International Hockey Federation

Handbook of Performance Requirements

for Synthetic Turf Hockey Pitches

incorporating test procedures

"The Pitch Handbook"

published April 2008

HANDBOOK OF PERFORMANCE REQUIREMENTS AND TEST PROCEDURES FOR SYNTHETIC TURF HOCKEY PITCHES

Foreword

Synthetic turf is increasingly used for hockey pitches around the world. It is some 30 years since such pitches were first used for international hockey. In that time, the structure and composition of pitches has developed tremendously. New materials and new construction and installation methods have been introduced. Pitches are now used widely at many levels of hockey play.

To support these developments while maintaining the quality of synthetic turf pitches, it is necessary to update this handbook of performance requirements from time to time. This version therefore reflects the latest synthetic turf technology.

However, FIH hopes to see further development in synthetic turf in the near future primarily in relation to the use of water. At present, all global level turf and pitches and some at national level require the application of water to achieve the performance requirements. This is not sustainable in a world where water is an increasingly scarce and valuable natural resource. FIH is therefore undertaking research and consulting with the synthetic turf industry to develop a specification for a global level turf which does not require the application of water. In doing so, the playing characteristics of the game and the safe actions of players will be taken into account.

Good progress is being made towards this goal but it will take a little time to complete the research, to establish requirements and for the industry to produce products. This latest version of the handbook therefore refers to global level unfilled turf requiring water but will be revised and republished as soon as the new requirements have been established.

In the interim and in relation to top level hockey, water-based pitches will continue to be specified. For some time after the new turfs are available, FIH will continue to allow top events to be played on existing water-based pitches which meet the performance requirements. Organisations considering the installation of new pitches or refurbishment of existing pitches can therefore use current approved turf products with confidence. Pitches installed in the near future using these turfs will continue to provide good facilities for hockey. Newly installed pitches using current turfs are not compromised by and do not contradict the aims of the FIH described above.

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April 2008

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HANDBOOK OF PERFORMANCE REQUIREMENTS AND TEST PROCEDURES FOR SYNTHETIC TURF HOCKEY PITCHES

"THE PITCH HANDBOOK"

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HANDBOOK OF PERFORMANCE REQUIREMENTS AND TEST PROCEDURES FOR SYNTHETIC TURF HOCKEY PITCHES

"THE PITCH HANDBOOK"

1 Introduction

1.1 Authority

This handbook is published by the International Hockey Federation (FIH) as a comprehensive statement of its requirements for approved synthetic hockey turf products and for certification of pitches constructed using those products.

To be approved by the FIH, a synthetic turf product supplied by an FIH licensee must meet the performance requirements in this handbook.

To be certified by the FIH, an installed hockey pitch must meet the performance and composition requirements in this handbook.

This handbook therefore establishes the technical basis for the supply of approved turf products and also acts as a reference for organisations contemplating the installation of synthetic pitches.

In the latter context, pitch owners are recommended to specify the desired performance requirements by reference to this handbook in any contract agreement for the construction of a hockey pitch.

1.2 Objective

The primary objective of FIH in codifying the relevant performance requirements is to ensure that hockey competitions and matches are conducted so as:

- to reflect relative team merit;
- to provide an opportunity for players to display and develop their hockey skills;
- to offer comfortable playing conditions and to limit danger to players;
- to extend pitch playability in adverse weather conditions.

The system of product approvals helps to ensure uniformity and improved pitch performance to the benefit of the game. This is extended by the scheme for certifying that installed pitches meet specified requirements.

Two approval levels are laid down for **synthetic turf products**:

- for FIH world-level competitions including specified qualifying tournaments - hereafter called '**global**' level turf;
- for other international matches and national competitions - hereafter called '**national**' level turf.

FIH is keen to identify turf which may be suitable for use by a number of sports including hockey (sometimes referred to as multi-sport turf). Where it is known that an approved hockey turf also complies with the specifications for one or more other sports, a corresponding indication will be included in the FIH list of approved turfs provided a compliance certificate has also been issued by the governing body of such other sport.

Further, to promote access to hockey, national hockey associations can be approached to advise on options; some have approval schemes for such turf. European Standard EN 15330-1 (Surfaces for Sports Areas) also provides useful information.

Two certification levels are laid down as requirements for **installed pitches**:

- FIH world-level competitions including specified qualifying tournaments and other competitions specified by organisers – hereafter called '**class 1**' level certified pitches;
- other matches – hereafter called '**class 2**' level certified pitches.

Technical requirements for the synthetic surfaces vary between these categories. They are the most stringent for class 1 levels, mainly to ensure predictable playability, and less demanding at class 2 levels mainly for cost reasons.

Before giving approval to particular competitions, FIH will specify the category of the pitch or pitches to be used by reference to this handbook The FIH website (www.worldhockey.org) or FIH Office should be contacted to verify up to date requirements but an indicative list of competitions requiring 'class 1' certified 'global' pitches is:

- Olympic Games
- World Cups
- Junior World Cups
- Champions' Trophies
- Champions' Challenges
- FIH Olympic Games Qualifying Tournaments
- FIH World Cup Qualifying Tournaments.

Other competition organisers also often specify requirements.

Pitch owners contemplating hosting an international or other top level competition should therefore consider carefully the choice of an approved turf product and level of pitch certification when planning the facility. In addition to consulting this handbook, they should seek advice on requirements from FIH or other competition organisers.

1.3 Performance Requirements

Several concepts underpin the performance requirements set out in this handbook:

- the requirements have been laid down after consultation with players, turf manufacturers and FIH accredited laboratories. They embrace products upon which hockey can be played safely and comfortably.
- product approvals will only be granted to products and/or combinations of products which have been tested by an FIH accredited laboratory and shown to comply with the requirements in this handbook. Such approvals are valid for a duration specified in this handbook and in licensing agreements with manufacturers.
- a current list of approved products from licensed manufacturers is published on the FIH website www.worldhockey.org.
- specific installed pitches will be granted a Certificate of Compliance after field testing by an FIH accredited laboratory showing that the pitch meets the requirements in this handbook.
- a current list of certified pitches is published on the FIH website www.worldhockey.org.

The technology on which synthetic turf is based continues to develop rapidly. As a consequence, the requirements in this handbook may change. In this case, a revised handbook will be published. Users of the handbook should therefore always check the pitches and equipment section of the FIH website to ensure they are using the latest version.

1.4 Durability

FIH is conscious of the need for durability characteristics for synthetic pitch products and installed pitches as a matter of prudence for pitch owners and to maintain a large number of high quality pitches around the world.

Consequently, a new test for durability of pitch products may be introduced in the future. In the meantime, pitch owners may find the standards included in EN 15330-1 (Surfaces for Sports Areas) helpful.

However, it must be understood that quality of maintenance and intensity of usage as well as climatic and environmental conditions have a significant influence on durability. Purchasers of products that have been approved by the FIH should therefore note that the approval applies to pitch products which have been tested at the beginning of their life.

To ensure that the proposed pitch meets requirements, it is prudent for pitch purchasers to investigate the durability of a product by inspection of similar installations which have been in use for some time. It is also wise to negotiate a quality guarantee for a reasonable pitch lifetime when agreeing supply contracts.

2 Definitions and Abbreviations

The following terms will be encountered in this handbook.

'Global Turf'	A synthetic turf supplied by a licensed manufacturer which has been shown by independent laboratory testing by an FIH accredited laboratory to meet the (top) global level performance requirements in this handbook.
'National Turf'	A synthetic turf supplied by a licensed manufacturer which has been shown by independent laboratory testing by an FIH accredited laboratory to meet the national level performance requirements in this handbook.
'Approved Turf Product'	A specified and unique combination of carpet and shock pad which has been tested by an FIH accredited laboratory and verified as meeting the requirements in this handbook and the conditions laid down in the licensing agreement.
'Certified Pitch'	A pitch which has been tested by an FIH accredited laboratory and verified as meeting the requirements in this handbook and the conditions laid down in the licensing agreement. The pitch carpet must be the carpet from an approved product but the shock pad may be as specified for that approved product or may be a pre-existing shock pad. If it is a pre-existing shock pad, it must be from another product which was an approved product at the time of installation of the shock pad.
'Licensing Agreement'	The formal agreement entered into by a turf manufacturer and the FIH governing the conditions under which approval of turf products may be granted.
'Licensed Manufacturer'	A synthetic turf manufacturer who has entered a licensing agreement with FIH. In this handbook and in the licensing agreement, "manufacturer" also includes a supplier who has entered a licensing agreement with FIH., but who is not necessarily itself a manufacturer.
'Class 1 Certificate'	The certificate issued to a pitch which meets the full (class 1) set of field test requirements in this handbook.
'Class 2 Certificate'	The certificate issued to a pitch which meets the limited (class 2) set of field test requirements in this handbook.

'Class 1 Global Pitch'	A pitch which meets the full (class 1) set of field test requirements in this handbook, uses a global turf product and is certified as suitable for FIH world-level and other specified competitions.
'Class 2 Global Pitch'	A pitch which meets the limited (class 2) set of field test requirements in this handbook and uses a global turf product.
'Class 1 National Pitch'	A pitch which meets the full (class 1) set of field test requirements in this handbook and uses a national turf product.
'Class 2 National Pitch'	A pitch which meets the limited (class 2) set of field test requirements in this handbook and uses a national turf product.
'Unfilled Turf/Pitch'	A turf product or pitch using a carpet of woven, tufted or knitted synthetic yarn in which the density of pile is sufficient to maintain yarn vertically without support or stabilization by other materials.
'Filled Turf/Pitch'	A turf product or pitch using a carpet of woven, tufted or knitted synthetic yarn fully supported or stabilised by the addition of filling material (eg sand and therefore sometimes referred to as a sand-filled turf/pitch).
'Dressed Turf/Pitch'	A turf product or pitch using a carpet of woven, tufted or knitted synthetic yarn partly supported or stabilised by the addition of filling material (eg sand and therefore sometimes referred to as a sand-dressed turf/pitch). Sometimes referred to as 'Obscured Turf/Pitch'.
'Sub-base'	The engineered support structure for a synthetic pitch.
'Shock Pad'	Resilient material under the pitch carpet to absorb kinetic energy. Sometimes referred to as 'Shock Absorbing Layer', 'Elastic Layer' or 'E-Layer'.
'Carpet'	The topmost layer of woven, tufted or knitted materials of a turf.
'Pile'	The full depth of tufts or loops of yarn which form the carpet.
'Yarn'	Material used for tufts or loops to manufacture the carpet.
'Permeability'	Capacity of a turf or pitch to transmit water by infiltration, drainage and absorption of the water through the carpet and shockpad to the structure immediately below.
'Ball'	An FIH approved hockey ball.
'EN'	European Normation

3 Accredited Test Laboratories

The tests referred to in this handbook are required to be undertaken by an FIH accredited laboratory.

In establishing a network of accredited laboratories for testing synthetic turf products and pitches to the requirements in this handbook, FIH has regard to a number of factors including:

- the integrity and independence of the organisation;
- the competence of the staff of the organisation;
- the possession of, or willingness by the organisation to acquire, the necessary test and calibration equipment;
- the willingness to work with FIH to verify test consistency.

Laboratories which have obtained FIH accreditation are authorised to carry out tests on both turf products and pitches to the specifications laid down in this handbook.

Independent of the result of testing, laboratory charges are the responsibility of the turf product manufacturer, pitch installer, pitch owner or other test applicant. It is the responsibility of the test applicant to contract an accredited laboratory to undertake tests.

Although the convenience of manufacturers, installers and owners has been a factor in establishing the laboratory network, there is no obligation to use a particular laboratory.

Official test reports must be in a format specified by FIH. Laboratory test reports are confidential to the laboratory, the test applicant and FIH but the applicant may supply copies to other parties.

A current list of FIH accredited laboratories is published on the FIH website www.worldhockey.org.

4 Turf Products: Licensing and Approval Procedures

4.1 Introduction

Manufacturers of synthetic turf for hockey pitches may apply to the FIH to have their products registered as FIH approved products. These products are tested by an FIH accredited laboratory and verified to meet the requirements set out in this handbook.

A current list of approved products from licensed manufacturers is published on the FIH website www.worldhockey.org.

A separate section of this handbook deals with the equivalent procedures for certifying installed pitches.

4.2 Manufacturer Licensing

Turf manufacturers are invited to enter a licensing agreement with FIH. Full information about the licensing agreement including a draft copy is available from the FIH office.

Only licensed manufacturers, their subsidiaries or licensees may seek FIH approval of their products. Any breach of the licensing agreement by a manufacturer, a subsidiary or a licensee may lead to cancellation of the licence and withdrawal of approval of the relevant products.

4.3 Pre-Approval Testing

Some manufacturers have their own product test facilities and use these facilities to check that their products meet FIH requirements.

Applicants which do not have these facilities are advised to seek an initial informal test by an FIH accredited laboratory. If the laboratory results indicate full compliance with the FIH requirements, the laboratory can then convert the informal result into a formal FIH report. If there are any short-comings in the results, the manufacturer can adjust the product design until the short-coming is resolved.

In all cases, approval of a product must be on the basis of a full set of tests by an FIH accredited laboratory.

4.4 Test Procedure

Turf product manufacturers must arrange for tests to be conducted by one of the FIH accredited laboratories.

4.5 Product Approval

Upon satisfactory completion of the tests and demonstration of compliance with the requirements set out in this handbook, a manufacturer may apply for a product approval.

Each application must identify clearly a discrete marketing name or code for the product. Each application must relate to a specific combination of turf carpet and shockpad. Any approval will be related only to that combination of turf carpet and shockpad. Separate applications are necessary for other combinations.

To enable verification that a supplied turf is an FIH approved product, detailed information will be required about the composition of the turf.

A manufacturer may produce an approved turf in more than one factory under their control. In this case, the product approval will be based on turf samples from one factory. However, the manufacturer must specify to the satisfaction of FIH its quality assurance processes which ensure that production at each factory is identical. To verify this, FIH may at any time require a manufacturer at the manufacturer's cost to have samples from any of its factories tested by an FIH accredited laboratory against the composition information from the original approved product.

The locations of factories used by manufacturers will be specified in the list of approved products published by FIH.

A product approval issued by FIH entitles the manufacturer to advertise, as specified in the licensing agreement, the particular turf product as having complied with FIH requirements. Where a manufacturer is supplying the same turf product through an FIH accepted subsidiary or agent, the subsidiary or agent will be entitled to advertise the FIH approval in a similar fashion. The licensing agreement between FIH and a manufacturer contains provisions relating to use of the FIH registered mark.

When a licensed manufacturer no longer wishes to be licensed, or if a manufacturer's licence lapses or is cancelled, the manufacturer must withdraw all materials which indicate that any of the subject manufacturer's pitch products carry an FIH approval.

From time to time, FIH will publish and keep updated a list of licensed manufacturers and of turf products which have been approved. This list will be published on the FIH website www.worldhockey.org.

Turf product approvals last 5 years from the date of testing. A re-test will be required after expiry of this period but FIH reserves the right to require re-testing of any product at any time. Unless the full composition of a turf product has been provided for a previous test, a re-test must incorporate all tests in this handbook. If the full composition has been provided for a previous test, a re-test only requires the laboratory to verify that the composition is unchanged.

Approval of a turf product will be withdrawn if it fails a re-test.

In accordance with the licensing agreement, a manufacturer is required to notify FIH of any material or production variation in a turf product for which approval has already been issued.

5 Turf Products: Performance Requirements and Test Procedures

5.1 Introduction

This section describes the requirements to be achieved and the test procedures to be followed in the conduct of laboratory tests on samples of pitch products submitted by FIH licensed manufacturers in order to gain FIH product approvals.

A subsequent section of this handbook describes the requirements and test procedures for a field test.

5.2 Preparation for Test Procedures

Product samples	Samples required for testing are two 1.5 m x 1.5 m specimens of both carpet and shock pad. Two further specimens of carpet at least 16 m by 3 m are required for ball roll and ball deviation tests. The long dimension of one of these samples must be in the direction of the manufacturing run. The long dimension of the other sample must be across the manufacturing run. As necessary, this latter sample must be joined by the manufacturer according to its pitch installation instructions or joined by the laboratory in accordance with the manufacturers instructions.
Sample preparation	Tests pieces must be prepared in accordance with instructions provided by the manufacturer. The carpet and shock pad must be laid on a solid (eg concrete), horizontal and smooth surface unless specified otherwise in this handbook or unless a dynamic base is specified by the manufacturer for incorporation in the installation of the turf.
Filled surface	Depth and consolidation of materials must simulate the conditions applying to installed products. If specified by the manufacturer, infill materials must be consolidated using a consolidating roller or other means. All tests pieces must be consolidated in the same way.
Wet surfaces	A synthetic turf requiring watering must be wet as described below for all tests.
Wet unfilled surface	Where these test procedures apply to an unfilled turf, the test piece must be immersed in tap water at 23℃ (± 2℃) for 3 0 minutes (± 2 minutes) and the test commenced immediately upon removal from the water. Where repetitive tests are required, the piece may be

immersed again and immediately removed from the water. Where tests are conducted on specimens too large for wetting in this way, the specimens may be prepared by the application of at least 3 litres of water spread evenly over each square metre of specimen area.

Wet filled surface — Where these test procedures apply to a filled turf requiring water, the specimen must be saturated by evenly applying a volume of water equal to the volume of the sample, draining for 20 minutes and then applying a further 3 litres of water per square metre evenly spread and testing within 5 minutes.

Dry surface tests: — Tests are specified on wet surfaces in order to verify performance in possible climatic conditions. However, manufacturers may also arrange for tests on dry surfaces for their information and to assist in the development of a "water-free" turf to meet future FIH global level requirements.

Partially wet surfaces: — In addition and again for their and FIH information, manufacturers may also arrange for tests on surfaces wetted in accordance with their instructions to pitch users.

5.3 Turf Product Composition

The application for product approval must incorporate a detailed specification including the following:

pile:
- pile material (characterized if appropriate by differential scanning calorimetry)
- mass per unit area of the carpet
- tufts per unit area of the carpet
- tuft withdrawal force
- pile length
- pile type (eg straight, curled, fibrillated)
- pile construction (eg tufted, woven, needle punched)
- gauge and stitch rate

shock pad:
- shock pad material
- mass per unit area of the shock pad
- tensile strength of the shock pad
- thickness of the shock pad

infill:
- infill material

particle size

particle shape

bulk density of infill materials

5.4 Turf Carpet

5.4.1 Requirements

The materials used in a turf carpet are not prescribed but:

global:	the turf carpet must be of an unfilled type which requires watering;
national:	the turf carpet may be of an unfilled or filled type which does not necessarily require watering.

5.5 Ball Rebound

5.5.1 Requirements

A hockey ball when dropped vertically from a height of 2 m (surface to the underside of the ball) on to a synthetic turf must achieve a mean rebound height:

global:	between 100 mm and 400mm (individual tests <± 20%)
national:	between 100 mm and 400 mm (individual tests <± 20%)

5.5.2 Test Procedure

The ball is released without imparting any impulse or spin.

The preferred procedure is to use a device which measures the time interval between the first and second contacts with the surface from which the rebound height is calculated. Alternatively, rebound height may be recorded by video or visually using a vertical scale. The method used must be specified in the test report and must have a resolution better than 15mm.

The test is conducted in five different locations at least 10 mm apart and at least 100 mm from the edge of the test piece. The mean rebound height from the five tests is calculated.

5.6 Ball Roll

5.6.1 Requirements

After rolling down a standard inclined plane or ramp, a hockey ball must roll a prescribed distance and have a maximum deviation from the straight line.

The following mean value must be achieved:

	ball roll	*deviation*
global	9 m – 15 m	max 3° (individual tests < ± 10 % from mean)
national	5 m – 15 m	max 3° (individual tests < ± 20 % from mean)

5.6.2 Test Procedure – Ball Roll Distance

The laboratory tests are carried out on a level surface. If a level surface is not possible, the mean of the uphill and downhill measurements is taken.

A standard inclined ramp or plane comprising two smooth parallel bars with inside facing edges 45 mm (± 5 mm) apart is used for this test. At their lower end, the bars curve to become parallel with the ground. Full details of the ramp are included in Annex C1 dealing with Test Equipment Specifications.

A ball is released down the ramp from a height of 1 m (± 5 mm) measured from the underside of the ball to the test surface. The ball is allowed to come to rest on the test surface. The ball roll distance is measured from the point where the ball first touched the surface to the centre of the ball when at rest. The ball roll distance is the mean of five rolls.

The position of the ramp must be changed slightly between each roll to avoid tracking on the surface.

Two sets of five tests are carried out on each of the two large test samples. On each sample, one set of tests is carried out along the longer length of the sample and another set of is carried out in the opposite direction. The mean of the twenty (4 x 5) tests is calculated.

5.6.2 Test Procedure – Ball Roll Deviation

Four further sets of fives tests are conducted in the same way as described above.

For each individual ball roll, the ball roll deviation from the centre line is measured at a distance 2 m from the end of the ball roll.

No individual ball roll deviation shall be more than 3°.

5.7 Ball-to-Surface Friction

5.7.1 Requirements

The co-efficient of friction between the turf and an FIH approved hockey ball must be:

	static	dynamic
global	≥ 0.50	≥ 0.35
national	≥ 0.50	≥ 0.35

5.7.2 Test Procedure

Three balls are taped firmly together, leaving the upper and lower surfaces exposed. These three balls are placed on a horizontal board surfaced with the turf product.

One end of the board is progressively raised and stopped at the first movement of the balls. The angle of elevation of the board is measured so that the static friction co-efficient can be calculated. The test is then repeated inverting the ball assembly and the mean result calculated.

The dynamic friction co-efficient is calculated in a similar manner. The minimum angle of elevation at which the board must be held so that the ball assembly continues to slide after receiving an initial impulse is measured.

In both cases, the co-efficient of friction is the tangent of the angle measured (eg tan Θ, where Θ is the angle between the board and the horizontal).

5.8 Underfoot Friction

5.8.1 Requirements

The determined mean co-efficient of friction must be in the following ranges:

global:	0.6 to 1.0 (individual tests < ± 0.1 from mean)
national:	0.6 to 1.0 (individual tests < ± 0.2 from mean)

5.8.2 Test Procedure

The underfoot friction is tested using the NSF modified Leroux apparatus. Full details of the apparatus including its set up for these tests are included in Annex C2 dealing with Test Equipment Specifications.

The test is conducted five times on different parts of each of the two test pieces and the scale value recorded. The mean scale value is calculated for each test piece.

Underfoot friction is calculated as follows:

$$S = (v - r) / 100$$

where:

S is the coefficient of friction

v is the mean scale value

r is the reduction value from the table in Annex C2.

5.9 Impact Response

5.9.1 Requirements

The force reduction values must be within the following ranges:

global:	40 % to 65 % (individual tests < ± 5 % from mean)
national:	40 % to 65 % (individual tests < ± 5 % from mean)

5.9.2 Test Procedure

The impact response is tested using the Artificial Athlete apparatus. Full details of the apparatus including its set up for these tests are included in Annex C3 dealing with Test Equipment Specifications.

The reference force is calculated with the apparatus set up on a concrete floor. The peak force applied to the surface at each of 11 impacts is measured. The mean reference force in Newtons (F) is the mean value of the last ten measurements.

The apparatus is set up on the synthetic turf. Three impacts take place at intervals of 60 s ± 5 s in the same location on the test piece. Within 5 s of each impact, the falling weight is lifted and re-attached to its support mechanism. The peak force for the second and third impacts is recorded. The test is repeated at two additional different locations giving in total six measurements of peak force (f) in Newtons.

The force reduction related to each of the six measurements of peak force on the turf is calculated as follows:

$$R = (1 - (F/f)) \times 100$$

where

R is the force reduction (impact response) expressed as a percentage

F is the reference force in Newtons

f is the peak force from the turf test.

5.10 Pile/pad Deformation

5.10.1 Requirements

The pile/pad deformation or stable level achieved must be:

global	≥ 40% (individual tests < ± 2 % from mean)
national	≥ 40% (individual tests < ± 2 % from mean)

5.10.2 Test Procedure

The test procedure is an extension of that prescribed for *Impact Response* above.

Following determination of the first impact response, a further ten unrecorded drops from the standard height are made in quick succession without repositioning the test piece between drops to compact the pile fully. The peak force is then measured for two more drops on the same (now compacted) location. Force reduction values are calculated for these two drops.

The test is repeated at two additional different locations.

5.11 Surface Colour

5.11.1 Requirements

The colour of the surface pile must be:

global	uniform: green or other FIH approved colour
national	uniform: green or other FIH approved colour

If the turf sample is not green, approval should be obtained from FIH for any other proposed colour. Eventually, other approved colours will be listed on the FIH website.

5.11.2 Test Procedure

Reported results must refer to a stated colour atlas (eg RAL colour charts).

5.12 Surface Gloss

5.12.1 Requirements

The surface must be sufficiently matt to avoid glare or specular reflections. When wet, the degree of gloss must be:

global	≤ 15%
national	≤ 15%

5.12.2 Test Procedure

Gloss measurements may be made using an 85 degree glossmeter meeting the characteristics and calibration requirements of a stated National Standard.

5.13 Turf Permeability

5.13.1 Requirements

The permeability of the pile and shock pad combination, including any geotextile conjointly installed, must allow a vertical water drainage rate (infiltration rate) of:

global	≥ the equivalent of 150 mm per hour
national	≥ the equivalent of 150 mm per hour

5.13.2 Test Procedure

The turf permeability is tested using a double-ring infiltrometer. Full details of the apparatus including its set up for these tests are included in Annex C4 dealing with Test Equipment Specifications.

After setting up on the test surface, the time taken for the water to fall by 20 mm from an initial ponding depth of 30 (±1) mm is measured. If a fall of 20mm has not been recorded after 30 minutes, the fall in water level is recorded at that time. The test is repeated at five different locations on the surface.

The infiltration rate is calculated as follows:

$$IR = (F \times C) / t$$

where

IR is the infiltration rate

F is the fall of water level (mm)

C is the temperature correction factor given in Annex C4

t is the measurement period in minutes.

6 Certified Pitches: Compliance and Certification Procedures

6.1 Compliance

Certification of compliance of an installed pitch with the requirements in this handbook is usually undertaken for one of the following reasons:

- to meet guarantee or funding conditions;
- to approve a pitch for a hockey match or tournament.

In the latter context, FIH and other match or competition organisers may specify that a pitch meets requirements set out in this handbook as described in more detail in the first section of this handbook.

National Associations, their affiliated bodies and pitch owners are also strongly advised to include in pitch construction contracts reference to performance requirements in this handbook including the conduct of field tests. As part of the guarantee provisions or as a condition of final payment, tests are often performed immediately following the installation of a pitch. However, in terms of true playability characteristics, it is preferable to test a pitch after between 100 and 200 hours of use for hockey play.

6.2 Pitch Testing Categories

There are currently two pitch testing categories which lead to the award of a pitch compliance certificate: **Class 1 and Class 2**.

Class 1 certificates are required for all pitches hosting FIH world level events and related qualifying tournaments. At their discretion, Continental Federations and other competition organisers may also require Class 1 certificates for particular events or matches.

A Class 1 certificate is valid for 2 years from the date of testing. At their discretion, Continental Federations and other competition organisers may recognise a Class 1 certificate for a maximum of 4 years from the date of testing.

Owners of pitches not requiring a Class 1 certificate are strongly encouraged to hold a current **Class 2** certificate. Continental Federations, National Associations and other competition organisers may specify which competitions require a Class 2 certificate pitch.

A Class 2 certificate is valid for 4 years from the date of testing.

6.3 Certification Process

Upon satisfactory completion of the tests demonstrating that a pitch meets the requirements set out in this handbook, a pitch owner may apply for a certificate of compliance through the laboratory conducting the tests. FIH has set up procedures with its accredited laboratories to issue certificates.

Each application must identify clearly the pitch and its location. If there is more than one pitch at the location, the pitch to which the certificate applies must be clearly identified if necessary by reference to a location plan.

To be eligible for certification, a pitch must be constructed using an FIH approved combination of turf carpet and shockpad. However, if a pitch is a refurbished one, the carpet must be the carpet from an approved product but the shock pad may be as specified for that approved product or may be a pre-existing shock pad from another product that was an approved product at the time of installation of said pre-existing shockpad.

A certificate of compliance issued by FIH will entitle the pitch owner to advertise, in a form approved by FIH, the particular pitch as having complied with FIH requirements.

From time to time, FIH will publish and keep updated a list of certified pitches. This list will be published on the FIH website www.worldhockey.org.

6.4 Test Procedure

Pitch installers or owners must arrange for field tests to be conducted by one of the FIH accredited laboratories. Reference to pitch owner in this handbook also applies to any other party seeking a certificate of compliance for a particular pitch.

Test reports must be made in a format specified by FIH. Laboratory test reports are confidential to the laboratory, the test applicant and FIH but the applicant may supply copies to other parties.

If a laboratory has been involved in the construction of the pitch (eg as a consultant, project manager or by testing construction stages), it is not permitted to undertake the tests for Class 1 certification; a different laboratory without any link to the other laboratory must be used.

7 Certified Pitches: Performance Requirements and Field Test Procedures

This section of the handbook describes the requirements to be achieved and the test procedures to be followed in the conduct of field tests on installed pitches. The tests are conducted by an FIH accredited laboratory at the request of pitch owners or other interested parties in order to obtain a FIH Certificate of Compliance.

7.1 Field Test Preparation: Spot Tests

Spot tests are conducted for:

- ball rebound;
- underfoot friction;
- impact response;
- pile/pad deformation (unfilled surfaces only);
- pitch permeability.

Before commencing spot tests, a pitch constructed using a turf requiring watering must be thoroughly watered to simulate conditions for the commencement of a top competition match. Re-watering at intervals of 45 minutes must be undertaken, if necessary, to maintain this condition. A drying pitch or strong winds cannot be used to justify acceptance of non complying test results. Tests should be conducted during a period of commonly prevailing conditions.

A minimum of five spot tests must be undertaken in the locations specified below. However, the testing laboratory is responsible for adequately describing the pitch condition. Therefore the testing personnel may increase the number of spot tests at their discretion and they may select other spots if they consider this will present a more complete picture of the pitch condition. The location of the spot tests must be identified in the test report and need not be the same for each test.

If the client authorising the tests is concerned about the performance of particular areas of the pitch, they should require the testing laboratory to conduct additional tests in those areas.

The diagram below illustrates 14 possible positions for the conduct of spot tests.

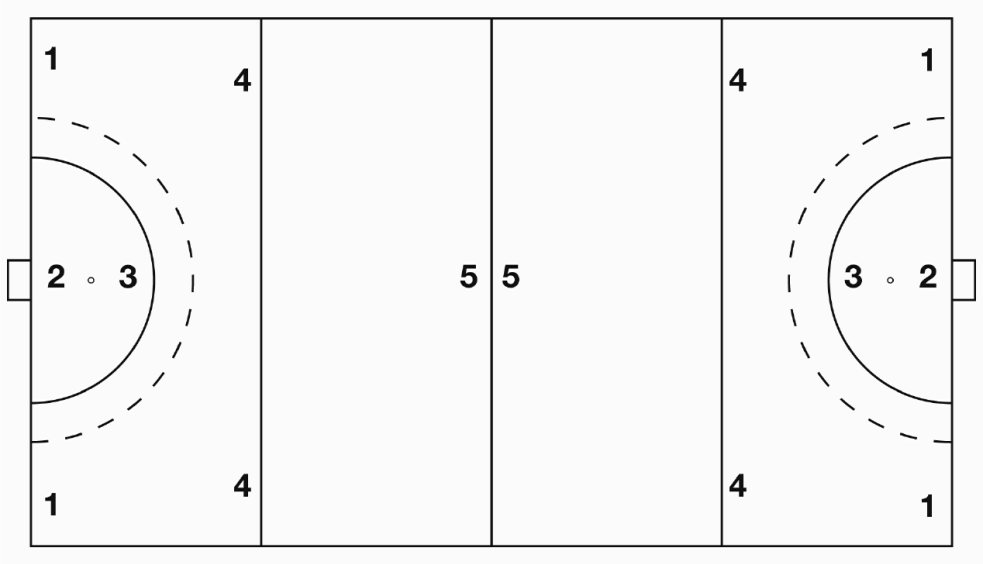


Figure: field of play

Test Position 1	This position is within the field of play and not more than three metres from the corner flag. Any one of the four marked positions may be chosen.
Test Position 2	This position is midway between the penalty stroke mark and the centre of the goal. Either of the two marked positions may be chosen.
Test Position 3	This position is a maximum of one metre inside the circle on the extended line from the centre of the goal-line through the penalty stroke mark. Test positions 2 and 3 must not be in the same circle.
Test Position 4	This position is within the field of play not more than 6 metres nor less than 4 metres from the side-line and on the 23 metre lines. Any one of the four marked positions may be chosen.
Test Position 5	This position is within three metres of the centre of the centre-line. Either of the two positions may be chosen.
Test Position 6	This test and its position is optional at the discretion of testing personnel. Any number of optional test positions may be used when the testing personnel are of the opinion that they are necessary to provide a true picture of the condition of the pitch or if required by the client.

7.2 Ball Rebound

7.2.1 Requirements and Procedures

The procedures are the same as for testing a turf product in the laboratory.

A hockey ball dropped vertically from a height of 2 m (surface to the underside of the ball) on to the pitch must achieve a mean rebound height:

class 1 and class 2 global:	between 100 mm and 400 mm (individual tests <± 20%)
class 1 and class 2 national:	between 100 mm and 400 mm (individual tests <± 20%)

7.3 Ball Roll

7.3.1 Requirements and Procedures

The procedures are the same as for testing a turf product. Two sets of measurements are taken in opposite directions along the direction of the manufacturing run and two tests in opposite directions across the direction of the manufacturing run.

After rolling down a standard inclined plane or ramp, a ball must roll a prescribed distance within a maximum deviation from the straight line.

The following must be achieved:

	ball roll	*deviation*
class 1 and class 2 global	9 m – 15 m	max 3° (indiv idual tests <± 10 % of mean)
class 1 and class 2 national	5 m – 15 m	max 3° (ind ividual tests <± 20 % of mean)

7.4 Underfoot Friction

7.4.1 Requirements and Procedures

The procedures are the same as for testing a turf product in the laboratory.

The determined co-efficient of friction must be:

class 1 global:	between 0.6 and 1.0 (individual tests <± 0.1 from mean)
class 1 national:	between 0.6 and 1.0 (individual tests <± 0.2 from mean)
class 2 global and national:	no test required

7.5 Impact Response

7.5.1 Requirements and Procedures

The procedures are the same as for testing a turf product.

The force reduction values must be within the following ranges:

class 1 global:	40 % to 65 % (individual tests <± 5 % deviation)
class 1 national:	40 % to 65 % (individual tests <± 5 % deviation)
class 2 global and national:	no test required

7.6 Pile/pad Deformation - unfilled turf only

7.6.1 Requirements and Procedures

The procedures are the same as for testing a turf product in the laboratory.

The stable level achieved must be:

class 1 global	≥ 40 per cent
class 1 national	≥ 40 per cent
class 2 global and national:	no test required

7.7 Pitch Dimensions, Run-offs and Markings

These requirements apply to both class 1 and class 2 pitch certificates.

7.7.1 Requirements

The dimensions of the field of play including run-offs must comply with the latest edition of the Rules of Hockey.

Pitch markings must conform with the latest edition of the Rules of Hockey and must not depart from the dimensions stated therein by more than the following tolerances:

length of straight lines	± 50 mm
width of lines	± 10 mm
radius of circle arcs	± 30 mm
position of penalty spots	± 30 mm
300mm external field markings	± 30 mm

The difference between diagonals must be less than 300 mm.

Lines intended to be straight must show no sudden deviation or irregularity.

Where pitch markings have been woven into a pitch and a change to the Rules of Hockey makes the markings redundant, the redundant markings must be painted out and any new markings painted on or inserted into the carpet.

7.7.2 Test Procedure

The type of measuring device used must be reported. Dimensional discrepancies exceeding the tolerances must be reported.

The first part of the run-off area referred to in the Rules of Hockey must have the same qualities of material, slope, smoothness and, for pitches requiring watering, pitch irrigation watering facilities as the field of play The surface must then extend on the same plane for the further minimum distance specified in the Rules of Hockey before any obstruction is encountered. These further surfaces may be surfaced with material different to the synthetic playing surface and may accommodate structures and/or fittings such as drain covers or covered reticulation channels.

The Rules of Hockey specify minimum run-off areas but it is strongly recommended that bigger areas are accommodated if possible.

Consideration must be given to the need to accommodate team officials, substitutes and match officials immediately adjacent to the field of play, but preferably not within the run-off areas.

Only the prescribed corner flags should obstruct the run-off areas and must be capable of bending to the horizontal without fracture and without injuring any person.

Water cannons or lighting masts must not intrude onto run-off areas. Pop-up sprinkler heads are acceptable providing a level seat is maintained when the sprinkler heads are in their lowered position.

7.8 Pitch Longitudinal Slope

7.8.1 Requirements

The requirements for the longitudinal fall of the pitch are:

class 1 and class 2 global: < 0.2%

class 1 and class 2 national: < 1.0%

7.8.2 Test Procedure

The longitudinal slope is determined by taking a series of measurements on the playing surface along the longitudinal axis through the centre of the centre-line. A surveyor's optical level and staff, or equivalent technique, must be used.

The means of measurement must be reported and a description or sketch of the slope pattern provided.

7.9 Lateral Pitch Profile

7.9.1 Requirements

Limits to the lateral slope are intended to preserve unbiased ball roll characteristics.

class 1 and class 2 global: < 0.4%

class 1 and class 2 national: < 1.0%

However, to accommodate extreme climatic conditions, a lateral slope up to 1.0% may be permitted exceptionally for global pitches, provided approval is given by FIH before installation of the concerned pitch on the basis of a substantiated request by the pitch owner.

7.9.2 Test Procedure

The surface profile of the pitch is determined by taking a series of measurements on the playing surface on a regular 10 metre grid, using a surveyor's optical level and staff, or equivalent technique.

The means of measurement must be reported and a description or sketch of the profile pattern provided.

In the report, the pitch sketch may combine the longitudinal slope and lateral profile measurements.

7.10 Pitch Smoothness

7.10.1 Requirements

The maximum deviation of the surface above or below a three metre long planimeter or straight edge laid in any direction must be:

class 1 and class 2 global: ≤ 6 mm

class 1 and class 2 national: ≤ 6 mm

There must be no significant height difference and no gaps or separation at joints and seams. The maximum tolerance for both height and gaps or separation is 2 mm.

The surface of the sub-base and the shock pad should provide such support to the top carpet as will ensure that the smoothness requirements are achieved at all times and at all pitch positions. Levels of both should be established at each stage of construction to ensure an acceptable result when the pitch carpet is laid.

7.10.2 Test Procedure

The pitch is checked at close intervals either with the planimeter or with survey equipment capable of producing at least a 6 mm contour plan or grid of levels derived from measurements at intervals of three metres. The means of measurement must be reported.

Pitch smoothness at all points on the pitch is a vital characteristic. The priority is to eliminate ripples which affect ball performance. Of particular importance are the four penalty corner push-out lines and the area at the top of each circle. These areas should be checked carefully.

7.11 Pitch Watering – pitches requiring watering

7.11.1 Requirements

These requirements apply to pitches using turf requiring watering.

Facilities enabling the whole pitch and run-offs comprised of turf to be made sufficiently and uniformly wet must be incorporated.

The average water precipitation over the field of play must be:

class 1 and class 2 global:	average 3 (±1) mm with no collection less than 2 mm
class 1 and class 2 national:	average 3 (±1) mm with no collection less than 2 mm

Any one test spot may not have 50% more or less precipitation than an adjacent test spot.

7.11.2 Test Procedures

A grid of dishes is laid out on the field of play and its run-offs on a grid at 10 m maximum intervals. A full watering cycle preferably under commonly prevailing weather and wind conditions is conducted. Collected water is measured and uniformity calculated and reported as a contour or grid diagram and table.

Pitch irrigation must service the whole of the pitch in the most commonly prevalent conditions. The wind cannot be used as a factor to influence acceptance particularly if such winds are likely to occur during proposed playing times.

It is important that the pitch surface must not become dry in some areas and remain wet in others during play. Accordingly, under some climatic conditions a need to water the pitch during the half-time interval of a match may occur. The capacity and programme flexibility of the system must meet this requirement.

7.12 Pitch Permeability – pitches requiring watering

7.12.1 Requirements and Procedures

The procedures are the same as for testing a turf product in the laboratory.

The permeability of the pile/pad combination, including any geotextile conjointly installed, must allow vertical water drainage rate (infiltration rate) of

class 1 global	≥ the equivalent of 150 mm per hour
class 1 national	≥ the equivalent of 150 mm per hour
class 2 global and national	no test required

7.13 Surface Colour

7.13.1 Requirements and Procedures

The procedures are the same as for testing a turf product in the laboratory.

The requirements are

class 1 and class 2 global:	uniform: green or another FIH approved colour
class 1 and class 2 national:	uniform: green or another FIH approved colour

7.13.2 Comment

Colour schemes other than uniformly green for the playing area and white for the marking lines must be approved by FIH before installation. Any newly approved colour scheme will be listed on the FIH website.

The run-off areas may in any case be of a different colour to the field of play.

The inclusion of advertising or logos on the field of play is prohibited. Advertising or logos may be included in the run-off areas subject to conditions imposed by the users of pitches or by the organisers of particular competitions including the FIH.

7.14 Artificial Lighting

7.14.1 Requirements

These requirements apply to both class 1 and class 2 certificated pitches if artificial lighting is installed and it is intended that some matches are played outside the hours of natural daylight.

Lighting requirements are contained in the latest version of the *FIH Guide to the Artificial Lighting of Hockey Pitches* which is available on the FIH website www.worldhockey.org.

7.14.2 Test Procedures

The laboratory undertaking the field test may assess the quality of the artificial lighting installed directly or employ professional assistance acting under the control of the laboratory personnel.

Measurement of the lighting levels is carried out using a lightmeter meeting the characteristics and calibration requirements of a National Standard. The procedures to be followed are those set down in the manufacturer's operating manual. The requirements to be met are specified in the relevant part of the latest version of the *FIH Guide to the Artificial Lighting of Hockey Pitches*.

Annex A Summary of Requirements: Turf Products

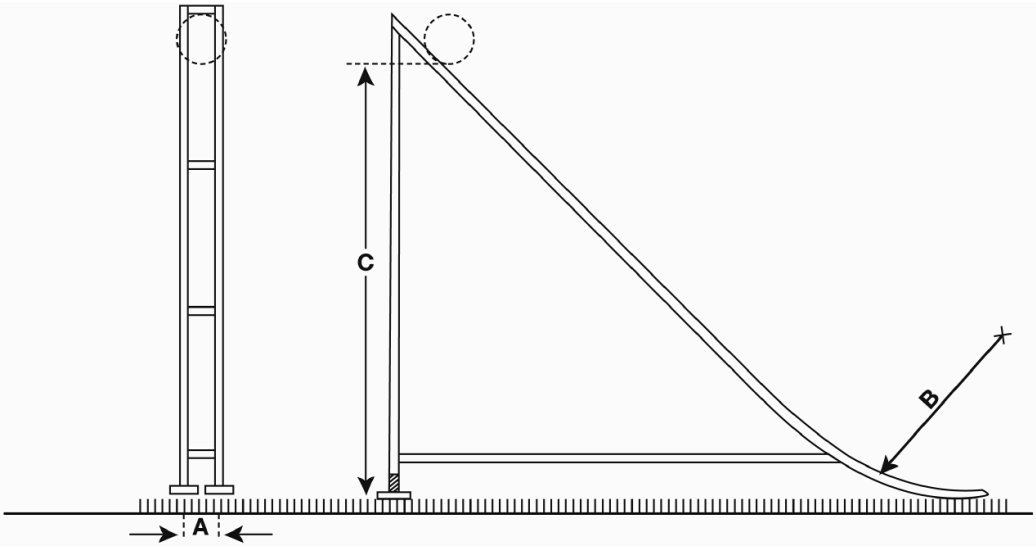
Performance Requirements	Global Turf Product	National Turf Product
Composition	fully specified	fully specified
Unfilled / Filled	unfilled	unfilled / filled
Ball rebound (vertical)	mean 100 mm – 400 mm individual tests < ± 20% from mean	mean 100 mm – 400 mm individual tests < ± 20% from mean
Ball roll	mean 9 m – 15 m individual tests < ± 10% from mean deviation ≤ 3°	mean 5 m – 15 m individual tests < ± 20% from mean deviation ≤ 3°
Ball to surface friction	static ≥ 0.50 dynamic ≥ 0.35	static ≥ 0.50 dynamic ≥ 0.35
Underfoot friction	coefficient of friction 0.6 – 1.0 individual tests < ± 0.1 from mean	coefficient of friction 0.6 – 1.0 individual tests < ± 0.2 from mean
Impact response	40 – 65 % individual tests < ± 5 % from mean	40 – 65 % individual tests < ± 5 % from mean
Pile pad deformation	≥ 40 % individual tests < ± 2 % from mean	≥ 40 % individual tests < ± 2 % from mean
Colour	'green' or other FIH approved colour uniform	'green' or other FIH approved colour uniform
Gloss	≤ 15 per cent when wet	≤ 15 per cent when wet
Pitch permeability	≥ 150 mm per hour	≥ 150 mm per hour

Annex B Summary of Requirements: Installed Pitches

Performance Requirements	Global Pitch	National Pitch	Required for Class 1 certificate?	Required for Class 2 certificate?
Composition	global turf product	national turf product	yes	yes
Ball rebound (vertical)	mean 100 mm – 400 mm individual tests < ± 20% from mean	mean 100 mm – 400 mm individual tests < ± 20% from mean	yes	yes
Ball roll	mean 9 m – 15 m individual tests < ± 10% from mean deviation ≤ 3°	mean 5 m – 15 m individual tests < ± 20% from mean deviation ≤ 3°	yes	yes
Underfoot friction	coefficient of friction 0.6 – 1.0 individual tests < ± 0.1 from mean	coefficient of friction 0.6 – 1.0 individual tests < ± 0.2 from mean	yes	no
Impact response	40 – 65 % individual tests < ± 5 % from mean	40 – 65 % individual tests < ± 5 % from mean	yes	no
Pile pad deformation	≥ 40 % individual tests < ± 2 % from mean	≥ 40 per cent individual tests < ± 2 % from mean	yes	no
Pitch dimensions and markings	line length ± 50 mm line width ± 10 mm circle radius ± 30 mm penalty spots position ± 30 mm length of 300 mm marks ± 30 mm diagonals < 300mm difference	line length ± 50 mm line width ± 10 mm circle radius ± 30 mm penalty spots position ± 30 mm length of 300 mm marks ± 30 mm diagonals < 300mm difference	yes	yes
Pitch run-offs (minima)	back-line 2 m same surface side-line 1 m same surface both plus 1 m similar surface	back-line 2 m same surface side-line 1 m same surface both plus 1 m similar surface	yes	yes
Pitch slope	longitudinal fall < 0.2 %	longitudinal fall < 1.0 %	yes	yes
Pitch profile	lateral fall < 0.4 % exceptions < 1.0% permitted on FIH approval	lateral fall < 1 %	yes	yes
Pitch smoothness	deviation ≤ 6 mm above or below 3 m straight edge	deviation ≤ 6 mm above or below 3 m straight edge	yes	yes
Pitch watering	average 3 (±1) mm of water no spot ≤ 2 mm	average 3 (±1) mm of water no spot ≤ 2 mm	yes if watering is required for the turf type installed	yes if watering is required for the turf type installed
Pitch permeability	≥ 150 mm per hour	≥ 150 mm per hour	yes	no
Colour	'green' or other FIH approved colour uniform	'green' or other FIH approved colour uniform	yes	yes
Artificial lighting	see *FIH Guide to the Artificial Lighting of Hockey Pitches*	see *FIH Guide to the Artificial Lighting of Hockey Pitches*	yes if a certificate is required for pitch use under floodlights	yes if a certificate is required for pitch use under floodlights

Annex C Test Equipment Specifications

C1 Ramp (ball roll)



end view *side view*

A internal dimension 45 ± 5 mm

B radius 500 ± 50 mm

C release height 1,000 ± 5 mm measured from the underside of the ball to the test surface

Specification

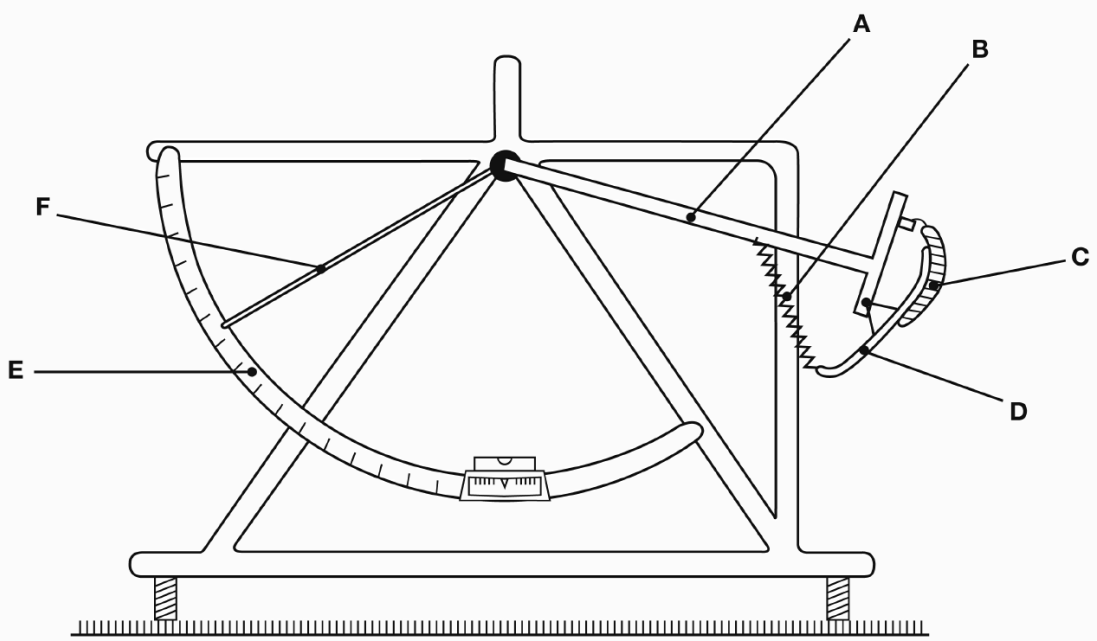
C1.1 The ramp consists of two smooth parallel bars secured at an angle in a rigid frame.

C1.2 The internal dimension between the bars is 45 ± 5 mm.

C1.3 The bars curve to become parallel to the ground at their lower end with a radius of 500 ± 50 mm.

C1.4 Adjustable feet enable the apparatus to be positioned securely.

C2 Resistance Tester (underfoot friction)



A **pendulum arm**

B **spring**

C **shoe profile**

D **profile holder**

E **scale**

F **pointer**

Specification

C2.1 A schematic drawing of the apparatus is shown in the diagram above. Its component parts are specified below.

C2.2 This apparatus is commonly known as the Leroux slip resistance tester.

C2.3 The pendulum has a length of 340 ± 3 mm to the shoe profile.

C2.4 The pendulum, profile holder and shoe profile has a mass of 1,600 ± 50 g.

C2.5 A spring adjusts the pressure of the shoe profile on the test turf; the spring has a K-value of 0.8 ± 0.05 N/mm.

C2.6 The frame incorporates a device for holding the pendulum horizontal to start the test and then to release it.

C2.7 A pointer on the scale records the maximum value in the test.

C2.8 A multi-studded rubber shoe profile is used. It has the following properties:

material:	neoprene rubber
width:	30 ± 2 mm
length:	120 ± 5 mm
studs:	13 ± 2 in number
stud height:	7 ± 1 mm
stud diameter (upper):	7 ± 1 mm
stud diameter (base):	11 ± 2 mm
stud hardness:	90° ± 5° (shore A scale)
stud stiffness:	95 ± 5 N/mm

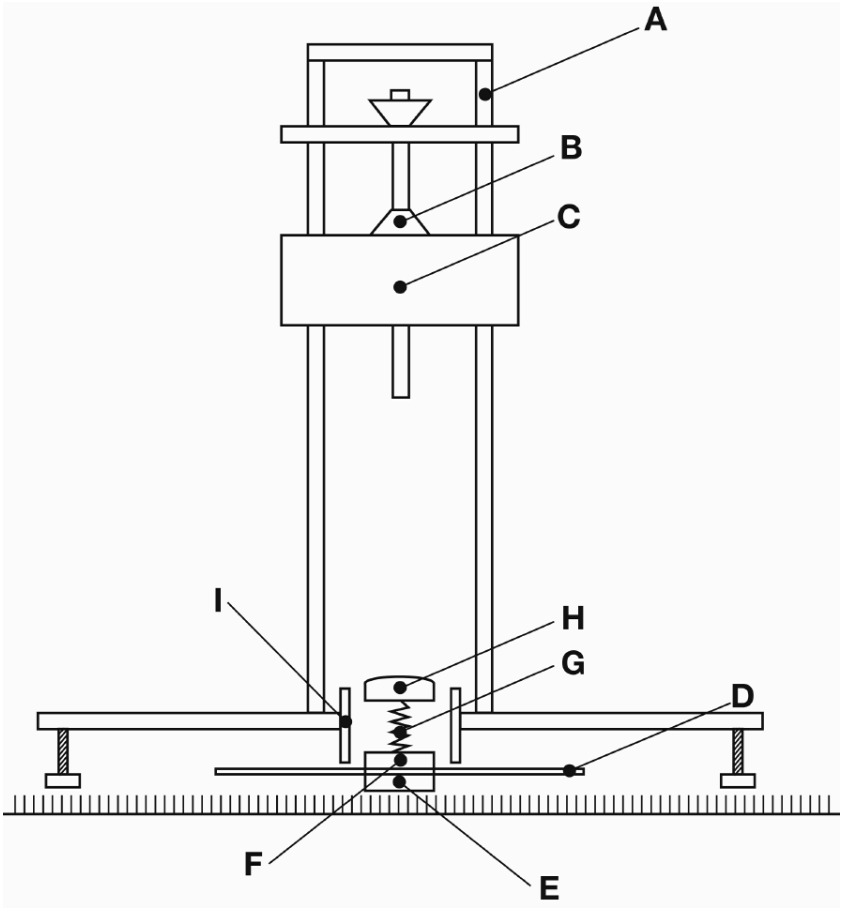
Calculation

In the calculation of underfoot friction:

$$S = (v - r) / 100$$

r is the reduction value from the table below.

mean scale value	reduction value
0 to 99.0	20
99.1 to 99.2	16
99.3 to 99.4	12
99.5 to 99.6	8
99.7 to 99.8	4
≥ 99.9	0



A	guide frame for the falling weight
B	electromagnet release
C	falling weight
D	sensors on projections from the base plate
E	base plate
F	force sensor
G	spring
H	upper plate
I	guide tube

Specification

C3.1 A schematic drawing of the apparatus is shown in the diagram above. Its component parts are specified below.

C3.2 The falling weight has a mass of 20 ± 0.1 kg. It must fall vertically and smoothly with minimum friction.

C3.3 An electromagnetic device retains the weight in its upper position ± 0.25 mm from the specified drop height.

C3.4 Adjustable supporting feet are located at least 250 mm from the point of application of the deforming force.

C3.5 The metal guide tube has an internal diameter of 71 ± 0.1 mm.

C3.6 The spring has a diameter of 69 ± 1 mm. Over the range 0.1 kN to 1.6 kN it behaves linearly with a spring rate of 40 ± 1.5 N/mm.

C3.7 The spring is fixed to a hardened upper plate which has a minimum thickness of 20 mm.

C3.8 The steel base plate has a diameter of 70 ± 0.1 mm and a minimum thickness of 10mm. It is flat on its lower side with an edge radius of 1mm.

C3.9 Two sensors are fitted on horizontal projections from the test foot.

C3.10 The test foot consists of the steel base plate, force sensor, spring and upper plate. The total mass of the test foot is 3.5 ± 0.35 kg.

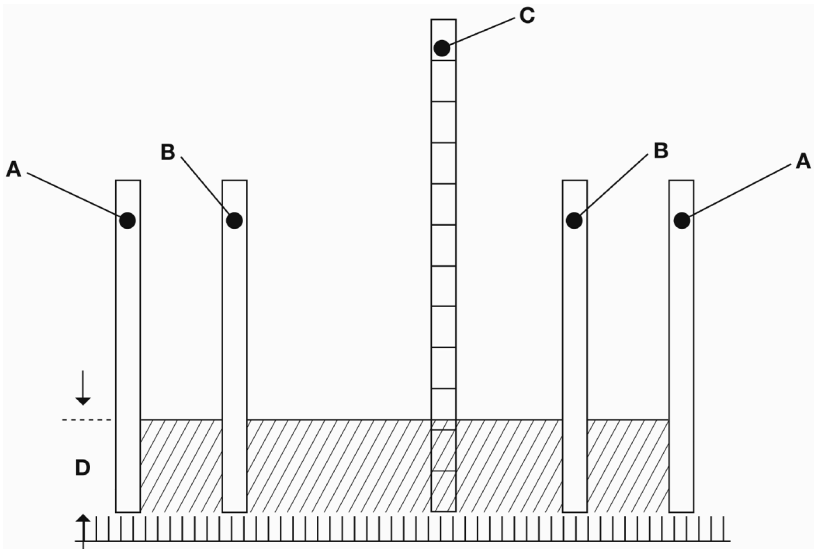
C3.11 The two sensors on projections from the base plate have a measuring range ± 10 mm and uncertainty ≤ 0.05 mm.

C3.12 The two sensors are positioned symmetrically around the central axis of the apparatus.

C3.13 The distance between the sensors and the central axis of the apparatus is ≤ 125 mm.

C3.14 The sensor system must be capable of recording the peak value of single force pulse signals of 10 ms duration with uncertainty ≤ ± 2%.

C4 Double-ring Infiltrometer (permeability)



A **outer cylinder**

B **inner cylinder**

C **scale**

D **water level**

Specification

C4.1 A sectional drawing of the apparatus is shown in the diagram above. Its component parts are specified below

C4.2 The outer cylinder has an inner diameter 500 ± 25 mm.

C4.3 The inner cylinder has an inner diameter 300 ± 25 mm.

C4.4 A graduated scale is used to measure water depth.

C4.5 If sealing material is necessary, silicone rubber or closed-cell foam may be used.

C4.6 Heavy weights may be used to improve the seal.

Annex D FIH Reference Documents

The International Hockey Federation publishes various reference and advisory documents on its website: www.worldhockey.org. The documents of particular relevance to this Pitch Handbook are:

List of FIH Accredited Laboratories

Guide to the Artificial Lighting of Hockey Pitches

List of Approved Synthetic Turfs

List of FIH Certified Installed Pitches

List of FIH Approved Balls