Designation: F355 – 01

An American National Standard

Standard Test Method for Shock-Absorbing Properties 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

2.2 *SAE Standard:*

SAE Recommended Practice J 211-1 March 1995 Instrumentation for Impact Tests, Part 1—Electronic Instrumentation[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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

3.1.2 *baseline*—the starting reference plane of the playing surface system from which the total penetration is determined. It is taken as the top plane of the playing surface system, when subjected to a static compression of 6.8 kPa (1.0 psi) for Procedure A.

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

3.1.4 *G*—the ratio of the magnitude of missile acceleration during impact to the acceleration of gravity, expressed in the same units.

3.1.5 G_{max}—the maximum value of *G* encountered during impact.

3.1.6 *severity index*—an arbitrary parameter equal to the integral of $G^{2.5}$ d*t* (at 0.05-ms integration interval) over the total duration of impact.

3.1.7 *head injury criteria (HIC)*—a measure of impact severity that takes into account the duration over which the most critical section of the deceleration pulse persists as well as the peak level of that deceleration.

3.1.8 *impact velocity*—the velocity of the missile as measured within 2.54 cm (1.0 in.) of the point of impact.

3.1.9 *rebound velocity*—the velocity of the missile as it crosses the baseline on rebound.

3.1.10 *time to* G_{max}—the difference between the time the missile crosses the baseline on impact and the time G_{max} is reached.

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

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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 Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

3.1.11 *dynamic hardness index*—the stress on a material due to rapid indentation by a moving missile with the geometry described in Procedure A.

3.1.12 *time to maximum penetration*—the difference between the time the missile crosses the baseline on impact and the time maximum penetration is reached.

4. Summary of Test Method

4.1 A test specimen is impacted at a specified velocity with a missile of given mass and geometry. A transducer mounted in the missile monitors the acceleration-time history of the impact, which is recorded with the aid of an oscilloscope or other recording device. Optionally, with the use of penetration measuring devices, the displacement history of the impact may also be recorded.

4.2 The three procedures covered in this test method are as follows:

4.2.1 *Procedure A* uses a cylindrical missile with a circular, flat, metal impacting surface with specified mass, geometry, and impact velocity appropriate for the intended end use.

4.2.2 *Procedure B* uses a missile with a hemispherical, metal impacting surface of specified mass, radius, and impact velocity appropriate for the intended end use.

4.2.3 *Procedure C* uses the ANSI C size metal headform with a specified mass, geometry, and impact velocity appropriate for the end use. For the purposes of this test method, the positioning of the headform shall be such that all impacts occur on the crown.

4.2.4 The specific mass and geometry of the missiles for each procedure are detailed in 6.2.

5. Significance and Use

5.1 Dynamic data obtained by these procedures are indicative of the cushioning properties of the playing surface systems and materials under the specific conditions selected.

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.

6.2 *Missile*—The missile shall be designed to meet the general requirements of 4.2.1-4.2.3. 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 Table 1.

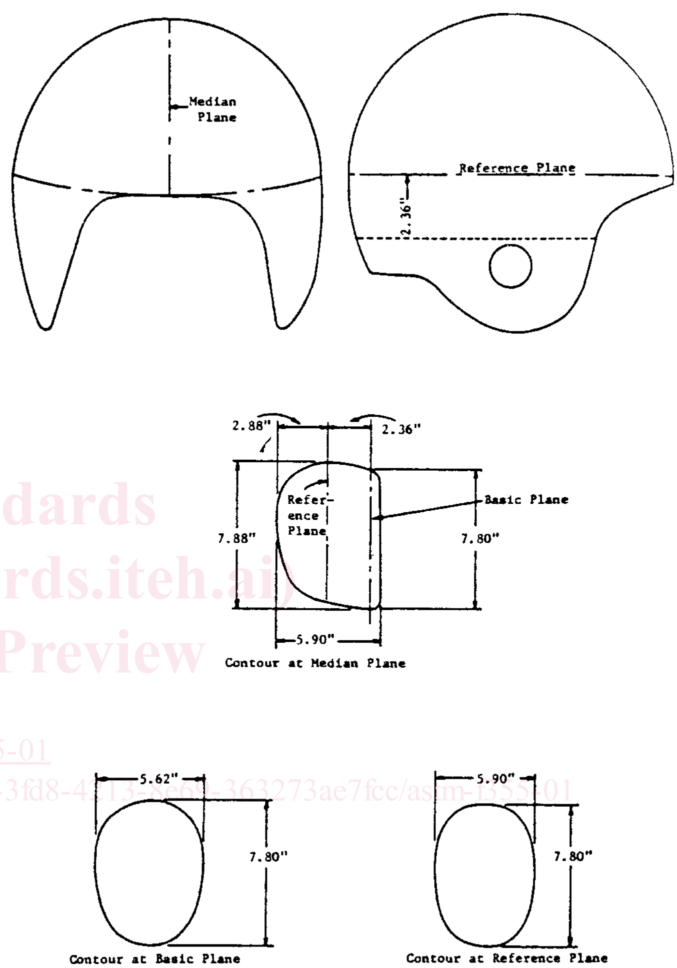
6.3 *Recording Equipment*—The recording equipment shall meet the following criteria:

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 20 000 Hz or 20 000 samples/s. The acceleration transducer system shall comply with the requirements of SAE J 211-1 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 J 211 may be substituted.

NOTE 2—Since impact test data may have high-frequency components

TABLE 1 Mass and Geometry of Missiles

Procedure	Weight	Geometry
A	9.1 kg ± 50 g (20 ± 0.11 lb)	129 ± 2.0-cm^2 (20 ± 1.0-in.^{2}) face with a circumference-relieved radius of 2 ± 0.25 mm (0.08 ± 0.01 in.) to eliminate sharp edges
B	6.8 kg ± 50 g (15 ± 0.011 lb)	radius of 82.6 ± 2.5 mm (3.2 ± 0.01 in.)
C	5.0 kg ± 50 g (11 ± 0.011 lb)	specified in Fig. 1



NOTE 1—All dimensions in inches (1 in. = 25.4 mm).

FIG. 1 Contour Dimensions of Test Headform for Procedure C