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An American National Standard

Standard Specification for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field[1]

This standard is issued under the fixed designation F 1936; 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 specification covers a test method and maximum impact attenuation for all types of installed turf playing systems for North American football.

1.2 It is recognized that laboratory testing results often reflect optimum conditions which may not correspond to the actual site conditions. Therefore, a method of testing along with a maximum for impact attenuation of installed synthetic turf playing systems is addressed herein.

1.3 This specification does not imply that an injury cannot be incurred if the surface system complies with this specification.

1.4 The following precautionary statement pertains only to the test procedure portion, Section 9, of this specification: *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:*

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]

F 1551 Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials[2]

2.2 *ISO Standard:*

ISO 6587[3]

NOTE 1—Additional references are listed at the end of this specification.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *abnormal drop*—any drop of the missile which, due to operator or equipment problem(s) or uncertainty, results in a reading which is questionable.

3.1.2 *average* G_{max}—sum of the G_{max} of the second and third drops divided by two and rounded to the nearest whole number.

3.1.3 *combination field system*—a field system which combines a natural turf surface which is enhanced by use of synthetic elements such as synthetic turf substructures, excluding water/drainage systems and single layer mesh fabrics, which are used for the sole source purpose of soil stabilization.

3.1.4 *drop height*—height from which the missile is released as measured from the bottom of the missile face to the top of the surface system.

3.1.5 *drop test*—a set of three successive and recorded drops of the impact missile onto the synthetic turf system within the guidelines prescribed.

3.1.6 *G*—the ratio of magnitude of missile acceleration during impact to the acceleration of gravity, expressed in the same units (*g*, that has units, can be measured, but *G*, being a ratio, is unitless).

3.1.7 G_{max}—the maximum value of G encountered during an impact rounded to the nearest whole number.

3.1.8 *impact velocity*—the velocity of the missile as it impacts the surface system.

3.1.9 *missile*—the striking part of the testing apparatus.

3.1.10 *natural grass field system*—a field system which is comprised of live and growing grass or other plant like materials which are rooted in soil.

3.1.11 *pile*—a surface texture composed of many individual thin strands or groups of strands bound to a backing fabric in a repetitive array.

3.1.12 *pile layover*—horizontal motion of the pile under the influence of impact.

3.1.13 *restraining ring*—a rigid circular device with a smooth or polished surface, creating little or no friction, used to restrict the horizontal movement of the missile upon impact.

3.1.14 *synthetic turf field system*—a 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).

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[1] This specification is under the jurisdiction of ASTM Committee F-8 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.65 on Artificial Turf Surfaces and Systems.

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

[3] Available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

3.1.15 *test point*—a location on the field system at which a series of measurements is taken.

4. Summary of Test Method

4.1 Turf field systems are tested according to this standard and Test Method F 355, Procedure A. A free-fall drop height of 2 ft (61 cm), as measured from the bottom of the missile face to the top of the turf field system shall be used. Any debris or material not part of the surface system shall be removed from the test point location prior to testing. Three successive drops, allowing a 3 min pause between drops, are recorded. The average G_{max} for the tested point will be calculated as the sum of the second and third G_{max} values divided by two and rounded to the nearest whole number.

5. Significance and Use

5.1 Data obtained from this specification are indicative of the relative impact attenuation characteristics of the turf playing field system and can be used only for comparison, establishing minimum requirements for use.

6. Performance Requirements

6.1 When tested in accordance with this sspecification and Test Method F 355, Procedure A, the average G_{max} at any single test point shall not exceed 200 average G_{max} when tested at a free-fall drop height of 2 ft (61 cm).

6.2 If a turf surface system is tested in accordance with Test Method F 355, Procedure A, as specified in this specification, and the average G_{max} of one or more of the tested points reported is in excess of 200 average G_{max}, the surface system should be replaced in full or in part.

7. Test Apparatus

7.1 The impacting missile shall be cylindrical with a circular, flat, metal, impacting surface weighing 20 lb (9.1 kg), having a 20 in.^{2} (129 cm^2) surface face with the impacting edges slightly beveled to eliminate sharp edges, a provision for mounting the accelerometer within ±1° of the vertical axis of the missile and for reaching a velocity of 11.35 ± 0.56 ft/s (3.46 ± 0.17 m/s) (referenced in Section 27 of Test Methods F 1551 as the velocity corresponding to a theoretical drop height of 24 in. (61 cm) (at sea level) upon impact from the drop height.

7.2 To restrict the influence of pile layover, the test equipment shall be designed to include a rigid restraining ring with a smooth or polished surface, creating little or no friction, having an interior dimension not to exceed the diameter of the missile by more than 0.032 in. (1 mm). The ring shall be securely mounted horizontal to the surface such that a minimum of ¼ of the missile shall freely pass through it prior to striking the surface, ensuring a vertical impact and precluding the missiles rebound onto the top of the ring.

7.3 The test equipment shall have sufficient stability to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration-time curve and to permit a vertical free-fall of the missile from the release height of 24 in. (61 cm) to the surface.

7.4 The signal from the acceleration transducer shall be conditioned with a low pass filter: complying to Channel Class 1000 as specified in Specification F 1292 (ISO 6587).

7.5 The acceleration recording system must be capable of accurately resolving the deceleration to a minimum of ±5 *g* from 0 to 500 *g*.

7.6 The acceleration transducer must be capable of withstanding impacts of at least 1000 *g* without damage.

7.7 A minimum system sampling rate required is 16 000 Hz.

7.8 The test equipment shall be capable of visual display and recording of the acceleration-time curve of each drop.

8. Test Positions

8.1 The following six test point locations are required:

NOTE 2—The test points are arranged to test the overall conditions and known "wear points" of a field (see Fig. 1).

8.1.1 *Point 1*—Goal Line, End A, Center Field,

8.1.2 *Point 2*—10 Yard Line, End A, and ¼ the distance measured from side line C toward the center of the field,

8.1.3 *Point 3*—25 Yard Line, End A, and ½ the distance measured from side line A toward the center of the field,

8.1.4 *Point 4*—Center field,

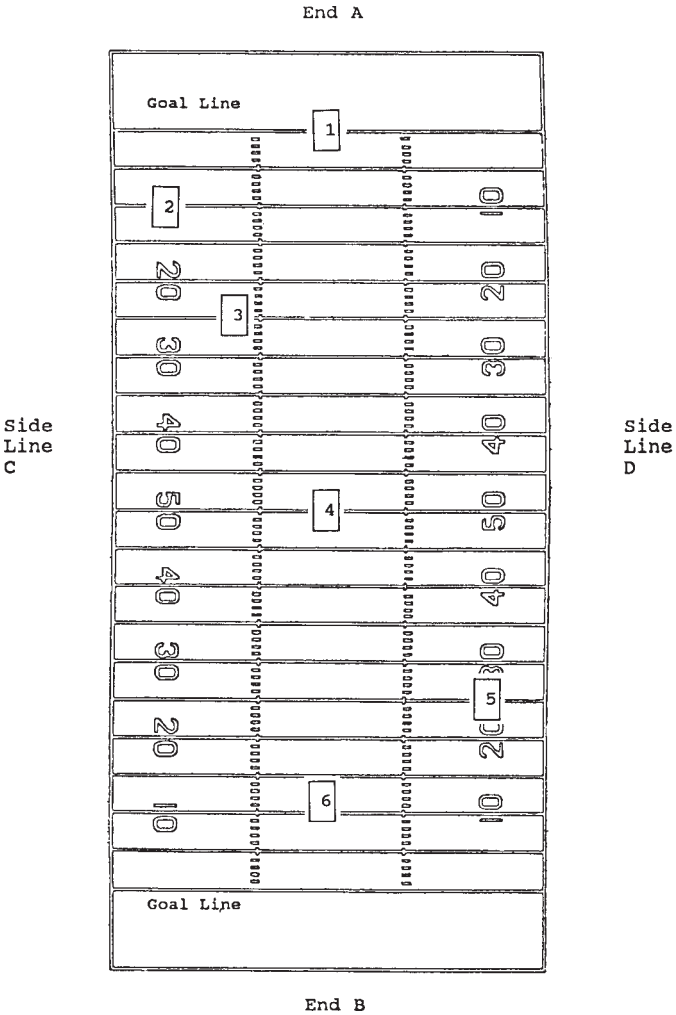

FIG. 1 Required Test Points as Laid Out on a 100 Yard North American Football Field

8.1.5 *Point 5*—25 Yard Line, End B, and ¼ the distance measured from side line D toward the center of the field, and

8.1.6 *Point 6*—12 Yard Line, End B, and Center of Field.

8.2 Actual drop site(s) shall be located within 36 in. (91 cm) in any direction of a required test point location.

8.3 For North American football fields with Canadian or other configurations differing from Fig. 1, adjust the test point location to like locations on the field and record the test points in accordance with 11.1.9.

8.4 *Optional*—One additional test point shall be added for each condition of the surface system construction or sub construction differing from the field in general. The additional test point shall be located in the area where the deviation occurs. Some examples are: side zone installed over rock (no asphalt) and area installed over a drainage element.

8.5 In the case of locating the test points on an unlined field: locate the above test points as accurately as possible noting the unlined condition in the test report as a site abnormality as described in Section 11.

8.6 Deviations in a test point location in excess of the stated tolerance must be recorded in the test report as a site abnormality as described in Section 11.

9. Test Procedure

9.1 Record the general overall weather conditions for each day of testing (sunny, light rain, gusting wind, etc.). Include a general description of the field conditions as influenced by the weather (damp, dry, areas of standing water, ice, etc.).

9.2 Record at each test point during testing the air temperature in the shade and the surface system temperature, as detailed in this section for this specific type of surface system, with all temperatures recorded in °C (°F). Additionally, it shall be noted if the test point is located on a line and, if so, the nature of the line (paint, chalk, sewn-in synthetic material).

9.2.1 *Synthetic Turf Systems*—Measurement of the surface system temperature shall be read using a temperature probe inserted ½in. (1.27 cm) below the fabric backing of the pile.

9.2.2 *Natural Turf Systems*—Measurement of the surface system temperature shall be read using a temperature probe inserted ½in. (1.27 cm) into the soil. A visual estimate of the percentage of turf cover (50 %, 90 %, etc.) and of soil moisture (dry, damp, wet, saturated, etc.) shall be recorded for each test point.

9.2.3 *Combination Turf Systems*—Measurement of the surface system temperature shall comply with 9.2.2 except where a synthetic element prohibits measurement of surface temperature as specified. When this occurs, the measurement of surface temperature shall be made as close to the specified depth as possible and the deviation shall be recorded in the site abnormalities section of the test report. A visual estimate of turf cover and soil moisture shall be recorded as described in 9.2.2.

9.3 Determine and record the test point location according to Section 8. Remove debris from the test site and set up the test apparatus.

9.4 Pre-warm equipment and, if necessary, calibrate the *g*-time in accordance with the manufacturer's recommendations.

9.5 Make three consecutive drops, at intervals of 3 ± 0.25 min, of the missile at each of the required and additional test point locations. Do not move the test equipment between consecutive drops. Record the data where:

H = drop height in ft (cm),
V = velocity, in/s (mm/s) and
g = acceleration of gravity, 386 in/s/s (9806 mm/s/s)

and display the acceleration time curve for each drop as it occurs. Check the displayed curve for abnormalities. Should more than three drops be needed, relocate the test point within the given tolerance of 36 in. (91 cm) and start over with the test point disregarding the previous drops for this location.

NOTE 3—It has been reported that on natural turf and soil surfaces, soil compaction from successive impacts (using Test Method F 355, Procedure A, and a drop height of 24 in. (61 cm)) altered G_{max} and depth of penetration.[4] This can also be influenced by soil bulk density, turf cover, and soil water content. To restrict these influences and the variation that might then occur between natural and artificial systems if an unspecified number of drops in one location were allowed, the number of successive drops permitted at any test point has been limited to three.

10. Calculation

10.1 G_{max}—Following each drop, determine (read) and record the maximum deceleration recorded during the drop in the time-deceleration history to the closest G.

10.2 *Average* G_{max}—Following the calculation of G_{max} for the third drop at each test point, calculate the sum of the G_{max} from the second and third drops, then divide the sum by two and round to the nearest whole number. The G_{max} from the first drop is disregarded.

11. Report

11.1 Report the following information:

11.1.1 Date the report was issued,

11.1.2 Name of the laboratory, company, or individual issuing the report,

11.1.3 Name and location of the test site,

11.1.4 Date of the site test; if more than one day was required, list all dates involved and the reason for the continuance.

11.1.5 Range of surface temperature in °C (°F), air temperature in °C (°F), general weather conditions during each day of testing, and overall weather influenced field conditions as detailed in Section 9,

11.1.6 Full and complete description of surface system being tested including all layers, the date and installation, and the identity of the provider of this information,

11.1.7 Name and version of the test method and procedure used,

11.1.8 Drop height and impact velocity (feet per second or metres per second),

11.1.9 Location of each test point; all points tested are to be included in the report with the exception of test points disregarded in accordance with Section 9,

11.1.10 List of the average G_{max} values by test point location,

[4] Henderson, R.L., Waddington, D.V., Morehouse, C.A., "Laboratory Measurement of Impact Absorption on Turfgrass and Soil Surfaces" and Schmidt, R.C., et al, "Natural and Artificial Playing Fields: Characteristics and Safety Features," *ASTM STP 1073*, pp. 127-135.

11.1.11 List the surface temperature, percent of turf cover, and soil moisture for each test point location as specified by surface type in Section 9,

11.1.12 Description of site abnormalities such as unlined condition, reduced field size, a flooded area of any other condition(s) which lead to an imprecise test point location or deviation from location or depth specified herein referring to the number of the particular test point influenced by each abnormality, and

11.1.13 *Conclusion*—State if, under the test conditions listed in the report, all test points met the requirement of <200 average G_{max} when tested in accordance with this specification or that all test points met the requirement of <200 average G_{max} except test point(s) listed.

11.1.14 The test report shall include the following statement:

11.1.14.1 Test results reported herein reflect the conditions of the tested field at the time testing and at the temperature(s) reported.

12. Keywords

12.1 average G_{max}; combination field system; drop test; field testing;G_{max}; impact; impact attenuation; natural grass field system; North American football; synthetic turf field system; test point

APPENDIX

(Nonmandatory Information)

X1. Rationale

X1.1 The need for a systematic means of evaluating the impact attenuation of an installed North American football playing system has been amply demonstrated by the current difficulty in establishing the shock absorbing properties of new and aging systems. The aim of this specification is to provide a uniform means and relatively transportable method of establishing this characteristic in the field based on historical data. According to historical data, the value of 200 G is considered to be a maximum threshold to provide an acceptable level of protection to users.

X1.2 The test method used in this specification (Procedure A of Test Method F 355), has been documented, through "unofficial" use for testing impact in fields for over 20 years. The development of this 2 ft fall height method can be traced back to the Ford and GM crash dummy tests of the 1960's, medical research papers from the 1960's and 1970's, and a Northwestern University study in which an accelerometer was fixed to the helmet of a middle line backer to measure the impact received during actual play. This study found the impact to be 40 ft/lb that translates to the 20 lb at a height of 2 ft used in Procedure A of Test Method F 355. For comparability and consistency, a set of standard test points was developed based on the experience of the task group in the areas of field testing and systems development. The maximum impact level of 200 average G_{max}, as accepted by the U.S. Consumer Product Safety Commission, was adopted for use here.

REFERENCES

(**1**) Gadd, Charles W., GM Research Laboratories, "Use of a Weight-Impulse Criterion for Estimating Injury Hazard," *SAE Technical Paper 660793*.

(**2**) MD's Reid, Tarkington, Epstein, and O'Dea, "Brain Tolerance to Impact in Football," *Surgery Gynecology and Obstetrics*, Vol 133, No. 6, Dec. 1971.

(**3**) MD's Reid, Epstein, and O'Dea, "Impact in Football," Evanston Hospital and the Northwestern University Medical School, *Selling Sporting Goods*, Sept. 1972.