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An American National Standard

Standard Test Method for Impact Attenuation of Playing Surface Systems and Materials[1]

This standard is issued under the fixed designation F355; 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 measurement of certain shock-absorbing characteristics, the impact force-time relationships, and the rebound properties of playing surface systems. This test method is applicable to natural and artificial playing surface systems and to components thereof. Typical playing surfaces are wrestling mats, football fields, soccer fields, playgrounds, and so forth.

NOTE 1—This test method may also be used to measure the shock-attenuation properties of materials used as protective padding, such as the padding on trampoline frames, football goal posts, gymnasium wall, shoulder pads, body padding, and so forth. It should not be used, without some modifications, to test the finished products.

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

1.3 *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:*[2]

D1596 Test Method for Dynamic Shock Cushioning Characteristics of Packaging Material

E105 Practice for Probability Sampling of Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

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

F1292 Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment

F2650 Terminology Relating to Impact Testing of Sports Surfaces and Equipment

2.2 *SAE Standard:*

SAE J211/1 Instrumentation for Impact Tests - Part 1 - Electronic Instrumentation (rev. July 2007)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms related to impact testing of sports surfaces equipment can be found in Terminology F2650.

4. Summary of Test Method

4.1 A test specimen is impacted at a specified velocity with a missile of given mass and geometry. An accelerometer mounted in the missile is used to record the acceleration-time history of the impact and the peak acceleration is used as a measure of impact severity. Optionally, the displacement history of the impact may also be recorded.

4.2 This test method defines three missiles for use in playing surface impact tests:

4.2.1 *Missiles A and D* are both cylindrical, with specified mass and geometry and a circular, flat, metal impacting surface. These missiles are used with a guidance mechanism.

4.2.2 *Missile E* has a hemispherical impacting surface of specified mass and geometry and may be used with a guidance system or, if equipped with a triaxial accelerometer, without guidance (“free-fall”).

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[1] This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.52 on Miscellaneous Playing Surfaces.

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[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] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

4.2.3 The specific masses and geometries of the missiles are detailed in 6.2.

5. Significance and Use

5.1 The results of this method quantify the impact attenuation of playing surface and system specimens under the specific test conditions.

5.2 The test method measures the outcome of impacts performed under specific conditions. It does not quantify the intrinsic material properties of the tested specimens.

5.3 Test results from different specimens obtained under the same conditions (that is, the same missile mass and geometry, drop height, etc.) may be used to compare impact attenuation under those conditions.

5.4 Test results obtained under different conditions are not comparable. Specifically obtained with different missiles are not equivalent and cannot be directly compared. Similarly, test results obtained using the same missile, but using different drop heights, are not directly comparable.

6. Apparatus

6.1 ~~*Testing Machine*—Any type of dynamic testing apparatus that impacts the test material on a massive, rigid anvil with a missile at a prescribed impact velocity and monitors and records the acceleration-time history is acceptable. The anvil mass (impacted base) should be at least 100 times that of the missile. The test apparatus may optionally be designed to test a playing surface in-place. In either case, the test specimen shall have dimensions larger than the impact area of the missile as specified in 7.1. The test machine and missile shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus that might be recorded on the acceleration-time curve.~~ Anvil—For tests performed on surface samples in a laboratory, the surface sample shall be mounted on a rigid anvil or base having a mass at least 100 times that of the missile.

6.2 *Impact Test System*—A device or system for performing an impact test in which an instrumented missile is dropped onto a playing surface or surfacing material from a predetermined drop height.

6.2.1 *Missile*—~~The missile shall be designed to meet the general requirements of 4.2.1 and 4.2.2. Provision shall be made such that the accelerometer can be securely fastened within ±5° of the vertical axis of the missile. The mass and geometry for each procedure is referenced in~~ :

6.2.1.1 The missile shall have one of the combinations of mass and geometry specified in Table 1~~.~~. (See also Fig. 1.)

6.2.1.2 The missile may include cavities and additional components required to accommodate the attachment of sensors or to attach a supporting assembly. The form of any cavities or additional components shall be generally symmetrical about the Z-axis of the level missile such that center of mass lies within 0.08 in. (2 mm) of the Z-axis and the moments of inertia about any two horizontal axes do not differ by more than 5 %.

6.2.1.3 A supporting assembly (for example, a handle or ball arm) may be rigidly attached to the missile as a means of connecting it to an external guidance system. The total mass of the drop assembly, which is the combined mass of the missile, accelerometer and supporting assembly shall be that defined in Table 1. The mass of the supporting assembly alone shall not exceed 30 % of the total mass.

6.2.2 *Guidance Mechanism for Guided Impact Tests*—For guided impact tests; the missile may be connected to low-friction guides (such as a monorail, dual rails, or guide wires) using a follower or other mechanism in order to constrain the fall trajectory of the missile to a vertically downward path. Missile A and D may be guided using a ventilated tube. The guidance system must

TABLE 1 Missile Mass and Geometry ~~of Missiles~~

~~Procedur~~Missile	Impacting Surface Shape	~~Weight~~Mass	Geometry
~~A~~		~~9.1 kg ±50g (20 ± 0.11 lb)~~	~~129 ± 2.0 cm² (20 ± 1.0 in.²) f ace with a circumference-relieved radius of 2 ± 0.25 mm (0.08 ± 0.01 in.) to eliminate sharp edges~~
A	Cylindrical	9.1 ± 0.050 kg (20.0 ± 0.11 lb)	Circular face with an area of 129 ± 2.0-cm²(20 ± 1.0-in.²) and a circumference-relieved radius of 2 ± 0.25 mm (0.08 ± 0.01 in.) to eliminate sharp edges
~~B~~		~~6.8 kg ±50g (15 ± 0.011 lb)~~	~~ra dius of 82.6 ± 2.5 mm (3.2 ± 0.01 in.)~~
D	Cylindrical	2.25 ± 0.050 kg (4.95 ± 0.011 lb)	Circular face with a diameter of 50 ± 0.1 mm (1.97 ± 0.04 in.) and a circumference-relieved radius of 0.75 ± 0.25 mm (0.03 ± 0.01 in.) to eliminate sharp edges
~~C~~		~~5. 0 kg ± 50 g (11 ± 0.011 lb)~~	~~speci fie din Fig.1~~
E	Hemispherical	4.6 ± 0.02 kg (10.1 ± 0.05 lb)	Hemispherical face with a diameter of 160 ± 2 mm (6.3 ± 0.1 in.)

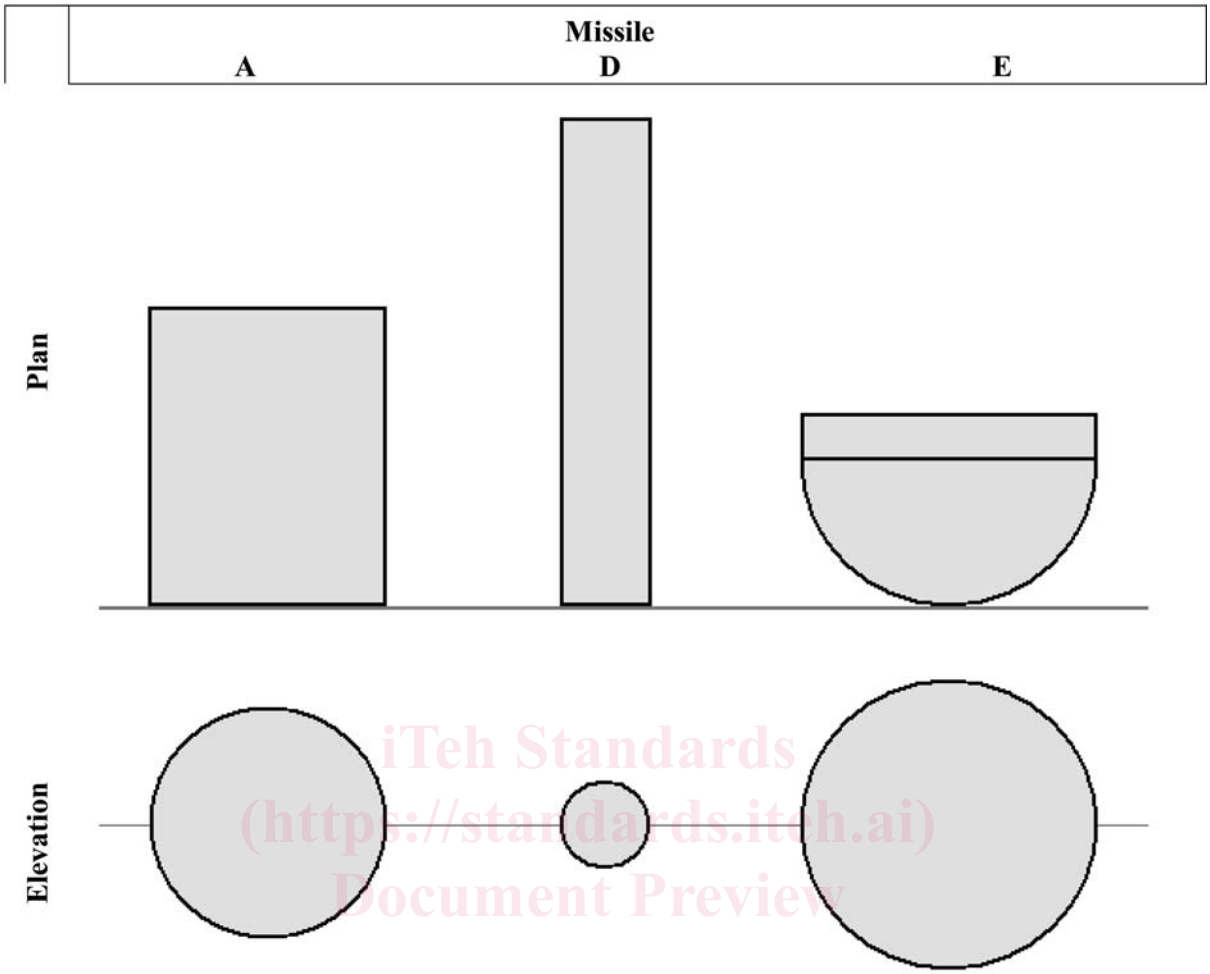

FIG. 1 Schematics Showing Approximate Relative Geometries of the A, D, and E Missiles

allow the missile to be leveled prior to a drop and must maintain the missile in a level (±5°) attitude during the drop. The guidance mechanism shall be constructed in a manner that that does not impede the trajectory of the missile during its fall or during its contact with the surface being tested; other than necessary impedance caused by friction in the guidance mechanism.

6.2.3 *Support Structure for Free-Fall Impact Tests*—For free-fall impact tests, a support structure (for example, a tripod) shall be used to ensure repeatable drop height and location. The support structure shall be sufficiently rigid to support the weight of the missile without visible deformation. The support structure shall be erected in a manner that does not impede the trajectory of the missile during its fall or during its contact with the surface being tested.

6.2.4 *Drop Height Control Mechanism*—The guidance mechanism of 6.2.2 or the support structure of 6.2.3 shall incorporate a means of repeatedly positioning the missile at a predetermined drop height.

6.2.5 *Release Mechanism*—The operation of any release mechanism provided as a means of initiating a drop of the missile shall not influence the fall trajectory of the missile following release.

6.3 ~~*Recording Equipment*—The recording equipment shall meet the following criteria:~~ Acceleration Measurement System—A transducer or transducers and associated equipment for measuring and recording the acceleration of the missile during an impact with an accuracy of within ±1 % of the true value.

6.3.1 ~~*Acceleration-Time*—The selection of the specific acceleration-time recording equipment, including transducers and recorders, is optional. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ±5% of the true value. The total system, detection and recording, shall be capable of measuring impulses up to 500 g at frequencies from 20 to 1000 Hz to an accuracy of ±5%. The minimum system sampling rate required is 20000 Hz or 20000 samples/s. The acceleration transducer system shall comply with the requirements of SAE J211/1 for a channel frequency Class 1000 data channel. A low pass filter having a 4-pole Butterworth transfer function and a corner frequency of 1650 Hz meets this requirement. A digital filter complient with Appendix C of SAE J211/1 may be substituted.~~ Accelerometers—An accelerometer shall be rigidly attached at the center of mass of the missile. The sensing axis or axes of the accelerometer shall pass through the center of mass of the missile.

6.3.1.1 For a free-fall test, a triaxial accelerometer is required.