Designation: F 1702 – 96

Standard Test Method for Measuring Shock-Attenuation Characteristics of Natural Playing Surface Systems Using Lightweight Portable Apparatus[1]

This standard is issued under the fixed designation F 1702; 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 determination of shock-attenuation characteristics of natural turfgrass and soil playing surface systems using lightweight portable apparatus. This test method is applicable for comparing natural surfaces and for assessing the effects of management practices on shock attenuation. This test method also can be used to assess the compactibility of natural surfaces by recording G_{max} values or penetration of successive impacts, or both.

1.2 This test method provides a procedure for assessing impact characteristics in the field, on actual playing surfaces and on research plots. Numerical data will not be comparable to data obtained using a different missile mass or geometry, using a different drop height, or using a different standard method, for example, Test Method F 355.

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

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 5874 Test Method for Determination of the Impact Value (IV) of a Soil[2]

E 105 Practice for Probability Sampling of Materials[3]

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process[3]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[3]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[3]

F 355 Test Method for Shock-Absorbing Properties of Playing Surface Systems and Materials[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *acceleration*—the instantaneous time rate of change of velocity, which may be positive or negative.

3.1.2 *G, n*—the dimensionless ratio of the acceleration (*a*) of the missile during impact to the acceleration due to gravity (*g*): $G = a/g$.

3.1.3 G_{max}, *n*—the maximum value of *G* encountered during impact.

3.1.4 *playing surface, n*—the surface of contact with a player, ball, or any other object or animal utilizing the surface. A natural playing surface may be turfgrass or other vegetation, soil, sand, other natural organic and inorganic materials, or combinations of these types of surfaces.

3.1.5 *playing surface system, n*—a composite that includes the contact surface, energy-absorbing materials, if any, and the substrates.

3.1.6 *turf, n*—a covering of mowed vegetation, usually a turfgrass, growing in association with an upper soil stratum of intermingled roots and stems.

3.1.7 *turfgrass, n*—a species or cultivar of grass, usually of spreading habit, which is maintained as a mowed turf.

4. Summary of Test Method

4.1 A 2.25-kg missile is dropped from a specific height onto a playing surface. A linear accelerometer mounted on the missile monitors the acceleration and the time history of impact. The G_{max} is detected, and with suitable instrumentation, the time history may be recorded optionally. Depth of penetration from successive drops may be recorded optionally as an indication of soil compactibility.

NOTE 1—This test method is based on an impact tester developed by Clegg **(1,2)**.[5] See Test Method D 5874. Such impact testers are commercially available. Commercially available Clegg Impact Soil Testers display results in impact value units, where one impact value equals ten G_{max} units, and typically do not display tenths of an impact value unit. For use in this standard, the display should be altered by the manufacturer or

[1] This test method is under the jurisdiction of ASTM Committee F-8 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.64 on Natural Turf.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 15.07.

[5] Numbers in parentheses refer to the list of references at the end of this test method.

authorized personnel to indicate tenths of an impact value or one G_{max} unit. Also, other suitable recording equipment can be used to obtain resolution to one G_{max}. A4.5-kg missile has been used to evaluate road base surfaces **(1,2)**. A0.5-kg poly(vinyl chloride) missile has been utilized to relate field surfaces to ball bounce **(3-6)**, player response **(7)**, and performance including injury potential **(8)**.

5. Significance and Use

5.1 The G_{max} values obtained by these procedures are indicative of the cushioning properties of playing surfaces. Optional time history data can be used to describe further these properties.

6. Apparatus

6.1 *Missile*—Construct the 2.250 ± 0.05-kg missile from a solid steel rod with a 5.0 ± 0.02-cm diameter and a flat impacting surface having a roundness or bevel of 0.5 to 1.0 mm on the edge. Include a T-shaped handle or other appropriate means for lifting the missile prior to dropping. The handle and accelerometer (rated at 5000 g) constitute a portion of the missile mass. The missile should be marked around the circumference to obtain a reference point to the guide tube top, which will indicate drop height.

6.2 *Guide Tube*—Construct the vented guide tube, through which the missile is dropped, of pipe having a smooth inside surface and a nominal inside diameter of 5.08 cm (2.0 in.), such as not to restrict a free fall of the missile, and a length of approximately 61 cm (24 in.). A bull's eye level may be attached to the guide tube to ensure that the tube is held in a vertical position during measurements. A circular end flange on the base of the tube helps to stabilize the tube. The bottom of the flange shall be milled so that it rests only on its perimeter and vented to allow for the escape of compressed air. Vents may also be utilized instead in the side of the tube just above the flange.

6.3 *Recording Equipment*—Follow the criteria below when using recording equipment:

6.3.1 G_{max}—Ensure that the recording system is capable of measuring shocks of up to a G_{max} of 1000, as produced by an accelerometer mounted on the missile.

6.3.2 *Acceleration-Time*—The acceleration-time history may be recorded optionally by suitable oscilloscope or computer instrumentation.

6.3.3 The band width of the acceleration measuring instrumentation must be sufficiently large to give good resolution of the peak acceleration (G_{max}). Commercially available devices have a band width of 7 kHz.

7. Test Unit

7.1 The test unit will be either:

7.1.1 An area of a playing surface that has had similar use and that has similar surface-system characteristics (for example, age, vegetation density, wear, soil moisture content) within its limits, or

7.1.2 An experimental area (plot) subjected to uniform treatment(s) that may or may not affect impact characteristics.

7.2 A test unit on a playing surface should not exceed approximately 1 m^2.

8. Number of Test Units

8.1 Similar areas of use, wear, etc., may be used to replicate test units on playing surfaces.

8.2 To characterize adequately the surface variability on a natural surface of a sports field, areas having different levels of use, wear, soil compaction, vegetative cover, etc., should be evaluated. If possible, replicate each type of use area.

8.3 Use a minimum of three test units (replications) in research experiments.

8.4 Due to the variable nature of natural surfaces, measure and average at least four locations within a test unit to obtain a test result. To obtain a specific quality assurance level, follow the sampling procedures of Practices E 105 and E 122.

9. Procedure

9.1 Operate and calibrate all recording equipment as recommended by the manufacturer. Periodically, at least prior to and after each series of impact tests, check the instrumentation output by dropping the missile on a standard surface, for example, a stable synthetic material placed on a rigid concrete or metal surface.

9.2 Place the guide tube on the playing surface and maintain in a vertical position during the drop.

9.3 Lift the missile to obtain a drop height of 45.7± 0.3 cm (18.0 ± 0.1 in.), and an approximate impact velocity of 2.85 m/s **(7)**. A mechanical stop may be attached to the top of the guide tube to aid in achieving the exact drop height.

9.4 Release the missile and record the G_{max} value. Lifting the missile to an exact height and then releasing it freely is possible with trained and experienced operators; however, a mechanical holding/releasing mechanism is recommended to insure proper height and release with less-experienced operators. Such a mechanism should not influence the impact velocity to a greater extent than manual operation.

9.5 Make one drop on each location and record the G_{max} value. Soil compaction due to impacting alters natural surface conditions. Successive drops, therefore, will not give results that are indicative of the initial impact characteristics of the test unit. Surface deformation due to successive impacts may be used to give an indication of surface compactibility. Record G_{max} values or depth of penetration, or both, for each drop. A scale, graduated in units of 2.5 mm (0.1 in.) may be placed on the missile handle to determine residual surface penetration. The scale should have at least 20 units, and readings should be taken before and after each drop.

9.6 Record environmental conditions at time of the test, including the soil water content.

10. Calculation

10.1 G_{max}—Determine G_{max} to the nearest whole unit by direct readout (a truncated value is acceptable with digital readout equipment) or from the acceleration-time history.

10.2 Additional impact related parameters such as time to G_{max}, impact duration, and penetration depth may be obtained by using appropriate recording equipment.

11. Report

11.1 Include the following information in the report:

11.1.1 Identification of the surface tested, including location and type of surface (turfgrass or soil). Vegetation should be described as to the type(s) and density, and depth of thatch, if