

## Colorado Procedure 25-13

*Standard Practice for*

### Calculation of Percent Relative Compaction of Soils and Soil-Rock Mixtures

#### 1. SCOPE

1.1 This procedure describes the method for calculating percent relative compaction of soils and soil-rock mixtures.

#### 2. REFERENCED DOCUMENTS

- 2.1 *AASHTO Procedures:*
- T 99 Moisture-Density Relations of Soils Using a 2.5-kg Rammer and a 305-mm Drop
  - T 180 Moisture-Density Relations of Soils Using a 4.54-kg Rammer and a 457-mm Drop
  - T 265 Laboratory Determination of Moisture Content of Soils
- 2.2 *Colorado Procedures:*
- CP 23 Determining Maximum Dry Density and Optimum Moisture Content of Soil-Rock Mixtures
  - CP 80 In-Place Density and Moisture Content of Soil and Soil-Aggregate by the Nuclear Method

#### 3. PROCEDURE

3.1 Determine the maximum dry density of the soil-rock mixture following the procedures of Subsection 3.2, 3.3, or 3.4.

3.2 Determining the valid project developed moisture / density curve for a soil-rock mixture.

3.2.1 Following the determination of the in-place density, obtain a minimum 9 lb sample of material from the density test as described in CP 80.

3.2.2 Determine the percent plus No. 4 in the material.

3.2.3 Use the minus No. 4 portion of the material to perform a one-point AASHTO T 99 or T 180, whichever is applicable. The one point

test shall be at a moisture content of +/- 2% of the optimum moisture content.

3.2.4 Using the percent moisture from a representative moisture specimen taken from the material in the compaction cylinder and dried per AASHTO T 265, calculate the dry density of the material from the compaction cylinder using the formula:

$$D_D = \frac{\frac{W_w}{M_v}}{1 + \frac{M}{100}}$$

Where:

- $D_D$  = Dry Density of compacted soil, lbs/ft<sup>3</sup>;
- $W_w$  = Wet weight of compacted soil, lbs;
- $M_v$  = Mold Volume for 4" mold = 0.0333 ft<sup>3</sup> and for a 6" mold = 0.0750 ft<sup>3</sup>;
- $M$  = percent moisture.

**NOTE 1:** Use the actual mold volume in this calculation if it has been determined.

3.2.5 Using the calculated dry density and the percent moisture of this material, plot the location of these data points on the appropriate moisture density relation curve.

3.2.6 A moisture density relation curve is valid and will be used when the plotted one point data is within 2.0 lbs/ft<sup>3</sup> at the specimen's moisture content.

**NOTE 2:** This moisture density relation curve must be from a soil on the project with the same soil classification. If the soil being tested has not been classified previously, it must be classified.

3.2.7 If the one point data determined does not plot within 2.0 lbs/ft<sup>3</sup> at the specimen's moisture content, check additional curves of the same soil classification that were generated on the project and meet the aforementioned criteria. If an applicable curve of the same soil

classification is not found, refer to Subsection 3.3 of this procedure.

3.3 If a valid moisture density curve cannot be determined from the one point test, use the material collected in Subsection 3.2.1 to determine the maximum dry density and optimum moisture content according to AASHTO T 99 or T 180, whichever is applicable, on the material passing the No. 4 sieve.

3.4 When the source of the soil-rock mixture is known and the maximum dry density, optimum moisture content, and soil classification has been previously determined:

3.4.1 The tester may use the moisture density relation curve after a one point test has been performed. The result must meet the criteria of Subsection 3.2. and then use the moisture density relation curve that has been approved by the Engineer.

3.5 The maximum dry density and optimum moisture content of a soil-rock mixture must be validated a minimum of 1 per 10,000 yds<sup>3</sup> for each soil classification using Subsection 3.2.

**NOTE 3:** This is required to verify and document that there has not been subtle or unnoticed changes in soil characteristics.

3.6 For soil-rock mixtures containing 5% or more plus No. 4 material, the maximum dry density of the soil-rock and optimum moisture content shall be rock corrected according to CP 23.

3.7 Calculate percent relative compaction by dividing the dry density of the material from the test site by that material's moisture density relation curve's maximum dry density, and multiply by 100%.

**NOTE 4:** When AASHTO T 99 / T 180 Method D is used by CP 23, the ¾ inch sieve shall be substituted for the No. 4 sieve. The material passing the ¾ inch sieve will be used for determining the un-corrected maximum dry density and optimum moisture content.

#### 4. RECORD

4.1 CDOT Form #427, Nuclear Moisture / Density Soils Test.