Designation: ~~D5874 – 02 (Reapproved 2007)~~ D5874 – 16

Standard Test ~~Method~~Methods for Determination of the Impact Value (IV) of a Soil[1]

This standard is issued under the fixed designation D5874; 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~~These test ~~method covers~~methods cover the determination of the Impact Value (IV) of a soil either in the field or a test ~~mold.~~mold, as follows:

1.1.1 *Field Procedure A*—Determination of IV alone, in the field.

1.1.2 *Field Procedure B*—Determination of IV and water content, in the field.

1.1.3 *Field Procedure C*—Determination of IV, water content, and dry density, in the field.

1.1.4 *Mold Procedure*—Determination of IV of soil compacted in a mold, in the lab.

1.2 The standard test method, using a 4.5 kg (10 lbm) hammer, is suitable for, but not limited to, evaluating the strength of an unsaturated compacted fill, in particular pavement materials, soils, and soil-aggregates having maximum particle sizes less than 37.5 mm (1.5 in.).

1.3 By using a lighter 0.5 kg (1.1 lbm) or 2.25 kg (5 lbm) hammer, this test method is applicable for evaluating lower strength soils such as fine grained cohesionless, highly organic, saturated, or highly plastic soils having a maximum particle size less than 9.5 mm (0.375 ~~in.).~~in.), or natural turfgrass.

1.4 By using a heavier 10 kg (22 lbm) or 20 kg (44 lbm) hammer, this test method is applicable for evaluating for harder materials at the top end the scales or beyond the ranges of the standard and lighter impact soil testers.

1.5 By performing laboratory test correlations for a particular soil using the 4.5 kg (10 lbm) hammer, IV may be correlated with an unsoaked California Bearing Ratio (CBR) or may be used to infer percentage compaction.

1.6 The values stated SI are to be regarded as the standard. The values stated in parentheses are given for information only.

1.7 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026. ~~The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses or both. How one applies the results obtained using this standard is beyond its scope.~~

1.8 For purposes of comparing, a measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal or significant digits in the specified limits.

1.8.1 The procedures used to specify how data are collected/recorded or calculated, in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.9 *This standard ~~may involve hazardous materials, operations, and equipment. 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.*

NOTE 1—The equipment and procedures contained in this test method are similar to those developed by B. Clegg in the 1970s at the University of Western Australia, Nedlands, Australia. Impact Value is also commonly known as Clegg Impact Value (CIV).

[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.

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***A Summary of Changes section appears at the end of this standard**

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/ft^3 (600 kN-m/m^3))
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/ft^3 (2,700 kN-m/m^3))
D1883 Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
D2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) (Withdrawn 2007)[3]
D2937 Test Method for Density of Soil in Place by the Drive-Cylinder Method
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4643 Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating
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 Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed in 3.2, all definitions are in accordance with Terminology D653.

3.2 *Definitions:Definitions of Terms Specific to This Standard:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D653.

3.2.1 *as-compacted target IV, n*—the desired strength, in terms of IV, to be achieved in the field for a particular material and construction process, at the as-compacted moisture condition. This may also be referred to as the *as-compacted target strength*.

3.2.2 *dried-back target IV, n*—the desired strength, in terms of IV, to be achieved in the field for a particular material and construction process prior to continuing with a subsequent layer, or sealing, or opening to traffic, after moisture has left the system through evaporation and/or drainage. This may also be referred to as the dried-back target strength.

3.2.3 *heavy impact value (IV),(IV/H), n*—the value expressed in units of tens of gravities (IV g) derived from the peak deceleration of a 4.5 kg (10 lbm) instrumented compaction hammer 50 mm (1.97using a 20 kg (44 lbm) mass hammer 130 mm (5 in.) in diameter free falling 450300 mm (18(12 in.).

3.2.4 *light heavy medium heavy impact value (IV/L),(IV/HMH), n*—the IV derived from using a 0.510 kg (1.1(22 lbm) mass hammer 50130 mm (1.97(5 in.) in diameter free falling 300 mm (12 in.).in).

3.2.5 *impact soil tester, n*—testing apparatus used to obtain an IV of a soil.

3.2.6 *impact value (IV), n*—the value expressed in units of tens of gravities (*g*) and reported to the nearest whole number derived from the peak deceleration of a 4.5 kg (10 lbm) instrumented compaction hammer 50 mm (2.0 in.) in diameter free falling 450 mm (18 in.).

3.2.7 *in-service target iv,IV, n*—the desired strength, in terms of IV, to be achieved in the field for a particular material and construction process. process once the road is opened to traffic and has reached equilibrium. This may also be referred to as the *in-service target strength*.

3.2.8 *light impact value (IV/L), n*—the IV derived from using a 0.5 kg (1.1 lbm) mass hammer 50 mm (2.0 in.) in diameter free falling 300 mm (12 in.).

3.2.9 *medium impact value (IV/M), n*—the IV derived from using a 2.25 kg (5 lbm) mass hammer 50 mm (2.0 in) in diameter free falling 450 mm (18 in.).

4. Summary of Test Method

4.1 The test apparatus is placed on the material to be tested either in a mold or on naturally occurring or compacted soil in the field. The hammer is raised to a set height and allowed to free fall. The instrumentation of the test apparatus displays a value in tens of gravities (*g*) of the peak deceleration of the hammer'shammer's impact as recorded by an accelerometer fitted to the top of the hammer body. A total of four blows of the hammer are applied on the same spot to determine the IV for each test performed.

[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.

4.2 A ~~light~~lighter hammer of 0.5 kg (1.1 lbm) or 2.25 kg (5 lbm) may be used for softer conditions or fragile materials instead of the 4.5 kg (10 lbm) standard hammer to determine the IV. When used the resulting value is termed the Light Impact Value ~~(IV/L).~~(IV/L) for the 0.5 kg (1.1 lbm) hammer or Medium Impact Value (IV/M) for the 2.25 kg (5 lbm) hammer.

4.3 A larger, heavier hammer of 10 kg (22 lbm) or 20 kg (44 lbm) may be used instead of the 4.5 kg (10 lbm) standard hammer to determine the IV for harder conditions or to test through a larger zone both horizontally and vertically. When used, the resulting value is termed the Heavy Medium Heavy Impact Value (IV/HMH) for the 10 kg (22 lbm) hammer or Heavy Impact Value (IV/H) for the 20 kg (44 lbm) hammer.

5. Significance and Use

5.1 Impact Value, as determined using the standard 4.5 kg (10 lbm) hammer, has direct application to design and construction of pavements and a general application to earthworks compaction control and evaluation of strength characteristics of a wide range of materials, such as soils, soil aggregates, stabilized soil and recreational turf. Impact Value is one of the properties used to evaluate the strength of a layer of soil up to about 150 mm (6 in.) in thickness and by inference to indicate the compaction condition of this layer. Impact Value reflects and responds to changes in physical characteristics that influence strength. It is a dynamic force penetration property and may be used to set a strength parameter.

5.2 This test method provides immediate results in terms of IV and may be used for the process control of pavement or earthfill activities where the avoidance of delays is important and where there is a need to determine variability when statistically based quality assurance procedures are being used.

5.3 This test method does not provide results directly as a percentage of compaction but rather as a strength index value from which compaction may be inferred for the particular moisture conditions. From observations, strength either remains constant along the dry side of the compaction curve or else reaches a peak and declines rapidly with increase in water content slightly dry of optimum water content. This is generally between 95 and 98 % maximum dry density (see Fig. 1 and Fig. 2). ~~A field~~An as-compacted target strength in terms of IV may be designated from laboratory testing or field trials as a strength to achieve in the field as the result of a compaction process for a desired density and water content. If testing is performed after compaction when conditions are such that the water content has changed from the critical value, determination of the actual water content by laboratory testing enables the field density to be inferred from regression equations using IV, density and water content.

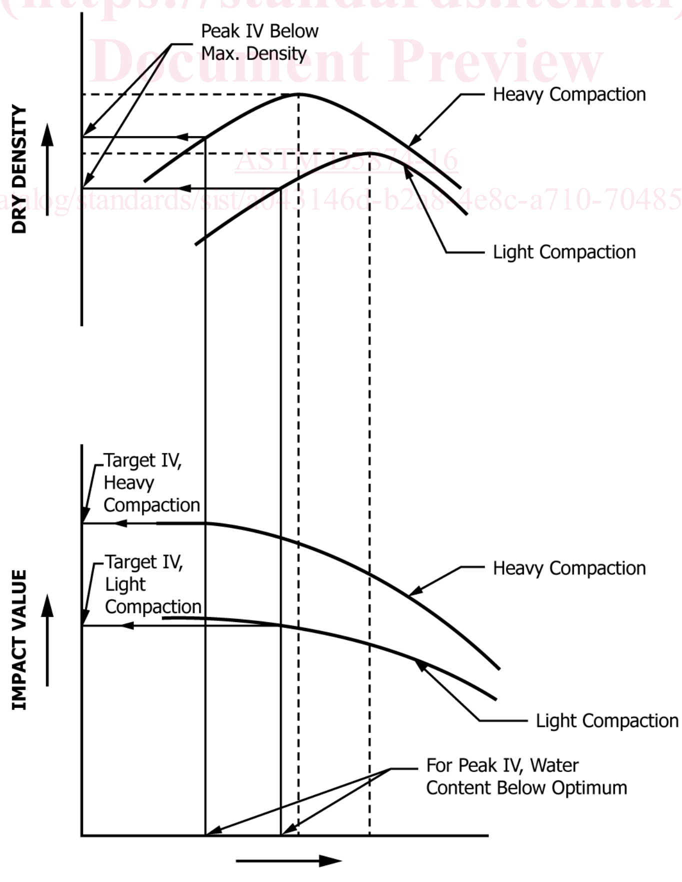

FIG. 1 Illustration of Target IV for Material ~~With~~with No Peak ~~but Drop~~

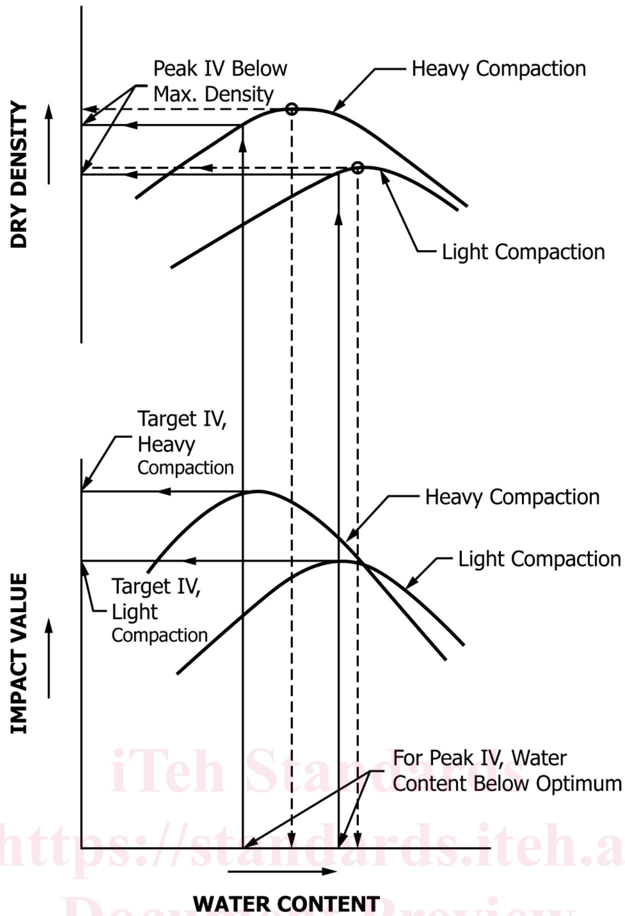

FIG. 2 Illustration of Target IV for Material ~~With~~with Pronounced Peak

NOTE 2—Impact Value may be used as a means to improve the compaction process by giving instant feedback on roller efficiency, uniformity, confirming the achievement of the target strength, and by inference the achieved density. When inferring density from IV, however, it should be considered as only indicative of density. Where strict acceptance on a density ratio basis is required, test methods that measure density directly shall be used.

5.4 This test method may be used to monitor strength changes during a compaction process or over time due to seasonal, environmental or traffic changes.

NOTE 3—For in-place soil strength evaluation where there may be a dry and hard surface layer (crust), testing both the crust and the underlying layer may be required.

5.5 The standard instrument is based on a ~~4.54~~4.5 kg (10 lbm) compaction hammer using a ~~457.2~~450 mm (18 in.) drop height. The hammer has been equipped with an accelerometer and instrumented using a peak hold electronic circuit to read the peak deceleration on impact. The circuitry is filtered electronically to remove unwanted frequencies and the peak deceleration is displayed in units of ten gravities (*g*) with the output below units of ten gravities truncated.

5.6 The peak deceleration on which IV is derived represents the area under the deceleration versus time curve which for most soils may be assumed as half a sinusoid. Applying double integration provides first the time velocity relationship and second, the time penetration relationship. As force is also directly related to deceleration, the IV therefore, represents both stress and penetration and may be taken as a direct measurement of stiffness or strength (see Fig. 3).

5.7 Impact Value may be correlated with an unsoaked CBR.

5.8 Impact Value may be expressed as a hammer modulus, analogous with elastic modulus or deformation modulus.

5.9 The light hammer uses the same accelerometer and instrumentation as the standard hammer. The smaller mass of 0.5 kg (1.1 lbm) results in more sensitivity for lower strength materials compared to the standard mass; that is, the zero to 100 IV scale is expanded with this lighter hammer mass and provides more definition on softer materials. To avoid confusion, the IV of the light hammer is notated as IV/L.

5.10 Light Impact Value has applications for recreation turf hardness evaluation, where the condition of the surface affects ball bounce characteristics, the performance or injury potential to participants, and where more sensitivity compared to the standard hammer is required or an imprint left by the 4.5 kg (10 lbm) hammer or other test methods is undesirable, such as on a golf putting green.

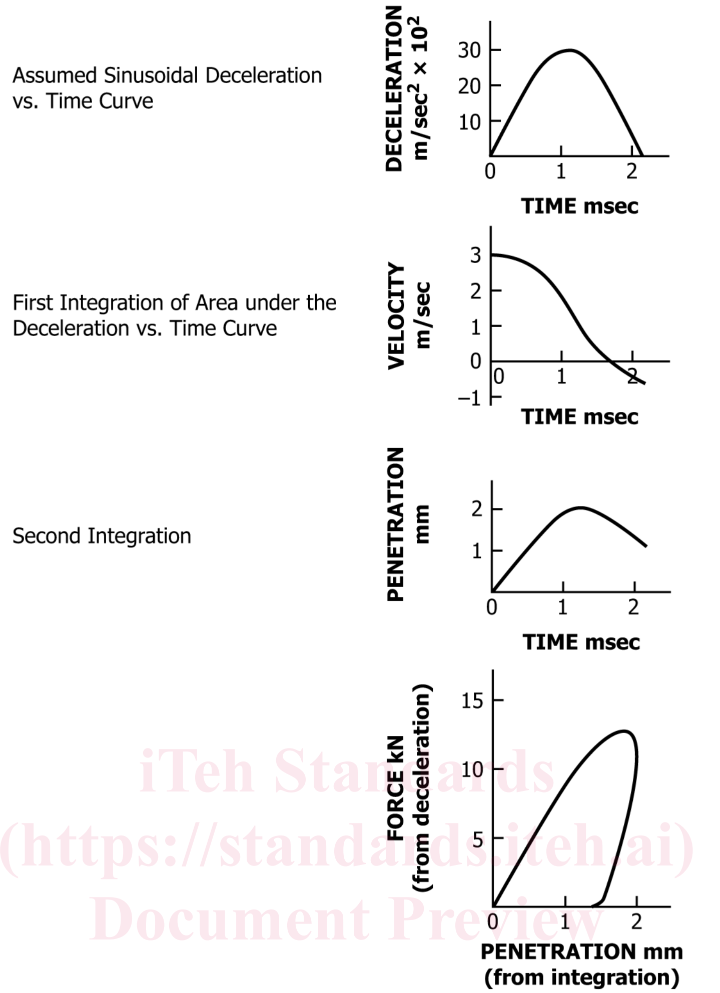

FIG. 3 Development of Force-Penetration from Deceleration Versus Time

~~NOTE 4—The agency performing this test method can be evaluated in accordance with Practice D3740. Not withstanding oil precision and bias contained in this test method, the precision of 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. Users of this test method are cautioned that compliance with Practice D3740 does not assure reliable testing. Reliable testing depends on many factors, and Practice D3740 provides a means of evaluating some of those factors.~~

5.11 The medium hammer uses the same accelerometer and instrumentation as the standard hammer and provides a sensitivity between that of the standard hammer and light hammer. The IV of the medium hammer is notated as IV/M.

5.12 The Medium Impact Value has application to sand and earthworks, and natural turfgrass and artificial turf hardness evaluation, the last primarily in relation to performance or injury potential to the participants, and is preferable over the Light Impact Value in relation to thicker thatch and longer grass for such application.

5.13 The heavy medium heavy hammer uses the same accelerometer and instrumentation as the standard hammer, and tests through a larger zone both horizontally and vertically because of its larger diameter mass. The IV of the heavy medium hammer is notated as IV/HMH.

5.14 The Heavy Medium Heavy Impact Value has application to testing the same materials as those tested by the standard, light and medium impact soil testers, for evaluation of a layer of soil up to about 380 mm.

5.15 The heavy hammer uses the same accelerometer and instrumentation as the standard hammer, and tests through a larger zone both horizontally and vertically. The IV of the heavy hammer is notated as IV/H.

5.16 The Heavy Impact Value has application to testing the same materials as those tested by the standard, light, medium, and heavy medium heavy impact soil testers, but the greater mass of this impact soil tester provides less sensitivity of the output so is applicable for harder materials at the top end the scales or beyond the ranges of the lighter impact soil testers. The larger diameter mass of the heavy impact soil tester tests through a larger zone both horizontally and vertically than the smaller diameter impact soil testers.

NOTE 4—The quality of the 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. Users of this test method are cautioned that compliance with Practice D3740 does not in itself ensure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Impact Soil Tester*—A test apparatus consisting of a hammer, guide tube, and electronic instrumentation. Detailed information on the apparatus is contained in Annex A1. A typical configuration is shown in Fig. 4.

6.2 *Mold*—A ~~152.4~~152.4 ± 0.7 mm ~~(6~~(6.000 ± 0.026 in.) diameter mold conforming to the requirements of Test Methods D698 Procedure C, D1557 Procedure C, or D1883 with a spacer disc.

6.2.1 Molds of other, typically larger, dimensions may be used but must be reported accordingly in the report.

NOTE 5—For a particular material, the smaller 101.6 mm (4 in.) mold may be used if it has been proven by a laboratory test comparison with the 152.4 mm (6 in.) mold that there is no significant difference in the IV results. Mold dimensions are to be consistent with Test Methods D698 and D1557.

7. Procedure

7.1 *Operational Verification Checks*—Perform operational verification checks at the commencement of any testing program, after repair, or when the instrument is suspect using the operational check ring as follows.

7.1.1 Place the ring on a dry, grease free smooth hard surface of a solid massive object, such as a concrete floor over ground. Place the guide tube centrally over the ring and drop the hammer five times from the set height mark as described in A2.1.3 for the standard 4.5 kg hammer or A2.1.4 for the light 0.5 kg hammer. Operate the instrumentation so as to obtain five separate readings. If this operational check procedure gives significantly different values than shown on the ring, examine the dryness, cleanliness, smoothness and firmness of the support for the ring and the ring itself and review the operational check procedure and rerun the check at the same or another location. If the ring value is not satisfactorily achievable, an electronic check may be carried out according to the manufacturer's calibration instruction for the accelerometer.

NOTE 6—To avoid the possibility of damage to the electronics or the hammer, the impact soil tester should not be used directly on hard surfaces such as concrete or otherwise in such a way on materials that it would give results of more than 100 IV (1000 *g*).

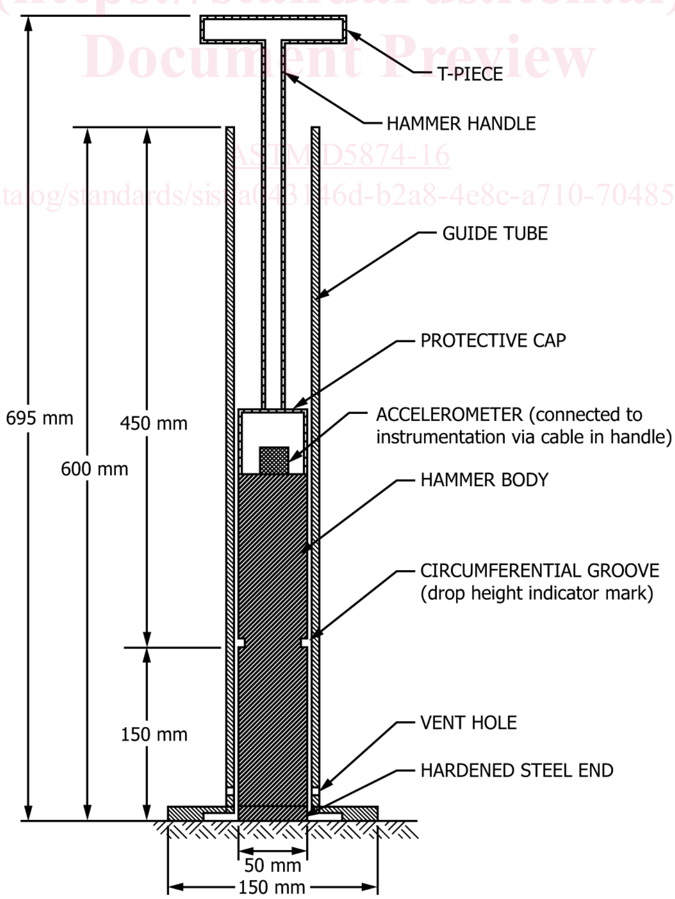

FIG. 4 Illustration (Cross Section) of ~~a~~ the Standard 4.5 kg Impact Soil Tester with Hammer at Rest in the Guide Tube