCOPE

1.1 This method covers the determination of the particle size distribution of fine and coarse aggregates by sieving.

2. REFERENCES

2.1 LS-600, Method of Dry Preparation of Aggregates for the Determination of Physical Constants

2.2 LS-601, Method of Test for Materials Finer than 75 μm Sieve in Mineral Aggregate by Washing.

2.3 LS-625, Guidelines for Sampling of Granular Materials

2.4 ASTM C 136 Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

2.5 ASTM D 75 Standard Practice for Sampling Aggregates

2.6 ASTM E 11 Standard Specification for Wire-Cloth Sieves for Testing Purposes

2.7 ASTM Manual on Testing Sieving Methods - Publication STP 447B

2.8 CAN/CGSB, 8.1, Sieves, Testing, Woven Wire, Inch Series

2.9 OPSS 1010, Ontario Provincial Standard Specification for Granular A, Granular B, Granular M, and Select Subgrade Material (SSM)

3. APPARATUS

3.1 BALANCE:

3.1.1 Fine Aggregate: A balance or scale readable to 0.1 g and accurate to within 0.1% of the test load at any point within the range of use.

3.1.2 Coarse Aggregate or a mixture of Coarse and Fine Aggregates: A balance or scale accurate to within 0.1% of the test load at any point within the range of use.

3.2 SIEVES: With square openings and of suitable sizes to furnish the information required by the specification covering the material to be tested. The sieve cloth and frame shall conform to ASTM E11 or CAN/CGSB 8.1. Half-height sieves shall not be used for sieving material coarser than 9.5 mm, unless results of sieving sufficency tests show that proper sieving action can be obtained.

3.3 OVEN: Of appropriate size capable of maintaining a uniform temperature of 110 ± 5°C.

3.4 SIEVE SHAKER: A mechanical apparatus capable of creating lateral and vertical motion of sieves accompanied by a jarring motion so as to keep aggregate particles moving continuously over the surface of the sieve.

3.5 SAMPLE SPLITTERS: For fine and coarse aggregates. (See Test Method LS-600, para. 3.6.)

4. PREPARATION OF TEST SAMPLE

4.1 Aggregate test samples for sieve analysis should be split from a larger field sample taken in accordance with LS-625, ASTM D75, or as otherwise specified. Where no sampling specification is given, the field sample should be at least four times the minimum test sample mass given in Table 1.

4.2 The sample of aggregate to be tested shall be, if necessary, thoroughly mixed and reduced by use of a sample splitter or by coning and then quartering to an amount suitable for testing. The sample to be tested shall be the end result of the reduction method used. No attempt shall be made to select samples of an exact predetermined mass.

4.3 Except for aggregate specifications included in OPSS 1010 as noted in para. 4.4 below, the minimum mass of the test sample is determined by the nominal maximum particle size as shown in Table 1.

Note 1: Nominal maximum particle size is defined as "the largest sieve in the applicable specification upon which any material is permitted to be retained".

Table 1

Nominal Maximum Size	Minimum Test Sample Mass, Kg
9.5 mm	1
13.2 mm	2
16.0 mm	3.5
19.0 mm	5
26.5 mm	10
37.5 mm	15
53.0 mm	20
63.0 mm	25
75.0 mm	45

4.4 For OPSS aggregate specifications, the minimum test sample mass for Granular A and M shall be 10 kg. For Granular B Type I, Granular B Type II and SSM, the minimum test sample mass shall be determined by the smallest sieve in Table 1 that 100 per cent of the material passes.

Note 2: Because of the wide range of possible gradations within the Granular B and SSM specifications, test sample sizes need to vary with the material, rather than the specification. Examples include: for a Granular B, Type I, with 100% passing the 53.0 mm sieve (some material retained on the 37.5 mm sieve), the minimum test sample mass is 20 kg; for an SSM with 100% passing the 13.2 mm sieve, the minimum test sample mass is 2 kg.

4.5 Fine aggregate portions (material passing 4.75 mm sieve) for testing should be reduced in size by splitting to 250 – 300 g. If the test sample is predominantly composed of fine sand, i.e., 100% passing 600 μm sieve, the sample size should be reduced to 125 - 150 g to prevent overloading on one or more sieves.

4.6 When greater precision is specified for testing fine aggregate, obtain 500 – 600 g of dried fine aggregate by use of a sample splitter or by quartering. Split this sample into two sub-samples of 250 – 300 g each. Fine sand samples should be reduced accordingly as directed in para 4.5.

5. TEST PROCEDURE

5.1 Dry the test sample to a constant mass using an oven operating at a temperature of 110 ± 5°C. If the sample contains asphalt coated particles, i.e., reclaimed asphalt pavement, the sample shall be dried to constant mass in an oven set at maximum 40°C or by air drying. Allow the sample to cool to room temperature before proceeding.

Note 3: For control purposes, particularly where rapid results are desired, it is generally not necessary to dry coarse aggregate for the sieve analysis test. The results are little affected by the moisture content unless: (a) the nominal maximum size is smaller than 13.2 mm; (b) the coarse aggregate contains appreciable material finer than 4.75 mm, or; (c) the coarse aggregate is highly absorptive, e.g, light-weight aggregate.

Note 4: Samples may be dried at higher temperatures associated with the use of hot plates without affecting results provided that steam is allowed to escape freely without generating pressures sufficient to fracture the particles, and that temperatures are not so great as to cause chemical alteration or physical breakdown of the aggregate.

5.2 Coarse Sieving Operation: Weigh and record the total mass of the dried test sample. Place the test sample in the uppermost sieve of a progressive series of sieves selected according to the specification requirements or material characteristics and vibrate by means of a lateral and vertical motion of the sieve accompanied by a jarring motion so as to keep the sample moving continuously

over the surface of the sieves. Continue the sieving operation by hand or by sieve shaker for a sufficient period, established by trial to meet the criterion for adequacy of sieving requirement specified in para 5.2.1. In no case should the particles be turned or manipulated through the sieve by hand.

Note 5: Use of a sieve shaker in excess of about 15 minutes to achieve adequate sieving may result in degradation of the sample. If the sieving sufficiency requirement cannot be achieved within 15 minutes of operation, the sieve shaker may have to be repaired or replaced. After separating the sample on each sieve by the sieve shaker, the sieving operation should be continued by hand to achieve the sufficiency requirement.

5.2.1 Continue sieving for a sufficient period and in such manner that, after completion, not more than 1.0 % by mass of the residue on any individual sieve will pass that sieve during 1 minute of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turn the sieve about one sixth of a revolution at intervals of about 25 strokes. In determining sufficiency of sieving for sizes larger than the 4.75 mm sieve, limit the material on the sieve to a single layer of particles. If the size of the mounted testing sieves makes the described sieving motion impractical, use 203 mm diameter sieves to verify the sufficiency of sieving.

Note 6: Individual coarse aggregate sieves meeting the requirements of E 11 may have sufficiently wide variations in opening size that difficulties may be experienced in measuring sieving sufficiency. It is preferable to determine the sieving sufficiency using the sieve the sample was first sieved on. If this is impractical, check that the sieve intended for determination of sieving sufficiency not only meets the requirements of E 11 but also has an opening size the same as, or smaller than that of the sieve on which it is desired to determine the sufficiency of sieving.

5.3 To prevent overloading of individual sieves, additional sieves to those required by the specification should be inserted so as to distribute the fractions more evenly. Material retained on these sieves shall be added in cumulative weighing to the next smallest specification sieve

Note 7: To determine the maximum amount of material allowed on a given sieve, refer to the information given in ASTM C136 or the tables published in ASTM STP 447B - ASTM Manual on Test Sieving Methods.

5.4 On completion of the coarse sieving operation, separate the sieves and weigh and record the individual mass of the fraction retained on each sieve.

5.5 Weigh and record the mass of material that passes the 4.75 mm sieve (pan portion). Check the initial dry mass of the sample against the mass of the sample after sieving. This mass is obtained by adding the mass of material passing the 4.75 mm sieve in the pan to the cumulative mass retained on the 4.75 mm sieve. The difference between the initial mass and the mass after sieving shall be no more than 0.30%, otherwise, a re-test is required.

Note 8: There is a probability of particle loss during sieving, causing a testing error. This loss is usually in the form of fines. However, occasionally, it could be in the form of coarse particles.

5.6 Reduce the pan portion according to para. 4.5 or para. 4.6 to produce the fine aggregate test portion. Where the fine aggregate test portion is prepared according to para. 4.6, perform the test on each sub-sample.

5.7 Fine Sieving Operations: Weigh and record the total mass of the prepared test sample. Wash the fine aggregate test portion according to the procedure given in LS-601. Dry the material retained on the 75 μm sieve to constant mass as described in para. 5.1. Weigh and record the total mass of the dried test sample.

5.8 Sieve the remaining test portion through the required nest of fine aggregate sieves in the manner described in para. 5.2.

5.9 On completion of the sieving operation, separate the sieves and weigh and record, cumulatively, the mass of the fraction retained on each sieve. Record the mass of any portion which passes the smallest sieve size (pan portion).

5.10 For test portions consisting of two sub-samples, weigh and record the cumulative mass of the fraction retained on each sieve (and pan portion) for each sub-sample separately. Provided that the difference on any sieve between the two individual sub-samples is no greater than 5%, a combined grading is calculated from the sum of the cumulative masses for each sieve (and pan portion), otherwise a re-test is required.

6. CALCULATIONS

6.1 All determinations shall be made to the nearest 0.1% of the mass of the sample.

6.2 Calculate the percentage of coarse and fine aggregates in the sample as follows:

$$\text{Per cent coarse aggregate, } D = \frac{B}{A} \times 100$$

$$\text{Per cent fine aggregate, } E = \frac{C}{A} \times 100$$

6.3 Calculate the cumulative percentages on each sieve for the coarse aggregate portion and the fine aggregate portion of the test sample.

6.3.1 Coarse Aggregate Portion:

Per cent retained $= \frac{X}{B} \times 100$

Per cent passing $= \frac{B-X}{B} \times 100$

6.3.2 Fine Aggregate Portion:

Per cent retained $= \frac{Y}{F} \times 100$

Per cent passing $= \frac{F-Y}{F} \times 100$

6.4 Calculations to obtain the complete gradation of the sample.

6.4.1 To determine the percentage retained on each sieve:

Per cent retained coarse aggregate sieves $= \frac{X}{A} \times 100$

Per cent retained fine aggregate sieves $= \frac{Y}{F} \times E + \%\ Ret.\ 4.75$

6.4.2 To determine the percentage passing on each sieve:

Per cent passing coarse aggregate sieves $= \frac{A-X}{A} \times 100$

Per cent passing fine aggregate sieves $= \frac{F-Y}{F} \times E$

where: A = Mass of total sample

B = Mass retained on the 4.75 mm sieve

C = Mass passing the 4.75 mm sieve, $C = A\text{-}B$

D = Per cent coarse aggregate

E = Per cent fine aggregate

F = Mass of fine aggregate test portion before washing

X = Cumulative mass retained on each sieve, coarse portion

Y = Cumulative mass retained on each sieve, fine portion

6.5 Calculate the fineness modulus, when required, by adding the total percentages of material in the sample that is coarser than each of the following sieves (cumulative percentages retained), and dividing the sum by 100 : 150 µm, 300 µm, 600 µm, 1.18 mm, 2.36 mm, 4.75 mm, 9.5 mm, 19.0 mm, 37.5 mm, and larger, increasing in the ratio of 2:1.

7. REPORTING RESULTS

7.1 The report shall include the following, as necessary:

7.1.1 Total percentages of coarse and fine aggregates.

7.1.2 Total percentage of material retained on or passing each coarse aggregate sieve based on the total mass of the oven-dry coarse aggregate portion.

7.1.3 Total percentage of material retained on or passing each fine aggregate sieve based on the total mass of the oven-dry test sample of the fine aggregate before washing.

7.1.4 Total percentage of material retained on or passing each sieve based on the total mass of the oven-dry total sample.

7.1.5 When two sub-samples of fine aggregate are tested, the mean of the results shall be reported as the final result.

7.1.6 Report the difference between the initial dry mass of the sample and the sum of the individual masses retained on each sieve as a percentage of the initial dry mass.

8. GENERAL NOTES

8.1 Figure 1 shows a laboratory worksheet that may be used to record test data and calculate results.

8.2 Check all sieves regularly to ensure that the mesh is not blinded, and is free from defects and distortion. Fine mesh sieves, if blinded by sand particles, can be cleaned using an ultrasonic bath. If this equipment is not available, a soft brass brush may be used for cleaning sieves coarser than the 150 µm and a nylon brush for finer sieves. This is done by brushing the underside of the wire cloth with a circular motion, taking care not to use too much pressure. The frame of the sieve may be gently tapped with the wooden handle of the brush. Under no circumstances should embedded particles be forced out of the openings with a pick or needle.

8.3 Small holes or breaks in fine mesh sieves may be repaired with an appropriate epoxy.

8.4 When emptying each of the sand sieves, brush the bottom of the inverted sieve gently, but firmly with the proper sieve brush, using a circular motion. This ensures that all sand particles are included with the sample, and that the sieve is kept clean, and its efficiency maintained.

8.5 In the case of Granular B and SSM (OPSS 1010). Particles larger than 26.5 mm may be removed, and hand sieved through the larger specified sieves. It is permissible to determine the percentage passing the 75 mm and larger sieves without drying the test sample. Remove any adhered fines from these larger particles, and return them to the test sample. The gradation of the passing 75 mm portion must be carried out after drying.

8.6 Unless a sieve shaker is used, hand sieve particles larger than 75 mm by determining the smallest sieve opening through which each particle will pass. Start the test on the smallest sieve to be used. Rotate the particles, if necessary, in order to determine whether they will pass through a particular opening; however, do not force particles to pass through an opening.

Figure 1. Gradation Computation Worksheet

Lab №:	Date:
Sample Description:	Specification:

Note: All masses are for dried aggregate.

Total Sample Mass *[A]* : g	% Coarse Aggregate *[D]*: %	% Fine Aggregate *[E]* : %

Coarse Aggregate

Sieve	Individual Mass Retained (g)	Cumulative Mass Retained (g) *[X]*	(Coarse Aggregate Portion Only)		% Passing (Total Sample)
			% Retained	% Passing	
106 mm					
75 mm					
63 mm					
53 mm					
37.5 mm					
26.5 mm					
22.4 mm					
19.0 mm					
16.0 mm					
13.2 mm					
9.5 mm					
6.7 mm					
4.75 mm		[B]			
Pan		Pan + [B]	Mass passing 4.75 mm (g) *[C = A – B]:*		

Fine Aggregate

Sample mass before washing (g): *[F]*		Mass passing 75μm sieve by washing (g):	
Sample mass after washing (g)		Mass passing 75μm sieve by sieving (g):	

Sieve	Cumulative Mass Retained (g) *[Y]*	(Fine Aggregate Portion Only)		% Passing (Total Sample)
		% Retained	% Passing	
4.75 mm				
2.36 mm				
1.18 mm				
600 μm				
300 μm				
150 μm				
75 μm				
Pan		Total mass passing 75 μm sieve (g):		

Note: Space provided for sub-samples

Technician: _____