T 224

CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST

FOP FOR AASHTO

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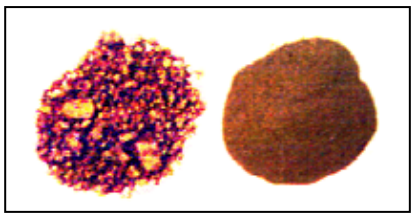
Significance

The procedures used to determine moisture-density relations in soils and soil-aggregate mixtures (AASHTO T 99 or T 180) are performed on samples obtained by sieving material through specified sieves. AASHTO T 99 and T 180 use the No. 4 or 3/4 in. sieve depending on the method (A, B, C, or D). These size limits are used because the equipment cannot accommodate large material.

When the material contains oversized (coarse) particles, an adjustment must be made to the optimum moisture content and maximum dry density.



Coarse and fine material

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Scope

This procedure covers the adjustment of the optimum moisture content and maximum dry density determined by the FOP for AASHTO T 99 / T 180 to compensate for coarse particles retained on the No. 4 or 3/4 in. sieve.

Two methods are available for correction; lab to field or field to lab. This FOP will cover only lab to field corrections (adjustment to the laboratory moisture-density test results).

See AASHTO T 224-01 (2004) for field to lab corrections.

The adjustment is based on the following:

- Density, moisture content, and percent by mass of the coarse material.
- Maximum dry density and optimum moisture content from the laboratory moisture-density test; and, percent by mass of the fine material.

For Methods A and B the adjustment is based on the percent of material retained on the No. 4 sieve (maximum of 40%). For Methods C and D, the adjustment is based on the percent of material retained on the 3/4 in. sieve (maximum of 30%).

Whether the split is on the No. 4 or the 3/4 in. sieve, all material retained on that sieve is defined

as coarse material.

This method applies to soils with percentages up to the maximums listed above for coarse particles. A correction may not be practical for soils with only a small percentage of coarse material.

The Agency shall specify a minimum percentage below which the method is not needed. If not specified, this method applies when more than 5 percent by mass of coarse particles is present.

Coarse and Fine Fraction Determination

When samples are split for determination of the percentages of coarse and fine fractions and the moisture content of the coarse material, use the following process.

04 1. Obtain a representative sample of material. This may be according to the FOP for AASHTO T 2, or by sampling from the footprint of the nuclear gauge as described in the FOP for AASHTO T 310. It is important that the sample container be sealed to prevent change in moisture content until testing begins.
2. Prior to drying, split the sample into coarse and fine fractions using the appropriate sieve. Determine and record moist mass of each fraction. Work quickly to prevent loss of moisture.
3. Dry the coarse material following the FOP for AASHTO T 255 / T 265 (Aggregate), or other agency-approved method. Record the mass and moisture content of the coarse fraction.
4. Dry the fine material using the appropriate method from FOP for AASHTO T 255 / T 265 or other agency-approved method. If the fine material is sandy in nature, use the instructions for aggregate. If the fine material contains any appreciable amount of clay, use the instructions for soil. Record the mass of the fine fraction.

05 ***Note 1:*** Some agencies permit determination of the percentage of coarse and fine fractions based on the mass of the materials in the moist condition.

06 5. Calculate the percentage of the fine and coarse particles by dry mass of the total sample as follows: (See Note 1)

$$P_f = \frac{100\,M_{DF}}{(M_{DF} + M_{DC})}$$

And

$$P_c = \frac{100\,M_{DC}}{(M_{DF} + M_{DC})}$$

Or, $P_c = 100 - P_f$

where:

P_f = percent of fine particles, by mass

P_c = percent of coarse particles, by mass

M_{DF} = mass of dry fine particles

M_{DC} = mass of dry coarse particles

Calculation Examples:

$$P_f = \frac{100 \times 15.4}{(15.4 + 5.7)} = 72.99, \text{say } 73.0\%$$

$$P_c = \frac{100 \times 5.7}{(15.4 + 5.7)} = 27.01, \text{say } 27.0\%$$

where:

M_{DF} = 15.4 lbs

M_{DC} = 5.7 lbs

$$M_D = \frac{M_m}{(1 + MC)}$$

where:

M_D = mass of dry material (fine or coarse).

M_m = mass of moist material (fine or coarse).

MC = moisture content of the fine or coarse portion, expressed as a decimal.

The preceding steps described drying the coarse and fine fractions in their entirety. Alternately, after completing step 2 above, the dry mass of the fractions may be calculated using the formula shown at the left. Use of this method is preferred when relatively large samples have been obtained that make drying the entire coarse and fine portions impractical.

This method requires splitting out representative samples from the coarse and fine fractions, and conducting moisture content testing according to the FOP for AASHTO T 255 / T 265.

07 **Moisture Adjustment**

When coarse particles are present, the optimum moisture content must be corrected. Adjustment to optimum moisture is based on the following:

- Optimum moisture content of the laboratory moisture-density test (T 99 or T 180)
- Moisture content of the coarse fraction
- Percentages of coarse and fine fractions present in the material

Note 2: Moisture content of coarse material can be assumed to be two (2) percent for most construction applications.

08 Calculate the corrected optimum moisture content according to the following formula:

$$MC_T = \frac{(MC_F \times P_f) + (MC_c \times P_c)}{100}$$

where:

MC_T = corrected optimum moisture content of the combined material, %

MC_F = optimum moisture content of the lab moisture-density test (T 99 or T 180)

P_f = percent fine fraction

MC_C = moisture content of coarse particles, % (See Note 2)

P_c = percent coarse fraction

09 Calculation Example:

10 $$MC_T = \frac{(7.9 \times 73) + (2.8 \times 27)}{100} = 6.52, \text{say } 6.5\%$$

where:

MC_T = corrected optimum moisture content, %

MC_F = 7.9%

P_f = 73.0%, from previous example

MC_C = 2.8%

P_c = 27.0%, from previous example

11 **Density Adjustment**

The density adjustment is based on:

- Percent, by mass, of coarse material
- Density of coarse material, where density equals the G_{sb}(OD) of coarse material times the unit weight of water
- Percent, by mass, of fine material
- Density of fine material (maximum dry density from moisture-density test)

Calculate the corrected dry density of the total sample (combined fine and coarse particles) as follows:

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$$D_d = \frac{100\, D_f\, k}{[(D_f)(P_c) + (k)(P_f)]}$$

or

$$D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

where:

D_d = corrected total dry density (combined fine and coarse particles), lb/ft^3

D_f = dry density of the fine particles determined in the lab, lb/ft^3

P_c = percent of coarse particles, by mass

P_f = percent of fine particles, by mass

k = 62.4 * G_{sb}(OD) of coarse particles, lb/ft^3 (See Note 3)

Note 3: If the G_{sb}(OD) is known, then this value will be used in the calculation. For most construction activities the G_{sb}(OD) of aggregate may be assumed to be 2.600.

Calculation

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Maximum laboratory dry density (D_f):	140.4 lb/ft^3
Percent coarse particles (P_c):	27%
Percent fine particles (P_f):	73%
Bulk Specific Gravity of Coarse Particles, G_{sb}(OD):	2.697
Mass per volume of coarse particles (k): (2.697)(62.4) =	168.3 lb/ft^3

$$D_d = \frac{(100)(140.4\,\text{lb/ft}^3)(168.3\,\text{lb/ft}^3)}{[(140.4\,\text{lb/ft}^3)(27) + (168.3\text{lb/ft}^3)(73)]}$$

$$D_d = \frac{2{,}362{,}932}{[3790.8 + 12285.9]}$$

$$D_d = \frac{2{,}362{,}932}{16{,}076.7}$$

D_d = 146.98, say 147.0 lb/ft^3

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Report

- Results shall be reported on standard forms approved by the agency.
- Report adjusted optimum moisture to the closest 0.1%.
- Report adjusted maximum dry density to the closest 0.1 lb/ft^3.

Tips!

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- Base the adjustment on the percent retained on the sieve size specified in the FOP for AASHTO T 99 / T 180.

REVIEW QUESTIONS

1. Describe the purpose of this procedure.

2. The adjustment is based on the mass of material retained on what size sieve?

3. A soil-aggregate mixture has a maximum dry density of 138.6 lb/ft^3. The coarse particles make up 22 percent of the material, and have a G_{sb}(OD) of 2.631.

   What is the corrected maximum density?