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An American National Standard

Standard Test Method for Characterization of Gymnastic Landing Mats and Floor Exercise Surfaces[1]

This standard is issued under the fixed designation F 1931; 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 shock absorption characteristics and rebound properties of landing mats and floor exercise surfaces used in the sport of gymnastics. It defines quantitative parameters for these characteristics.

1.2 This test method is performed under laboratory conditions and requires use of an impact-testing device.

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

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems, 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:*

F 355 Test Method for Shock Absorbing Properties of Playing Surface Systems and Materials[2]

F 1292 Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment[2]

2.2 *SAE Standards:*[3]

SAE J211 Instrumentation for Impact Test

3. Terminology

3.1 *Definitions:*

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

3.1.2 *base line, n*—the starting reference height of the mat or floor exercise surface from which penetration and rebound are measured; this is the top surface of the mat in its undeformed state.

3.1.3 *depth of penetration, n*—maximum deformation of test specimen at impact of missile that is dropped with a predetermined impact velocity; measurement is the differential of maximally compressed surface and base line height.

3.1.4 *floor exercise surface, n*—a structure generally consisting of a deck surface with foam or spring supports and one or more layers of cushioning material on top, designed for use in competitive gymnastics floor exercises.

3.1.5 *impact velocity, n*—the velocity of the missile as it crosses the base line on impact.

3.1.6 *landing mat, n*—a structure designed for cushioning falls or landing dismounts, or both, from gymnastic routines.

3.1.7 *low impact use, n*—usage of a mat for cushioning landings that are from heights below the surface of the apparatus and do not involve somersaulting dismounts, for example, pommel horse mats.

3.1.8 *mat system, n*—a two-mat system such as a base landing mat and a supplemental mat.

3.1.9 *maximum force, n*—the peak force exerted on the testing missile by the equipment surface; that is equal to the peak acceleration times the mass of the missile.

3.1.10 *rebound height, n*—theoretical maximum rebound distance of the missile from the base line of the apparatus after impact and under ideal (frictionless) conditions.

3.1.11 *rebound velocity, n*—the velocity of the missile as it crosses the base line on rebound.

3.2 *Symbols:*

3.2.1 F_{ave}—a weighted average of maximum force for a mat; the values for 8 drops on each of four defined points are averaged, with weighting to simulate dropping on nine points.

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

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

3.2.4 P_{ave}—a weighted average of depth of penetration for a mat; the values for 8 drops on each of four defined points are averaged, with weighting to simulate dropping on nine points.

3.2.5 R_{ave}—a weighted average of rebound height for a mat; the values for 8 drops on each of four defined points are averaged, with weighing to simulate dropping on nine points.

[1] This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.12 on Gymnastics and Wrestling Equipment.

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

[3] Available from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

4. Summary of Test Method

4.1 *Impact Test*—A test specimen of mat, mat system, or floor exercise surface is impacted at a specified velocity with a cylindrical missile of specified mass and geometry. The velocity, acceleration and displacement of the missile are monitored and the depth of penetration, rebound height and maximum force are recorded.

5. Significance and Use

5.1 Data obtained from this test method is indicative of the energy absorption and elasticity of the test specimen.

5.2 The results of the test method may be used by the consumer to determine the suitability of a mat, mat system, or floor exercise surface for its intended application. This test method is intended to provide data similar to tests conducted under the authorization of the Fédération Internationale de Gymnastique (FIG).[4]

6. Apparatus

6.1 *Impact testing machine*, consisting of a stand that allows vertical impacting of a specimen up to 1.2 by 2.4 m (4 by 8 ft) in size over any point of the test specimen. The legs of the test machine shall not touch the test specimen at any point. The drop height must be adjustable. The test machine and missile system must be designed to minimize friction and to minimize undesirable vibrations in the apparatus that might be recorded on the acceleration-time curve. In order to do this, the machine must be able to obtain the desired impact velocity within 5 cm (1.97 in.) of the theoretical drop height for this velocity. In addition, the apparatus should not contain resonant frequencies below 2000 Hz.

6.1.1 *Base*, of at least 500 kg (1100 lb), which is fixed to a rigid foundation such as a concrete slab or floor. The test specimen is to be placed on this impact base.

6.2 *Missile*, constructed of a rigid cylindrical steel body. The mass of the missile shall be 10 kg (22 lb) or 20 kg (44 lb), depending upon the type of mat being tested. The area that contacts the test specimen shall be 10 cm (3.94 in.) in diameter. The circumference of the missile shall have a 0.1 cm (0.039 in.) radius to relieve sharp edges.

6.2.1 *Alignment of Missile in Impact Testing Machine*—The missile shall be aligned so that the drop is within 0.5° of vertical.

6.3 *Recording Equipment*, meeting the following criteria:

6.3.1 *Acceleration-Time*—An accelerometer shall be mounted on the missile at a point on the surface that is on a vertical line through the center of gravity of the missile. Equipment must record vertical acceleration of missile during all contact phases of the drop. The recording system shall 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 200 *g* (200 × acceleration due to gravity) at sampling frequencies of at least 8 kHz to an accuracy of ± 5 %. The recording system should have a flat frequency response to beyond 3000 Hz. The recording system should conform with SAE J211.

6.3.2 *Velocity*—The velocity recording equipment, at a minimum, must measure and record impact and rebound velocities to an accuracy of ± 5 % of the true value, with a sampling frequency of at least 8 kHz. Any method that does not physically interfere with the impact and give erroneous acceleration-time results is acceptable.

6.3.3 *Displacement*—The displacement must be recorded during the contact phase of the impact, with a sampling frequency of at least 8 kHz. If accuracy can be validated, it is acceptable to determine displacement data from the integral of the velocity data.

7. Test Specimen

7.1 For landing mats and mat systems, the test specimen must be 1 by 1 m (39 by 40 in.) and the same thickness as the mat or mat system as used in actual practice. A 1-cm (0.39-in.) tolerance in thickness and a 2-cm (0.79 in.) tolerance in length and width is permitted.

7.2 For floor exercise surfaces, the test specimen must be at least 1 by 1 m (39 by 39 in.) and is generally one section of a multi-section floor exercise surface. A 2-cm tolerance in each dimension is permitted. The dimensions may not exceed 1.2 by 2.4 m (4 by 8 ft). It must be constructed with the same materials and support geometry/layout as competitive floor exercise surface. The test specimen must include all components of the floor exercise surface including deck, supports, padding material and top surface material.

7.3 This test method may be used for other size specimens of mats, as specified by the individual requesting the test.

8. Number of Specimens

8.1 A minimum of two samples must be tested for each set of conditions.

9. Conditioning

9.1 The test specimens should be preconditioned at 20 ± 2°C (68 ± 3.6°F) and at a humidity of 50 ± 10 % for a minimum of 4 h before testing. Do not stack test specimens during conditioning. Testing should take place under these same conditions.

10. Procedure

10.1 *Calibration*—Completely calibrate all test equipment within 30 days prior to testing.

10.2 Prewarm the recording equipment as recommended by the manufacturer. Calibrate acceleration, velocity and displacement recorders as necessary, following the procedures recommended by the equipment manufacturer.

10.3 After recording equipment has been prewarmed and calibrated, perform ten drops on a control object whose acceleration response is known. Check to ensure that the results from the system are accurate. If they are not, check the system set-up for errors and repeat this step. Do not proceed with tests until the system results are acceptable. Repeat this test after the entire mat has been tested to verify that the performance of the testing system has not changed over the course of the test.

[4] Available from Fédération Internationale de Gymnastique (FIG) Testing Procedures for Landing Mats, Surfaces for Floor Exercises and Vaulting Boards, 10, Rue Des Oeuches, P.O. Box 359, 2740 Moutier 1, Switzerland.