Designation: F 355 – 95

Standard Test Method for Shock-Absorbing Properties of Playing Surface Systems and Materials[1]

This standard is issued under the fixed designation F 355; 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, etc.

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, etc. 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:*

D 1596 Test Method for Dynamic Shock Cushioning Characteristics of Packaging Materials[2]

E 105 Practice for Probability Sampling of Materials[3]

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

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

F 1292 Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment[4]

2.2 *SAE Standard:*

SAE Recommended J 211 Oct. 90 Instrumentation for Impact Tests, Requirements for Channel Class 1000[5]

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 *base line*—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 1 kPa (0.14 psi) for Procedure A or the weight of missile for Procedure B, unless otherwise specified.

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* 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 it crosses the base line on impact.

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

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

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.

[1] This test method is under the jurisdiction of ASTM Committee F-8 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] *Annual Book of ASTM Standards*, Vol 15.09.

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

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

[5] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

3.1.12 *time to maximum penetration*—the difference between the time the missile crosses the base line 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 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

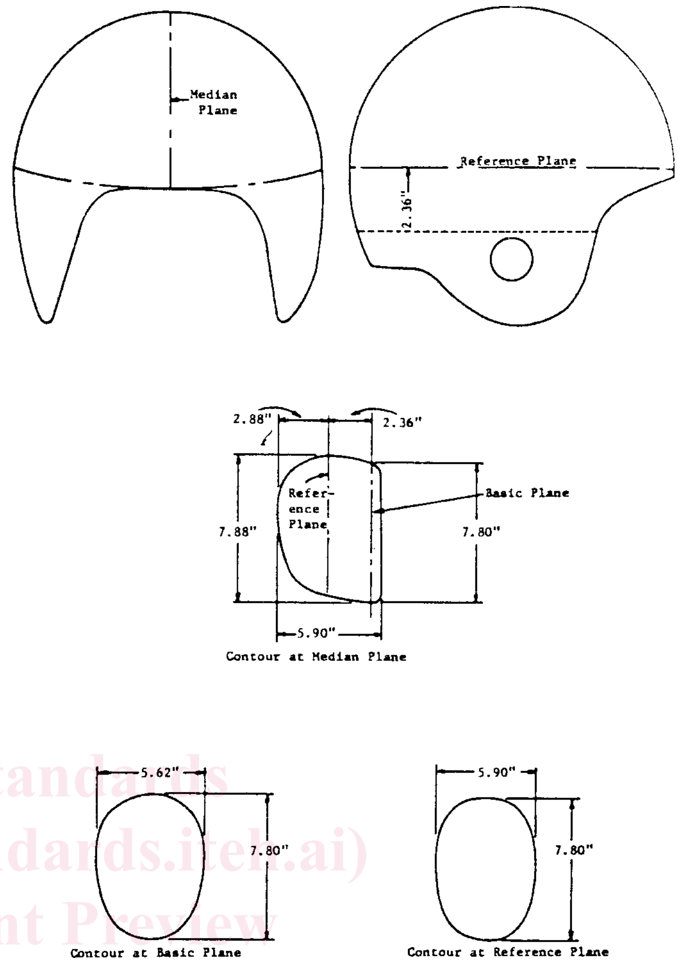
6.1 *Testing Machine*—Any type of dynamic testing apparatus that impacts the test material on a massive, rigid anvil with a missile at a prescribed impact velocity and monitors and records the acceleration-time history is acceptable. The anvil mass (impacted base) should be at least 100 times that of 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 $\pm 5°$ of the vertical axis of the missile.

NOTE 2—The following mass and geometry are specified for each procedure. *Procedure A*—A 9.1 kg (20 lb) missile with a 129 cm^2 (20 $in.^2$) face with a circumference relieved to eliminate sharp edges is recommended, *Procedure B*—A missile having a mass of 6.8 kg (15 lb) and a radius of 82.6 mm (3.25 in.) is recommended, *Procedure C*—A missile having a mass of 5.0 kg (11.0 lb) and a geometry as specified in Fig. 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 $\pm$ 5 % of the true value. The total system, detection and recording, shall be capable of measuring impulses up to 500 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5 %. The minimum system sampling rate required is 16 000 Hz or 16 000 samples/s. The acceleration data channel should comply with SAE Recommended J 211 Oct. 90 (a low pass filter having a 4-pole Butterworth transfer function and a corner frequency of 1650 Hz meets this requirement). Digital filtering at 1650 Hz can be substituted.



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

FIG. 1 Contour Dimensions of Test Headform for Procedure C

6.3.2 *Impact and Rebound Velocities*—The dynamic test equipment must have means of recording these velocities of the missile to an accuracy of ± 5 % of the true value. Any method that does not physically interfere with the impact and give erroneous acceleration-time results is acceptable.

6.3.3 *Displacement Time*—It is optional, but desirable, that the displacement-time history also be recorded. Any method that provides a linear signal proportional to displacement along the impact axis which can be monitored coincidentally with the acceleration-time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base line) of the playing surface system