Method of

DETERMINATION OF SPECIFIC GRAVITY OF AGGREGATE AND MINERAL FILLER FOR ASPHALTIC MIXTURES

DOTD Designation: TR 300-87

INTRODUCTION

These methods of test are intended for determining the specific gravity of aggregate and mineral filler used in asphaltic mixtures based on asphalt absorption of aggregate as determined in accordance with DOTD Designation: TR 320 and water absorption of aggregate as determined in accordance with AASHTO Designations: T 84 for fine aggregate and T 85 for coarse aggregate.

TABLE OF METHODS

Method A - Apparent Specific Gravity of Coarse Aggregate having a low absorption.

Method B - Apparent Specific Gravity of Fine Aggregate having a low absorption. This method is also used for determining the apparent specific gravity of mineral filler.

Method C - Effective Specific Gravity of Aggregates (Coarse, Fine or Combined) having a high absorption.

NOTE: Low absorption aggregates are aggregates having a water absorption of 2.0 percent or less and an asphalt absorption of 0.5 percent or less.

High absorption aggregates are aggregates having a water absorption greater than 2.0 percent or an asphalt absorption greater than 0.5 percent.

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METHOD A
APPARENT SPECIFIC GRAVITY OF COARSE AGGREGATE

Scope

1. This method of test is intended for determining the apparent specific gravity of coarse aggregate for use in asphaltic mixtures. The apparent specific gravity of an aggregate is based on the impermeable volume of the aggregate. This method is to be used for coarse aggregate having a water absorption of 2.0 percent or less and an asphalt absorption of 0.5 percent or less such as nonporous gravel and nonporous crushed stone.

Apparatus

2. (a) *Balance* - A balance having a capacity of 2 kg or more and sensitive to 0.1 g suitably arranged with appurtenances for weighing samples in air and in water.

(b) *Oven* - A constant temperature oven capable of maintaining any temperature between 100 and 400 ± 5°F.

(c) *Vacuum pump*

(d) *Miscellaneous tools* - Pot, stirring spoon, spatula, half-gallon mason jar with special cap (or other suitable container), etc.

Sample

3. (a) The sample of aggregate shall consist of approximately ten pounds and be representative of the material to be used.

(b) Samples of the coarse aggregate shall be screened through a No. 4 mesh sieve. If the material passing this sieve is more than 5%, the specific gravity of this fraction shall be determined in accordance with Method B for the Apparent Specific Gravity of Fine Aggregate and Mineral Filler.

Procedure

4. (a) Select approximately 1 to 2 kilograms of the aggregate from the sample to be tested by using DOTD Designation: TR 108, Method of Splitting and Quartering Samples. In no event shall a predetermined weight be used.

(b) Thoroughly wash the sample to remove dust or other coatings from the surface of the particles (see Figure 1), then immerse the sample in water for 24 ± 2 hours.

FIGURE 1

Washing Sample of Coarse Aggregate for Specific Gravity

(c) Transfer the sample into a mason jar (half-gallon capacity) or other suitable container. Fill the jar with water to a level approximately 1 inch above the surface of the aggregate and attach to a vacuum for 15 to 30 minutes as shown in Figure 2.

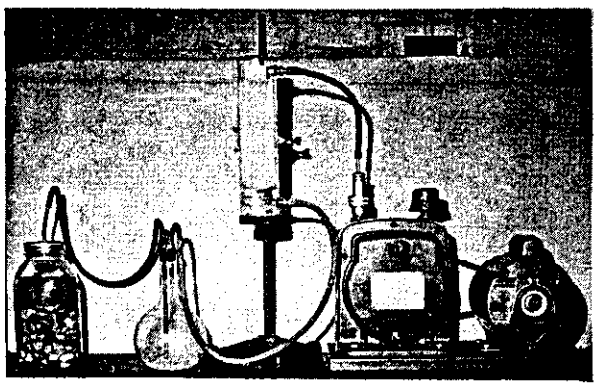

FIGURE 2

Coarse Aggregate Under Vacuum

(d) Place the sample in the weighing bucket (previously filled with water) and stir for approximately 30 seconds using a spatula to eliminate the presence of any trapped air bubbles.

(e) Place the weighing bucket in testing position and determine the weight of the sample under water. (See Figure 3.)

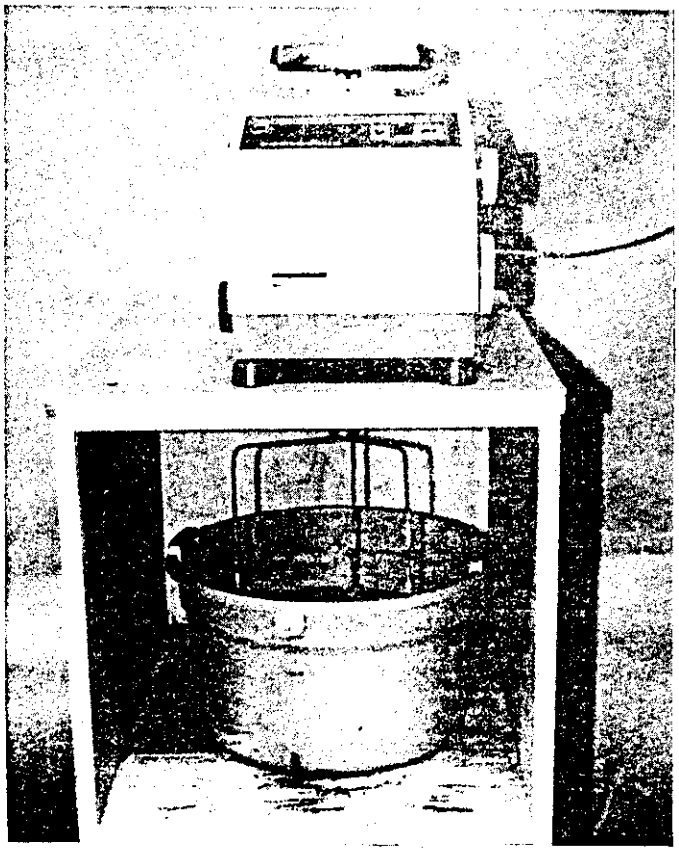

FIGURE 3
Weighing Sample in Water

(f) Dry the sample to constant weight at a temperature of 230 ± 9°F, cool to room temperature and weigh in air.

Calculations

5. Calculate the apparent specific gravity using the following formula:

$$\text{Apparent Sp. Gr.} = \frac{A}{A - B}$$

where:

A = wt. in air, g
B = wt. in water, g

example:

wt. in air (A) = 1202.1 g
wt. in water (B) = 742.3 g

$$\frac{1202.1}{1202.1 - 742.3}$$

$$= \frac{1202.1}{459.8}$$

Apparent Sp. Gr. = 2.61

Report

6. The result shall be reported as apparent specific gravity to the nearest hundredth (0.01).

Normal testing time is 2 days.

DOTD Designation: TR 300-87

METHOD B

APPARENT SPECIFIC GRAVITY OF FINE AGGREGATE AND MINERAL FILLER

Scope

1. This method is intended for determining the apparent specific gravity of mineral filler and fine aggregate (fraction passing a No. 4 mesh sieve) for use in asphaltic mixtures. The apparent specific gravity of an aggregate is based on the impermeable volume of the aggregate. This method is to be used for fine aggregate having a water absorption of 2.0 percent or less and an asphalt absorption of 0.5 percent or less.

Apparatus

2. (a) *Balance* - A balance having a capacity of 2 kg or more and sensitive to 0.1 g.

(b) *Oven* - A constant temperature oven capable of maintaining any temperature between 100 and 400 ± 5°F.

(c) *Vacuum pump*

(d) *Flask* - A 500 ml volumetric flask calibrated to within 0.15 ml at 77°F.

(e) *Water bath* - A water bath capable of maintaining a temperature of 77 ± 2°F.

(f) *Distilled water*

(g) *Pan* - Pan or suitable container for drying sample.

Sample

3. The sample shall consist of approximately five pounds of fine aggregate or one pound of mineral filler and be representative of the material to be used.

Procedure

4. (a) Place a 1000 gram portion of the fine aggregate in a suitable container and dry to constant weight at a temperature of 230 ± 9°F. Obtain 200-300 grams from the 1000 gram portion by using DOTD Designation: TR 108, Method of Splitting and Quartering (100 - 125 grams should be used for mineral fillers).

(b) Cool the sample to room temperatur and pour into the tared volumetric flask.

(c) Weigh the flask and contents Fill the flask with distilled water to a leve approximately 1 inch above the surface of the fin aggregate.

(d) The flask and contents shall b left at room temperature for 24 ± 2 hours. Afte this time it shall be placed under vacuum fo 15-30 minutes. (See Figure 1.)

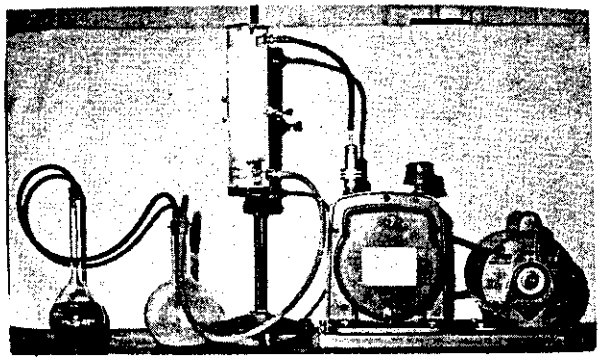

FIGURE I

Fine Aggregate Under Vacuum

(e) The water level shall be brought slightly above the calibration mark and placed a water bath at 77 ± 2°F for approximately 1 hou

(f) Adjust the water level so that t bottom of the meniscus will be at the same lev with the calibration mark.

(g) Weigh the flask and contents a record the weight.

Calculations

5. Calculate the apparent specific gravi using the following formula:

$$\text{Apparent Sp. Gr.} = \frac{A - B}{498.6 - C + A}$$

where:

A = wt. of flask + dry sample, g
B = wt. of flask, g
C = wt. of flask + sample + water, g

498.6 = a constant wt. of 500 ml of distilled water at 77 ± 2°F

example:

wt. of flask + dry sample (A) = 413.4 g
wt. of flask (B) = 189.2 g
wt. of flask + sample + water (C) = 826.6 g

$$\frac{413.4 - 189.2}{498.6 - 826.6 + 413.4}$$

$$= \frac{224.2}{85.4}$$

Apparent Sp. Gr. = 2.63

Report

6. The result shall be reported as apparent specific gravity to the nearest hundredth (0.01).

Normal testing time is 2 days.

DOTD Designation: TR 300-87

METHOD C

EFFECTIVE SPECIFIC GRAVITY OF AGGREGATES

Scope

1. This method of test is intended to determine the effective specific gravity of coarse, fine or combined aggregates for use in asphaltic mixtures. The effective specific gravity of an aggregate includes all void spaces in the aggregate particles except those that absorb asphalt. This method is to be used for aggregates having a water absorption greater than 2.0 percent or an asphalt absorption greater than 0.5 percent such as slag, shell, porous stone, recycled portland cement concrete, expanded clay, etc.

Apparatus

2. (a) *Balance* - A balance having a capacity of 2000 g or more and sensitive to 0.1 g.

(b) *Oven* - A constant temperature oven capable of maintaining any temperature between 100 and 400 ± 5°F.

(c) *Vacuum pump*

(d) *Water bath* - A water bath capable of maintaining a temperature of 77 ± 2°F.

(e) *Miscellaneous tools* - Enameled pot or mixing bowl, stirring spoon, half-gallon mason jar with special cap, pans, aluminum foil, etc.

(f) *1,1,1-Trichloroethane*

(g) *Extraction apparatus* - Same as DOTD Designation: TR 307, Alternate No. 1.

(h) *Glass plate* - Glass plate or watch glass.

Sample

3. (a) The sample of aggregate shall consist of approximately ten pounds and be representative of the material to be used.

(b) A quart sample of asphalt cement of the same source and grade to be used during construction should be obtained if possible. If not available, an asphalt cement of similar physical characteristics may be used.

Procedure

4. Two tests shall be run and the average used as the effective specific gravity of the aggregate.

(a) Dry the aggregate to con weight at a temperature of 230 ± 9°F and sep in accordance with DOTD Designation: TR Method of Splitting and Quartering.

(b) Weigh out and record the weig two approximately 1000 gram portions of aggregate and place each in a separate, c enameled pot or mixing bowl (500 grams if only minus No. 4 material).

(c) Heat the aggregate and as cement separately to 300 - 325°F.

(d) Mix the aggregate with e asphalt cement to completely and uniformly each aggregate particle. During mixing it m necessary to hold the pot over a bunsen burne just a few minutes to achieve a uniform coa

> A minimum of 4% asphalt retained coating as calculated in paragraph 5 (a) is required. Generally, the addition of approximately 6% asphalt cement by weight to the mixing pot bowl will yield the 4% minimum required. M asphalt cement will be needed when the samp contains a large amount of fines.

(e) Cover the pot or bowl with foi place mixture in the oven at 300 ± 5°F hours ± 20 minutes.

(f) After 6 hours, remove sample oven and remix. If any particles are completely coated with asphalt, additional as cement (heated to 300 - 325°F) will be adde the sample remixed.

(g) Spread the mixture onto a piece of aluminum foil and allow to cool to temperature. (At this point, if the test c be completed within the workday, the mixtur be left on foil overnight and the test cont the following morning.) Add a minimal amou trichloroethane to each emptied sample cont (with stirring spoons remaining in container separate the asphalt from aggregate part remaining in containers and on spoons.

(1) Dry the sheets of filter and weigh each separately to the nearest 0.1

(2) Fold each separately o diameter and fold twice again, one fold being over the other to make three segments. Op form a hollow 3-ply cone with a single seam. Place the cones in each of the metal 1

of the extraction apparatus.

(3) Holding by the bail, insert the first metal frame partially into the glass jar and, with trichloroethane, rinse contents from one sample container into the filter paper lined metal frame. After rinsing contents, place metal frame in the jar and repeat this step for the second metal frame. (At no time should the solvent level contact the tip of the cone in the lower frame.)

(4) Place loaded jar on electric hot plate, cover with condenser and circulate cold water through it, regulating to a gentle, steady flow.

(5) Adjust hot plate so that solvent boils gently and a steady flow of condensed solvent drips into the top cone. Care must be taken to adjust heat so that the material in each cone is covered with solvent and at the same time the cones do not overflow.

(6) Continue extraction until solvent running from tip of lower cone appears colorless when viewed against a white background; then shut off heat, but not water through condenser, and allow to stand until cool enough to handle.

(7) Remove metal frames from jar and allow to dry in air. When dry, transfer cones from the metal frames into pans and dry to constant weight in an oven operating at 230 ± 9°F.

(8) Remove pans from oven and weigh filter paper and contents of each separately. Subtract original weights of filter paper obtained in step 1 from these weights to determine the weights of aggregate.

(9) Subtract these weights of aggregate from the original weights obtained in step (b) to determine the weights of aggregate to be used in step 5 (a).

(h) Weigh the cooled mixture in air, being very careful not to lose any of the coated particles, and record the weight.

(i) Fill the half-gallon mason jar with water until the water is over the brim of the jar. Tightly screw the cap onto the jar and place jar under vacuum for approximately 5 minutes. Remove jar from vacuum and place in a water bath at 77 ± 2°F for approximately 1 hour. Remove jar from water bath, remove cap and carefully add water to refill the water level over the brim. Displace water using a glass plate in a manner not to create any unnecessary air pockets between the glass plate and water. Dry the outside of the jar with a clean cloth and remove glass plate in a manner not to disturb water in the jar. Weigh the water filled jar and record the weight.

(j) Pour approximately half of the water out of the jar and replace with the asphalt aggregate mixture. Replace as much water as needed to cover the mixture. Tightly screw the cap onto the jar and place under vacuum for a minimum of 30 - 45 minutes. Agitate the jar to release entrapped air.

(k) Remove jar from vacuum, remove cap and fill the jar with water until the water is over the brim. (Some of the lighter particles may float; however, after applying the cap these particles will become submerged into the water.) Tightly screw cap onto the jar and place in water bath at 77 ± 2°F for approximately 1 hour. Remove jar from water bath, remove cap and carefully add water to refill the water level over the brim. Displace water using a glass plate in a manner not to create any unnecessary air pockets between the glass plate and water. Dry the outside of the jar with a clean cloth and remove the glass plate in a manner not to disturb water in the jar. Weigh the water and mixture filled jar and record the weight.

Note: (It is permissible to have a small removable screen set into the neck of the jar to keep the lighter particles from coming above the top of the jar. If so the screen should be weighed with the jar whenever a weight is recorded.)

Calculations

5. (a) Calculate the exact percentage of asphalt in the mix using the following formula:

$$\% \text{ Asphalt in Mix (C)} = \frac{B - A}{B} \times 100$$

where:

A = wt. of agg. as determined in steps 4(b) and 4 (g)
B = wt. of mix as determined in step 4(h)

example:

wt. of aggregate from step 4(b) = 905.0
wt. of aggregate from step 4(g) = 6.0
wt. of aggregate (A) = 899.0
wt. of mix (B) = 946.5

$$\frac{946.5 - 899.0}{946.5} \times 100$$

$$= \frac{47.5}{946.5} \times 100$$

% Asphalt in Mix (C) = 5.01

(b) Calculate the specific gravity of the mixture using the following formula:

$$\text{Sp. Gr. of Mix (F)} = \frac{B}{D + B - E}$$

where:

B = wt. of mix as determined in step 4(h)
D = wt. of jar and water as determined in step 4(i)
E = wt. of jar, water and mix as determined in step 4 (k)

example:

wt. of mix (B) = 946.5
wt. of jar and water (D) = 2563.9
wt. of jar, water and mix (E) = 3117.6

$$\frac{946.5}{2563.9 + 946.5 - 3117.6}$$

$$= \frac{946.5}{392.8}$$

Sp. Gr. of Mix (F) = 2.41

(c) Calculate the percentage aggregate in the mix using the following for

$$\% \text{ Aggregate in Mix (X)} = 100 - C$$

where:

C = % asphalt in mix

example:

% asphalt in mix (C) = 5.01

% Aggregate in Mix (X) = 100 - 5.01 = 94

(d) Calculate the effective sp gravity of the aggregate using the fol formula:

$$\text{Eff. Sp. Gr. of Agg. (G)} = \frac{X}{\frac{100}{F} - }$$

where:

C = % asphalt in mix
F = sp. gr. of mix
H = sp. gr. of asphalt cement
X = % aggregate in mix

example:

% asphalt in mix (C) = 5.01
sp. gr. of mix (F) = 2.41
sp. gr. of asphalt cement (H) = 1.0
% aggregate in mix (X) = 94.99

$$\frac{94.99}{\frac{100}{2.41} - \frac{5.01}{1.03}}$$

$$= \frac{94.99}{36.63}$$

Eff. Sp. Gr. of Aggregate (G) = 2.59

Report

6. (a) If the two individual determinations deviate more than 0.01 from the average the tests shall be repeated.

(b) Report the average of two conforming determinations to the nearest hundredth (0.01) as the effective specific gravity of the aggregate.

NOTE: Use effective specific gravity of the absorptive aggregate to calculate the theoretical gravity of the asphaltic concrete mixture. See DOTD Designation: TR 304, Method B.

Normal testing time is 2 days.