

WSDOT Errata to FOP for AASHTO T 30

Mechanical Analysis of Extracted Aggregate

WAQTC FOP for AASHTO T 30 has been adopted by WSDOT with the following changes:

Procedure

18. *Step not recognized by WSDOT.*

MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE FOP FOR AASHTO T 30

Scope

This procedure covers mechanical analysis of aggregate recovered from asphalt mix samples in accordance with AASHTO T 30-24. This FOP uses the aggregate recovered from the ignition furnace 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 to determine compliance with design and production standards.

Apparatus

- Balance or scale: Capacity sufficient for the sample mass, readable to 0.1 g and conforming to AASHTO M 231.
- Sieves, meeting the requirements of FOP for AASHTO T 27/T 11.
- Mechanical sieve shaker, meeting the requirements of FOP for AASHTO T 27/T 11.
- Mechanical Washing Apparatus (optional).
- Suitable drying equipment, meeting the requirements of the FOP for AASHTO T 255.
- Containers: 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.
- Wetting Agent: Any dispersing agent, such as dishwashing detergent, that will promote separation of the fine materials.
- Utensil: device for agitating the sample during the washing procedure.

Sample Sieving

- In this procedure, it is required to shake the sample over nested sieves. Sieves are selected to furnish information required by specification. Intermediate sieves are added for additional information or to avoid overloading sieves, or both.
- The sieves are nested in order of increasing size from the bottom to the top, and the test sample, or a portion of the test sample, is placed on the top sieve.
- The loaded sieves are shaken in a mechanical shaker for approximately 10 minutes, refer to Annex A; *Time Evaluation*.

Mass Verification

The aggregate sample mass, $M_{(T30)}$, determined in this method, shall agree with the mass of the aggregate remaining after ignition, M_f from the FOP for AASTHO T 308, within 0.1 percent. If the variation exceeds 0.1 percent, the results cannot be used for acceptance.

Procedure

1. Determine and record the mass of the sample that was removed from the basket in the FOP for AASHTO T 308 to 0.1 g. Designate this mass as $M_{(T30)}$.
 2. Verify the mass of the sample is within 0.1 percent by subtracting $M_{(T30)}$ from $M_{f(T308)}$ dividing by $M_{f(T308)}$ and multiplying by 100 (see *Mass Verification Calculation* and example).
If the variation exceeds 0.1 percent, the sieve analysis results cannot be used for acceptance.
 3. 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.
 4. Place the test sample in a container and cover with water. Add a wetting agent 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.
 5. 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. Use a utensil to aid in the agitation process. To avoid degradation of the sample when using a mechanical washing device do not exceed 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.
6. Immediately pour the wash water containing the suspended material over the nested sieves; be careful not to pour out the coarser particles or over fill the 75 μ m (No. 200) sieve.
 7. Add water to cover material remaining in the container, agitate, and repeat Step 6. Continue until the wash water is reasonably clear. Rinse utensil into the washed sample.
 8. Remove the upper sieve, return material retained to the washed sample.
 9. Rinse the material retained on the 75 μ m (No. 200) sieve until water passing through the sieve is reasonably clear and wetting agent is removed.
 10. Return all material retained on the 75 μ m (No. 200) sieve to the washed sample by rinsing into the washed sample.
 11. Dry the washed test sample to constant mass according to the FOP for AASHTO T 255. Cool to room temperature. Determine and record the “dry mass after washing.”
 12. Select sieves required by the specification and those necessary to avoid overloading. (See Annex B.) With a pan on bottom, nest the sieves increasing in size starting with the 75 μ m (No. 200).
 13. Place the test sample, or a portion of the test sample, on the top sieve.
 14. 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, the time determined by Annex A).

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

15. Determine and record the individual or cumulative mass retained for each sieve including the pan. Ensure that all material trapped in full openings of the sieves are removed and included in the mass retained.

Note 3: For sieves 4.75 mm (No. 4) and larger, check material trapped in less than a full opening 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.

16. Perform the *Check Sum* calculation – Verify the *total mass after sieving* of material compared to the *dry mass after washing* is not more than 0.2 percent. Do not use test results for acceptance if the *Check Sum* result is more than 0.2 percent.

17. Calculate the total percentages passing, and the individual or cumulative percentages retained, to the nearest 0.1 percent by dividing the individual sieve masses or cumulative sieve masses by the total mass of the initial dry sample.

18. Apply the Aggregate Correction Factor (ACF) to the calculated percent passing, as required in the FOP for AASHTO T 308 “Correction Factor,” to obtain the reported percent passing.

19. Report total percent passing to 1 percent except report the 75 µm (No. 200) sieve to 0.1 percent.

Calculations

Mass verification

$$\text{Mass verification} = \frac{M_{f(T308)} - M_{(T30)}}{M_{f(T308)}} \times 100$$

Where:

$M_{f(T308)}$ = Mass of aggregate remaining in the basket assembly after ignition from the FOP for AASHTO T 308

$M_{(T30)}$ = Mass of aggregate sample obtained from the FOP for AASHTO T 308

Check Sum

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

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Percent Retained**Individual**

$$IPR = \frac{IMR}{M_{T30}} \times 100$$

Cumulative

$$CPR = \frac{CMR}{M_{T30}} \times 100$$

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**Individual**

$$PP = PCP - IPR$$

Cumulative

$$PP = 100 - CPR$$

Where:

- PP = Calculated Percent Passing
 PCP = Previous Calculated Percent Passing

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Reported Percent Passing

$$RPP = PP + ACF$$

Where:

RPP = Reported Percent Passing

ACF = Aggregate Correction Factor (if applicable)

Example**Mass verification**

$$\text{Mass verification} = \frac{2422.5 \text{ g} - 2422.3 \text{ g}}{2422.5 \text{ g}} \times 100 = 0.0\%$$

Given:

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

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

Dry mass of total sample, before washing (M_{T30}): 2422.3 gDry mass of sample, after washing out the 75 μm (No. 200) minus: 2296.2 gAmount of 75 μm (No. 200) minus washed out ($2422.3 \text{ g} - 2296.2 \text{ g}$): 126.1 g**Check sum**

$$\text{check sum} = \frac{2296.2 \text{ g} - 2295.3 \text{ g}}{2296.2 \text{ g}} \times 100 = 0.0\%$$

This is not more than 0.2 percent therefore the results can be used for acceptance purposes.

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Percent Retained for the 75 µm (No. 200) sieve

$$IPR = \frac{63.5 \text{ g}}{2422.3 \text{ g}} \times 100 = 2.6\%$$

or

$$CPR = \frac{2289.6 \text{ g}}{2422.3 \text{ g}} \times 100 = 94.5\%$$

Percent Passing using IPR and PCP for the 75 µm (No. 200) sieve

$$PP = 8.1\% - 2.6\% = 5.5\%$$

Percent Passing using CPR for the 75 µm (No. 200) sieve

$$PP = 100.0\% - 94.5\% = 5.5\%$$

Reported Percent Passing

$$RPP = 5.5\% + (-0.6\%) = 4.9\%$$

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**Individual
Gradation on All Sieves**

Sieve Size mm (in.)	Individual Mass Retained g (IMR)	Determine IPR by dividing IMR by M and multiplying by 100	Individual Percent Retained (IPR)	Determine PP by subtracting IPR from Previous PP	Percent Passing (PP)	Agg. Corr. Factor from T 308 (ACF)	Reported Percent Passing*
19.0 (3/4)	0		0		100.0		100
12.5 (1/2)	346.9	$\frac{346.9}{2422.3} \times 100 =$	14.3	$100.0 - 14.3 =$	85.7		86
9.5 (3/8)	207.8	$\frac{207.8}{2422.3} \times 100 =$	8.6	$85.7 - 8.6 =$	77.1		77
4.75 (No. 4)	625.4	$\frac{625.4}{2422.3} \times 100 =$	25.8	$77.1 - 25.8 =$	51.3		51
2.36 (No. 8)	416.2	$\frac{416.2}{2422.3} \times 100 =$	17.2	$51.3 - 17.2 =$	34.1		34
1.18 (No. 16)	274.2	$\frac{274.2}{2422.3} \times 100 =$	11.3	$34.1 - 11.3 =$	22.8		23
0.600 (No. 30)	152.1	$\frac{152.1}{2422.3} \times 100 =$	6.3	$22.8 - 6.3 =$	16.5		17
0.300 (No. 50)	107.1	$\frac{107.1}{2422.3} \times 100 =$	4.4	$16.5 - 4.4 =$	12.1		12
0.150 (No. 100)	96.4	$\frac{96.4}{2422.3} \times 100 =$	4.0	$12.1 - 4.0 =$	8.1		8
0.075 (No. 200)	63.5	$\frac{63.5}{2422.3} \times 100 =$	2.6	$8.1 - 2.6 =$	5.5	-0.6 (5.5 - 0.6 =)	4.9
minus 75 μ m (No. 200) in the pan	5.7						
Total mass after sieving = sum of sieves + mass in the pan = 2295.3 g							
Dry mass of total sample, before washing (M_{T30}): 2422.3g							

* Report total percent passing to 1 percent except report the 75 μ m (No. 200) sieve to 0.1 percent.

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**Cumulative
Gradation on All Sieves**

Sieve Size mm (in.)	Cumulative Mass Retained g (CMR)	Determine CPR by dividing CMR by M and multiplying by 100	Cumulative Percent Retained (CPR)	Determine PP by subtracting CPR from 100.0	Percent Passing (PP)	Agg. Corr. Factor from T 308 (ACF)	Reported Percent Passing*
19.0 (3/4)	0		0.0		100.0		100
12.5 (1/2)	346.9	$\frac{346.9}{2422.3} \times 100 =$	14.3	$100.0 - 14.3 =$	85.7		86
9.5 (3/8)	554.7	$\frac{554.7}{2422.3} \times 100 =$	22.9	$100.0 - 22.9 =$	77.1		77
4.75 (No. 4)	1180.1	$\frac{1180.1}{2422.3} \times 100 =$	48.7	$100.0 - 48.7 =$	51.3		51
2.36 (No. 8)	1596.3	$\frac{1596.3}{2422.3} \times 100 =$	65.9	$100.0 - 65.9 =$	34.1		34
1.18 (No. 16)	1870.5	$\frac{1870.5}{2422.3} \times 100 =$	77.2	$100.0 - 77.2 =$	22.8		23
0.600 (No. 30)	2022.6	$\frac{2022.6}{2422.3} \times 100 =$	83.5	$100.0 - 83.5 =$	16.5		17
0.300 (No. 50)	2129.7	$\frac{2129.7}{2422.3} \times 100 =$	87.9	$100.0 - 87.9 =$	12.1		12
0.150 (No. 100)	2226.1	$\frac{2226.1}{2422.3} \times 100 =$	91.9	$100.0 - 91.9 =$	8.1		8
0.075 (No. 200)	2289.6	$\frac{2289.6}{2422.3} \times 100 =$	94.5	$100.0 - 94.5 =$	5.5	-0.6 (5.5 - 0.6 =)	4.9
minus 75 μ m (No. 200) in the pan	2295.3						
Total mass after sieving = 2295.3 g							
Dry mass of total sample, before washing (M_{T30}): 2422.3g							

* Report total percent passing to 1 percent except report the 75 μ m (No. 200) sieve to 0.1 percent.

Report

- 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
- Percent passing to the nearest 1 percent, except 75 μm (No. 200) sieve to the nearest 0.1 percent.

ANNEX A TIME EVALUATION

(Mandatory Information)

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 before 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.

ANNEX B OVERLOAD DETERMINATION

(Mandatory Information)

- For sieves with openings smaller than 4.75 mm (No. 4), the mass retained on any sieve shall not exceed 7 kg/m² (4 g/in²) 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 x (sieve opening in mm) x (effective sieving area). See Table B1.

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 B1
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	203 mm	254 mm	305 mm
mm (in.)	(8 in.)	(10 in.)	(12 in.)
	dia.	dia.	dia.
Sieving Area m² (in²)			
	0.0285	0.0457	0.0670
	(44.2)	(70.8)	(103.5)
50 (2)	3600	5700	8400
37.5 (1 1/2)	2700	4300	6300
25.0 (1)	1800	2900	4200
19.0 (3/4)	1400	2200	3200
16.0 (5/8)	1100	1800	2700
12.5 (1/2)	890	1400	2100
9.5 (3/8)	670	1100	1600
6.3 (1/4)	440	720	1100
4.75 (No. 4)	330	540	800
-4.75 (-No. 4)	200	320	470

PERFORMANCE EXAM CHECKLIST

**MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE
FOP FOR AASHTO T 30**

Participant Name _____ Exam Date _____

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Total dry mass determined to 0.1 g?	_____	_____
2. Dry mass agrees with sample mass after ignition (M_f) from AASHTO T 308 within 0.1 percent?	_____	_____
3. Sample placed in container and covered with water?	_____	_____
4. Wetting agent added?	_____	_____
5. Contents of container agitated vigorously with a utensil?	_____	_____
6. Wash water poured through proper nest of two sieves?	_____	_____
7. Washing continued until wash water is reasonably clear and no wetting agent remaining?	_____	_____
8. Retained material returned to washed sample?	_____	_____
a. Utensil rinsed?	_____	_____
9. Washed material coarser than 75 μm (No. 200) dried to constant mass at 110 \pm 5 $^\circ\text{C}$ (230 \pm 9 $^\circ\text{F}$)?	_____	_____
10. Sample cooled to room temperature?	_____	_____
11. Dry mass after washing determined to 0.1 g?	_____	_____
12. Material sieved on specified sieves?	_____	_____
13. Mass of each fraction of aggregate, including minus 75 μm (No. 200), determined and recorded to 0.1 g?	_____	_____
14. Total mass of material after sieving agrees with mass before sieving to within 0.2 percent?	_____	_____
15. Percent passing each sieve determined correctly to the nearest 0.1 percent?	_____	_____
16. Aggregate correction factor applied, if applicable?	_____	_____
17. Percent passing on each sieve reported correctly to the nearest 1 percent and nearest 0.1 percent on the 75 μm (No. 200)?	_____	_____

Comments: First attempt: Pass _____ Fail _____ Second attempt: Pass _____ Fail _____

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Examiner Signature _____ WAQTC #: _____