

State of Nevada  
Department of Transportation  
Materials Division

**METHOD OF TEST FOR WASHING AND SIEVE ANALYSIS OF COARSE AND FINE AGGREGATE**

**SCOPE**

This test method covers the procedure used to accurately determine the particle size distribution of coarse and fine aggregate samples; including Base Aggregates, Aggregates for Bituminous Courses, Concrete Aggregates, and other selected materials. As used herein, the term "Coarse Aggregate" refers to material retained on the 4.75 mm (No. 4) sieve, and the term "Fine Aggregate" refers to material passing the 4.75 mm (No. 4) sieve.

**APPARATUS**

1. Balance, with a capacity of 12,000 g and sensitive to 0.1 g.
2. Sieves, testing sieves shall be of the woven-wire type with square openings, and shall be certified annually (Figure 1).
3. Mechanical Sieve shaker (Figure 2, 3 and 4), any mechanical sieve shaker may be used which produces the thoroughness of Hand Sieving, "SIEVE TEST PROCEDURE".
4. Oven, capable of maintaining a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).
5. Washing vessel, pans or containers of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any material.
6. Miscellaneous Tools, hand tools such as: Spoon, Stiff Bristle Brush, Trowel, Steel Wire Brush, Brass Wire Brush, Paint Brush (Figure 1).

**SAMPLE PREPARATION**

1. Obtain a representative sample per Test Method Nev. T200. Reduce the sample per Test Method Nev. T203. Weigh and record the sample as "Wet Weight" to the nearest 1 g.

Samples shall weigh, after drying, not less than the amount indicated in Table 1. The selection of samples of an exact predetermined weight shall not be attempted.

2. Dry the sample per Test Method Nev. T112.
3. Weigh and record the dried and cooled sample as "Dry Weight" to the nearest 1 g.

**TABLE 1**

Test Sample Size

Aggregate Size <sup>1</sup>	Minimum Dry Sample Weight <sup>2</sup>
100 mm (4 in.)	At the discretion of the Engineer
90 mm (3 1/2 in.)	30,000 g
75 mm (3 in.)	25,000 g
63 mm (2 1/2 in.)	20,000 g
50 mm (2 in.)	15,000 g
37.5 mm (1 1/2 in.)	9,000 g
25 mm (1 in.)	3,000 g
19 mm (3/4 in.)	2,500 g
12.5 mm (1/2 in.)	1,500 g
9.5 mm (3/8 in.)	1,000 g
4.75 mm (No. 4)	500 g
2.36 mm (No. 8)	250 g

<sup>1</sup>For purposes of this test method, "Aggregate Size" is defined to be the smallest sieve which will pass at least 90 percent of the sample, also referred to as the Nominal Maximum Size.

<sup>2</sup>Samples weighing 3,000 g or more shall be sieved through 40.640 x 10<sup>-2</sup> m (16 in.) or larger diameter sieves, to reduce the sample aggregate down to a size that can be tested with 304.8 mm (12 in.) or 203.2 mm (8 in.) diameter sieves. If this procedure is used, a combined sieve determination is made refer to "CALCULATIONS". The testing sieve frames may be square, round or rectangular, provided that not less than 1290.2 x 10<sup>-2</sup> m (508 in.) of sieving area is exposed.

**WASH PROCEDURE**

1. Perform the wash procedure on all samples except as follows:

Samples containing large portions of plus 25 mm (1 in.) aggregate may first be dry sieved over the required specification coarse aggregate sieve sizes down to the 25 mm (1 in.) or 19 mm (3/4 in.) sieve. The portion passing the 25 mm (1 in.) or 19 mm (3/4 in.) sieve is then split down to a representative sample of the required size (Table 1) and the wash test performed on this smaller sample.

In case of dispute, the wash test shall be performed on the entire sample prior to making the sieve test.

2. Place the dried and weighed sample into a washing vessel or vessels and cover with water. If desired, a small amount of wetting agent (liquid soap) may be added to assure a thorough separation of the finer aggregate particles from the coarser particles.

3. Agitate the contents of the washing vessel vigorously and immediately pour the wash water over a nest of two sieves consisting of a 2.36 mm (No. 8) or 1.18 mm (No. 16) sieve on top and a 75  $\mu\text{m}$  (No. 200) sieve.

The agitation should be sufficiently vigorous enough to result in the complete separation from the coarse particles of all finer particles than the 75  $\mu\text{m}$  (No. 200) sieve and bring the fine material into suspension, so that it will be removed by decantation of the wash water. Care shall be taken to avoid, as much as possible, the decantation of the coarse particles of the sample.

In order to remove all coatings and disperse all lumps, it may sometimes be necessary to scrub individual aggregate particles with a stiff fiber brush, and to rub soil lumps against sides and bottom of the washing vessel. The use of a spoon, rod or hand may be needed to stir and agitate the aggregate in the washing vessel.

Repeat the agitation/decantation procedure until the wash water is clear.

4. Wash the fine material retained on the 75  $\mu\text{m}$  (No. 200) sieve with a gentle stream of running water. Check the cleanness of the soil retained on the 75  $\mu\text{m}$  (No. 200) sieve by rubbing small amounts between the thumb and fingers. **DO NOT RUB THE SOIL OVER THE SURFACE OF THE 75  $\mu\text{m}$  (No. 200) SIEVE.** Continue washing until the water running through the 75  $\mu\text{m}$  (No. 200) sieve is clear.
4. Rinse the material retained on the nested sieves, plus the material remaining in the washing vessel, into a wide shallow pan. Decant the excess surface water back over the 75  $\mu\text{m}$  (No. 200) sieve, taking care not to pour any portion of the sample out of the pan. If material is decanted onto the 75  $\mu\text{m}$  (No. 200) sieve, repeat procedure. Dry the washed sample per Test Method Nev. T112.
6. Weigh and record the dried and cooled sample as "Wash Weight" to the nearest 1 g.

## SIEVE PROCEDURE

1. Obtain the proper sieve specifications from the Standard Specifications for Road and Bridge Construction and/or Special Provisions for each type of material to be tested. Place the sieves into the proper descending order in a complete sieve stack.
  - a. Visually examine sieves each day for broken wires, stretched screens and/or broken solder around the perimeters. Remove and replace any damaged sieves, send the damaged sieves to Headquarters Construction - Quality Assurance Section for disposal.
  - b. Never sieve hot samples, hot aggregate will distort the fine meshes of the 150  $\mu\text{m}$  (No. 100) and 75  $\mu\text{m}$  (No. 200) sieves.
  - c. Always insert a full sieve deck into the shaker so that the shaker does not get damaged.
  - d. Take care to avoid loss of material throughout the entire testing process.

- e. Never allow any sieve to come into direct contact with a hot drying device.
2. When sieving coarse aggregate without prior washing, brush the larger aggregate particles with a stiff bristle brush to remove coatings, and break up soil lumps, taking care not to lose the fine particles thus obtained.
3. Sieving No. 4 coarse concrete aggregate: Aggregates shall be reduced per Test Method Nev. T203, dried per Test Method Nev. T112 and then sieved through the required specification sieves utilizing a shaker with large rectangular sieve trays (large test master shaker). Material remaining in the pan shall be fine-graded with the conventional 304.8 mm (12 in.) or 203.2 mm (8 in.) sieves to determine the “% Pass” the 75  $\mu\text{m}$  (No. 200) sieve.
4. Place the cool dried weighed sample from the wash procedure, or the cool dried weighed sample of material without the washing into the appropriate sieve stack and place the sieve stacker into the sieve shaker.
5. Use one of the following methods for shaking:
  - a. Hand Sieving – Perform the hand method of sieving by means of a lateral and vertical shaking of the sieve, accompanied by a jarring action on a counter top to keep the sample moving continuously over the surface of the sieve. In no case shall fragments in the sample be forced through the sieve by your hand or fingers. Sieving shall be continued until not more than one percent by weight of the residue passes any sieve during the one minute of continuous shaking. For coarse aggregate, the thoroughness of sieving shall be determined with a single layer of material on the sieve.
  - b. Mechanical Sieving – Perform mechanical sieving on a mechanical shaker which gives the same type of shaking action described in (a.) "Hand Sieving". Shaking time is five minutes for coarse aggregate samples (in the large test master shaker) and ten minutes for combined (coarse and fine) or fine aggregate samples (in the Mary–Ann rotary shakers, the 12” sieve shaker or the 8” sieve shaker). Sieving time and thoroughness of mechanical sieving shall be verified periodically by the above described hand sieving method.
6. In no case shall the sieves be overloaded, see Table 2 to verify the maximum allowable quantity of material retained on each individual sieve. If the amount of material retained on any one sieve needs to be reduced, insert an additional sieve also known as a “buffer sieve” with openings slightly larger than the openings on the overloaded sieve, or split the entire sample into smaller portions, prior to sieving, and then combine respective fractions after sieving.

Table 2

Maximum Allowable Quantity of Material Retained on a Sieve, g

Sieve Opening Size	Nominal Dimensions of Sieve	
	203.2 mm (8 in.)	304.8 mm (12 in.)
75 mm (3 in.)	-	12600
63 mm (2 1/2 in.)	-	10600
50 mm (2 in.)	3600	8400
37.5 mm (1 1/2 in.)	2700	6300
25.0 (1 in.)	1800	4200
19.0 mm (3/4 in.)	1400	3200
12.5 mm (1/2 in.)	890	2100
9.5 mm (3/8 in.)	670	1600
4.75 mm (No. 4)	330	800
All sieves with openings smaller than 4.75 (No. 4)	200	450

7. Proper care of the sieves is necessary for accurate sieve results. Use the following procedure in removing particles stuck in each one of the sieves:
  - a. 2.36 mm (No. 8) sieves and larger: Clean by rounded piece of wood, such as a brush handle or a pointed trowel.
  - b. 2.00mm (No. 10) and 1.18 mm (No. 16) sieves: Clean by brushing with a steel wire brush.
  - c. 600  $\mu\text{m}$  (No. 30), 425  $\mu\text{m}$  (No. 40), and 300  $\mu\text{m}$  (No. 50) sieves: Clean by brushing with a stiff short bristle brass wire brush.
  - d. 150  $\mu\text{m}$  (No. 100) and 75  $\mu\text{m}$  (No. 200) sieves: Clean only by brushing with a small paint brush. These sieves are easily damaged.

Do not distort any sieve openings with any of the tools mentioned above.

8. After sieving, weigh the material (on the same balance used to weigh the total sample prior to sieving), retained on each sieve and the pan. Record these weights to the nearest 1g as "Weight Ret." on the worksheet. The weight of minus 75  $\mu\text{m}$  (No. 200) sieve material "Wash" removed from the sample by washing is found by subtracting the "Wash Weight" from the "Dry Weight" of the test sample prior to washing.

The sum of these weights must check with the dry weight within 3 g for combined (coarse and fine) and fine aggregate samples and within 10 g for coarse aggregate samples. If the sum of these weights are within the above stated tolerances, but do not check with the dry weight of the sample before

washing, adjust the sieve with the greatest weight retained to match the samples dry weight.

If the sum of these weights is outside the above stated tolerances, verification of weights shall be completed by re-weighing sample to verify dry weight after wash and/or by re-sieving the sample to verify weights retained on each sieve. If verification confirms an error outside of tolerances, then the test is considered invalid, and another test shall be performed.

“Weight Ret.” in the pan after sieving should not exceed 1% of the samples original dry weight. If the “Weight Ret.” in the pan exceeds 1% of the samples dry weight, it indicates that the sample was not sufficiently washed and is considered invalid and another test shall be ran. All future tests shall be washed more thoroughly.

## CALCULATIONS

1. Convert the “Weight Ret.” on the various sieves, pan and wash to “% Ret.” using the following formula:

$$P_r = \frac{W_r}{W_t} \times 100$$

Where:

$P_r$  = % Ret.; on each sieve, pan and wash.

$W_r$  = Weight Ret.; on each sieve, pan and wash.

$W_t$  = Total weight of dry sample prior to washing and sieving.

Make all calculations to the nearest 0.1 % and record these percentages as "% Ret." on the worksheet. The sum of the percentages retained on all sieves, pan and wash must equal 100.0%. If the sum does not equal 100.0%, then adjust the greatest percentage retained to equal 100.0%. In cases where the sum error is greater than 0.3%, re-check calculations. If the sum error is still outside the 0.3%, then the test is considered invalid, and another test shall be performed.

2. Calculate the “% Pass” for each sieve by one of the following methods:

Method 1: Place the “% Ret.” for the wash in the "% Pass" column for the pan. Add the “% Pass” the pan to the “% Ret.) on the 75 µm (No. 200) sieve to give the % Pass” on the next larger sieve. Continue in this manner for each sieve until the largest size is reached, at which time the “% Pass” should be 100.0%.

Method 2: Starting with the largest sieve size used, subtract the “% Ret.” on that sieve from 100% to give the total “% Pass” on the next smaller sieve. Then subtract the “% Ret.” on the next smaller sieve from the figure just obtained to give the total “% Pass” the third sieve. Continue in this manner until the pan and wash is reached, at which time the “% Pass” should be 0.0%.

Note: If 100.0% or 0.0% is not obtained in the “% Pass” column, then there is an error in the “Weight Ret.” or “% Ret.” columns that needs to be fixed.

3. If a coarse aggregate sample has been separated into two sizes for testing, compute the combined grading as follows:
  - a. Compute the individual grading of each size separately following the procedures outlined in the “CALCULATIONS” section paragraphs 1 and 2. This will give the “% Pass” for each sieve in both the coarse and fine portions of the sample.
  - b. Compute the percentage represented by the coarse and fine sizes, based on the total weight of the sample.

Example:

<u>Fraction</u>	<u>Size</u>		<u>Weight</u>	
	<u>Pass</u>	<u>Retained</u>	<u>Kilograms (lb)</u>	<u>Percentage</u>
Coarse	75 mm (3 in.)	25 mm (1 in.)	9.25 kg (20.4 lb)	49.5
Fine	25 mm (1 in.)	Pan	9.44 kg (20.8 lb)	50.5
Total			18.69 kg (41.2 lb)	100.0

- c. Taking the coarse and fine sizes separately, multiply the percentage of that size by the “% Pass” on each sieve.
- d. Add the products thus obtained on corresponding sieves. These sums constitute the overall grading on the combined sample.
- e. Refer to the Standard Operating Procedures (SOP Manual) for an example worksheet regarding the above calculations.

## REPORT

Record test results on NDOT form 040–013 or 040–050.

Report the total “% Pass” for each sieve on the appropriate NDOT form, to the nearest 0.1% on the appropriate sieve sheet and reported to the nearest whole number on the appropriate coversheet. Passing or failing percentages will be based on the coversheet results. All failures shall be circled in red.

On NDOT form 040–035 the fine aggregate shall be reported to 0.1%, so that an accurate fineness modulus may be calculated.

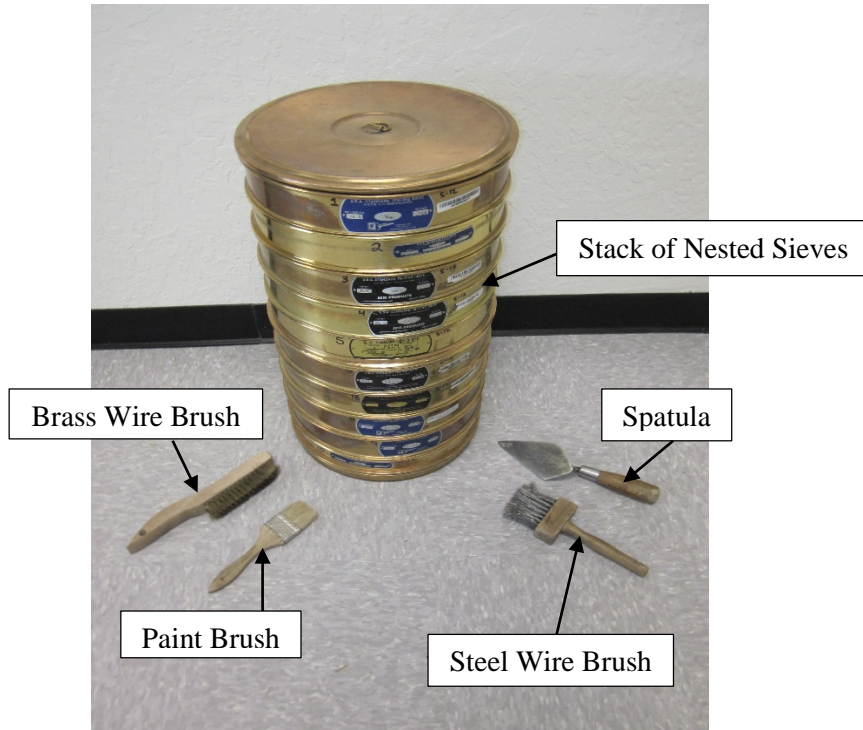


Figure 1



Figure 2

Mary-Ann Rotary – Mechanical Shaker





Figure 3  
12" Gilson – Mechanical Shaker



Figure 4  
Large Test Master – Mechanical Shaker