1206 Uncompacted Void Content of Fine Aggregate (Fine Aggregate Angularity Test) AASHTO Designation T 304

1206.1 Scope

The fine aggregate angularity test determines the loose uncompacted void content of a fine aggregate material.

The void content information derived from this test gives you an indication of the effect fine aggregate will have on stability and voids in the mineral aggregate.

AASHTO T 304 lists three different test methods (A, B, & C) to determine the void content of loose uncompacted fine aggregate samples. **Mn/DOT uses Test Method "A".**

1206.2 Equipment (See AASHTO T 304, Section 6 for details)

A. **Cylindrical Measure** – A right cylindrical measure of approximately 100mL capacity having an inside diameter of approximately 39mm and an inside height of approximately, 86mm.

B. **Funnel (Pycnometer Top)** - And a glass jar without a bottom.

C. **Funnel Stand**

D. **Square Glass Plate** - Approximately 60 X 60mm with a minimum 4mm thickness used to calibrate the cylindrical measure.

E. **Pan** - A metal or plastic pan of sufficient size to contain the funnel stand and prevent the loss of material.

F. **Metal Spatula** - 100mm long X 20mm wide with straight edges and the end cut at a right angle to the edges used to strike off the fine aggregate.

G. **Balance** - A balance conforming to the requirements of AASHTO M 231 (Class G2) with a minimum capacity of 2000g, a readability and sensitivity of 0.1g and an accuracy of 0.1g or 0.1%.

1206.3 Sample Preparation

A. For each component used in a blended mixture the following three values are needed: percent of the total blend mixture, percent passing the 4.75mm (#4) sieve and the bulk specific gravity of the percent passing the 4.75mm (#4) sieve.

Note 1: Tests run on extracted or belt run mixture samples are considered to be the correct blend. For these types of samples proceed to the "Test Procedure – Mix Blend (Method A)". The required amounts of material needed from the 1.18mm, 600µm, 300µm & 150µm (#16, #30, #50 % #100) sieves to equal the 190 gram test sample are acquired during the sample's gradation test.

1. Example of a four component mixture

	% of Mixture	**% Passing 4.75mm (#4)**	**Sp. Gr. -4.75mm (#4)**
Aggregate #1	81	71	2.648
Aggregate #2	9	98	2.637
Aggregate #3	5	25	2.691
Aggregate #4	5	94	2.545

B. Calculate the - 4.75mm (#4) percentage to be used from each component

1. (% of mixture) **x** (% passing 4.75mm [#4] sieve) ÷ 100

Aggregate #1: 81 **x** 71 ÷ 100 = 57.51%
Aggregate #2: 9 **x** 98 ÷ 100 = 8.82%
Aggregate #3: 5 **x** 25 ÷ 100 = 1.25%
Aggregate #4: 5 **x** 94 ÷ 100 = 4.70%

C. Calculate the Total Blend passing the #4.75mm (#4) sieve by adding the values from 1206.3B1.

1. 57.51 + 8.82 + 1.25 + 4.7 = 72.28%

D. Determine the amount of material, in grams, needed from each aggregate component so a sufficient representative sample of the total mixture blend is retained, after sieving, on each sieve size 1.18mm, 600µm, 300µm & 150µm (#16, #30, #50 % #100) sieves (Example shown is for 600 grams.)

1. $$\frac{600 \times \text{ \% passing 4.75mm (\#4) sieve for each component}}{\text{Total \% passing 4.75mm (\#4) in the blend}}$$

Aggregate #1: (600 **x** 57.51) ÷ 72.28 = 477.4g
Aggregate #2: (600 **x** 8.82) ÷ 72.28 = 73.2g
Aggregate #3: (600 **x** 1.25) ÷ 72.28 = 10.4g
Aggregate #4: (600 **x** 4.70) ÷ 72.28 = 39.0g

E. Calculate the mix blend - #4 (4.75mm) specific gravity to be used in the Fine Aggregate Angularity calculation.

1. Total the values of the four aggregates in Section 1206.3B1.
(57.51 + 8.82 + 1.25 + 4.70 = 72.28

2. For each of the four aggregates divide the values in Section 1206.3B1 by the specific gravity of the appropriate aggregate and total those values.

Aggregate #1: 57.51 ÷ 2.648 = 21.72
Aggregate #2: 8.82 ÷ 2.637 = 3.34
Aggregate #3: 1.25 ÷ 2.691 = 0.46
Aggregate #4: 4.70 ÷ 2.545 = 1.85

27.37

3. Divide the total achieved in 1206.3E1 by the total achieved in 1206.3E2 to arrive at the Mix Blend –4.75mm (#4) specific gravity which will be used in the calculation of the Fine Aggregate Angularity.

$$\frac{72.28}{27.37} = 2.641 \text{ (Mix Blend Specific Gravity)}$$

1206.4 Calibration of Cylindrical Measure

A. First determine the volume of your cylindrical measure by using the following calibration procedure.

1. Apply a thin coat of grease to the top edge of your dry, empty cylinder measure.

2. Determine the mass of measure, grease and glass plate by weighing.

3. Fill your measure with freshly boiled, deionized water adjusted to a temperature of 18 - 24 °C (60 - 75 °F).

4. Determine and record the temperature of the water.

5. Slide the glass plate onto the top of your measure in a manner ensuring that no air bubbles will be trapped under the glass plate.

6. Dry the outside surfaces of your measure and determine the mass of the measure, water, glass plate and grease by weighing.

7. After the final weighing, remove the grease and determine the mass of your clean, dry, empty measure for subsequent tests.

8. Determine the volume (to the nearest 0.1-ml of the measure where:

M = Net mass (weight) of water in grams.
D = Density of the water. kg/m³

Note 2: See the table in AASHTO T 19/T 19M-93, Section 8.4 for the water density based on the temperature of the water used. It will be necessary to interpolate between the values shown in that table. In the example a water temperature of 22.28 °C. is used, values marked with an asterisk (*) are from the referenced table (above) and the density in kg/m³ calculated as follows:

[(997.97* – 997.54*) ÷ (23.0* – 21.1*)] = 0.2263

D = {997.54 + [0.2263 **x** (23.0 – 22.28)]} = 997.7029 = 997.70

Weight of Measure, grease, and glass plate = 226.1 g

Weight of Measure, grease, glass plate, and water = 325.7 g

M = (325.7 g – 226.1 g) = 99.6 g

Volume of measure (cylinder), mL is determined as follows:

V = 1000 **x** (M ÷ D)

V = {1000 **x** 99.6 ÷ 997.70 = 99.83 mL

1206.5 Test Procedure – Mix Blend (Method A)

A. Weigh out and combine the following quantities of your fine aggregate blend that has been dried and sieved in accordance with AASHTO T 27 as follows:

Passing 2.36mm (#8) sieve and retained on the 1.18mm (#16)	= 44 grams
Passing 1.16mm (#16) sieve and retained on the 600µm (#30)	= 57 grams
Passing 600µm (#30) sieve and retained on the 300µm (#50)	= 72 grams
Passing 300µm (#50) sieve and retained on the 150µm (#100)	= 17 grams
Total	= 190 grams

Note 3: The tolerance for each of these increments is ± 0.2 grams.

B. Thoroughly mix the individual sieve increments with a spatula until it appears to be a homogeneous 190-gram sample.

C. Position the jar and funnel section in the stand and center the cylindrical measure.

D. Using a finger, block the opening of the funnel.

E. Pour the test sample into the funnel and level with a spatula.

F. Remove your finger and allow the material to fall freely in the cylindrical measure.

G. After the funnel empties and the cylindrical measure is full, strike-off the excess fine aggregate with a single pass of the spatula using the straight edge of the blade vertically and in light contact with the top of the measure.

Note 4: Until this operation is completed avoid any vibration or disturbance that could cause the material to compact.

H. After strike-off, lightly tap the cylinder to compact the material so none will be lost when transferring the cylinder to the scale and brush the adhering material from the outside of the cylinder.

I. Determine the mass of the cylinder and material to the nearest 0.1g and record.

J. Do Sections 1206.5B through 1206.5H twice and determine the average of the two readings minus the weight of the cylinder.

K. Calculate the Uncompacted Voids as follows:

$$U = \frac{V - (F/G)}{V} \times 100$$

Where:

U = Uncompacted Voids

V = Volume of Measure

F = Net mass of fine aggregate in the measure
(Average mass determined in step #10 above)

G = Bulk Dry Specific Gravity of the Blend of fine aggregate

L. Report the Uncompacted Voids to the 0.1 percent.

1206.6 Report Form

FINE AGGREGATE ANGULARITY
(UNCOMPACTED VOIDS IN FINE AGGREGATE)
(AASHTO T 304)

Laboratory No. ______________________ **Bituminous Rec. ID** __________________

Source ____

Location ____

Tested By _______________________________________ **Date** ____________________

	Lab ID#	____________
(G)	**Avg. Specific Gravity**	____________
(V)	**Volume of cylinder**	____________
(A)	**Tare weight of cylinder**	____________

	Test Runs		
	Weight of cylinder	**Run 1**	__________
	And aggregate	**Run 2**	__________
	(Run 1 + Run 2)	**Total**	__________
(B)	**(Total ÷ 2)**	**Average**	__________

<u>Note that the two formulas below for Uncompacted Voids give the same result.</u>

Uncompacted voids $= \{[V - ((B - A) \div G)] \div V\} \times 100$ **or**

$$\text{Uncompacted voids} = \frac{V - \dfrac{B - A}{G}}{V} \times 100$$

Uncompacted voids (0.1%) = __________.___%

Remarks: ____

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