T 113

LIGHTWEIGHT PIECES IN AGGREGATE
FOP FOR AASHTO T 113

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02 ## Scope

This FOP describes methods of determining the percentage of lightweight pieces in coarse and fine aggregates.

Aggregates are tested in a saturated-surface-dry (SSD) condition in a heavy solution of the required specific gravity. Floating particles are removed from the sample with a skimming device, and the percentage of lightweight pieces is calculated as the proportion by mass of floating particles to that of the original sample tested.

03 ## Significance

This method is used to determine conformance with AASHTO M 6 and M 80 regarding the permissible amounts of lightweight pieces in fine and coarse aggregates. For this FOP, coal and lignite particles are defined as those having a specific gravity less than 2.00; chert particles are those having a specific gravity less than 2.40.

04 ## Apparatus

- **Balance:** Meeting requirements of AASHTO M 231, of sufficient capacity and readable to 0.1% of sample mass or better.
- **Containers:** Suitable for drying the aggregate samples and suitable for containing the heavy liquids during test.
- **Skimmer:** A suitably shaped piece of No. 50 screen cloth conforming to AASHTO M 92 for removing floating pieces during the sink-float separation portion of the test.

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- **Oven or Hotplate:** Capable of maintaining a uniform temperature of 230 ±9° F.
- **Sieves:** No. 50 and No. 4 sieves conforming to AASHTO M 92.
- **Specific Gravity Measurement:** Hydrometers conforming to ASTM E 100 for the desired ranges of heavy liquid specific gravity, or suitable balance and glassware capable of measuring specific gravity within ±0.01.

06 **Heavy Liquid**

The heavy liquid shall be one of the following:

- A solution of zinc chloride in water for materials having specific gravities less than 2.00.
- A solution of zinc bromide in water for materials having a specific gravity of less than 2.60.
- 07 A mixture of kerosene and 1,1,2,2 tetrabromoethane, proportioned to produce solutions of the desired specific gravity.
- Heavy liquid specific gravities shall be maintained within ±0.01 at all times during the testing procedure.

08 **Safety**

The chemicals used to make the heavy liquids are toxic, both by inhalation and absorption through the skin.

Suitable personal protective equipment such as face shields, goggles, and gloves must be worn to prevent inhalation or skin contact. Solutions must be used only in vent hoods or out of doors.

09 **Sampling**

Obtain the sample according to AASHTO T 2. Reduce to appropriate testing size according to AASHTO T 248.

The sample used for testing shall conform to the requirements of Table 1.

Table 1 – Test Sample Size 10

Nominal Maximum Aggregate Size	Minimum Sample Mass (g)
No. 4	200
3/8”	1500
3/4”	3000
1½”	5000
3”	10000

Sample Preparation

11 Dry the sample to constant mass and cool to room temperature prior to conducting the test. Constant mass is defined as that moisture condition where there is no more than 0.1% loss in mass after an additional 2 hours of drying in an oven regulated at 230 ±9° F.

Procedure

Fine Aggregate

12 1. Sieve the dried material over a No. 50 screen until less than 1% of the retained material passes the screen after an additional 1 minute of continuous sieving.

13 2. Determine the mass of the material coarser than the No. 50 screen to the nearest 0.1 g and bring to a saturated-surface-dry (SSD) state as described in AASHTO T 84 (See Note 1).

14 3. Introduce the sample into the heavy liquid in a container of suitable size such that the volume of the liquid is at least three times the absolute volume of the fine aggregate. Agitate the sample in the liquid to permit lightweight pieces to float.

4. Pour the heavy liquid and floating pieces over the skimmer into a second container, taking care to not decant any of the particles that sank.

15 5. Return to the first container the liquid from the second container, agitate, and repeat step 4 until the sample has no more floating pieces.

6. Wash the decanted pieces in the skimmer with a suitable solvent to remove the heavy liquid, and allow them to become at least surface dry (See Note 2).

16 7. Further dry the washed sample to constant mass as noted under sample preparation.

If a heavy liquid was made using kerosene and tetrabromoethane, drying shall take place either out of doors or under a vent hood. If an oven is used, it must be forced air ventilated. In no case may the sample temperature exceed 239° F.

Note 1: As an alternative to the full soaking period stated in AASHTO T 84, if the aggregate absorption is known for the material being tested, the mass of water required to achieve the SSD state may be added to the dry sample, thoroughly mixed and covered for at least 30 minutes. Remix the sample at the end of the saturation period and test for the SSD condition according to AASHTO T 84.

Note 2: Water is a suitable solvent for solutions made with zinc bromide or zinc chloride. Alcohol is a suitable solvent for solutions made with 1,1,2,2, tetrabromoethane

17 8. Allow the sample to cool to room temperature and determine the mass of the lightweight pieces to the nearest 0.1 g.

Coarse Aggregate

18 1. Sieve the dried material over a No. 4 screen until less than 1% of the retained material passes the screen after an additional 1 minute of continuous sieving.

2. Determine the mass of the material coarser than the No. 4 screen to the nearest 1 g and bring material to a saturated-surface-dry (SSD) state as described in AASHTO T 85.

19 3. Introduce the sample into the heavy liquid in a container of suitable size such that the volume of the liquid is at least three times the absolute volume of the coarse aggregate. Agitate the sample in the liquid to permit lightweight pieces to float.

4. Using the skimmer, remove the floating pieces and save them. Repeatedly agitate the material in the heavy liquid and remove the lightweight pieces until no more pieces float to the surface.

20 5. Wash the lightweight pieces with a suitable solvent to remove the heavy liquid (See Note 2). After washing allow the pieces to become at least surface dry prior to drying to constant mass.

6. Further dry the washed sample to constant mass as noted under sample preparation.

21 **If a heavy liquid was made using kerosene and tetrabromoethane, drying shall take place either out of doors or under a vent hood. If an oven is used, it must be forced air ventilated. In no case may the sample temperature exceed 239° F.**

22 7. Allow the sample to cool to room temperature and determine the mass of the lightweight pieces to the nearest 1 g.

Calculations

Calculate the percentage of lightweight pieces according to the following formulas:

23 **Fine Aggregate**

$$\mathbf{L = 100\frac{W_1}{W_2}}$$

24 **Coarse Aggregate**

$$\mathbf{L = 100\frac{W_1}{W_3}}$$

where:

L = percentage of lightweight pieces

W_1 = dry mass of pieces that float

W_2 = dry mass of portion of specimen coarser than the No. 50 screen

W_3 = dry mass of portion of specimen coarser than the No. 4 screen

25 **Report**

- Report on standard agency forms
- Project identification and location
- Material source and description, including nominal maximum size
- Type(s) and specific gravity of solution(s)
- Percentage of Lightweight pieces categorized as coal & lignite (specific gravity less than 2.00), calculated to the nearest 0.1%
- Percentage of lightweight pieces categorized as chert (specific gravity less than 2.40), calculated to the nearest 0.1%

Tips

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- Follow all required safety precautions during testing and when drying samples to constant mass after the sink-float procedure.
- Use the appropriate heavy liquids. (specific gravity of 2.40 for chert; 2.00 for coal & lignite).
- Check heavy liquid specific gravity frequently to assure that variation does not exceed ±0.01 at any time during testing.

REVIEW QUESTIONS

1. According to this FOP, what is the minimum required test sample mass when nominal maximum size is ¾ inch; when nominal maximum size is 1 inch?

2. Summarize specific gravity requirements for the heavy liquid(s).

3. Describe the safety precautions when handling the chemicals and heavy liquids.

4. In what moisture condition are aggregates when the sink-float procedure is performed?

5. What is the minimum volume of heavy solution needed for a coarse aggregate sample of 3812 grams having a specific gravity of 2.653?

6. Describe the skimming process for coarse aggregate testing.

7. Describe the remaining procedures after the skimming process but prior to calculation.

8. Given the following, the percentage of chert particles as reported is _____.

   Dry Mass of Sample Before Test: 3812 g
   Dry Mass of Lightweight Pieces (Chert): 13 g
   Dry Bulk Specific Gravity (Gsb): 2.649

PERFORMANCE EXAM CHECKLIST

LIGHTWEIGHT PIECES IN AGGREGATE
FOP FOR AASHTO T 113

Participant Name:_____ Exam Date:_____

Procedure

Heavy Liquid Preparation and Safety

1. Solution(s) correctly prepared using all required safety procedures? _____
2. Specific gravity of solution checked with hydrometers or suitable glassware and is ±0.01 of that specified (2.00 for coal and lignite; 2.40 for chert)? _____
3. Sufficient heavy liquid placed in a suitable container that will permit use of the skimming device (volume of solution at least 3 times that of the solid volume of the aggregate being tested)? _____
4. All required safety precautions adequately described (PPE, ventilated hood, temperature control, etc)? _____

Sampling and Sample Preparation

1. Sample obtained by AASHTO T 2 and reduced by T 248? _____
2. Sample of suitable size? (Table 1) _____
3. Aggregate dried to constant mass at 230 ±9° F? _____

Procedure (Fine Aggregate)

1. All masses determined to 0.1 g? _____
2. Sample sieved over No. 50 screen until less than 1% of material passes after 1 minute of continuous sieving? _____
3. Mass correctly determined and sample brought to SSD condition? _____
4. Material placed in heavy liquid and agitated? _____
5. Liquid poured off over skimmer into second container without decanting pieces that sank? _____
6. Liquid returned to first container and the agitation and skimming process continued until no more floating particles appear? _____
7. Lightweight pieces cleaned of heavy solution in an appropriate solvent and allowed to surface dry? _____
8. Lightweight pieces further dried to constant mass and allowed to cool? _____
9. Final dry mass of lightweight pieces determined? _____
10. Specific gravity of solution after testing within ±0.01 of the value before test? _____
11. Calculations properly performed and reported to 0.1%? _____

Procedure (Coarse Aggregate)

1. All masses determined to 1 g? _____
2. Sample sieved over No. 4 screen until less than 1% of material passes after 1 minute of continuous sieving? _____
3. Mass correctly determined and sample brought to SSD condition? _____
4. Material placed in heavy liquid and agitated? _____
5. Floating particles removed using skimmer and saved? _____
6. Agitation and skimming process continued until no more floating particles appear? _____
7. Lightweight pieces cleaned of heavy solution in an appropriate solvent and allowed to surface dry? _____
8. Lightweight pieces further dried to constant mass and allowed to cool? _____
9. Final dry mass of lightweight pieces determined? _____
10. Specific gravity of solution after testing within ±0.01 of the value before test? _____
11. Calculations properly performed and reported to 0.1%? _____

Comments: First attempt: (Pass/Fail) ___ Second attempt: (Pass/Fail) ___

Signature of Examiner_____.