

MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE FOP FOR AASHTO T 30

Scope

This procedure covers mechanical analysis of aggregate recovered from bituminous mix samples in accordance with AASHTO T 30-15. This FOP utilizes the aggregate recovered from the ignition oven used in AASHTO T 308. AASHTO T 30 was developed for analysis of extracted aggregate and thus includes references to extracted bitumen and filter element, which do not apply in this FOP.

Sieve analyses determine the gradation or distribution of aggregate particles within a given sample in order to determine compliance with design and production standards.

Apparatus

- Balance or scale: Capacity sufficient for the sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g
- Sieves
- Mechanical sieve shaker
- Mechanical Washing Apparatus (optional)
- Suitable drying equipment (see FOP for AASHTO T 255)
- Containers and utensils: A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water

Sample Sieving

- In this procedure it is required to shake the sample over nested sieves. Sieves are selected to furnish information required by specification.
- Sieves are nested in order of decreasing size from the top to the bottom and the sample, or a portion of the sample, is placed on the top sieve.
- Sieves are shaken in a mechanical shaker for approximately 10 minutes or the minimum time determined to provide complete separation for the sieve shaker being used as established by the Time Evaluation.

Time Evaluation

The minimum time requirement should be evaluated for each shaker at least annually by the following method:

1. Shake the sample over nested sieves for approximately 10 minutes.
2. Provide a snug-fitting pan and cover for each sieve, and hold in a slightly inclined position in one hand.
3. Hand-shake each sieve by striking 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, turning the sieve about one sixth of a revolution at intervals of about 25 strokes.

If more than 0.5 percent by mass of the total sample prior to sieving passes any sieve after one minute of continuous hand sieving adjust shaker time and re-check.

In determining sieving time for sieve sizes larger than 4.75 mm (No. 4), limit the material on the sieve to a single layer of particles.

Overload Determination

- For sieves with openings smaller than 4.75 mm (No. 4), the mass retained on any sieve shall not exceed 7 kg/m^2 (4 g/in^2) of sieving surface.
- For sieves with openings 4.75 mm (No. 4) and larger, the mass (in kg) shall not exceed the product of $2.5 \times$ (sieve opening in mm) \times (effective sieving area). See Table 1.

Additional sieves may be necessary to keep from overloading the specified sieves. The sample may also be sieved in increments or sieves with a larger surface area.

TABLE 1
Maximum Allowable Mass of Material Retained on a Sieve, g
Nominal Sieve Size, mm (in.)
Exact size is smaller (see AASHTO T 27)

Sieve Size mm (in.)	203 dia (8)	305 dia (12)	305 by 305 (12 × 12)	350 by 350 (14 × 14)	372 by 580 (16 × 24)
Sieving Area m ²					
	0.0285	0.0670	0.0929	0.1225	0.2158
90 (3 1/2)	*	15,100	20,900	27,600	48,500
75 (3)	*	12,600	17,400	23,000	40,500
63 (2 1/2)	*	10,600	14,600	19,300	34,000
50 (2)	3600	8400	11,600	15,300	27,000
37.5 (1 1/2)	2700	6300	8700	11,500	20,200
25.0 (1)	1800	4200	5800	7700	13,500
19.0 (3/4)	1400	3200	4400	5800	10,200
16.0 (5/8)	1100	2700	3700	4900	8600
12.5 (1/2)	890	2100	2900	3800	6700
9.5 (3/8)	670	1600	2200	2900	5100
6.3 (1/4)	440	1100	1500	1900	3400
4.75 (No. 4)	330	800	1100	1500	2600
-4.75 (-No. 4)	200	470	650	860	1510

Mass Verification

- Using the aggregate sample obtained from the FOP for AASHTO T 308, determine and record the mass of the sample, $M_{(T30)}$, to 0.1 g. This mass shall agree with the mass of the aggregate remaining after ignition, M_f from T 308, within 0.10 percent. If the variation exceeds 0.10 percent the results cannot be used for acceptance.

$$\frac{M_{f(T308)} - M_{(T30)}}{M_{f(T308)}} \times 100$$

Where:

$$M_{(T30)} = 2422.3 \text{ g}$$

$$M_{f(T308)} = 2422.5 \text{ g}$$

$$\frac{2422.5 \text{ g} - 2422.3 \text{ g}}{2422.5 \text{ g}} \times 100 = 0.01\%$$

Procedure

1. Nest a sieve, such as a 2.0 mm (No. 10) or 1.18 mm (No. 16), above the 75 μ m (No. 200) sieve.
2. Place the test sample in a container and add sufficient water to cover it. Add a detergent, dispersing agent, or other wetting solution to the water to assure a thorough separation of the material finer than the 75 μ m (No. 200) sieve from the coarser particles. There should be enough wetting agent to produce a small amount of suds when the sample is agitated. Excessive suds may overflow the sieves and carry material away with them.
3. Agitate vigorously to ensure complete separation of the material finer than 75 μ m (No. 200) from coarser particles and bring the fine material into suspension above the coarser material. When using a mechanical washing device, exercise caution to avoid degradation of the sample. Maximum agitation is 10 min.
Note 1: When mechanical washing equipment is used, the introduction of water, agitating, and decanting may be a continuous operation. Use care not to overflow or overload the 75 μ m (No. 200) sieve.
4. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, being careful not to pour out the coarser particles.
5. Add a second change of water to the sample remaining in the container, agitate, and repeat Step 5. Repeat the operation until the wash water is reasonably clear. Continue washing until the agent is removed.
6. Rinse the material on the nested sieves until water passing through the sieve is reasonably clear.
7. Remove the upper sieve, return material retained to the washed sample.
8. Rinse the material retained on the 75 μ m (No. 200) sieve until water passing through the sieve is reasonably clear.
9. Return all material retained on the 75 μ m (No. 200) sieve to the washed sample by flushing into the washed sample.
10. Dry the washed aggregate to constant mass in accordance with the FOP for AASHTO T 255, and then cool prior to sieving. Record the “dry mass after washing.”
11. Select sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom and place the sample, or a portion of the sample, on the top sieve.
12. Place sieves in mechanical shaker and shake for the minimum time determined to provide complete separation for the sieve shaker being used (approximately 10 minutes).

Note 2: Excessive shaking (more than 10 minutes) may result in degradation of the sample.

13. Determine the mass retained on each sieve (individual/cumulative) to the nearest 0.1 g. Ensure that all material trapped in full openings of the sieves are cleaned out and included in the mass retained.

Note 3: For sieves No. 4 and larger, material trapped in less than a full opening shall be checked by sieving over a full opening. Use coarse wire brushes to clean the 600 μm (No. 30) and larger sieves, and soft bristle brushes for smaller sieves.

14. Verify the total mass of material after sieving agrees with the mass before sieving within 0.2 percent. (Check sum). When the masses before and after sieving differ by more than 0.2 percent, do not use the results for acceptance purposes.
15. Divide the masses for each sieve (individual/cumulative) by the total dry mass before washing and multiply by 100 to determine the percent retained on and passing each sieve.
16. Calculate the percent retained and passing each sieve to the nearest 0.1 percent.
17. Apply the Aggregate Correction Factor to the calculated percent passing, as required in the FOP for AASHTO T 308 "Correction Factor" Steps 10 through 12, to obtain the reported percent passing.
18. Report percentages to the nearest 1 percent except for the percent passing the 75 μm (No. 200) sieve, which shall be reported to the nearest 0.1 percent.

Calculations

$$\text{check sum} = \frac{\text{dry mass after washing} - \text{total mass after sieving}}{\text{dry mass after washing}} \times 100$$

PERCENT RETAINED:

Where:

IPR= Individual Percent Retained

CPR= Cumulative Percent Retained

M= Total Dry Sample mass before washing

IMR= Individual Mass Retained

CMR= Cumulative Mass Retained

$$\text{IPR} = \frac{\text{IMR}}{M_{T30}} \times 100 \quad \text{OR} \quad \text{CPR} = \frac{\text{CMR}}{M_{T30}} \times 100$$

Where:

IPR= Individual Percent Retained

CPR= Cumulative Percent Retained

M_{T30} = Total Dry Sample mass before washing

IMR= Individual Mass Retained

CMR= Cumulative Mass Retained

PERCENT PASSING and REPORTED PERCENT PASSING:

Where:

PP= Calculated Percent Passing

PCP= Previous Calculated Percent Passing

$$\text{RPP} = \text{Reported Percent Passing} \quad \text{PP} = \text{PCP} - \text{IPR} \quad \text{OR} \quad \text{PP} = 100 -$$

$$RPP = PP + \text{Aggregate Correction Factor}$$

Where:

PP= Calculated Percent Passing

PCP= Previous Calculated Percent Passing

RPP= Reported Percent Passing

Example

Dry mass of total sample, before washing (M_{T30}): 2422.3 g

Dry mass of sample, after washing out the 75 μm (No. 200) minus: 2296.2 g

Amount of 75 μm (No. 200) minus washed out: $2422.3 \text{ g} - 2296.2 \text{ g} = 126.1 \text{ g}$

Percent Retained 75 μm (No. 200):

$$\frac{63.5 \text{ g}}{2422.3 \text{ g}} \times 100 = 2.6\% \quad \text{or} \quad \frac{2289.6 \text{ g}}{2422.3 \text{ g}} \times 100 = 94.5\%$$

Percent Passing: 8.1% – 2.6% = 5.5% or 100 %– 94.5% = 5.5%

Reported Percent Passing: 5.5% + (-0.6%) = 4.9%

Gradation on All Screens

Sieve Size mm (in.)	Mass Retained (g) (MR)	Percent Retained (PR)	Cumulative Mass Retained (g) (CMR)	Cumulative Percent Retained (CPR)	Calc'd Percent Passing (PP)	Agg. Corr. Factor from T 308 (ACF)	Reported Percent Passing (RPP)
19.0 (3/4)	0.0		0.0	0	100.0		100
12.5 (1/2)	346.9	14.3	346.9	14.3	85.7		86
9.5 (3/8)	207.8	8.6	554.7	22.9	77.1		77
4.75 (No. 4)	625.4	25.8	1180.1	48.7	51.3		51
2.36 (No. 8)	416.2	17.2	1596.3	65.9	34.1		34
0.18 (No. 16)	274.2	11.3	1870.5	77.2	22.8		23
0.600 (No. 30)	152.1	6.3	2022.6	83.5	16.5		16
0.300 (No. 50)	107.1	4.4	2129.7	87.9	12.1		12
0.150 (No. 100)	96.4	4.0	2226.1	91.9	8.1		8
75 μm (No. 200)	63.5	2.6	2289.6	94.5	5.5	-0.6	4.9
Pan	5.7		2295.3				

Check sum:

$$\frac{2296.2 \text{ g} - 2295.3 \text{ g}}{2296.2 \text{ g}} \times 100 = 0.04\%$$

This is less than 0.2 percent therefore the results can be used for acceptance purposes.

Report

- Results on forms approved by the agency
- Sample ID
- Depending on the agency, this may include:
 - Individual mass retained on each sieve
 - Individual percent retained on each sieve
 - Cumulative mass retained on each sieve
 - Cumulative percent retained on each sieve
 - Aggregate Correction Factor for each sieve from AASHTO T 308
 - Calculated percent passing each sieve to 0.1 percent
- Reported percent passing to the nearest 1 percent, except 75 μm (No. 200) sieve to the nearest 0.1 percent.