



Standard Test Method for Evaluating the Force Reduction Properties of Surfaces for Athletic Use¹

This standard is issued under the fixed designation F2569; 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 quantitative measurement and normalization of impact forces generated through a mechanical impact test on an athletic surface. The impact forces simulated in this test method are intended to represent those produced by lower extremities of an athlete during landing events on sport or athletic surfaces.

1.2 This test method may be applied to any surface where athletic activity may be conducted.

1.3 The test methods described are applicable in both laboratory and field settings.

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

1.5 *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 ~~DIN Standard:~~ ASTM Standards:²

E177 [Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

E691 [Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

2.2 DIN Standard:³

DIN 18032-2 Halls for Gymnastics, Games and Multipurpose Use, Part 2: Sports Floors, Requirements, Testing

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *force reduction, n*—ability of a surface to reduce impact forces as compared to a rigid surface using a specified impact. Force reduction expresses the difference between the impact forces generated on the test and rigid surfaces as the percentage of the impact force from the rigid surface.

3.1.2 *rigid surface, n*—concrete surface covered by a steel plate used as the basis for measuring force reduction.

3.1.3 *test surface, n*—athletic surface upon which force reduction testing is conducted (for example, indoor wood courts, poured urethane courts, walk/jog tracks, and so forth).

4. Summary of Test Method

4.1 The dynamic interaction between the athlete and the surface is significant to the performance, comfort, and possibly the safety of the athlete. Therefore, the ability of the surface to reduce impact forces is important. This test method provides a non-destructive means for evaluating the force reduction properties of a surface in both laboratory and field settings. Impact forces are recorded by releasing a 20 kg mass and allowing it to impact a spring resting on a test foot resting on the surface. The force reduction of the surface is presented as a percentage of the reduction in the impact forces produced on the test surface, compared to the impact force generated on a rigid surface. This test method is more closely associated with the impacts generated by the

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.

Current edition approved July 15, 2007. Published August 2007. DOI: 10.1520/F2569-07.

Current edition approved Nov. 1, 2011. Published February 2012. Originally approved in 2007. Last previous edition approved in 2007 as F2569 – 07. DOI: 10.1520/F2569-11.

² Available from Beuth Verlag GmbH (DIN-- DIN Deutsches Institut für Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany, <http://www.en.din.de>.

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.

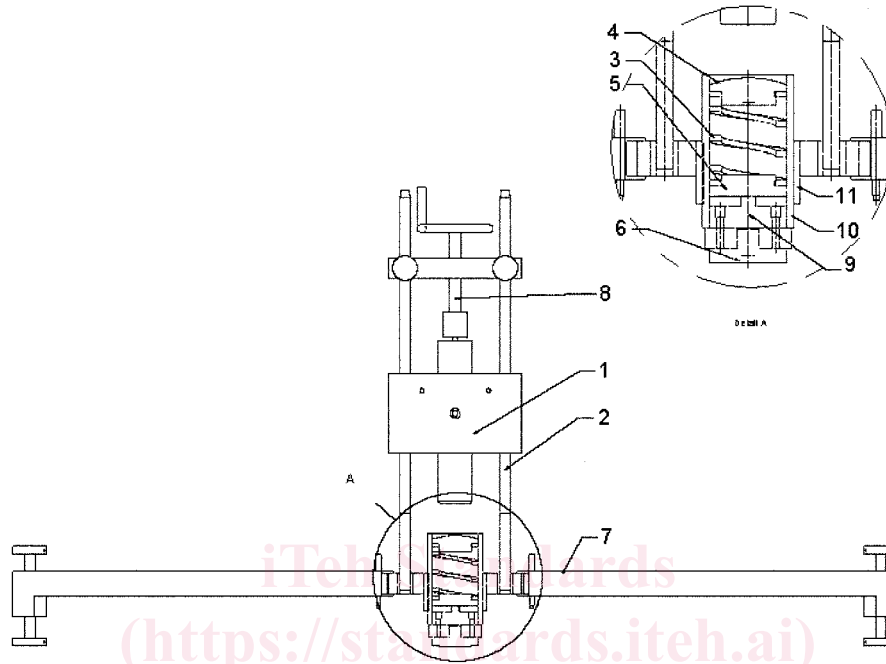
³ The sole source of supply of the apparatus known to the committee at this time is Rein Kratmessegeräte, D-89150 Laichingen, Gottlieb-Diamler-Str. 62 Germany. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

³ Available from Beuth Verlag GmbH (DIN-- DIN Deutsches Institut für Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany, <http://www.en.din.de>.

lower extremities, and is not an indication of the ability of the test surface to prevent head injury trauma.

5. Significance and Use

5.1 The force reduction property is just one of the important properties of a surface used for athletic activity. It may be an indicator of the performance, safety, comfort, or suitability of the surface.



1	=	drop mass and striker
2	=	guide rod
3	=	spring
4	=	upper end-cap
5	=	bottom end-cap
6	=	test foot
7	=	adjustable support
8	=	height adjustment and release mechanism
9	=	load cell
10	=	housing sleeve
11	=	guide hole

FIG. 1 Force Reduction Test Apparatus

5.2 Manufacturers of athletic surfaces may use this test method to evaluate the effects of design changes on the impact forces generated on the surface.

5.3 Facility owners may use this standard to evaluate the performance of existing sport/athletic surfaces. Results may be useful during the selection process for a replacement surface, or for an additional athletic surface being added to the facility.

5.4 Facility owners may also use this test method to verify that newly installed surfaces perform at or near the levels included in project specifications.

6. Apparatus

6.1 *Force Reduction Test Apparatus*—This test method utilizes a force reduction test device similar to the one outlined in DIN 18032-2. The force reduction device is shown in Fig. 1. A mass of 20 kg is allowed to fall onto an anvil, which transmits the load via a spring to a test foot resting on the surface. The foot is fitted with a force transducer that enables the peak force during the impact event to be recorded. The peak force is compared with the result obtained on a rigid floor, and the percentage of force reduction calculated for the test surface.

6.1.1 The apparatus shall conform to the following requirements:

6.1.1.1 Falling mass with a striker screwed into the bottom side of the mass. The striker has a diameter of 50 ± 10 mm (2.0 ± 0.4 in.) and a length of 75 ± 25 mm (3 ± 1 in.). The total mass of the falling weight and the striker is 20 ± 0.05 kg (44 ± 0.1 lb);

6.1.1.2 Ensure the drop mass travels in a vertical path from release to impact, such as by using guide rods;

6.1.1.3 Spring⁴ with a spring rate 2000 ± 100 kN/m ($11\,420 \pm 571$ lb/in.), an outside diameter of 70.0 ± 0.1 mm (2.75 ± 0.004 in.), a free length of 75 ± 10 mm (3.95 ± 0.39 in.);

(I) Spring rate shall be determined by linear regression through force-deflection data recorded the following loads; 200 N, 2000 N, 4000 N, 6000 N, 8000 N, and 10 000 N (45 lb, 448 lb, 897 lb, 1346 lb, 1794 lb, and 2243 lb).

6.1.1.4 Upper spring end-cap made of hardened steel with a diameter of 70.0 ± 0.1 mm (2.75 ± 0.004 in.).

6.1.1.5 Bottom spring end-cap made of hardened steel to contact the load-cell with a diameter of 70.0 ± 0.1 mm (2.75 ± 0.004 in.). The face of this end-cap that contacts the load cell may be made flat, or it may have a recess milled into it to fit a load-button on the load cell.

6.1.1.6 Test foot diameter 70.0 ± 0.1 mm (2.75 ± 0.004 in.), thickness 12 ± 1 mm (0.47 ± 0.04 in.) with a radius of 500 ± 50 mm (20 ± 2.0 in.) and filleted edges with a radius of 1 ± 1 mm (0.004 ± 0.004 in.);

6.1.1.7 Adjustable support with three contact points (spaced $120 \pm 5^\circ$) to set apparatus vertical ($\pm 2^\circ$), such as by using a pair of calibrated levels with a minimum distance of 600 mm (24 in.) between the falling axis and the axis of the contact points;

6.1.1.8 Capable of producing a drop height between 22.0 mm (0.87 in.) and 88.0 mm (3.46 in.) with a lifting facility to hold and release the drop mass and to adjust the drop height between bottom of the striker and the upper spring end-cap to an accuracy of 0.25 mm (0.01 in.);

6.1.1.9 Mass of test foot and load cell and spring, end-caps and any other attached components shall be 3.0 ± 0.5 kg (6.6 ± 1.1 lb);

6.1.1.10 Housing sleeve that ensures the axis of the spring and the load-cell are collinear. Housing sleeve length sufficient to extend below the spring over the load-cell and cover a minimum of 90 % of the free length of the spring. The housing sleeve must have an inside diameter of 71 ± 0.1 mm (2.80 ± 0.004 in.) and a minimum thickness of 4 mm (0.25 in.). The housing sleeve shall not be attached to the test foot, load-cell, or spring in any fashion. The inside and outside shall ensure smooth uninterrupted travel of the spring during impact, such as by polishing the surfaces.

6.1.1.11 The housing sleeve shall fit through a guide hole with a clearance of 0.5 ± 0.05 mm (0.019 ± 0.002 in.). The inside of the guide hole shall allow smooth uninterrupted travel of the housing sleeve during impact, such as by polishing the surface.

6.2 *Rigid Surface*—Concrete, 15 cm (5.9 in.) minimum thickness with a 10 mm (0.39 in.) thick steel plate fully glued to the concrete using an adhesive with a Young's modulus ≥ 10 kN/mm²(1.45 Mpsi).

6.3 *Data Collection and Analysis System:*

6.3.1 Sampling frequency of at least 2000 Hz;

6.3.2 Butterworth filter 120 Hz, 2-pole for collecting data on both the rigid and the test surface;

6.3.3 Electronic load-cell with amplifier, with a loading capacity of at least 10 000 N (2242 lb) and an accuracy of 1 % or better, and

6.3.4 Recording equipment capable of storing enough force data to calculate data, display readings and graph impact force-time curves.

6.4 *Appropriate Devices for Determining Surface/Air Temperatures and Relative Humidity:*

6.4.1 Measurements may be obtained using hand-held commercially available devices.

7. Testing Conditions

7.1 The following general testing conditions shall be recorded and included in the test report for information purposes only.

7.1.1 *All Surfaces:*

7.1.1.1 Testing is to be conducted at $23 \pm 2^\circ\text{C}$ ($72 \pm 4^\circ\text{F}$) when possible. Record surface and air temperature (to the nearest 1°C (2°F)) and relative humidity (to the nearest 1 %). Surface temperature measurements should be taken in manner appropriate to the test surface. Other ASTM guides and specifications may also require testing at additional temperatures.

7.1.1.2 The force reduction shall be tested using the missile drop height specified by the test procedure/standard named in the test report. If no specific drop height is specified therein, the standard drop height of 55 mm (2.2 in.) shall be used. Additional drop heights may be tested and should be agreed on by the purchaser and the seller. Other ASTM guides and specifications may also require testing at additional drop heights.

7.1.2 *Laboratory Sample Sizes*—Standards that reference this method shall ensure that the sample size is sufficiently large and that test points are sufficiently far from the edge of the sample that edge effects are prevented from altering the outcome of the tests.

8. Procedure

8.1 Because of the definition of the rigid surface, testing of the rigid surface can not be conducted on-site. Documentation of the rigid surface will refer to the rigid surface present at the testing person's/company's laboratory.

8.2 Locate and document all points to be tested. This includes points on the athletic surface and the rigid surface when applicable.

⁴ The sole source of supply of the apparatus known to the committee at this time is Rein Kratmessegerate, D-89150 Laichingen, Gottlieb-Diamler-Str. 62 Germany. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.