Method of Test for
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE
DOTD Designation: TR 113-15

INTRODUCTION

These methods of test are designed to determine the particle size distribution of fine and coarse aggregates. The mix of coarse and fine particles within the material being tested, in conjunction with the proposed use of the material, determines which test method is to be used. Table 1, Testing Requirements, identifies the basic appropriate test method. When materials are not listed in Table 1, the department will determine the test method to be used. When the percentage of material passing the 75 μm (No. 200 sieve is critical to the proposed use, the district laboratory engineer has the authority to require a washed gradation in addition to or in place of dry sieving.

These methods are not to be used alone for sieve analysis of aggregates recovered from asphaltic mixtures or for the sieve analysis of mineral fillers. The sieve analysis of mineral filler is to be determined in accordance with DOTD TR 102. The sieve analysis of aggregates recovered from asphaltic mixtures is determined in accordance with DOTD TR 309; only the steps for dry sieving in this procedure are used in conjunction with TR 309.

TABLE OF METHODS

Method A – Dry sieve only.
Method B – Wash and dry sieve.
Method C – Split sample. Dry sieve, then wash representative portion of material passing the 4.75 mm sieve.

<table>
<thead>
<tr>
<th>Material</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Sand or Mortar Sand</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Uncrushed Coarse Aggregate for Concrete</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Crushed Coarse Aggregate for Concrete</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Lightweight Aggregate for Concrete</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Sand Clay Gravel – Base Course Aggregate</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>Sand – Base Course Aggregate</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Stone – Base Course Aggregate</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>Recycled PCC – Base Course Aggregate</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
</tbody>
</table>

---continued---
## TABLE 1
Testing Requirements continued

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Method/Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushed Slag – Base Course Aggregate</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Stone – Aggregate Surface Course</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>Sand Clay Gravel – Aggregate Surface Course</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>Recycled PCC – Aggregate Surface Course</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>RAP – Aggregate Surface Course</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Crushed Slag – Aggregate Surface Course</td>
<td>TR 113 Method C</td>
</tr>
<tr>
<td>Aggregates For Asphallic Surface Treatment, Excluding Lightweight &amp; Expanded Clay</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Stone, Stone &amp; Slag – Aggregate for Asphallic Mixtures</td>
<td>AASHTO T84 APPENDENDIX x1 AASHTO T 85</td>
</tr>
<tr>
<td>Coarse Sand – Aggregate for Asphallic Mixtures</td>
<td>AASHTO T84 APPENDENDIX x1 AASHTO T 85</td>
</tr>
<tr>
<td>Fine Sand – Aggregate for Asphallic Mixtures</td>
<td>AASHTO T84 APPENDENDIX x1 AASHTO T 85</td>
</tr>
<tr>
<td>Natural Sand – Aggregate for Asphallic Mixtures</td>
<td>AASHTO T84 APPENDENDIX x1 AASHTO T 85</td>
</tr>
<tr>
<td>Screenings – Aggregate for Asphallic Mixtures</td>
<td>AASHTO T84 APPENDENDIX x1 AASHTO T 85</td>
</tr>
<tr>
<td>Lightweight and Expanded Clay – Aggregate for Asphallic Mixtures</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Crushed Gravel Stone or Crushed Slag for Asphalt Treated Drainage Blanket</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Granular Material – Bedding Material</td>
<td>TR 112 &amp; TR 113 Method C</td>
</tr>
<tr>
<td>Bedding Material, excluding Shell</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Sand for Embankment</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Blended Calcium Sulfate – Non-Plastic Embankment</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Back Fill Stone or Crushed Gravel</td>
<td>TR 113 Method A</td>
</tr>
<tr>
<td>Backfill Sand Granular B</td>
<td>TR 112 &amp; TR 113 Method B</td>
</tr>
<tr>
<td>Back Fill Stone Gravel C</td>
<td>Method C</td>
</tr>
</tbody>
</table>
REFERENCE DOCUMENTS

1. AASHTO Designation; M 92, Standard Specifications for Sieves for Testing Purposes
2. DOTD TR 112, Amount of Material Finer than the 75 μm Sieve
3. DOTD TR 108, Splitting and Quartering Samples
4. DOTD TR 106, Determining Total Moisture and Free Moisture in Aggregates

OVERLOADING

A sieve is considered overloaded when the mass of the material retained on a sieve exceeds the maximum allowed as follows:

1. For sieves with openings 4.75 μm (No. 4) and larger, the mass in kilograms shall not exceed the product of 2.5 x sieve opening in millimeters x effective area of sieving surface in square meters (the mass in pounds shall not exceed the product of 0.089 x sieve opening in inches x effective area of sieving surface in square inches).

2. For sieves with openings smaller than No. 4 (4.75 μm), the mass in kilograms shall not exceed 7 x effective area of sieving surface in square meters (the mass in pounds shall not exceed 0.01 x area of sieving surface in square inches).

Table 2 shows the maximum allowable mass retained on any sieve at the completion of the sieving operation for standard screen sizes based on the above relationships.

<table>
<thead>
<tr>
<th>Sieve/Screen Sizes</th>
<th>BOX SCREEN 420 x 340 mm (16 ⅜ x 13 ⅜ in) kg (lb)</th>
<th>STD. MECHANICAL SHAKER SCREEN 375 x 580 mm (14 ¾ X 22 ¾ in) kg (lb)</th>
<th>U. S. STANDARD 305 mm (12 in Dia.) kg (lb)</th>
<th>U. S. STANDARD 254 mm (10 in Dia.) kg (lb)</th>
<th>U. S. STANDARD 203 mm (8 in Dia.) kg (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mm (2 in)</td>
<td>17.96 (39.65)</td>
<td>27.10 (59.73)</td>
<td>8.38 (18.47)</td>
<td>5.72 (12.61)</td>
<td>3.56 (7.85)</td>
</tr>
<tr>
<td>37.5mm (1½ in)</td>
<td>13.47 (29.74)</td>
<td>20.33 (44.80)</td>
<td>6.28 (13.84)</td>
<td>4.29 (9.46)</td>
<td>2.67 (5.89)</td>
</tr>
<tr>
<td>25.0mm (1 in)</td>
<td>8.98 (19.82)</td>
<td>13.55 (29.86)</td>
<td>4.19 (9.24)</td>
<td>2.86 (6.17)</td>
<td>1.78 (3.92)</td>
</tr>
<tr>
<td>19.0mm (¾ in)</td>
<td>6.83 (14.87)</td>
<td>10.30 (22.40)</td>
<td>3.18 (7.01)</td>
<td>2.17 (4.78)</td>
<td>1.35 (2.98)</td>
</tr>
<tr>
<td>12.5mm (⅜ in)</td>
<td>4.49 (9.91)</td>
<td>6.78 (14.93)</td>
<td>2.09 (4.61)</td>
<td>1.43 (3.15)</td>
<td>0.89 (1.96)</td>
</tr>
<tr>
<td>9.5mm (⅛ in)</td>
<td>3.41 (7.43)</td>
<td>5.15 (11.20)</td>
<td>1.59 (3.51)</td>
<td>1.09 (2.40)</td>
<td>0.67 (1.48)</td>
</tr>
<tr>
<td>4.75mm (No. 4)</td>
<td>1.62 (3.71)</td>
<td>2.44 (5.60)</td>
<td>0.75 (1.75)</td>
<td>0.54 (1.19)</td>
<td>0.33 (0.73)</td>
</tr>
<tr>
<td>&lt;4.75mm (No. 4)</td>
<td>1.01 (2.23)</td>
<td>1.52 (3.36)</td>
<td>0.47 (1.43)</td>
<td>0.40 (0.89)</td>
<td>0.20 (0.44)</td>
</tr>
</tbody>
</table>
DEFINITIONS

For the purposes of this test procedure, the following definitions will apply.

**Coarse Aggregate**  — Naturally occurring or manufactured materials that are retained on the 4.75 mm (No. 4) sieve.

**Fine Aggregate**  — Naturally occurring or manufactured materials that pass the 4.75 mm (No. 4) sieve.

**Decantation Loss**  — “Decant Loss” on Worksheet. The amount of material loss when washing over the 75 μm sieve.

**Percent Difference**  — The difference between the initial dry total mass and the accumulated total mass, expressed as a percentage of initial dry total mass. This difference is usually caused by material loss during testing or weighing errors. This parameter is used to judge the accuracy of the test result.

**Split Sample**  — A representative portion of material passing the 4.75 mm (No. 4) sieve used to reduce sample size in order to determine the gradation of fine aggregate.
Method of Test for
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE
DOTD Designation: TR 113-15

Method A

I. Scope

This method of test is used to determine the particle size distribution of aggregates by dry sieving only.

II. Apparatus

A. Balance
   1. Sample size 2 kg or less, readability and sensitivity to 0.1 g.
   2. Sample size greater than 2 kg, but not more than 5 kg, readability and sensitivity to 1 g.
   3. Sample size greater than 5 kg, readability and sensitivity to 2 g.

B. Mechanical Sieve Shaker – capable of imparting a vertical or lateral and vertical motion to the sieves, causing the particles thereon to bounce and turn, presenting different orientations to the sieving surface.

C. Sieves – conforming to the requirements for AASHTO Designation M 92. Sieve sizes will be appropriate for the specifications for which the material is being tested. Additional sieves may be necessary to prevent overloading of these primary sieves.

D. Catch Pan

E. Drying Device
   1. Oven – an oven capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F), 55 ± 5°C (131 ± 9°F), and 38 ± 5°C (100 ± 9°F).
   2. Hot Plate – an approved hot plate with a shield. Open-flame hot plates must be equipped with a shield which evenly disperses heat and prevents direct contact of the flame with the drying pan.

3. Miscellaneous tools – spoons, spatulas, brushes, etc.

F. Personal Protective Equipment – goggles, dust respirator, equipment for handling hot substances

G. Aggregate Test Report – DOTD Form No. 03-22-0745 (Figure A-1).

III. Health Precautions

Proper equipment and precautions are to be used whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Use appropriate respirator and turn on ventilation system when working in dusty areas.

IV. Sample

Sample adequate material to comply with Table 1 after drying to constant mass; however, in no case shall the minimum sample size be less than 13 kg.

V. Procedure

A. Dry the sample in accordance with DOTD TR 106.

B. Obtain a representative portion, in accordance with DOTD TR 108, which will yield at least the minimum quantity shown in Table 1. Record on the worksheet as initial dry total mass in the entry field.

Note A-1: To obtain the minimum mass of the representative portion of lightweight aggregate, multiply the values shown in Table 1 by 0.5.
TABLE 1
Approximate Minimum Mass of Dry Representative Portion

<table>
<thead>
<tr>
<th>Maximum Size</th>
<th>Approximate Minimum Mass, Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 mm (3 ½ in)</td>
<td>35 kg</td>
</tr>
<tr>
<td>75 mm (3 in)</td>
<td>30 kg</td>
</tr>
<tr>
<td>63 mm (2 ½ in)</td>
<td>25 kg</td>
</tr>
<tr>
<td>50 mm (2 in)</td>
<td>20 kg</td>
</tr>
<tr>
<td>37.5 mm (1 ½ in)</td>
<td>13 kg</td>
</tr>
<tr>
<td>25.0 mm (1 in)</td>
<td>10 kg</td>
</tr>
<tr>
<td>19.0 mm (¾ in)</td>
<td>5 kg</td>
</tr>
<tr>
<td>12.5 mm (¾ in)</td>
<td>2 kg</td>
</tr>
<tr>
<td>9.5 mm (%in)</td>
<td>1 kg</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>500 g</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>100 g</td>
</tr>
</tbody>
</table>

1Maximum Size – for the purpose of this test procedure, maximum size is defined as the first sieve on which the specifications allow material to be retained.

C. Use the specifications to select the appropriate sieves to determine the particle distribution, including additional sieves necessary to prevent overloading of specification sieves.

Note A-2: Refer to the introduction for information on overloading of sieves.

D. Nest sieves in mechanical shaker in order of decreasing size of openings from top to bottom, placing the catch pan on the bottom.

E. Pour representative portion over top sieve.

F. Turn on mechanical shaker. Continue sieving operation to refusal.

Note A-3: Refusal is defined as the point when not more than 0.5% by mass of the representative portion passes through any sieve during one minute of continuous sieving.

G. Determine the mass of the material retained on each sieve and the catch pan and record on the worksheet in the designated locations as “Mass Retained.”

H. Check the mass retained for each sieve and refer to the table in the Introduction to determine if any sieve has been overloaded.
   1. If no sieve has been overloaded, proceed to Step I.
   2. If a sieve has been overloaded, recombine the representative portion.
      a. If intermediate sieve(s) are available, insert the appropriate intermediate sieve(s) immediately above the overloaded sieve(s) in the nest, and repeat the sieving operation in accordance with Steps E – H.
      b. If the correct size intermediate sieve(s) are not available, split the recombined representative portion in accordance with DOTD TR 108. Repeat Steps E – H for each portion. In Step G, add the masses retained on each sieve size for each portion and record the sum as “Mass Retained”.

I. Add together the Mass Retained for each individual sieve and the catch pan, then record this sum as “Accumulated Total”.

J. Determine and record the following to the degree of accuracy shown in the example on the worksheet (Figure A-1).
   1. The percent difference in accordance with Step VI.A. If the percent difference exceeds 0.2%, obtain a new representative portion and repeat Steps V.C – V.J. or a new sample and repeat the test.
2. The percent retained on each sieve in accordance with Step VI.B.
3. The percent coarser than each sieve size in accordance with Step VI.C.
4. The percent passing each sieve in accordance with Step VI.D.

VI. Calculations

A. Calculate the percent difference using the following formula:

\[ D = \frac{W_i - W_a}{W_i} \times 100 \]

where:
- \( D \) = percent difference
- \( W_i \) = initial dry total mass, g
- \( W_a \) = accumulated total mass, g
- 100 = constant, converting decimal to %

example:
- \( W_i = 17,573 \) g
- \( W_a = 17,568 \) g

\[ D = \frac{17573 - 17568}{17573} \times 100 = \frac{5}{17573} \times 100 = 0.000284 \times 100 = 0.0284\% \]

B. Calculate the percent retained for each sieve using the following formula:

\[ R = \frac{W_x}{W_a} \times 100 \]

where:
- \( R \) = percent retained
- \( W_x \) = mass retained on each individual sieve (x), g
- \( W_a \) = accumulated total mass, g
- 100 = constant, converting decimal to %

example: 19mm (\( \frac{3}{4} \) in) sieve
- \( W_{19} = 2,556 \) g
- \( W_a = 17,568 \) g

\[ R = \frac{2556}{17568} \times 100 = 0.145491 \times 100 = 14.5491 \]

\[ R = 14.55\% \]

C. Calculate the Percent Coarser (Cumulative Percent Retained) for each sieve using the following formula:

\[ C_x = \sum R_x \]

where \( x \) goes from all sieves \( >x \) to \( x \)

where:
- \( C_x \) = percent coarser for each sieve (x)
- \( R_x \) = percent retained for sieve (x)
- \( \sum \) = sum of & retained on all sieve larger than sieve (x)

example:
- \( R_{37.6} = 0 \)
- \( R_{19.0} = 14.55 \)
- \( R_{4.75} = 82.40 \)

\[ C_{4.75mm} = 0 + 14.55 + 82.40 \]

\[ C_{4.75mm} = 96.95 \]
D. Calculate the Percent Passing for each sieve using the following formula:

\[ P_x = 100 - C_x \]

where:

- \( P \) = percent passing
- \( C_x \) = Percent coarser for sieve \( x \)
- 100 = constant representing 100%

example: 4.75 mm sieve

\[ C_{4.75} = 96.95 \]

\[ P_{4.75 \, mm} = 100 - 96.95 \]
\[ = 3.05 \]
\[ P_{4.75 \, mm} = 3\% \]

VII. Report

Report the percent passing each sieve to the nearest whole percent.

VIII. Normal Testing and Reporting Time

Normal testing and reporting time is 2 days.
## Metric / English

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Mass (g) Retained</th>
<th>% Retained</th>
<th>% Coarser</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>2 1/2</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>25.5</td>
<td>1 1/4</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>19.0</td>
<td>3/4</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>16.0</td>
<td>3/8</td>
<td>100</td>
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<tr>
<td>12.5</td>
<td>1/2</td>
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<td>9.5</td>
<td>3/8</td>
<td>100</td>
<td>100</td>
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</tr>
<tr>
<td>4.75</td>
<td>No. 4</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

**Initial Dry Mass (g):** 7508

**Initial Dry Mass % (g):** 3.05

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**Remarks:**

1.  

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**Approved By:**

- **Date:**

**Figure A-1**
I. Scope

This method of test is used in conjunction with DOTD TR 112 to determine the particle size distribution of aggregates by washing and dry sieving.

II. Apparatus

A. Balance
   1. Sample size 2 kg or less, readability and sensitivity to 0.1 g.
   2. Sample size greater than 2 kg, but not more than 5 kg, readability and sensitivity to 1 g.
   3. Sample size greater than 5 kg, readability and sensitivity to 2 g.

B. Mechanical Sieve Shaker – capable of imparting a vertical or lateral and vertical motion to the sieves, causing the particles thereon to bounce and turn, presenting different orientations to the sieving surface.

C. Sieves – conforming to the requirements for AASHTO Designation M 92. Sieve sizes will be appropriate for the specifications for which the material is being tested. Additional sieves may be necessary to prevent overloading of these primary sieves.

D. Catch Pan

E. Drying Device
   1. Oven – an oven capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F), 55 ± 5°C (131 ± 9°F), and 38 ± 5°C (100 ± 9°F).
   2. Hot Plate – an approved hot plate with a shield. Open-flame hot plates must be equipped with a shield which evenly disperses heat and prevents direct contact of the flame with the drying pan.

F. Miscellaneous tools – spoons, spatulas, brushes, etc.

G. Personal Protective Equipment – goggles, dust respirator, equipment for handling hot substances

H. Aggregate Test Report – DOTD Form No. 03-22-0745 (Figure B-1).

III. Health Precautions

Proper equipment and precautions are to be used whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Use appropriate respirator and turn on ventilation system when working in dusty areas.

IV. Sample

Sample adequate material to comply with Table 1 after drying to constant mass; however, in no case shall the minimum sample size be less than 13 kg.

V. Procedure

A. Dry the sample in accordance with DOTD TR 106.

B. Obtain a representative portion, in accordance with DOTD TR 108, which will yield at least the minimum quantity shown in Table 1. Record on the worksheet as initial dry total mass in the lower entry field.

C. Determine the decantation loss, in accordance with DOTD TR 112.

D. Use the specifications to select the appropriate sieves to determine the particle distribution, including additional sieves necessary to prevent overloading of specification sieves.
**TABLE 1**
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</tr>
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<td>2.36 mm (No. 8)</td>
<td>100 g</td>
</tr>
</tbody>
</table>

1Maximum Size – for the purpose of this test procedure, maximum size is defined as the first sieve on which the specifications allow material to be retained.

**Note B-1:** Refer to the Introduction for information on overloading of sieves.

E. Nest sieves in mechanical shaker in order of decreasing size of openings from top to bottom, placing the catch pan on the bottom.

F. Pour the dried test specimen remaining from DOTD TR 112 over top sieve.

G. Turn on mechanical shaker. Continue sieving operation to refusal.

**Note B-2:** Refusal is defined as the point when not more than 0.5% by mass of the test specimen passes through any sieve during one minute of continuous sieving.

H. Determine the mass of the material retained on each sieve and the catch pan and record on the worksheet in the designated locations as “Mass Retained.”

I. Check the mass retained for each sieve and refer to the table in the Introduction to determine if any sieve has been overloaded.

1. If no sieve has been overloaded, proceed to Step J.

2. If a sieve has been overloaded, recombine the test specimen.
   a. If intermediate sieve(s) are available, insert the appropriate intermediate sieve(s) immediately above the overloaded sieve(s) in the next, and repeat the sieving operation in accordance with Steps F – I.
   b. If the correct size intermediate sieve(s) are not available, split the recombined test specimen in accordance with DOTD TR 108. Repeat Steps F – I for each portion. In Step H, add the masses retained on each sieve size for each portion and record the sum as “Mass Retained”.

J. Add together the Mass Retained for each individual sieve, the catch pan, and the “decant loss” from DOTD TR 112, then record this sum as “Accumulated Total”.

K. Determine and record the following:

1. The percent difference in accordance with Step VI.A. If the percent difference exceeds 0.2%, obtain a new sample and repeat the entire test procedure.
2. The percent retained on each sieve in accordance with Step VI.B.
3. The percent coarser than each sieve size in accordance with Step VI.C.
4. The percent passing each sieve in accordance with Step VI.D.

**VI. Calculations**

A. Calculate the percent difference using the following formula:
Method B

\[ D = \frac{W_i - W_a}{W_i} \times 100 \]

\( D \) = percent difference
\( W_i \) = initial dry total mass, g
\( W_a \) = accumulated total mass, g
100 = constant, converting decimal to %

example:

\( W_i = 522.0 \text{ g} \)
\( W_a = 521.8 \)

\[ D = \frac{522.0 - 521.8}{522.0} \times 100 \]
\[ = \frac{0.2}{522.0} \times 100 \]
\[ = 0.000383 \times 100 \]
\[ = 0.0383 \]
\( D = 0.0383\% \)

B. Calculate the percent retained for each sieve using the following formula:

\[ R = \frac{W_x}{W_a} \times 100 \]

where:

\( R \) = percent retained
\( W_x \) = mass retained on each individual sieve (x), g
\( W_a \) = accumulated total mass, g
100 = constant, converting decimal to %

example: 4.75\text{mm sieve}

\( W_{4.75} = 20.4 \text{ g} \)
\( W_a = 521.8 \text{ g} \)

\[ R = \frac{20.4 \times 100}{521.8} \]
\[ = 0.039095 \times 100 \]
\[ = 3.9095 \]
\( R = 3.91\% \)

C. Calculate the Percent Coarser (Cumulative Percent Retained) for each sieve using the following formula:

\[ C_x = \sum R_x \]

where \( x \) goes from all sieves \( >x \) to \( x \)

where:

\( C_x \) = percent coarser for each sieve (x)
\( R_x \) = percent retained for sieve (x)
\( \Sigma \) = sum of & retained on all sieve larger than sieve (x)

example:

\( R_{0.6} = 0 \)
\( R_{4.75} = 3.91 \)
\( R_{1.18} = 12.90 \)

\[ C_{1.18 \text{mm}} = 0 + 3.91 + 12.90 \]
\[ C_{1.18 \text{mm}} = 16.81 \]

D. Calculate the Percent Passing for each sieve using the following formula:

\[ P_x = 100 - C_x \]

where:

\( P \) = percent passing
\( C_x \) = Percent coarser for sieve \( x \)
100 = constant representing 100%
example: for 1.18 mm Sieve

\[ C_{1.18} = 16.81 \]

\[ P_{1.18} = 100 - 16.81 = 83.19 \]

\[ P_{1.18} = 83\% \]

VII. Report

Report the results of the sieve analysis to the nearest whole percent.

VIII. Normal Testing and Reporting Time

Normal testing and reporting time is 2 days.
### Aggregate Test Report (03-22-0745)

**Figure B-1**

**Method C**
I. **Scope**

This method of test is used in conjunction with DOTD TR 112 to determine the particle size distribution of aggregates by dry sieving the material retained on the 4.75 mm (No. 4) sieve, then washing and dry sieving the material passing the 4.75 mm (No. 4) sieve (split sample).

II. **Apparatus**

A. **Balance**
   1. Sample size 2 kg or less, readability and sensitivity to 0.1 g.
   2. Sample size greater than 2 kg, but not more than 5 kg, readability and sensitivity to 1 g.
   3. Sample size greater than 5 kg, readability and sensitivity to 2 g.

B. **Mechanical Sieve Shaker** – capable of imparting a vertical or lateral and vertical motion to the sieves, causing the particles thereon to bounce and turn, presenting different orientations to the sieving surface.

C. **Sieves** – conforming to the requirements for AASHTO Designation M 92. Sieve sizes will be appropriate for the specifications for which the material is being tested. Additional sieves may be necessary to prevent overloading of these primary sieves.

D. **Catch Pan**

E. **Drying Device**
   1. **Oven** – an oven capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F), 55 ± 5°C (131 ± 9°F), and 38 ± 5°C (100 ± 9°F).
   2. **Hot Plate** – an approved hot plate with a shield. Open-flame hot plates must be equipped with a shield which evenly disperses heat and prevents direct contact of the flame with the drying pan.

F. **Miscellaneous tools** – spoons, spatulas, brushes, etc.

G. **Personal Protective Equipment** – goggles, dust respirator, equipment for handling hot substances

H. **Aggregate Test Report** – DOTD Form No. 03-22-0745 (Figure C-1).

III. **Health Precautions**

Proper equipment and precautions are to be used whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Use appropriate respirator and turn on ventilation system when working in dusty areas.

IV. **Sample**

Sample adequate material to comply with Table 1 after drying to constant mass; however, in no case shall the minimum sample size be less than 13 kg.

V. **Procedure**

A. Dry the sample in accordance with DOTD TR 106.

B. Obtain a representative portion, in accordance with DOTD TR 108, which will yield at least the minimum quantity shown in Table 1. Record on the worksheet as initial dry total mass in the upper entry field.

C. Use the specifications to select the appropriate sieves from the largest to the 4.75 mm (No. 4) sieve, to determine the particle distribution of the coarse fraction and the amount of material passing the 4.75 mm (No. 4) sieve in accordance with Steps V.D – V.J. of Method A.
TABLE 1

<table>
<thead>
<tr>
<th>Maximum Size</th>
<th>Approximate Minimum Mass, Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 mm (3 ½ in)</td>
<td>35 kg</td>
</tr>
<tr>
<td>75 mm (3 in)</td>
<td>30 kg</td>
</tr>
<tr>
<td>63 mm (2 ¾ in)</td>
<td>25 kg</td>
</tr>
<tr>
<td>50 mm (2 in)</td>
<td>20 kg</td>
</tr>
<tr>
<td>37.5 mm (1 ½ in)</td>
<td>13 kg</td>
</tr>
<tr>
<td>25.0 mm (1 in)</td>
<td>10 kg</td>
</tr>
<tr>
<td>19.0 mm (¾ in)</td>
<td>5 kg</td>
</tr>
<tr>
<td>12.5 mm (½ in)</td>
<td>2 kg</td>
</tr>
<tr>
<td>9.5 mm (⅓ in)</td>
<td>1 kg</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>500 g</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>100 g</td>
</tr>
</tbody>
</table>

1

Maximum Size – for the purpose of this test procedure, maximum size is defined as the first sieve on which the specifications allow material to be retained.

D. Determine the particle distribution of the material passing the 4.75 mm (No. 4) sieve in accordance with Steps V.B – V.K. of Method B.

VI. Calculations

A. Calculate the percent difference using the following formula:

\[ D = \frac{W_i - W_a}{W_i} \times 100 \]

\[ D \] = percent difference
\[ W_i \] = initial dry total mass, g
\[ W_a \] = accumulated total mass, g

B. Calculate the percent retained for each sieve using the following formula:

\[ R = \frac{W_x}{W_a} \times 100 \]

\[ W_x \] = mass retained on each individual sieve (x), g
\[ W_a \] = accumulated total mass, g

100 = constant, converting decimal to %

example:

\[ \begin{align*}
W_i & = 15,784 \\
W_a & = 15,782 \\
\end{align*} \]

\[ D = \frac{15784 - 15782}{15784} \times 100 \\
= \frac{2}{15784} \times 100 \\
= 0.000126 \times 100 \\
= 0.0126 \\
D & = 0.01\% \\
\]

B. Calculate the percent retained for each sieve using the following formula:

\[ R = \frac{W_x}{W_a} \times 100 \]

where:

\[ R \] = percent retained
\[ W_x \] = mass retained on each individual sieve (x), g
\[ W_a \] = accumulated total mass, g

100 = constant, converting decimal to %

example: 4.75mm sieve

\[ \begin{align*}
W_{4.75} & = 7,841 \\
W_a & = 15,782 \\
\end{align*} \]

\[ R = \frac{7841}{15782} \times 100 \\
= 0.496831 \times 100 \\
= 49.6831 \\
R & = 49.68\% \\
\]
C. Calculate the Percent Coarser (Cumulative Percent Retained) for each sieve using the following formula:

\[ C_x = \sum R_x \]

where \( x \) goes from all sieves >\( x \) to \( x \)

where:
- \( C_x \) = percent coarser for each sieve (\( x \))
- \( R_x \) = percent retained for sieve (\( x \))
- \( \sum \) = sum of & retained on all sieve larger than sieve (\( x \))

example:
- \( R_{37.5} = 0.98 \) mm
- \( R_{4.75} = 49.68 \) mm

\[ C_{4.75 \text{ mm}} = 0.98 + 49.68 \]
\[ C_{4.75 \text{ mm}} = 50.66 \]

D. Calculate the Percent Passing for each sieve using the following formula:

\[ P_x = 100 - C_x \]

where:
- \( P \) = percent passing
- \( C_x \) = Percent coarser for sieve \( x \)
- 100 = constant representing 100%

example: for 4.75 mm (No. 4) Sieve

\[ C_{4.75} = 50.66 \text{ mm} \]
\[ P_x = 100 - 50.66 \]
\[ P_x = 49.34 \]
\[ P_x = 49\% \]

E. Calculate the percent difference for the material passing the 4.75 mm (No. 4) sieve, using the following formula:

\[ d = \frac{w_i - w_a}{w_i} \times 100 \]

where:
- \( d \) = percent difference
- \( w_i \) = initial dry total Mass of the split portion passing the 4.75 mm (No. 4) sieve, g
- \( w_a \) = accumulated total mass of the split portion passing the 4.75 mm (No. 4) sieve, g
- 100 = constant, converting decimal to %

example:
- \( w_i = 538.4 \) g
- \( w_a = 538.1 \) g

\[ d = \frac{538.4 - 538.1}{538.4} \times 100 \]
\[ = \frac{0.3}{538.4} \times 100 \]
\[ = 0.000557 \times 100 \]
\[ = 0.05557 \]
\[ d = 0.06\% \]

F. Calculate the percent retained for each sieve smaller than the 4.75 mm (No. 4) sieve using the following formula:

\[ r_x = \frac{w_a}{w_a} \times R_{pan} \]
where:

\[ r_x = \text{percent retained on each sieve} \]
\[ w_x = \text{mass retained on each individual sieve (x), g} \]
\[ w_a = \text{accumulated total, g} \]
\[ R_{\text{pan}} = \text{percent of total material retained in the pan, calculated in Step B.} \]

example: 425 mm sieve

\[ w_{425 \text{ mm}} = 189.2 \text{ g} \]
\[ w_a = 538.1 \text{ g} \]
\[ R_{\text{pan}} = 49.32 \]

\[ r_{425 \text{ mm}} = \frac{189.2}{538.1} \times 49.32 \]
\[ = 0.35160 \times 49.32 \]
\[ = 17.3409 \]
\[ r_{425 \text{ mm}} = 17.34 \]

G. Calculate the Percent Coarser (Cumulative Percent Retained) for each sieve smaller than 4.75 mm (No. 4) sieve using the following formula:

\[ c_x = \sum r_x + \sum R_x \]

where \( x \) goes from all sieves >x to x

where:

\[ c_x = \text{percent coarser for each sieve (x)} \]
\[ r_x = \text{percent retained for sieve (s)} \]
\[ \Sigma = \text{sum of percent retained on all sieves larger than sieve (x)} \]
\[ \Sigma R_x = \text{sum of percent retained on 4.75 mm (No. 4) sieves} \]

example:

\[ R_{75 \mu m} = 16.38 \]
\[ R_{4.25 \mu m} = 17.34 \]
\[ R_{4.75 \mu m} = 50.66 \]

\[ c_{75 \mu m} = 16.38 + 17.34 + 50.66 \]
\[ c_{75 \mu m} = 84.38 \]

H. Calculate the Percent Passing for each sieve finer than the 4.75 mm (No. 4) using the following formula:

\[ p_x = 100 - c_x \]

where:

\[ p_x = \text{material passing sieve x, \%} \]
\[ c_x = \text{material coarser than sieve x, \%} \]
\[ 100 = \text{constant representing 100\%} \]

example: 75 \( \mu m \) (NO. 200) sieve

\[ c_{75 \mu m} = 84.38 \]

\[ p_{75 \mu m} = 100 - 84.38 \]
\[ p_{75 \mu m} = 15.62 \]
\[ p_{75 \mu m} = 16\% \]

VII. Report

Report the results of the sieve analysis to the nearest whole percent.

VIII. Normal Testing and Reporting Time

Normal testing and reporting time is 2 days.
Figure C-1
Aggregate Test Report (03-22-0745)