Performance and Quality Guidelines for Shock Pads

SYNTHETIC TURF COUNCIL

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Printed August 2020
Revised July 2023

Preface

The Synthetic Turf Council (the 'STC') is a non-profit association dedicated to addressing the desire of the industry to enhance its reputation for quality. It has earned support by developing documents that facilitate communication and good business practices between all parties to the synthetic turf systems including owners, selection teams, architects, designers, specifiers, consultants, testing laboratories, suppliers, manufacturers, installation and maintenance contractors, etc. Every attempt will be made to dispense information that is unbiased, objective, and in the best interest of all the parties and the owner/end-user in particular. The STC also suggests the utilization of guidelines and test methods that already exist, whenever applicable, to generate greater understanding in the selection and use of synthetic turf systems. The STC offers to serve as a neutral platform where all elements of the industry can discuss, mediate, or resolve issues.

The initial undertaking by the Synthetic Turf Council has been the development of guidelines for synthetic turf performance to be considered for a synthetic turf system. Minimums, or ranges, suggested in these guidelines seek to improve the level of confidence in the process of selecting synthetic turf systems by owner/user/clients, selection teams and design professionals. It also seeks to increase the quality control of the system during manufacturing, installation, and post- installation. This document facilitates a guideline for industry testing for all the parties and aids in the confirmation of meeting the expectations and the delivery of systems, products, and services in order to promote genuine satisfaction by the user/owners of synthetic turf systems. These guidelines developed by the STC are a continual work in progress and may be changed at any time through an orderly process that accommodates consideration of documented input. While this document contains suggested minimums and/or ranges, STC promotes the use of all systems that not only meet or exceed those guidelines, but also encourages innovation.

The development of documents like these suggested guidelines is intended to facilitate constructive input, and forge a cooperative atmosphere, between users and producers. The STC invites users, professionals, manufacturers, risk managers, school officials, sports authorities, contractors and/or the representative associations of these segments to utilize these suggested guidelines.

Acknowledgments

This document is the dedicated work of the STC Essential Elements Task Force members to whom special credit is due:

- Alastair Cox, International Hockey Federation (FIH), Task Force Chair
- John Amato, JJA Sports LLC
- John Baize, Act Global
- Leon Behr, Schmitz Foam Products-ProPlay
- Robert Carter, ARMACELL
- Tim Fullerton, Heavenly Greens
- Michael Gentile, Firefly Sports Testing
- Mark Heinlein, The Motz Group
- Damon Henderson, Controlled Products LLC
- Joe Leedie, ForeverLawn Inc.
- Jimmy Kloczko, SportsEdge
- Luke McCoy, Kaestle Boos Associates, Inc.
- Rob Moors, Schmitz Foam Products-ProPlay
- David Price, Select Engineering Consultants
- Laith Ross, RossTarrant Associates
- Andy Shuttleworth, Permavoid Ltd.
- Dr. Phil Stricklen, Turf
- Kevin Swank, Hellas Construction
- Barry Takallou, CRM Co. LLC
- Sabrina Thomas, Thomas Testing Inc.
- Isabel Wright, ARMACELL

Photos were provided by:

- Armacell LLC
- Controlled Products LLC
- Fukunaga and Associates
- Hellas Construction
- Kaestle Boos Associates, Inc.
- Regupol
- Schmitz Foam Products-ProPlay
- Shaw Industries
- Stantec Sport Group
- Trocellen

The STC also acknowledges the work and cooperation of the EMEA Synthetic Turf Council (ESTC) that allowed their Performance Guide to Shock pads to be used as the basis of this Guideline.

The STC gratefully acknowledges the individuals and organizations for their continued support and participation in the STC.

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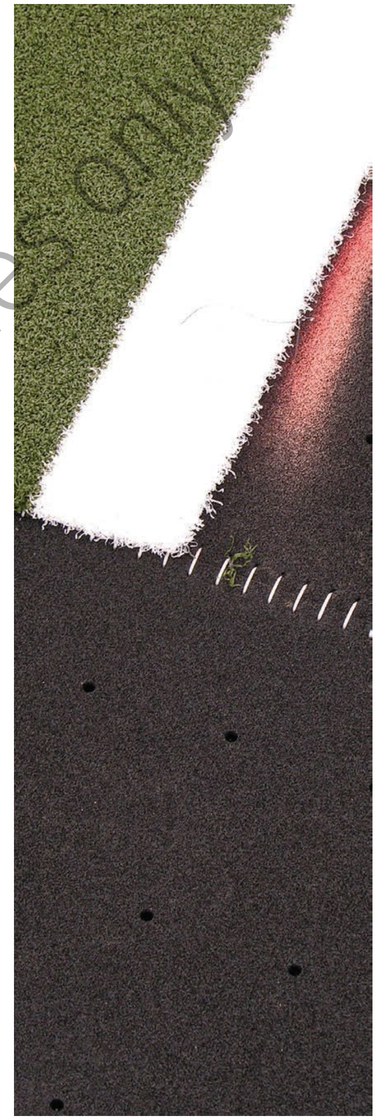
Introduction



Shock pads are often used in the construction of synthetic turf sports systems. They are installed beneath the synthetic turf carpet and are designed to assist in providing the sports performance and player protection properties that athletes require. They also aid the retention of these properties through the life of the playing surface.

Shock pads are produced in two generic forms:

- **Pre-fabricated shock pads** are manufactured in a factory as rolls or panels and transported to site to be installed on a prepared base. They are made from a range of different elastic materials including, foams, rubbers and plastics.
- **Insitu shock pads** (also commonly referred to as elastic layers) are produced from a specified blend of binders (normally polyurethane) and elastomeric granules (normally recycled tire granulate). The two components are mixed on site before being laid with a paving machine onto the prepared base.

Both types of shock pad are successfully used throughout North America, and this guide applies to both.

This guideline has been prepared by the Synthetic Turf Council and has two principal objectives:

- To allow designers of synthetic turf systems to compare the performance of different shock pads in an objective way to allow the selection of the most appropriate shock pad for a specific application;
- To specify minimum durability criteria to ensure that when a shock pad is incorporated into a synthetic turf system it will continue to perform adequately for the life of the synthetic turf sports system and normally for at least the life of two synthetic turf carpets.

Some multi-functional shock pads are designed to provide additional non- sporting properties to assist in the construction and performance of a field. These include providing horizontal drainage and structural stability to the base, in a similar way to a paved asphalt layer. It is the responsibility of the field designer to determine if they wish to incorporate multi-functional shock pads into a field's design.

Other products, such as drainage cells, that are used in the construction of a synthetic turf field may provide some characteristics of a shock pad. In order to meet the STC definition of a shock pad as it relates to a synthetic turf system, however, such products should perform in accordance with the recommendations of this guideline.

It is very important to consider that a shock pad forms part of the synthetic turf sports surfacing system and it is the performance of the total system that influences the athlete's perception of a sports field and determines if it is providing the required levels of player protection and sports performance. Due to the different types of synthetic turf on the market, ranging from long pile (typically 1½ inch – 2½ inch) infilled surfaces (such as crumb rubber with or without sand, TPE, EPDM, coated sand, organic infills, etc.) that are typically used for football, soccer and rugby, to non-filled short pile surfaces (typically ½ inch) used for field hockey, there are many different shock pads, with differing performance characteristics available.

Guidance on the required levels of performance are available from numerous sources including STC, ASTM, and the international sports federations (Fédération Internationale de Football Association (FIFA), International Hockey Federation (FIH) and World Rugby.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1. Dynamic Properties of Shock Pads

The principal objective of a shock pad is to provide a permanent shock-absorbing layer within the synthetic turf system which provides a minimum level of impact protection to athletes running on and falling onto the surface, irrespective of the type of synthetic turf laid over the shock pad, or its condition.

A number of different ways of measuring the impact attenuation properties of synthetic turf sports surfaces have been developed around the world. Some simulate the action of athletes running and falling on a surface, others simulate head impacts, while others just provide a consistent way of comparing the performance of against a defined standard as adopted by ASTM or one the international sports governing bodies.

The most commonly used test methods are detailed below and some have been incorporated into this guideline. The table below provides further details about the relevance of each test method for the major sports played on synthetic turf within North America. Where requirements are specified by sports' governing bodies on in national/international standards, these are on the complete Turf system and not just the shock pad.

Test method	Impact Simulation	Requirements set by sports' governing bodies	Requirements set in national/ international standards	Test method described in national/ international Standards
Force reduction (also called Shock Absorption in some standards)	Athlete running on surface	FIFA World Rugby FIH	EN 15330-1	ASTM F3189 CEN TC 16717
g-max	Head Impact		ASTM F1936	ASTM F 355
HIC	Head Impact	World Rugby	EN 15330-1	ASTM 3146-18 EN 1177
Clegg Hammer	N/A – comparative test only	NFL		ASTM F1702

1.1 **Force Reduction:** Force Reduction is measured using an Advanced Artificial Athlete. This is a piece of test equipment that has been developed to assess the impact attenuation properties of synthetic turf surfaces. It is an evolution of the Artificial Athletes originally developed in Germany in the 1970s and used to simulate the loading of a sports surface as an athlete runs across it. During the test the peak impact force experienced is measured. This peak force is compared to a theoretical value based on a measurement made on rigid non-yielding surface (concrete) and the result expressed as percentage reduction in force. The larger the percentage reduction the greater the degree of impact absorption being provided by the surface

1.1.1 **Performance Criteria:** The STC recommends that the Force Reduction properties of a shock pad are measured in accordance with ASTM F3189 under the conditions detailed in Annex B.

When tested under the test conditions described in table B.1, it is recommended that:

- the minimum Force Reduction measured with the load spreading plate, under any of the conditions described is 30% Force Reduction;
- the maximum variation between the highest and lowest values of Force Reduction measured with the load spreading plate, under any of the conditions described (excluding the test at 23°F [-5°C]) is 5% Force Reduction (absolute);
- the maximum variation between the three test positions, tested at 72°F under dry conditions with the load spreading plate, is ± 2.5% Force Reduction (absolute) from the mean; and
- the minimum Force Reduction, measured under dry conditions at 72°F without the load spreading plate is 20%.

If a shock pad is intended for use in regions where the ambient temperature may be expected to fall below 32°F (0°C) it should also be tested in accordance with the procedure described in Annex B.6 without the load spreading plate, and the result reported to enable field designers to determine if the shock pad is suitable for use under prevailing site conditions.

Note - Products not complying with these guidelines may serve other functions within a sports surfacing system and also contribute to the sports performance properties, but they are not considered to be a shock pad, as defined by this guideline.

1.1.2 **Production Variability:** A manufacturing tolerance of ± 5% FR (absolute) from the manufacturer's declared value is considered acceptable.

1.1.3 **Vertical Deformation:** Vertical Deformation is a measure of how much a surface deforms under the loading of an athlete running across it. If a surface compresses excessively it may provide a surface that athletes will consider to be tiring (similar to running on loose sand) and unstable and in excessive cases this can increase the risk of ligament and overuse injuries

1.2 **Characterization:** Vertical Deformation is measured using the Advanced Artificial Athlete, in accordance with ASTM F3189. It is recommended that tests are made under the conditions detailed in Annex B, Table B.1. and the results reported, to enable the developer of a sports surfacing system to determine the suitability of a shock pad for the specific application.

1.2.1 **Consistency Criteria:** The maximum variation between the three test positions, tested at 72°F under dry conditions without the load spreading plate, is recommended to be ± 2.5mm from the overall mean.

1.2.2 **Production Tolerance**: A manufacturing tolerance of ± 2mm from the manufacturer's declared value is considered acceptable.

1.3 **Head Injury Criteria (HIC):** Head Injury Criterion (HIC) is a measure of the likelihood of head injury arising from an impact. The test is used in a wide range of head impact risk assessments including sport and play application.

For sports applications a hemispherical impactor designed to simulate a human head is dropped onto the sports surface and the deceleration the simulated head experiences is measured, along with the time duration of the impact. The data is processed and a value of HIC is calculated. Tests are normally made from a number of different fall heights and the results plotted so a Critical Fall Height equating to a HIC of 1000 can be determined; a HIC score of 1000 being equivalent to a 3 % chance of a critical head injury. In North America, the three sports that currently specify requirements for require HIC testing of the system are the Rugby Union, Rugby League, Gaelic Games (Hurling and Gaelic Football).

Characterization: If a shock pad is intended to be used in a synthetic turf sports surface system that is required to achieve a minimum critical fall height (when tested in accordance with ASTM 3146-18), the HIC values of the shock pad should be measured and reported. Tests should be made at a range of drop heights starting at 6 inches (300 mm) and increasing in 6 inch (300 mm) increments until the HIC value exceeds 1500 or a height of 78 inches (2000 mm) is achieved, whichever occurs sooner. Tests should be made in a minimum of three locations per drop height, the mean value for each height being calculated and reported. The tests should be made at 73.4 ± 3.6°F (23 ± 2 ºC) under dry conditions.

Tests should be made with and without a load spreading plate as described in Annex C.

Note: As each impact may damage the load spreading plate a new area should be impacted for each test.


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2. Durability

2.1 **Tensile Properties:** Measuring the tensile properties of a shock pad is a well-established quality control procedure used to ensure shock pads have adequate strength.

Depending on the profile and thickness of a shock pad its tensile properties are measured in one of three ways. The different minimum guideline values of tensile strength detailed in clauses 4.1.1, 4.1.2 and 4.1.3 reflect the different test methods and they must not be compared to each other. In each clause the guideline values are based on current experience.

2.1.1 **Homogenous Shock Pads And Elastic Layers That Are Less Than 1 Inch (25mm) Thick:** The STC recommends that the tensile strength of the shock pad is ≥ 21.75 lbf/in2 (≥ 0.15 MPa), when tested in accordance with EN 12230. Following air ageing, undertaken in accordance with EN 13817, the tensile strength is recommended to be ≥ 21.75lbf/in2 (≥ 0.15 MPa) and the loss in tensile strength as a result of the air ageing is recommended to be no greater than 25% of the tensile strength of the unaged shock pad.

Note: The 1 inch thickness restriction of this test method is due to the limitation of the standard sample cutter used to prepare the test specimens; it is not suitable for materials that are 1 inch or more in thickness.

2.1.2 **Homogenous Shock Pads And Elastic Layers That Are 1 Inch (25mm) Or More Thick:** The STC recommends that the vertical tensile strength of the shock pad is ≥ 14.50 lbf/in2 (≥0.10 MPa) when tested in accordance with clause 8.17.1.2 of the FIH Hockey Turf & Field Standards.

Following air ageing, undertaken in accordance with EN 13817, the tensile strength should be ≥ 14.50 lbf/in2 (≥0.10 MPa) and the loss in tensile strength as a result of the air ageing should be no greater than 25% of the tensile strength of the unaged shock pad.

Note: As it is difficult to precisely prepare dumbbell test specimens from shock pads that are more than 1 inch thick a different method of test i based on determining the vertical tensile strength of the shock pad has been adopted in this guide.

European Standard EN 1177 (2018) and Maximum Abbreviated Injury Scale, first developed by the Association for the Advancement of Automotive Medicine and used extensively in the automotive industry as an indicator of the severity of head-related injuries.

2.1.3 **Shock Pads With Channels, Slots Or Groves:** The STC recommends that the tensile strength of the shock pad should be ≥ 7.25 lbf/in2 (≥ 0.05 MPa) when tested in accordance with clause 8.17.1.3 of the FIH Hockey Turf & Field Standards.

Following air ageing, undertaken in accordance with EN 13817, the tensile strength should be ≥ 7.25 lbf/in2 (≥ 0.05 MPa) and the loss in tensile strength as a result of the air ageing should be no greater than 25% of the tensile strength of the unaged shock pad.

Note: This test method was developed in recognition that shock pads containing channels, slots or groves cannot be tested in the same way as homogenous shock pads. As shock pads with slots or groves will have sections that are much thinner than the overall thickness of the shock pad, their tensile strength will be lower.

2.2 **Resistance To Dynamic Fatigue**: To ensure shock pads are able to provide satisfactory performance for the intended service life of the product it is important that they do not breakdown or lose performance as a result of repeated impacts. To assess this a sample of shock pad is impacted 10,000 times on the same spot and any changes in the shock absorbing properties or thickness is assessed.

2.2.1 **Performance Criteria:** The STC recommends that a sample of the shock pad should be subjected to Dynamic Fatigue conditioning in accordance with EN 17324.

After the conditioning, the maximum loss of Shock Absorption compared to the value measured on an unconditioned sample is recommended to be 5% Force Reduction and the Shock Absorption is recommended to be still be at least 20%; all measured without the load spreading plate.

After the conditioning, any change in thickness is recommended to be ≤ 15% of the shock pad's initial thickness.

2.3 **Dimensional stability:** All materials expand and contract with changes in temperature. The degree to which this occurs depends on the types of material, the temperatures they are being exposed to and whether there are physical constraints to control and limit the dimensional changes. Generally, materials expand when they are subjected to hot temperatures and contract when exposed to cold temperatures.

Synthetic turf surfaces generally comprise several components including a synthetic turf carpet, some form of infill and, in many cases, a shock pad. When a system is being designed it is very important that the combination of materials is considered as a complete system and its ability to withstand the range of temperatures a specific field is likely to experience should be established. This verification should consider the:

- type and quantity of infill material(s) used to part fill the carpet;
- ability of a shock pad to not increase or decrease in size as temperatures change;
- weight and quality of the primary and secondary backings of the synthetic turf carpet; and
- drainage rates of the synthetic turf surfacing system and the base on which it is laid.

2.3.1 **Resistance To Expansion:** Many shock pads restrict expansion by having groves or channels cut in their construction; as the shock pad expands the groves or channels close, meaning the overall size of the shock pad remains stable. It is therefore very important that any test used to measure dynamic expansion allows these design features to operate as intended. Such a test has been developed by the European Standards Committee (CEN). It measures the resistance of a shock pad to bowing or curling due to expansion, when exposed to high temperatures.

2.3.1.1 **Performance Criteria:** When tested in accordance with EN 17326 the maximum value of bowing or curling should be 5 mm.

2.3.2 **Resistance To Shrinkage:** At the time of publishing this Guide a satisfactory test for assessing the potential for shock pads to shrink has not been developed and consumers are therefore advised to seek adequate warranty provision for this property from the sports surface system developer or field designer.


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3. Material Properties

3.1 **Thickness**: The thickness of the shock pad should be measured and reported. The STC recommends that for bound rubber crumb shock pads the thickness is measured in accordance with EN 1969. For pre-fabricated foam and geo-felt shock pads. the thickness is recommended to be measured in accordance with EN 9863-1.

3.1.1 **Production Tolerance – Prefabricated Shock Pads:** A manufacturing tolerance of ± 10% of the manufacturer's declared value is considered acceptable, providing any variations in thickness do not mean a field fails to satisfy the appropriate surface regularity (evenness), sports performance and consistency criteria, specified in the project specification.

3.1.2 **Production Tolerance – In-Situ Laid Shock Pads:** When in-situ laid shock pads are installed, the thickness may be dependent on the regularity of the base on which they are laid. As these are often outside the tolerances specified for the final playing surface, the thickness of the installed shock pad may vary in an attempt to improve the regularity of the field. For in-situ shock pads the installed thickness should therefore be at least 90% of the manufacturer's declared value. Thicknesses greater than 100% are considered acceptable, provided that the field also satisfies the appropriate surface regularity, sports performance and consistency criteria, specified in the project specification.

3.2 **Mass Per Unit Area:** The STC recommends that the mass per unit area of the shock pad is measured in accordance with ISO 8543 and the result is reported.

A manufacturing tolerance of ± 15% of the manufacturer's declared value is considered acceptable.

4. Drainage Properties

4.1 **Vertical Water Infiltration**: The STC recommends that the vertical water infiltration is measured in accordance with EN 12616. Three measurements should be made, each at least six inches (150mm) apart and the mean value calculated and reported.

4.1.1 **Performance Criteria:** Shock pads designed to allow the vertical flow of water through them should have a water infiltration rate of 20 inches/hour (500mm/h) or greater.

4.1.2 **Production Tolerance:** The measured value is recommended to be 90% or greater of the manufacturer's declared value.

4.2 **Horizontal Water Flow Capacity:** Increasingly sports fields are being designed to drain using some form of horizontal drainage and many shock pads are now designed to facilitate this, by allowing the lateral flow of water within the structure of the shock pad.

The STC recommends that where the horizontal drainage flow rates of a shock pad needs to be known, it is measured in accordance with ASTM D4716.

4.2.1 **Production Tolerance:** The measured value is recommended to be 90% or greater of the manufacturer's declared value.

5. Toxicology Tests

The STC suggests that any toxicological test and analysis of shock pads for synthetic turf fields be performed according to Synthetic Precipitation Leaching Procedure (SPLP) (EPA SW-846 Method 1312) extraction tests, utilizing EPA 6010B analysis method.

The SPLP method has been recommended by the STC because it is a national standard in the U.S. designed to simulate the migration of chemicals from soils exposed to acid rain conditions. The test conditions simulate 100 years of acid rain exposure.

The recommendations detailed are taken from the US Drinking Water Standards with the rationale that if the leachate from the shock pad products is safe to drink, it would not be harmful to the environment surrounding the synthetic turf fields where it is installed.

Component	Test Method	Limits (mg/L)
Arsenic	6010B	0.01
Barium	6010B	2
Cadnium	6010B	0.005
Chormium	6010B	0.1
Lead	6010B	0.015
Mercury	EPA 7470	0.002
Selenium	6010B	0.05
Silver	6010B	0.1

6. Toxicology Institutes

When independent third-party testing of shock pads is required to assess their performance, it is recommended the laboratory is certified to ISO/IEC 17025. Details of suitable test laboratories can be obtained from (www.syntheticturfcouncil.org).

Disclaimer

For the purposes of this document, the following terms and definitions apply.

Shock pad – an elastic material placed beneath a synthetic turf sports surface that is designed to aid the provision of the performance properties of the sports surfacing system.

Pre-fabricated shock pad – shock pad manufactured in a factory and normally comprising rolls or tiles that are laid on the base of the sports area.

In-situ shock pad or elastic (e) layer – shock pad formed as a wet pour mix and normally incorporating a binder (e.g. polyurethane) and elastomeric granulate that is mixed and machine-laid on site using a paving machine or similar. Some forms of in-situ elastic layer also include pea gravel or other small aggregates. These are normally are used when the elastic layer is designed to also act as load bearing structure forming part of the base of the field.

Sports surfacing system – all components of the playing surface that influence its sports performance or bio-mechanical characteristics including the synthetic turf, carpet, infill and shock pad or elastic layer, together with any supporting layers designed to contribute to the performance of the surface.

Product declaration – statement or datasheet provided by the shock pad manufacturer that describes the composition and expected performance of the shock pad.

Annex B: Test Conditions

This annex provides information for those wishing to test shock pads to determine how their performance compares to guidelines given in this document.

Table B1 – test conditions (ambient and elevated temperatures)

Shock pad condition	Test temperature	Test made with load spreading plate	Test made directly onto shock pad
Dry	72° ± 5°F (23° ± 2°C)	✓	✓
Wet	72° ± 5°F (23° ± 2°C)	✓	
Dry	105° ± 5°F (40° ± 2°C)	✓	
Dry	40° ± 5°F (5° ± 1°C)	✓	
Wet / Frozen*	23° ± 2°F (-5°C)	✓	

** Only applicable for shock pads intended for use in regions where the ambient temperature may be expected to fall below 32°F (0°C).*

Tests carried out at 72°F should be made in three test locations, each approximately 8 inches (200mm) apart and at least 4 inches (100mm) from the sides of the test specimen.

For tests at non-ambient laboratory conditions one series of measurements should be made at least 100mm (4 inches) from the sides of the test specimen.

Frozen conditions should be produced using the procedure detailed in B.6.

B.1 Sample Conditioning

Unless otherwise specified, tests should be undertaken at a temperature of 72 ± 5 °F (23 ± 2°C) and test specimens should be conditioned for a minimum of 3 hours at the specified temperature prior to test.

Note: As shock pads are generally not sensitive to humidity it is not considered necessary to specify strict humidity conditions for the laboratory. Nevertheless, it is advisable for the humidity to be nominally 50% RH.

B.2 Test Floor

Force Reduction, Deformation and HIC tests should be made on a rigid concrete floor comprising a rigid, non-vibrating, smooth, level and even concrete floor on which a peak force (Fmax) of 6.60 ± 0.25 kN is achieved.

The shock pad should be attached to the concrete floor using 2 inch (50 mm) wide double-sided sticking tape. This should be attached to the outer edges of the test specimen.

B.3 Wet Test Conditions

Wet test conditions are produced by immersing the shock pad in water to a depth of at least ½ inch (12 mm) above the top of the shock pad. After a minimum of 30 minutes, remove the test specimen from the water and place it on a free draining base to allow it to drain by gravity for 5 ± 2 minutes. Test the specimen for the appropriate property within a further 15 ± 2 minutes.

B.4 Procedure For Tests At 105°F (40°C)

Place the shock pad test specimen in an air-circulating oven conforming to ISO 188, at a temperature of 118 ± 5°F (47.5 °C).

After 120 ± 5 min, remove the test specimen from the oven. Place the test specimen on the test floor and allow it to cool. Monitor its temperature using a digital temperature probe inserted into the test specimen. When the temperature probe reads 108 ± 3°F (42 °C), measure the Force Reduction.

Move the apparatus and repeat to obtain three results ensuring the temperature of the test specimen does not fall below 100°F (38°C).

B.5 Procedure For Tests At 41°F (5°C)

Place the shock pad test specimen in a conditioning cabinet at a temperature of 14°F (-10°C) to 32°F (0°C).

After 120 ± 5 min, remove the test specimen from the conditioning cabinet. Place the test specimen on the test floor and allow it to warm. Monitor its temperature using a temperature probe inserted into the test specimen.

When the temperature gauge reads 41°F (5°C), measure the Force Reduction.

Move the apparatus and repeat to obtain three results ensuring the temperature of the test specimen does not rise above 45°F (7°C).

B.6 Procedure For Tests At 23°F (-5°C)

Immerse the shock pad in water to a depth of at least ½ inch (12 mm) above the top of the shock pad.

After a minimum of one hour, remove the test specimen from the water and place it on a free draining base to allow it to drain by gravity for 30 ± 2 minutes before placing the test specimen in a conditioning cabinet at a temperature of 18°F (-8°C) to 10°F (-12°C).

After 240 ± 5 min, remove the test specimen from the conditioning cabinet. Place the test specimen on the test floor and allow it to warm. Monitor its temperature using a temperature probe inserted into the test specimen. When the temperature gauge reads 23° ± 2°F (-5°C), measure the Force Reduction.

Move the apparatus and repeat to obtain three single impact results ensuring the temperature of the test specimen does not rise above 27°F (-3°C).

Annex C: Properties of Load Spreading Plate

This annex provides information to those wishing to test shock pads to determine how their performance compares to guidelines given in this document.

Property	Unit	Test Method	Nominal Values
Material	-	-	Polypropylene composite
Dimensions	mm	-	500 ± 10 x 500 ± 1
Thickness	mm	-	1.0 ± 0.2mm
Density g/cm³	g/cm³	ISO 1183	0.92 ± 0.05
Flexural modulus	N/mm^2	ISO 178	3500 ± 100
Tensile Properties			
Strength at break	MPa	ISO 527	120 ± 10
Tensile Strain	%		20 ± 2
Tensile Modulus	kJ/m^2		4200 ± 100

The plate must be replaced whenever tests cannot be made on an area without damage, or where the plate cannot lie flat on the test specimen due to buckling or bowing.

The plate should be loosely laid on the shock pad during the testing process.

A suitable product is Curv C100A by Propex Fabrics, Germany (see www.curvonline.com), other products may be available.

Annex D: Incorporated Test Methods

Test methods from other publications are incorporated into this Guide by dated or undated reference. Where dated references are used, subsequent amendments to, or revisions of, any of these publications will apply to this Guide only when incorporated into it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

ASTM F3189-17, *Standard Test Method for Measuring Force Reduction, Vertical Deformation, and Energy Restitution of Synthetic Turf Systems Using the Advanced Artificial Athlete*

ASTM 3146-18, *Standard Test Method for Impact Attenuation of Turf Playing Systems Designated for Rugby as Measured in the Field*

ASTM D4716 / D4716M-14, *Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head*

EN 1969, *Surfaces for sports areas – Determination of thickness of synthetic sports surfaces*

EN 12616, *Surfaces for sports areas – Determination of water infiltration rate*

EN 13817, *Surfaces for sports areas — Procedure for accelerated ageing by exposure to hot air*

EN 15330-1, *Surfaces for sports areas. Synthetic turf and needle-punched surfaces primarily designed for outdoor use. Specification for synthetic turf surfaces for football, hockey, rugby union training, tennis and multi-sports use*

EN 17324, *Surfaces for sports areas — Test method for the determination of the resistance to dynamic fatigue of shock pads and sports surfaces*

EN 13726, *Surfaces for sports areas — Determination of dimensional stability of shock pads used within sports systems*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 9863-1, *Geosynthetics. Determination of thickness at specified pressure. Single layers*

ISO 8543, *Textile floor coverings: Methods for determination of mass*

References

ASTM F355-16, *Standard Test Method for Impact Attenuation of Playing Surface Systems, Other Protective Sport Systems, and Materials Used for Athletics, Recreation and Play*

ASTM F1936-10, *Standard Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field*

ESTO *Performance Guide to Shock pads (2017 edition)*

FIFA Quality Programme for Football Turf, *Handbook of Requirements*

FIH (International Hockey Federation), *Hockey Turf and Field Standards — Part 2*

NFL, *Football Operations — Field Certification*

STC, *Guidelines for Synthetic Turf Performance*

US EPA SW-846 Test Method 1312, *Synthetic Precipitation Leaching Procedure*

World Rugby, *Rugby Turf Performance Specification*

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STC PERFORMANCE and QUALITY GUIDELINES for SHOCK PADS (the "Guide" or "Guideline") includes selected guidelines ("Guidelines") to consider when comparing the performance and durability of different shock pads however, these are not exhaustive and there may be other important items that might be considered for the specific situation and performance required. The use of these Guidelines is voluntary and are not, and should not be considered, as standards for determining the performance and durability of shock pads or the synthetic turf systems in which they are incorporated. This Guideline does not imply, suggest or in any way guarantee that performance and durability issues could not arise if a shock pad meets any or all of these suggested Guidelines, and does it imply or suggest that if any of the Guidelines are not met that the performance and durability of such shock pad will fail. The suggested Guidelines are not intended to be, and are not to be considered as, safety standards and this document does not imply that an injury is less likely to occur if the suggested Guidelines are followed and does it imply or suggest that if any of the Guidelines are not met that injury is more likely to occur.

As experience is gained with the guidance detailed methods described in 4.1.2 and 4.1.3 the STC will review the relevant recommendations minimum tensile strength guideline to see if they should be modified.

About the Synthetic Turf Council

The Synthetic Turf Council (STC) is a 501(c)6 non-profit trade association serving the synthetic turf industry. Its mission is to lead, educate and advocate for the synthetic turf industry. Founded in 2003, the STC assists buyers and end users with the selection, use and maintenance of synthetic turf systems in sports field, golf, municipal parks, airports, landscape and residential applications. It is a resource for current, credible, and independent research on the safety and environmental impact of synthetic turf, as well as technical guidance on the selection, installation, maintenance, and environmentally responsible disposal of synthetic turf. Membership includes builders, landscape architects, testing labs, maintenance providers, manufacturers, suppliers, installation contractors, infill material suppliers and other specialty service companies.

Synthetic Turf Council

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