Tex-200-F, Sieve Analysis of Fine and Coarse Aggregates

Overview

Effective date: August 1999 to October 2004.

Use this method to determine the particle size distribution of aggregate samples, using sieves with square openings.

Apparatus

The following apparatus is required:

- sample-splitter, quartering machine, quartering cloth, or shovel and a smooth surface
- set of standard U. S. sieves which meets the requirements of Test Method "Tex-907-K, Verifying the Accuracy of Wire Cloth Sieves"
- mechanical sieve shaker
- balance readable to 0.1 g with an accuracy to 0.5 g
- drying oven capable of attaining a minimum temperature of 93 °C (200 °F) or more, or suitable microwave oven
- various pans
- scoop
- brass wire brush
- bristle brush.

Preparing Material Sample

Use this sequence for proper sample preparation.

Preparing Material Sample	
Step	**Action**
1	Place a representative sample of processed aggregate in oven and dry to constant weight at a minimum temperature of 93 °C (200 °F). (Aggregates may be dried in a pan over an open flame with frequent stirring). ♦ For field testing of Portland cement concrete aggregate, it is not necessary to completely dry, but merely to surface dry, the coarse aggregate. ♦ Rock asphalt samples must be dried at 60 ± 3 °C (140 ± 5 °F). • Adjust oven temperatures so that native bitumen is not fluxed from aggregate. • For control testing, do not dry rock asphalt aggregate.
2	Quarter dry, processed aggregate samples using one of the following methods: ♦ sample splitter

Preparing Material Sample	
Step	**Action**
	♦ quartering cloth ♦ quartering machine ♦ mix on a smooth clean surface with a large flat scoop or shovel until blended, and quarter with a straight edge.
3	For fine materials (major portion passing 2.00 mm [No. 10] sieve) thoroughly blend sample and take small portions from several places in the pan to make up the test sample.
4	For control testing, create the test sample for all size aggregates by blending small portions taken from several places in the pan.
5	For plant control testing, weigh aggregates in the same proportions as used in the bituminous mixture being produced, then combine and sieve to yield the combined aggregate gradation.
6	Reverse steps 1 through 5 when this proves more practical.

This table provides comparative information for the reduction of a test sample from a given quantity of material.

Minimum Sample Size	
Nominal Maximum size	**Minimum size of Sample**
4.75 mm (No. 4)	500 g (1 lb.)
9.5 mm (3/8 in.)	1000 g (2 lbs.)
12.5 mm (1/2 in.)	1500 g (3 lbs.)
19.0 mm (3/4 in.)	2000 g (4 lbs.)
25.0 mm (1 in.)	3000 g (6 lbs.)
37.5 mm (1-1/2 in.)	4000 g (8 lbs.)

Part I, Dry Sieve Analysis (Based on Weight)

This part is used to determine a weight-based, dry-sieve analysis for a aggregate sample.

Procedure

The following table gives the precise sequence for performing weight-based, dry-sieve analysis.

Weight Based, Dry Sieve Analysis	
Step	**Action**
1	Accurately weigh the total sample to the nearest 0.1 g.
2	Place the set of sieves, with the largest opening on top, into a pan and pour the aggregate onto the top sieve.
3	Separate the material into a series of particle sizes using the sieves necessary to determine compliance with specifications for the material.
4	♦ Hand sieve by lateral and vertical motion of the sieves with a "jarring" action that keeps the material moving continuously over the surface of the sieves. ♦ Continue hand sieving until, by visual observation, no material passes through the sieve.

Weight Based, Dry Sieve Analysis	
Step	**Action**
5	♦ When mechanical sieving, establish a shaking time that will assure proper sieving of the material without degradation. ♦ Assure thoroughness of sieving as described in Step 4.
6	Brush any particles clinging to each sieve into the next lower sieve with a bristle brush, taking care to lose none of the material.
7	Determine the weights to the nearest 0.1 g of aggregate retained in each sieve in succession, and record these weights with the respective passing and retained sieve sizes.
8	Record the weight of material passing the smallest size sieve used.
9	At the completion of this analysis all material, with the exception of that portion passing the smallest opening sieve, will be on the balance pan.

NOTE: If the sieve analysis of a material is desired on a 'total retained' basis, choose one of the following two methods:

- Make an individual retained sieve analysis, then convert, mathematically, to a 'total retained' analysis. Cumulatively add the weights of all material retained on sieves larger than the particular sieve-size under consideration, to the material retained on that sieve.
- Make the original sieve analysis a 'total retained' analysis by weighing the material cumulatively, placing the material retained on one sieve directly on top of the previously weighed material from the larger size sieve, already on the balance. Note the difference.

Part II, Washed Sieve Analysis (When Specified Based on Weight)

This part is used to determine weight from materials requiring a washed sieve analysis.

Preparing Sample

Follow the steps indicated under 'Preparing Material Sample.'

Procedure

This process gives precise data based on weight from materials requiring a washed sieve analysis.

Weight Based, Washed Sieve Analysis	
Step	**Action**
1	Weigh the total dry sample to the nearest 0.1 g and record the weight as W_T under 'Calculations.'
2	Place the sample in a wash pan and inundate with clean potable water.
3	Gently mix the water into the sample with the hands to break up clay lumps or "sandballs" and

Weight Based, Washed Sieve Analysis	
Step	**Action**
	loosen the coating of fines on the coarse aggregate.
4	Rinse any sample particles clinging to the hands back into the wash pan.
5	♦ Soak sample a minimum of 10 minutes. ♦ After soaking, remix the sample with the hands as noted in Step 3.
6	Place a set of sieves, a 2.00 mm (No. 10) and a 75 µm (No. 200), in a pan or over an open sink.
7	Flush the wetted sample over the set in small batches to prevent overloading (clogging) and damage to the 75 µm (No. 200) sieve.
8	When the material retained on the 2.00 mm (No. 10) sieve is adequately washed, remove it and place in a clean drying pan.
9	Continue to wash the material retained on the 75 µm (No. 200) sieve until the wash water runs clean. Then place it in the drying pan with the previously cleaned 2.00 mm (No. 10) material.
10	♦ Continue the process until entire sample has been washed over the set of sieves. ♦ After the final wash, the sieves must be rinsed over the drying pan.
11	Decant excess water from the drying pan and dry washed sample to a constant weight.
12	Weigh the dried washed sample and record the weight as W_w under 'Calculations.'
13	Determine the sieve analysis of the dried washed sample as described in 'Part I, Dry Sieve Analysis (Based on Weight).'
14	Report the percentages to the nearest 0.1% for each size of aggregate retained on each sieve as set forth by specification requirements.

NOTE: Take care to prevent loss of material during the sieving operation. However, if there is a small discrepancy (less than 0.2%) between the original dry weight of sample and the sum of the weights of the various parts, assume the small amount as particles passing the smallest size sieve and use the original weight. If the discrepancy is large (greater than 0.2%), check the weights of the various sizes or rerun the analysis with a new sample to correct the error.

Calculations

Use the following calculations to determine sieve analysis:

♦ Dry Sieve Analysis:

$$W = \left(\frac{X_1}{W_T} \right) \times 100$$

Calculate the percentages by weight retained between consecutive sieves.

Where:

- W = Percentage by weight retained between consecutive sieves
- X_1 = Weight of oven dry aggregate passing one sieve size and retained on the next smaller sieve size or pan

- W_T = Total weight of original dry sample which equals the sum ($X_1 + X_2$, etc.) of all the weights of aggregate retained on sieve sizes and includes the portion which passes the smallest size sieve used.

♦ Washed Sieve Analysis

The calculations are the same as for dry sieve analysis except the percent finer than the 75 µm (No. 200) is:

$$Passing\ 75\ \mu m\ (No.200) = \frac{(W_T - W_W)}{W_T} \times 100$$

Where:

- W_W = Total weight of the washed dry sample
- W_T = Total weight of the original dry sample.

NOTE: A small amount of additional passing 75 µm (No. 200) material is usually found during the sieve analysis performed after washing. Add this to the pass 75 µm (No. 200) percentage calculated above.

Part III, Volumetric Sieve Analysis

This part is used to determine a volume-based, sieve analysis for an aggregate sample.

Report Forms

The following worksheet and Excel program may be used with this test method.

♦ Volumetric Sieve Analysis Worksheet (Volume)

♦ QC/QA test data worksheets (used in conjunction with Hot Mix specification) (Newqcqa1). (Refer to the 'Help' tab for detailed instructions on how to use the program.)

Apparatus

The following apparatus is required:

♦ sample splitter, quartering cloth, shovel, or quartering machine

♦ set of standard U. S. Sieves which meets the requirements of Test Method "Tex-907-K, Verifying the Accuracy of Wire Cloth Sieves"

♦ mechanical sieve shaker

♦ drying oven capable of attaining a temperature of 93 °C (200 °F) or more, or suitable microwave oven

- glass graduates, 2000 mL (68 fl. oz.), with 20 mL (0.68 fl. oz.) graduations, and 250 mL (8.45 fl. oz.), with 2 mL (0.07 fl. oz.) graduations
- a wide-mouth funnel
- water or other appropriate liquids
- round pans with diameter to fit sieves
- scoop
- brass wire brush
- bristle brush.

Preparing Sample

Follow the steps indicated under 'Preparing Material Sample.'

Procedure

This procedure produces precise data for materials requiring a volumetric sieve analysis.

Volumetric Sieve Analysis	
Step	**Action**
1	Place the set of sieves, with the largest opening on top, into a pan and pour the aggregate onto the top sieve.
2	Perform a sieve analysis on the aggregate sample by separating the material into a series of particle sizes using sieves necessary to determine compliance with specifications for the material.
3	Hand sieve with a lateral and vertical motion of the sieves, and a 'jarring' action that keeps the material moving continuously over the surface of the sieves.
4	Continue hand sieving until, by visual observation, no material passes through the sieve.
5	When mechanical sieving, establish a shaking time that will assure proper sieving of the material without degradation.
6	Check the thoroughness of sieving as described in Step 4.
7	Fill the glass graduate with water or other appropriate liquid, enough to cover entire sample.
8	Make an initial reading of the liquid level and record on the 'Volumetric Sieve Analysis Worksheet.' An example of a completed worksheet is shown in the 'Example of Volumetric Sieve Analysis Worksheet' (ExVolume).
9	Place the aggregate retained on the largest sieve size into the graduate. NOTE: This step may be reversed if analysis involves certain absorptive aggregates.
10	Read the liquid level within 20 seconds and record on the worksheet.
11	♦ Eliminate entrapped air from the graduate, particularly after adding the fine aggregate. ♦ This can be done by gently rolling the graduate or stirring the aggregate prior to taking a reading.
12	♦ Prior to adding each aggregate size, re-check the liquid level reading. ♦ If it differs from the liquid level recorded for the previous aggregate size, use the new reading as the initial liquid level prior to adding the next aggregate size.

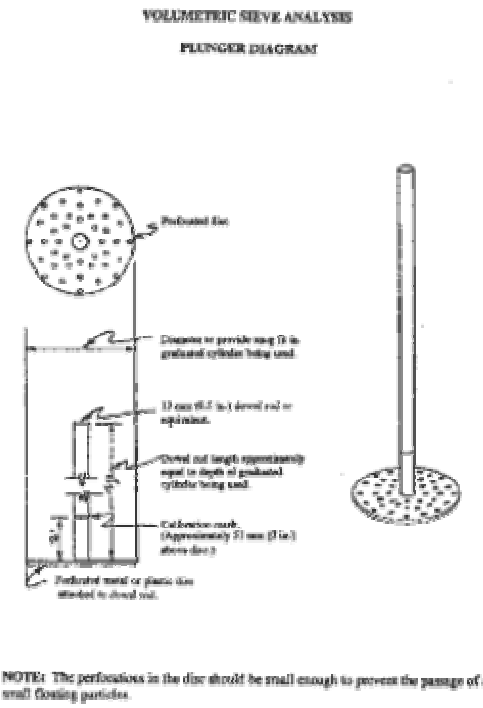
Volumetric Sieve Analysis	
Step	**Action**
	♦ The object of the procedure is to measure the volume change of the liquid for each size aggregate.
13	♦ Determine the volume of each size of aggregate by subtracting the liquid reading prior to the addition of each size of aggregate from the liquid reading after the addition of each size of aggregate, and enter the result in column 3 of the worksheet. ♦ The difference in initial and final readings will be the total volume of the aggregate.
14	♦ Divide the volume of each aggregate fraction by the total aggregate volume to determine the percent retained on each sieve and enter in Column 4. ♦ This percent will be an expression of each size as a portion of the total aggregate.
15	Total percent retained and percent passing may then be calculated from these values.

Procedure for the Volumetric Sieve Analysis of Lightweight Aggregate (with Specific Gravities such that Some of the Particles Float)

This process gives precise data relating to aggregate compounds in which some percentage of the total volume includes material that is lighter than water or the usual suspension medium.

Apparatus

Same apparatus as listed for 'Part III, Volumetric Sieve Analysis' with the addition of a 'plunger' (see 'Volumetric Sieve Analysis – Plunger Diagram').



NOTE: The perforations in the disc should be small enough to prevent the passage of any small floating particles.

Figure -1. Volumetric Sieve Analysis-Plunger – Diagram.

Preparing Sample

Follow the steps indicated under 'Preparing Material Sample.'

Procedure

The following steps detail the 'Floating Particle Volumetric Sieve Analysis' procedure.

'Floating Particle' Volumetric Sieve Analysis	
Step	**Action**
1	Same as Step 1 for the previous standard 'Volumetric Sieve Analysis.'
2	Fill the graduate with water or other appropriate liquid, enough to cover entire sample.
3	Cover the entire sample of aggregate, plus at least an additional 51 mm (2 in.), which must be more than the distance from the perforated disc to the calibration mark on the plunger.
4	Slowly lower the plunger into the liquid, permitting air and liquid to percolate through the holes in the perforated disc, until the liquid level reaches the calibration mark on the plunger handle.
5	Trap all material beneath the plunger disc, eliminating any air prior to making readings.
6	♦ With the liquid level on the calibration mark of the plunger handle, read and record the liquid level from the scale on the graduated cylinder. ♦ This is the 'zero' or 'initial' reading.
7	Remove the plunger and place the aggregate retained on the largest sieve into the graduate. (Begin with the finest size when preparing more absorptive materials.)
8	Slowly lower the plunger into the solvent until the level rises to the calibration mark on the plunger handle.
9	Read and record the liquid level from the calibrated scale on the graduated cylinder within 20 seconds of the aggregate being added.
10	Check the liquid level when ready to add the next aggregate size.
11	♦ Record this as the initial reading and pour in the next sieve-size material. ♦ Make this reading within 20 seconds, in the same manner described above.
12	♦ Continue this procedure for each sieve size material. ♦ Take care when lowering the plunger into the liquid so that floating particles do not slip by the edge of the plunger disc.
13	Make calculations in the same manner described previously under standard 'Volumetric Sieve Analysis' procedure.

NOTE: Improve the precision of this procedure by using two graduates:

- A 2000 mL (60 fl. oz.) graduate with 20 mL (0.6 fl. oz.) graduations; and
- a 250 mL (7.5 fl. oz.) graduate with 2 mL (0.06 fl. oz.) graduations.
- The volumes of the larger amounts of aggregate of any given size can be measured in the 2000 mL (60 fl. oz.) graduate.
- The volumes of small amounts of aggregate of any given size can be measured with a greater precision in the 250 mL (7.5 fl. oz.) graduate.
- All that is necessary is to follow the given procedure, reading the liquid level before and after each size aggregate is put into a graduate. Subtracting the 'before' reading from the 'after' reading will yield the volume of the sample put into the graduate.