INTERNATIONAL

Designation: ~~D5874 – 16~~ D5874 – 24

Standard Test 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 These test methods cover the determination of the Impact Value (IV) of a soil either in the field or a test 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,~~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 *Units*—The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

1.3 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.).

1.4 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.), or natural turfgrass.

1.5 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.

1.6 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. The IV of the 0.5 kg (1.1 lbm) and 2.25 kg (5 lbm) hammers may be independently correlated to an unsoaked CBR or used to infer the percentage compaction for lower strength soils.

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

[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**

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

1.8 For purposes of ~~comparing,~~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,~~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.

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, Perth, Western Australia, Australia. Impact Value is also commonly known as Clegg Impact Value (CIV).

1.9 *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~~safety, health, and environmental 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).~~

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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~~D1556/D1556M Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method (Withdrawn 2024)[3]
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 (Withdrawn 2024)[3]
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
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 Content of Soil and Rock by Microwave Oven Heating
D4959 Test Method for Determination of Water Content of Soil By Direct Heating
D6026 Practice for Using Significant Digits and Data Records 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~~ For definitions of common technical terms used in ~~3.2, all definitions are in accordance with~~ this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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,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/H), n*—the IV derived from using a 20 kg (44 lbm) mass hammer 130 mm (5 in.) in diameter free falling 300 mm (12 in.).

3.2.4 *heavy medium heavy impact value (IV/HMH), n*—the IV derived from using a 10 kg (22 lbm) mass hammer 130 mm (5 in.) in diameter free falling 300 mm (12 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 numberin whole numbers 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, n*—the desired strength, in terms of IV, to be achieved in the field for a particular material and construction 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'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.

4.2 A lighter hammer of Lighter hammers at 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) 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 ofLarger, heavier hammers at 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.aggregates and stabilized soil. 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 using a 50 mm (2 in.) diameter hammer or up to 380 mm (15 in.) in thickness using a 130 mm (5 in.) diameter hammer, 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 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~~ and, for both cases, declines rapidly with increase in water content beyond a point slightly dry of optimum water ~~content.~~ content, at approximately 0.5 percent. This is generally between 95 and 98 % maximum dry density (see Fig. 1 and Fig. 2). 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.

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 solely from IV, however, it ~~should be~~ is 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.

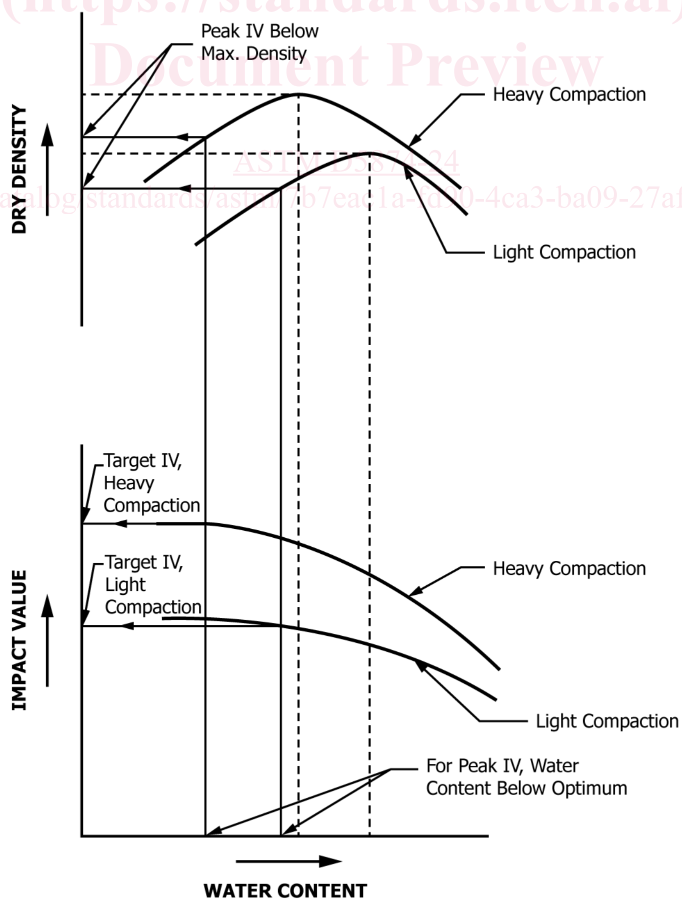

FIG. 1 Illustration of Target IV for Material with No Peak

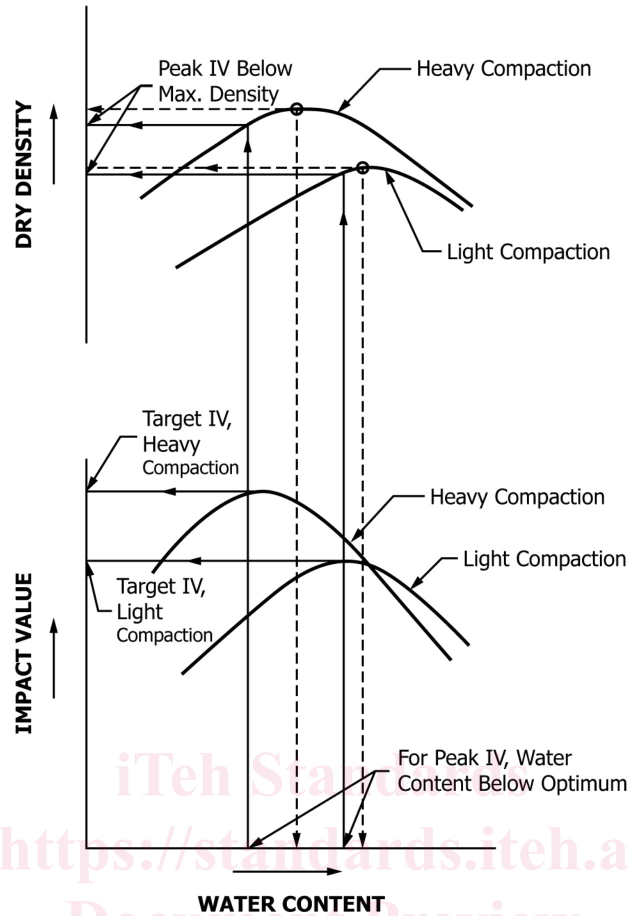

FIG. 2 Illustration of Target IV for Material with Pronounced Peak

5.5 The standard instrument is based on a 4.5 kg (10 lbm) compaction hammer using a 450 mm (18 in.) drop height. The hammer ~~has been~~ is 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~~ time-velocity relationship and ~~second, the time penetration~~ second the time-penetration relationship. As force is also directly related to deceleration, the IV ~~therefore,~~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~~lighter hammers use the same accelerometer and instrumentation as the standard hammer. ~~The smaller mass of~~ Utilization of lighter masses at 0.5 kg (1.1 lbm) and 2.25 kg (5 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~~these lighter hammer ~~mass~~masses and provides more definition on softer ~~materials.~~ materials, along with there being less indentation into the material. To avoid confusion, the IV of the ~~light hammer~~lighter hammers is notated as ~~IV/L.~~IV/L for the 0.5 kg (1.1 lbm) mass and as IV/M for the 2.25 kg (5 lbm) mass.

~~5.10 Light Impact Value has applications for recreation turf hardness evaluation, where the condition of the surface affects ball~~

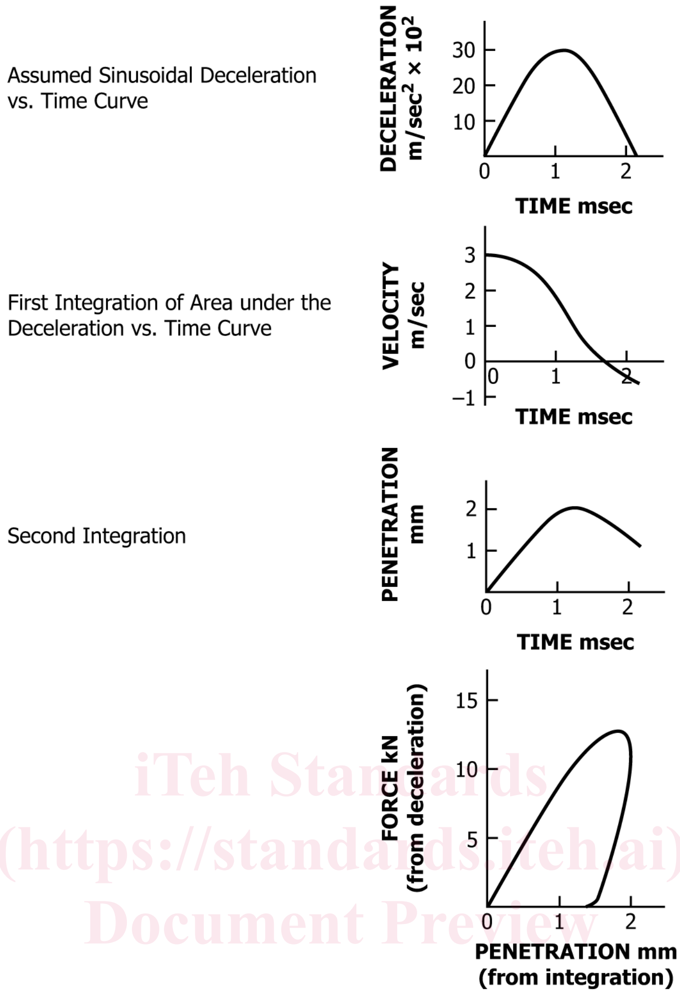

FIG. 3 Development of Force-Penetration from Deceleration Versus Time

~~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.~~

5.10 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.~~

5.11 ~~The~~ Light Impact Value and Medium Impact Value ~~has application to sand and earthworks, and natural turfgrass and artificial~~ have application to testing of sand, peat and for natural and artificial recreation turf hardness evaluation, ~~the last primarily in relation to~~ where it is that the hardness of recreation turf surfaces affects ball bounce characteristics and the performance or injury potential to ~~the participants, and~~ participants. Medium Impact Value is preferable over ~~the~~ Light Impact Value in relation to assessing natural turf where there is thicker thatch and longer grass ~~for such application.~~ whereas Light Impact Value is preferable for finely mown grass surfaces where less indentation than that of the medium hammer is desired, such as testing of grass tennis courts and golf putting greens.

5.12 The medium hammer has application to testing of earthworks materials.

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