



Designation: D7380 – 08

Standard Test Method for Soil Compaction Determination at Shallow Depths Using 5-lb (2.3 kg) Dynamic Cone Penetrometer¹

This standard is issued under the fixed designation D7380; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the procedure for the determination of the number of drops required for a dynamic cone penetrometer with a 5-lb (2.3-kg) drop hammer falling 20 in. (508 mm) to penetrate a certain depth in compacted backfill.

1.2 The device is used in the compaction verification of fine- and coarse-grained soils, granular materials, and weak stabilized or modified material used in subgrade, base layers, and backfill compaction in confined cuts and trenches at shallow depth.

1.3 The test method is not applicable to highly stabilized and cemented materials or granular materials containing a large percentage of aggregates greater than 1.5 in. (37 mm).

1.4 The method is dependent upon knowing the field water content and the user having performed calibration tests to determine cone penetration resistance of various compaction levels and water contents.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 1—It is common practice in the engineering profession to concurrently use pounds to represent both a unit of mass (lbm) and a force (lbf). This standard has been written using the gravitational system of units (lbf) when dealing with the inch-pound system. In this system, the pound (lbf) represents a unit of force (weight). However, the use of balances or scales recording pounds of mass (lbm) or the reading of density in lbm/ft³ shall not be regarded as a nonconformance with this standard.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

Current edition approved April 1, 2008. Published April 2008. DOI: 10.1520/D7380-08.

2. Referenced Documents

2.1 ASTM Standards:²

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³))

D1556 Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4959 Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating

D6026 Practice for Using Significant Digits in Geotechnical Data

D6938 Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

D6951 Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—Refer to Terminology D653 for standard definition of terms.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *5-lb dynamic cone penetrometer (5-lb DCP)*—(Fig. 1) a device that uses a 5-lb (2.3-kg) hammer to penetrate a cone tip inside the soil where the number of drops needed to penetrate a certain distance between two marks on the driving rod is used to determine soil compaction effort.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

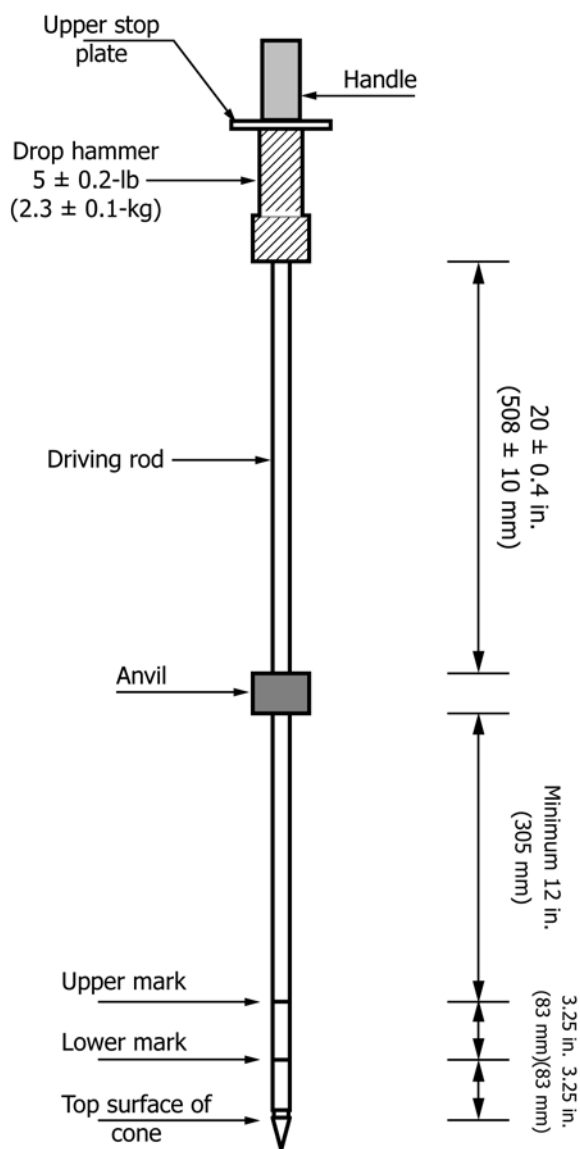


FIG. 1 Schematic Diagram of the 5-lb DCP Device

3.2.2 *extension rod*—in dynamic cone penetrometer, an optional extension of the driving rod to allow the use of the 5-lb DCP in deep confined holes.

3.2.2.1 *Discussion*—The extension rod has a sliding sleeve with two markers similar to the ones on the 5-lb DCP driving rod for identifying the penetration distance and allowing the readings to be taken near or at the surface of the hole.

3.2.3 *electronic readout unit*—in dynamic cone penetrometer, optional readout device to automatically count the number of hammer drops and penetration distance inside the soil.

4. Summary of Test Method

4.1 The 5-lb DCP is placed vertically and the drop hammer is used to penetrate the soil until the lower mark on the driving rod is leveled with the surface of the soil.

4.2 The operator lifts the drop hammer to the upper stop disk and releases it, allowing it to fall freely under gravity and

strike an anvil, causing the cone to be driven into the soil. The number of drops needed to penetrate the cone a distance 3.25 in. (83 mm) from the lower mark on the driving rod to the upper one is counted.

4.3 The number of drops is used to determine the pass or fail of soil compaction based on the results of calibration tests between the number of drops and soil percent compaction in similar soil of known percent compaction and water content.

5. Significance and Use

5.1 The test method is used to assess the compaction effort of compacted materials. The number of drops required to drive the cone a distance of 3.25 in. (83 mm) is used as a criterion to determine the pass or fail in terms of soil percent compaction.

5.2 The device does not measure soil compaction directly and requires determining the correlation between the number of drops and percent compaction in similar soil of known percent compaction and water content.

5.3 The number of drops is dependent on the soil water content. Calibration of the device should be performed at a water content equal to the water content expected in the field.

5.4 There are other DCPs with different dimensions, hammer weights, cone sizes, and cone geometries. Different test methods exist for these devices (such as D6951) and the correlations of the 5-lb DCP with soil percent compaction are unique to this device.

5.5 The 5-lb DCP is a simple device, capable of being handled and operated by a single operator in field conditions. It is typically used as Quality Control (QC) of layer-by-layer compaction by construction crew in roadway pavement, back-fill compaction in confined cuts and trenches, and utility pavement restoration work.

NOTE 2—The quality of results produced by this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of these factors.

6. Apparatus

6.1 A schematic diagram of the 5-lb DCP is shown in Fig. 1. The device consists of an $1\frac{1}{16} \pm \frac{1}{16}$ in. (17.5 ± 1.6 mm) steel rod with a 5 ± 0.2 lb (2.3 ± 0.1 kg) drop hammer. The hammer drops a distance 20 ± 0.4 in. (508 ± 10 mm) between the upper stop plate and the anvil.

6.2 *Driving Rod*—The driving rod has two permanent marks or grooves to monitor cone penetration depth. The lower mark is at a distance $3\frac{1}{4}$ in. (83 mm) from the top surface of the cone and the distance between the two marks is 3.25 in. (83 mm).

6.3 *Cone Tip*—A replaceable cone tip of hardened steel or similar material with angle 25 ± 2 degrees is placed at the bottom of the driving rod. Fig. 2 shows the dimensions of the cone tip.

6.4 *Extension Rod*—An extension rod may be used to monitor compaction in deep cuts and trenches where

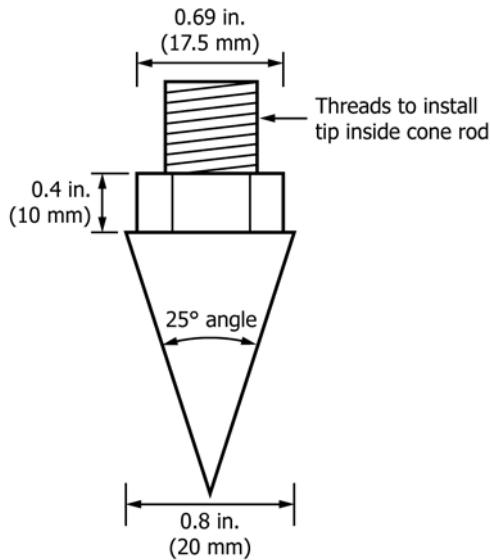


FIG. 2 Dimensions of the Cone Tip

extension rod should be of the same diameter and material as the driving rod. Fig. 3 shows a schematic of the device with the extension rod used in a confined hole.

6.5 When the device is used in small holes and trenches, a sleeve is used to monitor the penetration distance from the surface as shown in Fig. 3. The lower mark on the sleeve is leveled with the ground surface using a straight edge and the sleeve is tightened by a screw to prevent it from moving during the test. Fig. 4 shows the dimensions of the sleeve.

6.6 The addition of extensions will change the mass of the device and the energy delivered to the cone. When extension rods and sleeves are used, calibration tests should be performed with these extensions attached to the device.

6.7 An automated electronic data readout unit may be used to register the number of drops and the penetrating distance. The system should give a signal and stop counting the number of drops once the penetration equals the distance from the lower mark to the top one.

6.8 The optional automated data readout unit should not interfere with the operation and results of the device. The

the operator has to work from the ground surface. The

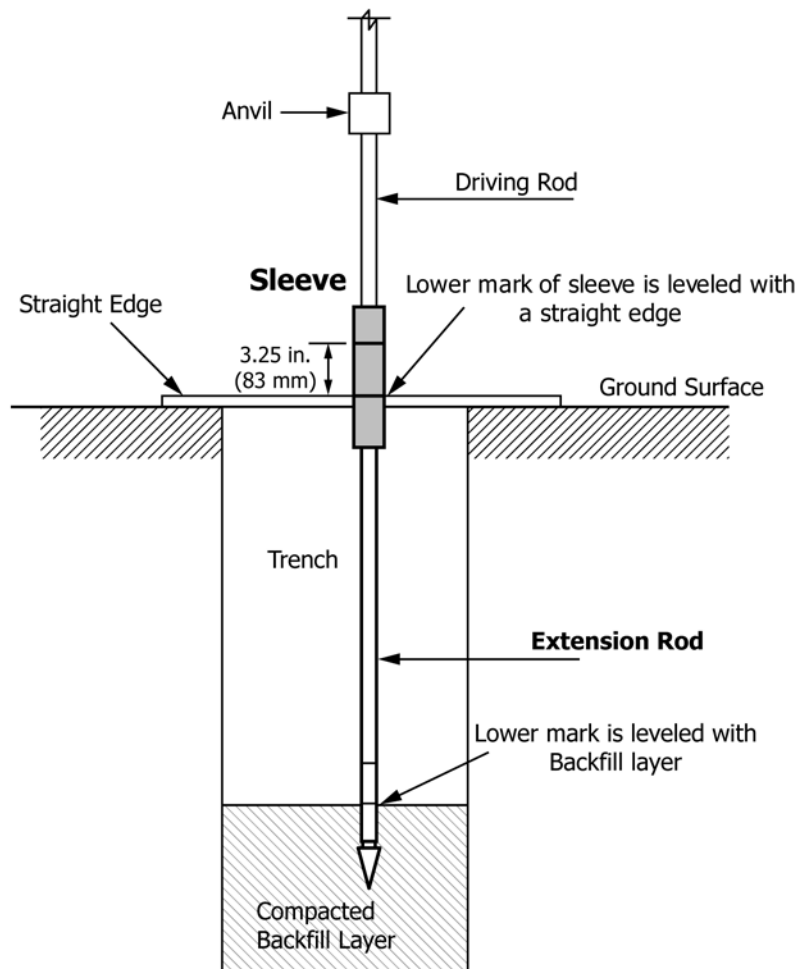


FIG. 3 Schematic of the 5-lb DCP with Extension Rod in Confined Excavation