Designation: F1551 – 09

An American National Standard

Standard Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials[1]

1. Scope

1.1 These test methods establish a recommended list from which suitable test methods shall be selected for the identification of physical property characteristics and comparison of the performance properties of synthetic turf systems or components for athletic and recreational uses, or both.

1.2 Some of the test procedures are suitable only for the laboratory characterization of either components or the complete system; others are suitable for tests on installed sports fields; and some tests may be applied in both the laboratory and the field.

1.3 The test procedures included in these test methods apply as a group to the description of synthetic turf playing surfaces.

1.4 Some of the test procedures are specific for components of the synthetic turf system, and others apply to the complete synthetic turf playing surface.

1.5 Reference to the methods for testing the synthetic turf playing surface and its components contained herein should state specifically the particular test or tests desired and not necessarily refer to these test methods as a whole.

1.6 This is a physical property characterization standard, and it shall not be construed as a safety standard.

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

1.8 *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]

2.1.1 *Pile Fiber:*

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1577 Test Methods for Linear Density of Textile Fibers
D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method
D3218 Specification for Polyolefin Monofilaments
D7138 Test Method to Determine Melting Temperature of Synthetic Fibers

2.1.2 *Fabric:*

D1335 Test Method for Tuft Bind of Pile Yarn Floor Coverings
D1776 Practice for Conditioning and Testing Textiles
D2859 Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
D4158 Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)
D5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
D5251 (Withdrawn 2014)[3]
D5793 Test Method for Binding Sites per Unit Length or Width of Pile Yarn Floor Coverings
D5823 Test Method for Tuft Height of Pile Floor Coverings
D5848 Test Method for Mass Per Unit Area of Pile Yarn Floor Coverings
E648 Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
F1015 Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces

[1] These test methods are under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and are the direct responsibility of Subcommittee F08.65 on Artificial Turf Surfaces and Systems.

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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] The last approved version of this historical standard is referenced on www.astm.org.

2.1.3 *Shock Absorbing Cushion Underlayment:*

D395 Test Methods for Rubber Property—Compression Set

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

D1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)

D1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)

D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging

D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams

D3575 Test Methods for Flexible Cellular Materials Made From Olefin Polymers

D3936 Test Method for Resistance to Delamination of the Secondary Backing of Pile Yarn Floor Covering

F355 Test Method for Impact Attenuation of Playing Surface Systems and Materials

2.1.4 *Turf Systems:*

D1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)

F355 Test Method for Impact Attenuation of Playing Surface Systems and Materials

F1015 Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces

F1936 Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field

F2117 Test Method for Vertical Rebound Characteristics of Sports Surface/Ball Systems; Acoustical Measurement

F2333 Test Method for Traction Characteristics of the Athletic Shoe–Sports Surface Interface

2.1.4 *Infill Materials:*

D5644 Test Methods for Rubber Compounding Materials—Determination of Particle Size Distribution of Recycled Vulcanizate Particulate Rubber

F1632 Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes

2.2 *Other Standards:*

AT-030 Sports Shoe Traction

NOTE 1—AstroTurf® Industries internal test procedure is suitable as a basis for new ASTM test methods.

DIN 18-035 Part 6—Water Permeability of Synthetic Turf Systems and Permeable Bases

EN 12234 Surfaces for Sports Areas – Determination of Ball Roll

EN 12616 Surfaces for Sports Areas – Determination of Infiltration Rate

EN 14808 Surfaces for Sports Areas- Determination of Force Reduction

EN 14809 Surfaces for Sports Areas – Determination of Vertical Deformation

prEN 15301-1 Surfaces for Sports Areas- Part 1. Determination of Rotational Resistance

3. Terminology

3.1 *Definitions*—Terms are as defined in the referenced ASTM procedures comprising these test methods.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *fabric construction*—the method of assembly of pile ribbon and backing yarns that produces the fabric, usually tufting, knitting, or weaving.

3.2.2 *infilled turf system*—field system having a long pile height and either one or more substances in the face of the fabric to provide the desired playing properties. Infill substances can be either sand, rubber or other substances or a combination of items.

3.2.3 *lengthwise direction, n—in textiles*, the direction in a machine-made fabric parallel to the direction of movement the fabric followed in the manufacturing machine.

3.2.4 *matting*—the extent of change of the apparent synthetic turf pile thickness from the original value due to permanent compression of the pile from sports use.

3.2.5 *pile, n—for pile fiber turf surfacing*, surface texture composed of many individual thin strands or groups of strands bound to a backing fabric in a repetitive array.

3.2.6 *pile lay*—the direction in which most of the pile fibers lean in the original, uncrushed fabric.

3.2.7 *secondary backing*—a material adhered to the backing side of a pile turf fabric.

3.2.8 *sports shoe traction*—a measure of the static or sliding coefficient of friction between a weighted sports shoe and the turf pile surface, horizontal motion.

3.2.9 *synthetic turf field system*—composite of synthetic contact surface material, any fill material used in the contact surface, energy absorbing material, fabric layers, adhesives, if any, and other constructed layers (as applicable to the individual system construction).

3.2.10 *synthetic turf system components*—the separate components such as turf fabric, shock-absorbing pad, and adhesives that comprise the synthetic turf playing surface when assembled; the subcomponents such as pile yarns and backing yarns that comprise the turf fabric.

3.2.11 *texture*—the detailed configuration of loops, cut pile ends, and individual fibers in the pile layer.

3.2.11.1 *Discussion*—Texture is the detailed appearance of the pile that changes by matting, crushing, flattening, fuzzing, untwisting, etc. during exposure to service. The texture should be distinguished from the construction, that is, the specifications of kinds of yarns, yarn sizes, and the mode of combination.

3.2.12 *water permeability*—the rate at which water of a specified head flows vertically through synthetic turf or other components of the system.

4. Summary of Test Methods

4.1 The purpose of these test methods is to provide a comprehensive characterization of synthetic turf playing surfaces.

TABLE 1 Performance Test Methods for Synthetic Turf Surfaces

Test Method		Section	Item Tested
Pile Fiber			
D792	density (specific gravity)	9	synthetic yarn
D1577	linear density of textile fibers (denier)	10	pile of yarn on mfg. turf fabric
D1907	linear density of yarn (denier - skein method)	11	bobbin of yarn
D2256	breaking strength and elongation	12	bobbin of yarn
D3218	yarn thickness	13	synthetic yarn
D7138	melting point (Fisher-John method or DSC method)	14	synthetic yarn
Fabric			
D1335	resistance to tuft pullout	15	synthetic turf fabric
D2859	flammability of pile floor covering (methenamine tablet)	17	synthetic turf fabric
D4158	abrasion resistance (uniform abrasion method)	18	non-infilled turf
D5034	grab tear strength	19	synthetic turf fabric
D5251	resistance to matting (tetrapod method)	20	non-infilled turf
D5793	binding sites per unit	21	synthetic turf fabric
D5823	pile height	22	synthetic turf fabric
D5848	pile fiber, mass per unit	23	synthetic turf fabric
E648	flammability of synthetic turf (flooring radiant panel test)	24	synthetic turf fabric
F1015	relative abrasiveness of synthetic turf surfaces	25	synthetic turf fabric
Shock Absorbing Pad Component			
D395	compression set under constant load	26	shock-absorbing pad
D412	Dogbone tensile & elongation (Die A)	27	shock-absorbing pad
D624	tear resistance (Die C)	28	shock-absorbing pad
D1667	compression resistance	29	shock-absorbing pad
D1876	T-peel strength of secondary pad	30	synthetic turf and pad
D2126	hydrolytic stability	31	shock-absorbing pad
D3574	tensile and elongation urethane foams	32	shock-absorbing pad
D3575	water absorption (% weight gain)	33	shock-absorbing pad
D3936	delamination strength of secondary backing	34	synthetic turf and reinforcement fabric
F355	shock absorbency of playing surface systems and materials	35	shock-absorbing pad
Turf Systems			
D1667	compression resistance (modified method)	29	synthetic turf system
F355	shock absorbency of playing surface systems and materials	35	synthetic turf system
F1015	relative abrasiveness of synthetic turf surfaces	25	synthetic turf or system
F1936	shock absorbency of playing surface systems in the field	36	synthetic turf system
F2117	vertical rebound (acoustical measurement)	37	synthetic turf system
F2333	athletic shoe traction	38	synthetic turf or system
Other Standards – Turf Systems			
AT-030	sports shoe traction	41	synthetic turf or system
DIN 18-035	water permeability of synthetic turf system	42	synthetic turf or system
EN 12234	ball roll	43	synthetic turf system
EN 12616	infiltration rate	44	synthetic turf or system
EN 14808	force reduction	45	synthetic turf system
EN 14809	vertical deformation	46	synthetic turf system
Infill Material			
D5644	particle size distribution of recycled rubber	40	ground rubber
F1632	particle size analysis and sand shape grading	39	sand

4.2 Specific conditions of the referenced procedures are recommended to encourage uniform application of these test methods.

4.3 Table 1 is an index of the test methods listed herein.

5. Significance and Use

5.1 These test methods constitute a standard for obtaining data in research and development, quality control, acceptance and rejection under specifications, and for special purposes.

5.2 The data obtained from use of these test methods are applicable to the system and its components under conditions of the particular test procedures and are not necessarily the same as the data that might be obtained in other environments or use conditions.

5.3 The selection of test methods or tests should be limited to those appropriate to the system or material(s) being evaluated.

6. Conditioning of Materials

6.1 Conduct laboratory tests under known conditions of temperature and humidity as specified in the individual test procedures. In the absence of specified conditions, tests must be conducted under the standard laboratory conditions of 23 ± 2°C (73.4 ± 3°F) and 65 ± 5 % relative humidity. Materials must be conditioned, undeflected, and undistorted at the temperature and humidity of test for at least 24 h prior to testing.

6.2 Conduct field tests on installed, indoor or outdoor synthetic turf playing surfaces at ambient temperature and humidity conditions. Measure and record the temperature of the synthetic turf surface, shock-absorbing pad, or other specific components being characterized by the particular test.

7. Sampling

7.1 For laboratory tests, select representative samples of components, in accordance with specific sampling instructions of the test procedure, when provided.

7.2 For field tests, specify locations on the synthetic turf playing surface where tests are conducted.

8. Application of Test Procedures

8.1 References to the test procedures stated herein are to be followed with regard to the apparatus, preparation of specimens, procedures, calculations, and reporting of results, except when different conditions are noted specifically in these test methods.

8.2 Precision and bias statements are given for each test procedure in the respective test methods.

8.3 Test procedures shall be followed except when test method-specific conditions are provided.

TEST PROCEDURES

9. Test Methods D792, Specific Gravity (Relative Density) and Density of Plastics by Displacement

9.1 *Scope:*

9.1.1 This test procedure describes measurement of the specific gravity of fibers and filaments.

9.1.2 This test is appropriate and applicable to the pile yarn component of synthetic turf fabrics before the product is made.

10. Test Methods D1577, Linear Density of Textile Fibers

10.1 *Scope:*

10.1.1 This test procedure describes measurement of the linear density (denier) of textile fibers and filaments.

10.1.2 The test is appropriate and applicable to the pile yarn component of synthetic turf fabrics after the product is manufactured.

10.2 *Test Method Specific Conditions:*

10.2.1 *Test Method A*—The direct weighing method is recommended.

10.2.2 The linear density of finish-free fiber is the recommended measurement; see 12.1 of Test Methods D1577.

10.2.3 Manufacturing process may change yarn denier as measured.

11. Test Method D1907, Linear Density of Yarn (Yarn Number) by the Skein Method

11.1 *Scope*—This test method covers the determination of the linear density (denier) of all types of yarn in (bobbin) package form.

11.2 *Test Method Specific Conditions:*

11.2.1 Specified lengths of yarn are wound on reels as skeins, and weighed.

11.2.2 Nine meters is recommended length weighed in grams times 1000 for denier, grams per 9000 meters.

12. Test Method D2256, Tensile Properties of Yarns by the Single Strand Method

12.1 *Scope:*

12.1.1 This test procedure describes measurement of the tensile properties strength, elongation, and (optionally) modulus for textile fibers and filaments.

12.1.2 The test is appropriate and applicable to the pile fiber component of synthetic turf fabrics before the product is made.

12.2 *Test Method Specific Conditions:*

12.2.1 Option A1, standard-conditioned, straight fiber or filament is recommended.

12.2.2 Horn grip clamps are recommended.

12.2.3 The recommended gage length is 15.2 cm (6 in.).

12.2.4 The recommended cross-head speed is 30.5 cm/min (12 in./min).

12.2.5 The tangent method is recommended if the modulus is calculated (Appendix, Test Method D2256).

12.2.6 The measurement of strength and elongation may be conducted on monofilaments or multifilament yarns; specify which.

13. Specification D3218, Polyolefin Monofilaments

13.1 *Scope:*

13.1.1 This specification covers polyolefin monofilament yarn materials, and test methods for standard polyolefin monofilaments.

13.1.2 This test method covers the determination of the thickness of flat polyolefin monofilaments, by a micrometer.

13.1.3 This method can also be used for slit-filament tape yarn.

13.2 *Test Method Specific Conditions*—Measure the thickness of the specimen to the nearest 2.5 µm (0.1 mil) using the micrometer.

14. Test Method D7138, Determine Melting Temperature of Synthetic Fibers

14.1 *Scope:*

14.1.1 These test methods describe several techniques for the characterization of polyamides, polypropylene, and other fibers.

14.1.2 The applicable part of this test procedure is that describing the measurement of melting point for polyamide fibers and other fibers used in constructing synthetic turf fabrics.

14.2 *Test Method Specific Conditions:*

14.2.1 A temperature rise of 2°C/min with the Fisher-Johns melting point apparatus is recommended. Follow Test Method 2 where applicable.

14.2.2 Acceptable alternatives for the measurement of melting point is differential scanning calorimetry (DSC) instruments. Report the temperature rise and other pertinent experimental conditions used with DSC Method 1.

15. Test Method D1335, Tuft Bind of Pile Floor Coverings

15.1 *Scope:*

15.1.1 This test provides a method for measuring the tuft bind in pile fabrics such as carpets.

15.1.2 The test is appropriate and applicable to the pile yarn component of synthetic turf fabrics.

15.2 *Test Method Specific Conditions:*

15.2.1 Test Method D1335 is written in the language of fabrics of tufted construction. However, application may be extended to knitted and woven synthetic turf fabrics if the concept of tuft is redefined suitably.

15.2.2 *Tufted Fabrics*—For the purposes of Test Method D1335, a tuft has the conventional definition of the two halves of the mono or multifilament loop of pile that is inserted between the adjacent yarns of the tufting medium (backing fabric), held in place by a primary coating (adhesive), and not otherwise connected mechanically to the tufting medium (see Fig. 1).

15.2.3 *Knitted Fabrics*—For the purposes of Test Method D1335, a tuft is comprised of the adjacent legs of two loops of pile. Each loop passes under a yarn of fabric backing, but adjacent legs are not restrained mechanically, thereby permitting pullout without rupture of the backing yarns (see Fig. 2).

15.2.4 *Woven Fabrics*—For the purposes of Test Method D1335, a tuft is defined suitably as in the case of knitted fabrics (14.2.3) to avoid rupture of the backing yarns when determining tuft pullout (see Fig. 3).

15.3 The specified cross-head speed for the measurement of tuft bind with all fabrics is 30.5 ± 1.0 cm/min (12 ± 0.05 in./min).

15.4 For turf made with multi-filament fibers, one tuft leg (Figure 1) includes all filaments of the multi-filament bundle.

16. Practice D1776, Conditioning and Testing Textiles

16.1 *Scope:*

16.1.1 This practice covers the conditioning and testing of textiles in those instances where such conditioning is specified in a test method.

16.1.2 The conditioning prescribed in this practice is designed to obtain reproducible results on textiles and textile products.

17. Test Method D2859, Flammability of Finished Textile Floor Covering Materials

17.1 *Scope:*

17.1.1 This test covers determination of the flammability of finished textile floor covering materials using the methenamine tablet method.

17.1.2 This test method should be used for measuring and describing the properties of materials or assemblies in response to heat and flame under controlled laboratory conditions. It should not be used for describing or appraising the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions.

17.2 *Test Method Specific Conditions:*

17.2.1 This test method involves the exposure of conditioned and oven-dried samples to a methenamine tablet ignition source in a draft-protected environment and measurement of the resulting char length.

17.2.2 The test method may be used for assessing the effect of a specific underlayment or cushion in combination with a floor covering.

17.2.3 Condition the samples as directed in Practice D1776.

17.3 *Sampling and Test Specimens:*

17.3.1 Cut eight specimens from each lot fabricated for each playing surface or field.

17.3.2 This test is applicable for new, non-used, synthetic turf surfaces and materials.

17.4 *Procedure, Results, and Report*—Test Method D2859 applies as written for synthetic turf fabrics and surfaces.

18. Guide D4158, Abrasion Resistance of Textile Fabrics (Uniform Abrasion Method)

18.1 *Scope:*

18.1.1 This test describes the Schiefer and Krasny method for determining the resistance of fabrics to abrasion.

18.1.2 The test is useful for characterizing the abrasion resistance of non-infilled synthetic turf fabrics.

18.2 *Test Method Specific Conditions:*

18.2.1 The type of abradant wheel used must be specified when reporting the results.

18.2.2 The spring steel blade abradant is the recommended standard.

18.2.3 The counterweight used must be specified when reporting the results.

18.2.4 The 4.536-kg (10-lb) counterweight is the recommended standard.

18.2.5 The standard abrading wheel r/min is 260.

19. Test Method D5034, Breaking Strength and Elongation of Textile Fabrics (Grab Test)

19.1 *Scope:*

19.1.1 This test provides methods for determining the breaking strength and elongation of textile fabrics.

19.1.2 Of the various test methods described in Test Method D5034 for measuring the strength of textile materials, the grab test (Section 9.2) is recommended for use with synthetic turf fabrics.

19.1.3 The modified grab test procedure is applicable only to unraveling or high-strength fabrics.

19.2 *Test Method Specific Conditions:*

19.2.1 The recommended instrument type for the tensile testing is a constant rate of extension (CRE) tensile testing machine.

19.2.2 The recommended sample size is 10.2 by 15.2 cm (4 by 6 in.). The sample elongation is in the longer dimension.

19.2.3 The recommended clamps (top and bottom) are 2.54 by 2.54 cm (1 by 1 in.) on one side and 2.54 by 5.08 cm (1 by 2 in.) on the other side. The shorter side of the clamp is oriented in the direction of sample elongation.

19.2.4 The recommended gage length is 7.6 cm (3 in.).

19.2.5 The recommended cross-head speed is a uniform 30.5 cm/min (12 in./min).

19.2.6 The test method is applicable to knitted fabrics. (**Warning—**Higher strengths and elongation, than anticipated, could result.)

20. Practice D5251, Operation of the Tetrapod Walker Drum Tester

20.1 *Scope:*

20.1.1 This practice describes the equipment and operation of the Tetrapod Walker for testing shorter pile, non-infilled synthetic turf surfaces for resistance to matting.

20.1.2 This practice may be used upon mutual agreement between the purchaser and the supplier to set purchasing specifications.

20.1.3 The values stated in inch-pound units are to be regarded as the standard for all measurements except mass. The SI values are provided for information only for all measurements except mass.

20.2 *Summary of Practice—*The specimen is secured as the lining of a rotatable drum with the pile surface exposed. A four-legged metal casting (tetrapod) walks on the pile surface as it is tumbled in the drum, which is rotated about its longitudinal axis for a specified number of revolutions.

20.3 *Significance and Use:*

20.3.1 This equipment may be used to bring about the changes in texture on the surface of pile turf surfacing caused by mechanical action.

20.3.2 The acceptance criteria of this practice shall be set by mutual agreement between the purchaser and the supplier.

20.4 *Apparatus and Reagent Tetrapod Walker*[4] Tester:

20.4.1 *Driving System,* which cradles a drum on rollers and keeps the axis of the drum level, rotates at 5.2 ± 0.2 rad/s (50 ± 2 r/min), and has a counter that can be preset to stop the drum after any number of revolutions. Drive systems that do not reverse shall have the direction of rotation shown on the drum.

20.4.2 *Drum,* constructed of a rigid material and capped by a lid that is secured firmly. Each drum is equipped with two springs to hold the test specimen in place during testing. The inner dimensions of the drum are as follows: diameter, 205 ± 5 mm (8.0 ± 0.2 in.); and height, 190 ± 5 mm (7.6 ± 0.2 in.).

20.4.3 *Tetrapod—*A metal casting tetrahedral in shape with four legs placed equidistant from one another. That is, the outer most points correspond to the points on an equilateral tetrahedron, and the large angle between any two legs is 109.5°. Each leg shall have a replaceable plastic foot at the end. The free standing height of the tetrapod with three of the four plastic feet in one plane is 125 ± 2 mm (5 ± 0.1 in.). The total mass of the tetrapod, including the feet, is 1000 ± 2.5 g.

20.4.4 *Reagent Solvent—*Ethyl or isopropyl alcohols are suitable. Do not use cellosolve, chlorinated, or ketone solvents.

20.5 *Preparation of Specimen:*

20.5.1 *Marking the Specimen—*Before cutting out the test specimen, mark the direction of the pile lay and direction of the tetrapod walk on the secondary backing of each specimen.

20.5.2 *Size of Specimen—*Cut the specimen 61 by 20.5 cm (24 by 8 in.). The long dimension shall be parallel to the lengthwise direction of the carpet. Take no specimen within 10 cm (4 in.) of the trimmed edge.

20.6 *Conditioning—*Bring the specimen to moisture equilibrium for testing in the standard atmosphere for testing textiles, having a relative humidity of 65 ± 2 % at 21± 1°C (970 ± 2°F). Condition for a minimum of 12 h.

20.7 *Procedure:*

20.7.1 Test the conditioned specimen in a standard atmosphere at 65 ± 2 % relative humidity at 21 ± 1°C (70 ± 2°F).

20.7.2 Ensure that the inside of the drum and feet of the tetrapod are clean, smooth, and free from any contamination. Wipe the tetrapod tumbler and inside of the drum with a clean, lint-free tissue and one of the recommended reagents.

20.7.3 Inspect the tetrapod feet for signs of wear or damage, and replace as necessary.

20.7.4 Place the specimen in the drum, with the lay of the pile and drum rotation in the same direction.

NOTE 2—Some testers have the capability of reversing their direction of rotation intermittently.

20.7.5 Place the specimen in the drum with the pile yarn exposed.

20.7.6 Carefully fit one spring over the specimen at the closed end of the drum and the second spring at the open end. The solid part of the springs should bridge any carpet seams.

20.7.7 Place the tetrapod tumbler in the drum on the carpet surfaces.

20.7.8 Secure the lid to the drum, and then position the drum on the rollers of the drive mechanism and ensure that the drum is level.

20.7.9 Set the counter for 50 000 revolutions unless otherwise specified.

20.7.10 Remove the specimen from the drum at the end of the specified revolutions.

20.8 *Report:*

20.8.1 State that the test was conducted as directed in Practice D5251.

20.8.2 Identify the tested specimen.

20.8.3 Report the atmospheric conditions.

20.8.4 Report whether the drum rotation reverses.

20.8.5 Report the number of revolutions.

20.8.6 Report the appearance (texture) rating versus standard matting sample Numbers 1 through 5 or provide photographs of the matted samples versus photographs of a control matted turf sample.

[4] The Tetrapod Walker can be purchased from Lawson Hemphill Sales Inc., P.O. Box 6388, Spartanburg, SC; or Machine Control B.A.A. Canada Inc., 701 Ave. Meloche, Dorval, Quebec.

21. Test Method D5793, Binding Sites per Unit Length or Width of Pile Yarn Floor Coverings

21.1 *Scope:*

21.1.1 This test method describes the measurement of the number of binding sites per unit length or width of machine-made, woven, knitted, and tufted pile yarn floor covering.

21.1.2 This test procedure describes methods appropriate and applicable for characterizing synthetic turf fabric.

21.2 *Test Method Specific Conditions:*

21.2.1 If the binding sites are visible from the back, place the test specimen face down on a flat surface; otherwise, place the test specimen back down and shear the pile close to the backing to reveal the binding sites.

21.2.2 Count the binding sites with a graduated scale or tape, reading to the nearest 1 mm (0.05 in.) in the direction to be counted.

22. Test Method D5823, Tuft Height of Pile Floor Coverings

22.1 *Scope*—This method covers the determination of tuft height using a grooved specimen holder.

22.2 *Test Method Specific Conditions:*

22.2.1 Sever the leg of each selected tuft leg or loop as close to the backing surface as possible with the angled flush wire cutter and place in grooved specimen holder.

22.2.2 Read the graduated scale at the opposite end of the tuft element and record to the nearest 0.5 mm (0.01 in.).

22.2.3 Pile height (blade length) is also measured by inserting a small graduated ruler into the pile down to the backing and reading the overall height of the pile for machine set-up or rough field work.

23. Test Method D5848, Mass Per Unit Area of Pile Yarn Floor Coverings

23.1 *Scope:*

23.1.1 The test method is designed for the characterization of pile materials such as carpets.

23.1.2 This test procedure describes several methods appropriate and applicable for characterizing synthetic turf fabrics and suitable measurements of mass per unit area.

23.2 *Test Method Specific Conditions:*

23.2.1 The normally applicable tests of the group are as follows: total mass per unit area (Section 7); component masses per unit area (Section 8); and pile yarn mass per unit area (Section 9).

23.2.2 When the floor covering exhibits a strong pile lay, brush the pile surface in the direction of the pile lay to make the surface more uniform.

23.2.3 With coarse gages and straight lengthwise lines of binding sites it is possible to lose a whole row of tufts by a small lateral shift in the location of the specimen location when the long dimensions parallel to the line of binding sites. Angling the specimen 14° avoids this problem.

24. Test Method E648, Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

24.1 *Scope:*

24.1.1 This test describes the apparatus and technique for determining the critical radiant flux (CRF), a measure of the flammability resistance of fabrics using the flooring radiant panel method.

24.1.2 The test is applicable to synthetic turf fabrics.

24.2 *Test Method Specific Conditions:*

24.2.1 The test method applies as written to synthetic turf fabrics.

24.2.2 The results for CRF will differ, depending on whether the fabric tested also has its shock-absorbing pad placed under it during the test.

NOTE 3—Test Method E648 is applicable to floor-covering system specimens that follow or simulate accepted installation practices. Tests on the individual elements of a floor system are of limited value and are not valid for evaluation of the flooring system.

24.2.3 Run tests with and without the undercushion, and report the results of both tests.

24.2.4 Some infill materials may release large amounts of heat which can damage the test apparatus.

25. Test Method F1015, Relative Abrasiveness of Synthetic Turf Playing Surfaces

25.1 *Scope:*

25.1.1 This test was designed specifically for use with synthetic turf fabrics.

25.1.2 This test is applicable to both laboratory and field measurement.

25.1.3 The test also may have use for natural grass playing surfaces.

25.2 *Test Method Specific Conditions*—The test method applies as written to synthetic turf fabrics and surfaces.

26. Test Methods D395, Rubber Property—Compression Set

26.1 *Scope:*

26.1.1 This test method covers the testing of shock-absorbing pad components intended for use in applications in which the pad will be subjected to compressive stresses in air or liquid media.

26.1.2 This test is appropriate and applicable to the shock-absorbing pad component of synthetic turf playing surfaces.

26.2 *Test Method Specific Conditions:*

26.2.1 *Test Method A*—Compression set under constant force in air is to be used.

26.2.2 The test specimens are to be 5.08 by 5.08 cm (2 by 2 in.) by gage of the cushion underlayment to be used.

26.2.3 The compression load is to be 1.8 kN (400 lb or 100 psi) for 22 h.

26.2.4 The compression set is calculated after 24 h recovery.

27. Test Methods D412, Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension

27.1 *Scope:*

27.1.1 This test method describe procedures used to evaluate the tensile (tension) properties of vulcanized rubbers and thermoplastic rubbers and thermoplastic elastomers.

27.1.2 Test Method A (Dumbbell and Straight Section Specimens) is the method of choice.

28. Test Method D624, Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer

28.1 *Scope:*

28.1.1 This test describes a characterization of rubber or foam samples by tear resistance.

28.1.2 The test applies to the shock-absorbing pad component of synthetic turf playing surfaces.

28.2 *Test Method Specific Conditions:*

28.2.1 The sample is an unnicked, 90° angle specimen cut with ASTM Die C.

28.2.2 The specified cross-head speed is 50.8 cm/min (20 in./min).

29. Specification D1667, Flexible Cellular Materials—Vinyl Chloride Polymers and Copolymers (Closed-Cell Vinyl)

29.1 *Scope:*

29.1.1 This specification applies to the shock-absorbing pad component.

29.1.2 This test consists of measuring the force necessary to produce a 25 % deflection on a round 6.45-cm^2 (1-in.^{2}) test specimen.

29.1.3 This test method is recommended for polyvinyl chloride (PVC) foams or copolymer thereof, polyolefin foams, and other pads.

29.2 *Test Method Specific Conditions:*

29.2.1 Test to Specification D1667Suffix D (compression deflection test) with the following deviations:

29.2.2 *Compression Force Deflection Test (CFD)*—A round 2.87-cm (1.129-in. diameter) sample is prepared using a rotary die cutter. Use an ASTM D75 cutting tool (1.129 in. diameter) for the drill press.[5] Use a flat compression foot that is larger than the specimen to compress the sample. Cut three specimens for testing and averaging the results.

29.2.3 *Indention Force Deflection Test (IFD)*—This test method is required for uneven surfaced pads, that is, convoluted, etc., where a 6.4515-cm^2 (1.0-in.^{2}) specimen is not representative of the sample.

29.2.3.1 Cut a 25.4-cm^2 (10-in.^{2}) specimen. Use a 15.24-cm (6-in.) diameter compression foot plate, which is smaller than the specimen, to compress the sample.

29.2.4 Using a CRE (compression) instrument, deflect the specimen 25 % of its original height. (The specimen gage will be 75 % of its original gage at 25 % deflection.)

29.2.5 Record the force on a strip chart and read the force from the strip chart at 25 % deflection, or record the value if the machine compresses the specimen 25 % automatically and provides the value. This is an immediate reading, not a 60 s hold and read value.

29.2.6 The cross-head speed is to be 5.1 cm/min (2.0 in./min).

29.2.7 The test specimen gage is the shock-absorbing pad component gage used in the final product. Measure the pad thickness as described in Section 15 of Specification D1667.

29.3 *Calculation:*

$$CFD \text{ at } 25\,\% = \text{report force direct as determined in 29.2.2} \quad (1)$$

$$IFD \text{ at } 25\,\% = \frac{\text{total force required at } 25\,\% \text{ compression deflection}}{28.26} \quad (2)$$

where:

28.26 = in.^{2} of specimen compressed under the 6-in. diameter compression foot plate.

29.4 *Report:*

29.4.1 Report the following data:

29.4.1.1 Average unit force required, expressed in kPa or psi.

29.4.1.2 CFD at 25 % or IFD at 25 %, depending on the method used.

29.4.1.3 Diameter of the compression foot used.

29.4.1.4 Compression or cross-head speed.

29.4.1.5 Sample temperature at the time of testing.

30. Test Method D1876, Peel Resistance of Adhesives (T-Peel Test)

30.1 *Scope:*

30.1.1 This test is designed for determination of the peel resistance of adhesive bonds, primarily between flexible adherents, by means of a T-type specimen.

30.1.2 The applicability to synthetic turf playing surfaces primarily is to characterize the adhesive bond between the turf component and the (adhesively attached) shock-absorbing pad component.

30.2 *Test Method Specific Conditions:*

30.2.1 Section 4.2 of Test Method D1876 is modified to accommodate 5.08-cm (2-in.) wide test specimens instead of 2.54-cm (1-in.) wide specimens.

30.2.2 Section 5 of Test Method D1876 may be modified to shorter periods of specimen conditioning. (Specify conditioning.)

30.2.3 The recommended cross-head speed is 30.5 cm/min (12 in./min).

31. Test Method D2126, Response of Rigid Cellular Plastics to Thermal and Humid Aging

31.1 *Scope:*

31.1.1 This series of tests specifies procedures for measuring the effect of various combinations of temperature and relative humidity on specimen physical dimensions.

31.1.2 This test is used to determine aging effects on the shock-absorbing pad component for the purposes of characterizing synthetic turf playing surfaces.

31.1.3 The test applied to the shock-absorbing pad components is also extended to include nonrigid as well as rigid cellular plastics that may be used in their construction.

[5] The sole source of supply of the apparatus known to the committee at this time is NAEF Press & Dies, Inc., Bolton Landing, NY 12814. 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,[1] which you may attend.

31.2 *Test Method Specific Conditions*—Test Method D2126, 70°C (158°F) at 97 % relative humidity, is recommended for the shock-absorbing pad component of synthetic turf playing surfaces.

32. Test Methods D3574, Testing Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams

32.1 *Scope:*

32.1.1 This test describes a series of material characterizations selected particularly for polyurethane foams.

32.1.2 When applicable to synthetic turf playing surfaces, the test will be applied to the shock-absorbing pad component made from polyurethane or other foams.

32.1.3 Of particular interest among the test methods listed is that for tension, Test E—Tension Test, Section 45 of Test Methods D3574.

32.1.4 The material characterizations other than the tension test of Test Methods D3574 are supplemental to other, analogous tests listed in these test methods.

32.1.5 When overlap of the tests is evident, preference is to be given to the more general tests listed in these test methods.

32.2 *Test Method Specific Conditions:*

32.2.1 Die A of Test Methods D412 is specified (the die of Fig. 1, Test Methods D3574) for the tension test.

32.2.2 The recommended gage length is 8.9 cm (3.5 in.).

32.2.3 The recommended cross-head speed is 50.8 cm/min (20 in./min) for the tension test.

33. Test Methods D3575, Flexible Cellular Materials Made From Olefin Polymers

33.1 *Scope*—This test method covers measurement of the water absorbed by the shock-absorbing pad component material during submersion under pressure and is applicable to other pads or cushions.

33.2 *Test Specimens*—Test specimens shall be 10 by 10 cm (4 by 4 in.) by the thickness of material being supplied. The specimen may or may not have natural skins on top or on bottom or on both surfaces.

33.3 *Number of Specimens*—Test three specimens for each sample. The values reported shall be the mean of those observed. Test two additional specimens and report the mean for all five values if any value deviates more than 20 % from this mean.

33.4 *Procedure:*

33.4.1 Measure the area of the cut surfaces in accordance with Section 8, and calculate the area of the cut surfaces.

33.4.2 Weigh the specimens and submerge them under a 3-m (10-ft) head of water equal to 30 kPa (4.35 psi) at room temperature, 18 to 29°C (65 to 90°F), for 48 h. Then place the specimens in an air stream for the minimum time required to remove visible water from the surfaces and reweigh.

33.5 *Calculation*—Calculate the water absorption, expressed in kg/m^2 (lb/ft^2) of cut surfaces (surfaces without skin or rind), as follows:

$$water\ absorption = \frac{W_2 - W_1}{A} \quad (3)$$

where:

W_1 = specimen mass before immersion, kg (lb),
W_2 = specimen mass after immersion, kg (lb), and
A = area of cut surface, m^2 (ft^2).

33.6 *Report*—Report the average water absorption in kg/m^2 (lb/ft^2) of the three specimens tested, except as noted in 33.3.

34. Test Method D3936, Delamination Strength of Secondary Backing of Pile Floor Covering

34.1 *Scope:*

34.1.1 This test measures the delamination strength of the adhesive bond between the primary and secondary portions of a pile floor covering.

34.1.2 The applicability to synthetic turf playing surfaces is for those representatives of the turf pile fabric component that use secondary backings, usually, but not restricted to, fabrics of tufted construction.

34.2 *Test Method Specific Conditions*—The test method is applicable as written to the turf pile fabric of synthetic turf playing surfaces.

35. Test Method F355, Shock Absorbing Properties of Playing Surface Systems and Materials

35.1 *Scope:*

35.1.1 This test was designed specifically for playing surface systems.

35.1.2 The test is applicable to both laboratory and field measurement.

35.2 *Test Method Specific Conditions:*

35.2.1 Procedure A, 4.2.1 of Test Method F355 is recommended.

35.2.2 An impact velocity of 3.43 ± 0.17 m/s is required. (This velocity corresponds to a theoretical drop height of 0.61 m (24 in.) at sea level.)

35.2.3 This is a physical property characterization standard, and it shall not be construed as a safety standard.

36. Specification F1936, Shock-Absorbing Properties of North American Football Field Playing systems as Measured in the Field

36.1 *Scope:*

36.1.1 This specification was designed specifically for all North American football field surface systems.

36.1.2 This test is applicable to field measurement.

36.2 *Test Method Specific Conditions:*

36.2.1 This specification employs the Test Method F355 procedure A missile with an impact velocity of 3.43 ± 0.17 m/s. (This velocity corresponds to a theoretical drop height of 0.61 m (24 in.) at sea level.)

36.2.2 This specification states a minimum of 8 predetermined test points.

36.2.3 The procedure produces a test report that states which points met or did not meet the requirement of under 200 average G_{max}.

NOTE 4—This specification is implicable to both measurements of shock absorbency properties and measuring infill depth.

37. Test Method F2117, Vertical Rebound Characteristics of Sports Surface; Acoustical Measurement

37.1 *Scope:*

37.1.1 This test method covers the quantitative measurement and normalization of the vertical rebound produced during impacts between athletic balls and athletic surfaces.

37.1.2 Test Method F2117 is an acoustical measurement system and is the preferred ball rebound method.

37.2 *Test Method Specific Conditions*—The ball is released from a specified height and allowed to impact the test surface, where the rebound height is measured.

38. Test Method F2333, Traction Characteristics of Athletic Shoe-Sports Surface Interface

38.1 *Scope:*

38.1.1 This test method is useful for determining the traction between the athletic surface and an athletic shoe.

38.1.2 This test uses applied forces that are sport specific.

38.1.3 Methods are given for linear and rotational traction.

38.2 This test method can be used in the laboratory or the field.

39. Test Method F1632, Particle Size Analysis and Sand Shape Grading of Sports Field Rootzone Mixes

39.1 *Scope*—This test method covers the determination of particle size distribution of putting green and other sand-based rootzone mixes.

39.2 *Test Method Specific Conditions:*

39.2.1 This test method applies to infilled turf systems.

39.2.2 This test method also describes a qualitative evaluation of sand particle shape.

40. Test Methods D5644, Rubber Compounding Materials - Determination of Particle Size

40.1 *Scope*—These test methods describe the procedures for determining average size distribution of recycled vulcanizate particulate.

40.2 *Test Method Specific Conditions*—Method A describes the Ro-tap sieve test method for 60 mesh or coarser particles.

41. Test Method AT-030—Sports Shoe Traction (Coefficient of Friction) and Traction Differential

41.1 *Scope*—This test method is applicable to determination of the shoe traction between shoes and playing surfaces in both the laboratory and the field under various conditions. The shoe traction on a playing surface is determined by dividing the horizontal force required for motion of the shoe by the sum of weight of the shoe and any weight placed on the shoe.

41.2 *Terminology:*

41.2.1 Shoe traction is defined herein as the coefficient of friction between a weighted shoe and a playing surface, where the horizontal force, F, required to move the shoe in a horizontal direction is divided by the vertical force, N applied by the shoe.

$$ST = \text{shoe traction} = F/N \tag{4}$$

If the force, F, is just sufficient to initiate motion, the coefficient of static traction is being measured. If F sustains motion at constant velocity, however, the coefficient of dynamic traction is the relevant quantity.

41.2.2 The vertical force, N, is equal to the weight of the shoe plus any weight placed on the shoe.

41.2.3 Shoe traction is normally calculated from the minimum force required to initiate horizontal movement of the shoe over the surface, as this is related to the maximum force a player can exert in stopping or turning without slipping (coefficient of static traction).

41.2.4 Sports shoe traction differential is a measure of difference in sports shoe traction in two or more directions along the turf pile surface.

41.2.5 Traction level is the average of the four shoe traction values normally measured (see 41.2.3).

41.2.6 In addition to shoe traction, ST, two other derived traction indices are useful: traction level, TL, and differential traction, DT. If ST_i is one of these four values, then, mathematically,

$$TL = 1/4 \sum_{i=1}^{4} ST^i \tag{5}$$

DT is defined as the average value of the absolute deviation of the four ST values from their mean (TL), that is,

$$DT = 1/4 \sum_{i=1}^{4} |ST_i - TL| \tag{6}$$

where each difference in absolute values is always considered to be a positive quantity. DT is a useful index of perceived directionality on the playing surface, that is, a difference in traction depending on the direction of measurement. A uniform sports surface would ideally have DT = 0.

41.3 *Test Design:*

41.3.1 A barbell weight is placed on top of a shoe with the front edge of the weight on the toe of the shoe approximately 3.8 cm (1½ in.) from the front end of the shoe and the back of the weight on the counter of the shoe. Additional weights may be placed on top of this weight, if desired. Care must be taken to ensure that the weights are balanced properly to prevent them from dragging on the surface during testing. An alternative test device is a sports shoe sole, with the uppers cut off, adhered permanently to a weight such as to provide a flat sole surface.

41.3.2 Measurements are made by placing a nylon belt around the back of the shoe, as close to the bottom of the sole as possible, and a push-pull gage at the other end of the belt, and then pulling the gage slowly but steadily in a horizontal plane, parallel to the playing surface. The minimum force required either to initiate sliding of the shoe over the turf surface or to maintain movement (dynamic traction) is recorded.

41.3.3 Two shoes must be tested in four directions at three locations on a field. Each direction is at a 90° angle to the previous direction tested. The four directions for an artificial surface are with the pile lay, across the pile lay in Direction A, against the pile lay, and across the pile lay in Direction B, 180°

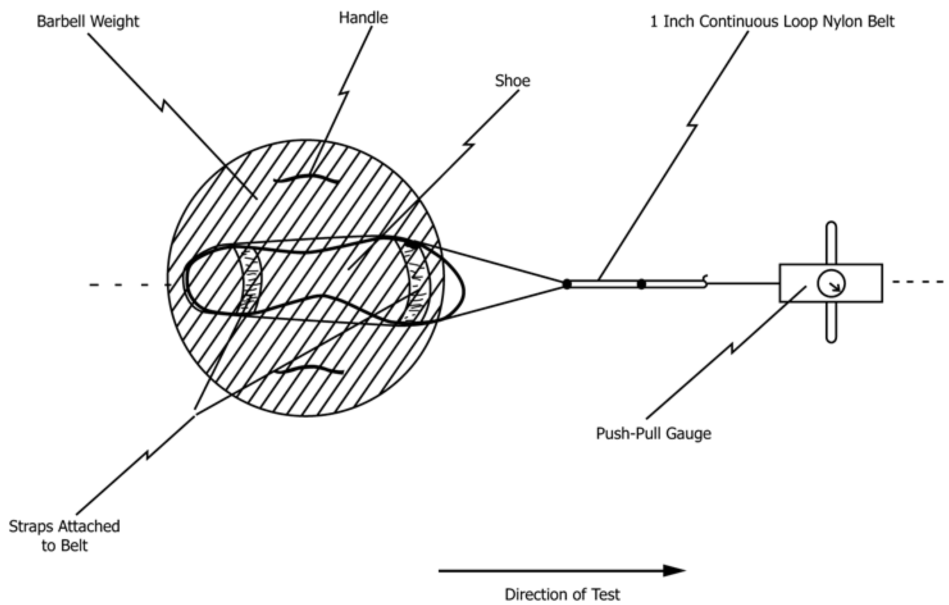

FIG. 1 Shoe Traction Setup (Top View)

from Direction A. The shoe traction test setup is shown in Figs. 1 and 2. Directions of testing are illustrated in Fig. 3.

NOTE 5—The same shoes must be used to compare different artificial turfs for shoe traction and traction differential.

41.4 *Apparatus:*

41.4.1 *Continuous Loop Nylon Strap or Belt,* modified 2.54-cm (1-in.) wide, 183 cm (72 in.) are shown in Fig. 4.

41.4.2 *Barbell Weight,* 11.34 kg (25 lb), approximately 27.9 cm (11 in.) in diameter with 1-cm (0.375-in.) vinyl foam attached to one side.

41.4.3 *Digital Push-Pull Gage,* 100 lb limitation, with a maximum force pointer or an equivalent scale.[6]

41.4.4 *Shoes,* two different types, size 11.

41.4.5 *Relative Humidity Meter.*

41.4.6 *Three Dial Thermometers,* with 12.7-cm (5-in.) spiked probes.

41.5 *Setup:*

41.5.1 Surfaces may be tested in either the laboratory under controlled conditions or the field under prevailing conditions. The assumptions are as follows: that the test shoe and test surface are exposed to the same conditions (for example, wet surfaces are tested with wet shoes), the surfaces are anchored down in a manner indicative of their end-use applications (that is, samples do not move during testing), and the conditions under which the surfaces are tested can be recorded. The minimum recommended sample size is 1 by 1 m; the minimum usable sample size is 23 by 76 cm (9 by 30 in.) in the direction of the test (that is, the direction in which the shoe is pulled).

41.5.2 If the samples have a tendency to move, they may be held firmly to the subsurface by having an individual stand on the test surface directly behind the test shoe with his or her feet, one behind the other, on a line perpendicular to the direction of testing. Weights may be placed on the test surface when necessary, allowing a single operator to make the shoe traction measurements. Having an assistant greatly improves the efficiency of performing the evaluations in all cases since the assistant can record the measurements as they are made, read aloud, and, by handling the weights placed on the test shoe, greatly reduce the physical strain that would be put on a single operator.

41.5.3 Surfaces may be tested both indoors and outdoors at other than ambient conditions, provided that the samples are conditioned at the desired environment. Care must be taken to condition the shoe and surface under as similar environments as possible. For example, it may be necessary to wet the test shoe more frequently than the test surface when testing wet turf under dry weather conditions since shoe soles generally dry faster than turf surfaces.

41.6 *Procedure:*

41.6.1 The following procedure is intended as a guide for developing good techniques when setting up for routine shoe traction testing and is outlined to key in on some important factors that could significantly affect the evaluation of raw data obtained by the procedure.

41.6.2 Choose a test area (or sample) indicative of the total system to be evaluated. It should not be more soiled, more matted, wetter, muddier, etc. than the total system unless that specific condition is being evaluated.

41.6.3 Condition the samples. If the playing surface is to be tested at other than ambient conditions, expose both the surface and the shoes to the test environment for a minimum of 2 h.

NOTE 6—Specific test designs may preclude this requirement (for

[6] The sole source of supply of the digital push/pull force gauge known to the committee at this time is Imada, Inc., 3100 Dundee Road, Suite 707, Northbrook, IL 60062. 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,[1] which you may attend.

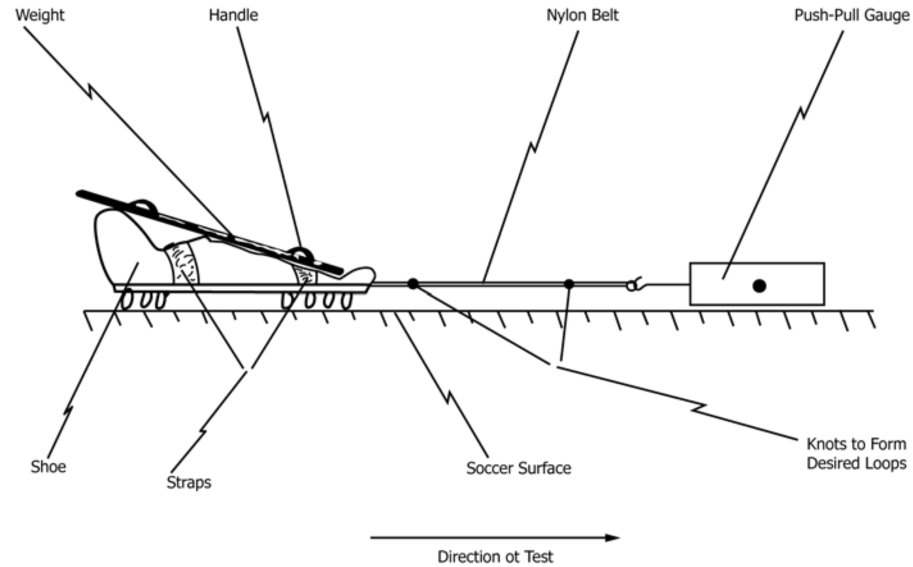

FIG. 2 Shoe Traction Setup (Side View)

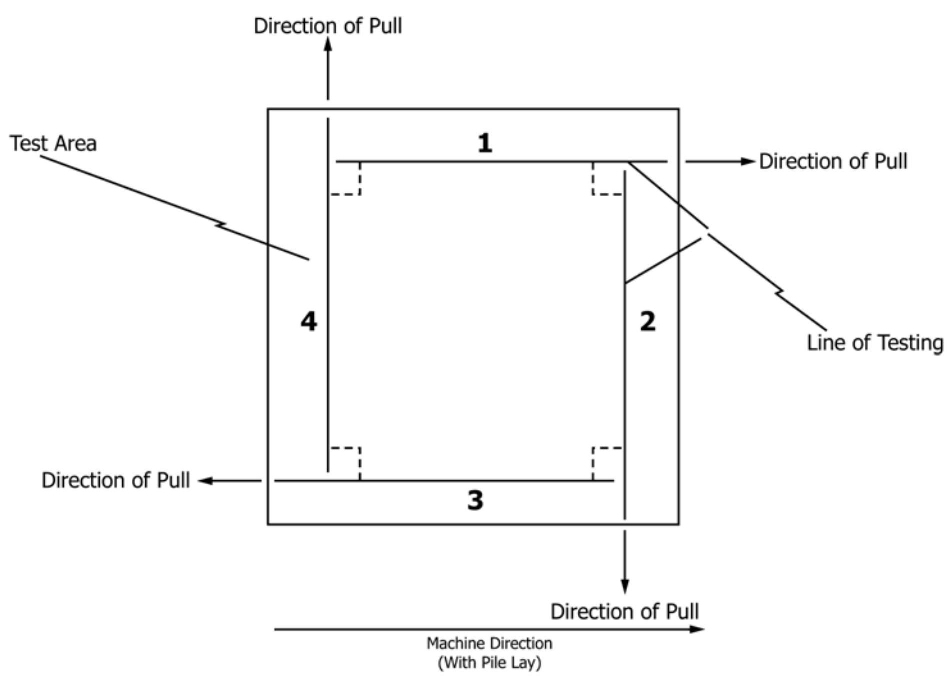

FIG. 3 Directions of Testing

example, simulating conditions existing immediately following a brief shower).

41.6.4 Place one dial thermometer, probe up, on the test surface to measure the air temperature. Insert the probe of a second thermometer horizontally through the turf or grass cover to measure the turf temperature. The subsurface temperature is measured by inserting the probe of a third thermometer into the ground for natural systems or halfway through the pad for artificial systems. Care must be taken not to shade any of the thermometers. (This step may be omitted when testing under controlled environments.) Actual temperature measurements are made in 41.7.5.

41.6.5 Record the sample identification and test conditions. In field testing particularly, it is not always possible to control the condition of the sample or environment during or just prior to making an evaluation. It is therefore very important to note, in as much detail as possible, the conditions under which the surface is evaluated.

41.7 *Measurements:*

41.7.1 Standard procedure includes making measurements in four directions (namely, each direction is at a 90° angle to the preceding direction of testing, and with artificial surfaces the directions are specifically with the pile lay, across the pile

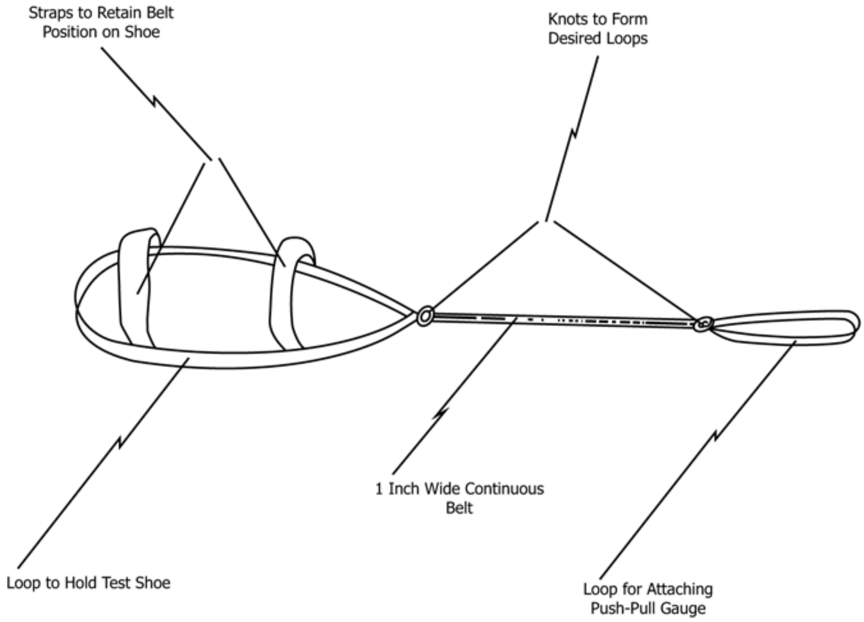

FIG. 4 Belt Modifications

lay (A), against the pile lay, and across the pile lay (B) as illustrated in Fig. 4); at three locations on the field (for example, a high-use area, moderate-use area, and low-use area); and on two different shoes. The following procedure details the evaluation of a given test area with a single shoe.

41.7.2 Place a sports shoe on the test area such that the direction of testing is parallel to a line passing through the centers of the heel and toe of the shoe and the toe of the shoe is in advance of the heel, as is demonstrated in Fig. 1.

41.7.3 Position the modified belt (Fig. 4) on the shoe such that the belt falls on a line parallel to the line of testing. (See Fig. 1.) The strap should be adjusted to maintain the belt horizontal to the test surface during pulling (Fig. 2).

41.7.4 Place a barbell weight on top of the shoe, with the front edge of the weight on the toe of the shoe approximately 3.8 cm (1.5 in.) from the front end of the shoe and the back of the weight on the counter of the shoe. Care must be taken that the weight is balanced properly to prevent it from dragging on the surface during testing. The foam-covered side of the weight is placed in contact with the shoe to prevent the weight from slipping. (Bolting two cabinet handles to the top of the weight facilitates handling of the weight greatly.) The digital push-pull gauge has a maximum force limitation of 45.4 kg (100 lb), but it is adequate with most shoes for evaluating playing surfaces under a wide variety of weather conditions when the weight on the shoe is limited to a maximum of 11.4 kg (25 lb).

41.7.5 Make the measurements. Attach the push-pull gage to the forward most loop of the belt and slowly (approximately 7.6 cm (3 in./s)) but steadily pull in a horizontal plane, parallel to the playing surface, on a line passing through the horizontal centers of the heel and toe of the shoe. The shoe should be pulled a minimum of 30.5 cm (12 in.). The measurement should be made immediately after the weight has been placed on the shoe. (Allowing the weighted shoe to rest on the surface could result in the subsurface taking a temporary compression set.) Record the temperature(s) at the time of measurements.

41.7.6 Record the data. Record the minimum force (*F*) required to initiate movement of the shoe over the playing surface. If stick-slip conditions are encountered; record both the maximum force and the sustaining force, using these separately to calculate the static and dynamic shoe tractions, respectively. (That is, the shoe stops and remains stationary and the horizontal force increases, which causes the shoe to move forward; the force decreases until the shoe stops, and the process is repeated.)

41.7.7 Test the remaining three directions. Remove the weight from the shoe, and place the shoe and strap to the right of, but perpendicular to, the last direction of testing as shown in Fig. 3. Repeat the steps given in 41.7.2 – 41.7.5 three times to complete the test series for a given test area with one shoe.

41.8 *Calculations:*

41.8.1 Calculate the shoe traction, ST, for each measurement made in each direction of testing, where:

$$ST = \text{shoe traction} = F/N \quad (7)$$

N = vertical force on the surface (namely, total weight of the shoe and any weight placed on it), and
F = horizontal force required to cause movement of the shoe over the surface.

41.8.2 Calculate the traction level,

$$TL = 1/4 \sum_{i=1}^{4} ST_i \,(\text{see } 41.2.1) \quad (8)$$

41.8.3 Calculate the differential traction,

$$DT = 1/4 \sum_{i=1}^{4} |\, ST_i - TL \,| \,(\text{see } 41.2.1) \quad (9)$$

41.9 *Report*—Include the following information in the report for each test series:

41.9.1 Sample identification and location;

41.9.2 Date and time of testing;

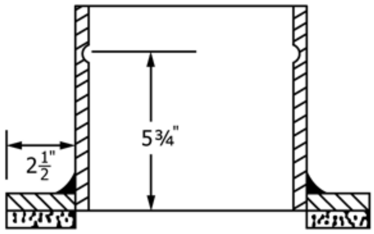

FIG. 5 Asphalt Permeability Tester Design

41.9.3 Type of size 11 shoe(s) used, including the sole configurations, cleat composition, and size and length of the cleat;

41.9.4 Total vertical force, *N*, applied to the test surface;

41.9.5 Prevailing weather conditions;

41.9.6 Environmental conditions during testing (for example, ambient, wetted, washed, length of exposure, etc.);

41.9.7 Surface or sample conditions (for example, clean, dirty, matted, new, worn, wet, dry, damp, muddy, soft, hard, long grass, short grass, smooth, level, irregular, etc.)

41.9.8 Air, turf, and subsurface temperatures;

41.9.9 Relative humidity;

41.9.10 Traction level and standard deviation for the shoe traction values calculated in 41.8.1;

41.9.11 Differential traction; and

41.9.12 Any deviations from the recommended procedure.

42. DIN 18-035, Part 6—Water Permeability of Synthetic Turf Systems and Permeable Bases

42.1 *Construction*—PVC tubing, 27.3-cm (10.75-in.) outside diameter, 25.4-cm (10.00-in.) inside diameter, 10-cm (0.375-in.) wall, 20.32-cm (8-in.) length, fused to a 6.35-cm (2.5-in.) PVC flange; a machined index ring marking overall 15.24 cm (6 in.) of flow head 7.57 L (2.00 gal). A gasket seal, same size as the flange, cut from 2.54-cm (1-in.) thick, 1-PCF polyurethane upholstery foam. The total weight of the unit is approximately 4.5 kg (10 lb). (See Fig. 5.)

42.2 *Procedure*—Position the tester on the permeable system or base (asphalt) with the wetted gasket in place, and create a seal by having one operator stand on the flange along a diameter. The second operator is to fill the vessel to a level above the index ring by using a hose or pouring water into the tester from a bucket. Start timing when the falling water level reaches the 15.24-cm (6-in.) index mark. Stop timing when the highest spots on the surface are exposed above the water level.

42.3 *Calculation of Rainfall Capacity:*

42.3.1 It will be sufficient for most purposes to report that the total flow time in the test (or average of flow times at various positions) does not exceed 600 s (10 min). This time is the minimum calculated for base (asphalt) thickness in the range of 7.62 to 15.24 cm (3 to 6 in.) when corrections to the observed drain time are applied (see below), to meet the specification of 25.4 cm/h (10 in./h) rainfall capacity. Flow times will usually be 1 to 2 min.

42.3.2 The first correction required is that for the variable flow during the test due to the falling head. The relation between the rainfall capacity provided by this test, *V* in./h, and the observed flow time, *t* s, is as follows:

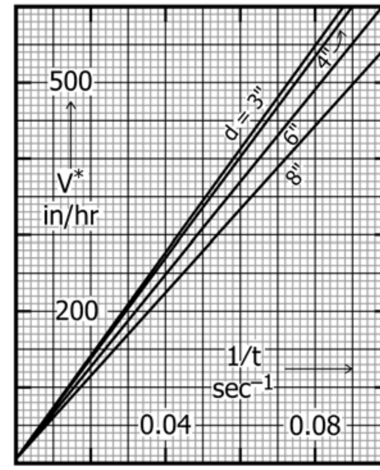

FIG. 6 Graphical Relationship of True Permeability, *V (in./h), to Test Flow Time, *t* (s)**

$$t = 8290\,(d/V)\log(1+6/d) \tag{10}$$

where:

d = thickness of the base (asphalt), in.

42.3.3 The rainfall capacity provided by this test, *V* in./h, is somewhat optimistic in terms of the true base (asphalt) permeability because the cross-sectional area of base (asphalt) available for flow increases as the water penetrates. The true permeability, *V** in./h, as, for example, that which one would find in the laboratory with a Marshall plug confined in a pipe section, is related to *V* by the following:[7]

$$V^* = V/(1+0.236d) \tag{11}$$

42.3.4 Combination of the two corrections given yields the following:

$$V^* = 8290d\log(1+6/d)/(1+0.236d)t \tag{12}$$

When required, calculate *V** in in./h from the above equation (see also the graph in Fig. 6). For example, $d = 3$ in., $t = 100$ s, log $(1 + 6/d) = 0.477$, $V^* = 69$ in./h.

43. Test Method EN 12234, Test Method Surfaces for Sports Areas – Determination of Ball Roll

43.1 *Scope:*

43.1.1 The speed of the ball roll is important for players to be able to make good passes on the turf. The resistance provided by the turf fibers controls the ball roll speed.

43.1.2 A ball is rolled down a ramp and is allowed to roll across the surface until it comes to rest. The distance the ball has traveled across the surface is recorded.

44. Test Method EN 12616 Surfaces for Sports Areas – Determination of Infiltration Rate

44.1 *Scope:*

44.1.1 The ability for rain water to drain from an athletic field is important to prevent ponding on the surface that will affect the playability of the sports surface. The surface should drain as a sufficient rate to prevent accumulation of surface

[7] See Prins and Hermans, *Journal of Physical Chemistry* , Vol 63, 1959, p. 716.

ponding during the highest expected rainfall event in the geographical area where the field is located.

44.1.2 Two concentric rings are placed on top of the turf. Water is allowed to flow separately into the inner and outer ring. Water is introduced at a rate to keep a constant water depth in both rings. The water in the outer ring maintains a head of water surrounding the inner ring. The infiltration rate is calculated by measuring the flow of water into the inner ring by means of a flow meter. The infiltration rate is the flow rate into the inner ring in cubic centimeters during the 20 min test.

45. Test Method EN 14808, Surfaces for Sports Areas – Determination of Force Reduction

45.1 *Scope:*

45.1.1 The force reduction measures the ability of the turf to absorb the impact of a player running on the surface.

45.1.2 A mass is allowed to fall onto a spring that rests, via a load cell and test foot on the test specimen. The maximum force applied is recorded. The percentage reduction in the force relative to the maximum force measured on a concrete surface is reported as the force reduction.

46. Test Method EN 14809, Surfaces for Sports Areas – Determination of Vertical Deformation

46.1 *Scope:*

46.1.1 Vertical deformation is an indicator of the stability of the surface. Surfaces with high vertical deformation values may seem unstable for the player. The player will adjust his gait to allow himself to feel comfortable running on the surface.

46.1.2 A mass is allowed to fall onto a spring that rests via a load cell and test foot on the test specimen. The maximum and standard deformation of the surface is determined.

47. Test Method prEN 15301, Surfaces for Sports Areas Part 1 – Determination of Rotational Resistance

47.1 *Scope:*

47.1.1 The interaction between the shoe and the turf surface affect the athlete's ability to start, stop, and turn on the surface. A shoe-surface interaction that is too strong, can lead to foot fixation that may result in injury to the lower extremity.

47.1.2 The torque required to rotate a loaded test foot in contact with the surface is measured and the rotational resistance is calculated.

48. Keywords

48.1 artificial turf; athletic recreation; baseball; cricket; field hockey; football; golf; infilled system; knitted turf; lacrosse; playground; rugby; soccer; softball; sport playing systems; synthetic turf; tufted turf; turf system

APPENDIX

(Nonmandatory Information)

X1. RATIONALE

X1.1 Over the past several years, there have been several test methods established for various components of, or synthetic turf systems, or both. These test methods define the key test methods currently in use, categorizing the tests into five main areas: fiber, fabric, pad, miscellaneous components, and the entire system; and dividing the tests into the performance of property tests. These test methods do not establish minimum requirements, only standard test methods.

X1.2 For various synthetic turf systems or components, or both, to be compared uniformly, a recommended performance test method guide is necessary. These test methods establish the recommended test methods for various performance properties as well as defining why these tests are applicable to the performance of the system.